A1-AV8BB-NFM-000

NATOPS FLIGHT MANUAL

NAVY MODEL

AV-8B/TAV-8B 161573 AND UP AIRCRAFT

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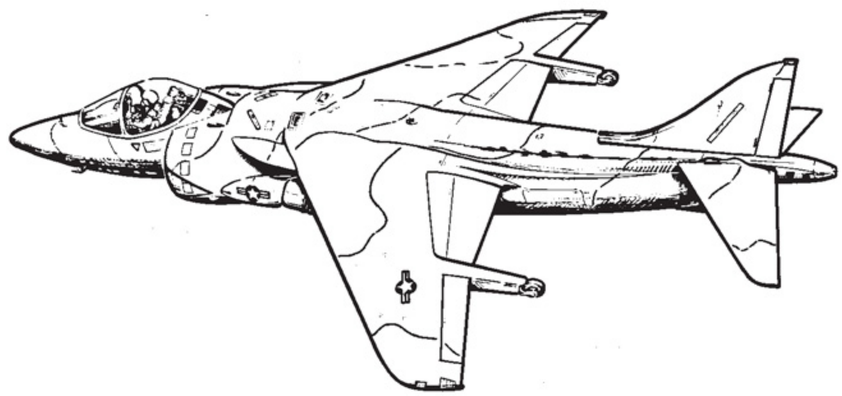

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DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
RADM WILLIAM A. MOFFETT BUILDING
47123 BUSE ROAD, BLDG 2272
PATUXENT RIVER, MD 20670-1547

15 March 2008

LETTER OF PROMULGATION

1. The Naval Air Training and Operating Procedures Standardization (NATOPS) Program is a positive approach toward improving combat readiness and achieving a substantial reduction in the aircraft mishap 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 requirements and procedures 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 OPNAV Instruction 3710.7, 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 carried for use in naval aircraft.

S. R. EASTBURG
Rear Admiral, United States Navy
By direction of
Commander, Naval Air Systems Command

INTERIM CHANGE SUMMARY

The following Interim Changes have been cancelled or previously incorporated into this manual.

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 thru 33	Previously incorporated

The following Interim Changes have been incorporated into this Change/Revision.

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
34	192005Z MAR 07 Crosswind Component Calculation
35	202004Z JUN 07 Landing Gear EP/EAAS
36	102006Z DEC 07 Emergency DC Wiring AFC-481

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
37	242006Z NOV 08	18-5(18-6 Blank)	CHP 18 OCF Procedure Correction
38	052015Z FEB 09	9-17/18	RendezvousTechnique

P 052015Z FEB 09
FM COMNAVAIRSYSCOM PATUXENT RIVER MD//4.0P//
TO ALL HARRIER AIRCRAFT ACTIVITIES
COMNAVAIRFOR SAN DIEGO CA//N421A//
AIRTEVRON THREE ONE CHINA LAKE CA//51J000D/51J00MD//
COMFLOAN MARISTAT INFO COMNAVSAFECEN NORFOLK VA//11//
COMNAVAIRSYSCOM PATUXENT RIVER MD//4.0P/4.1/5.0F/4.6.3.3//
VMAT TWO ZERO THREE//CO/OPSO/NATOPS/MO//
FLTREADCEN EAST CHERRY PT NC//AV8FST//
PEOTACAIR PATUXENT RIVER MD//PMA-257/PMA-257SP/PMA-257IT//
AJEMA//NINTHSQUADRON//
GRUPAER GROTTAGLIE COMMARFORCOM//ALD/G-6/DSS//
COMMAFORPAC//ALD/G-6/DSS//
CG FIRST MAW//ALD/G-6/DSS//
CG SECOND MAW//ALD/G-6/DSS//
CG THIRD MAW//ALD/G-6/DSS//
MAG TWELVE//CO/OPSO/MO/DSS//
MAG THIRTEEN//CO/OPSO/MO/DSS//
MAG FOURTEEN//CO/OPSO/MO/DSS//
VMA 211//CO/OPSO/MO/DSS//
VMA 214//CO/OPSO/MO/DSS//
VMA 223//CO/OPSO/MO/DSS//
VMA 231//CO/OPSO/MO/DSS//
VMA 311//CO/OPSO/MO/DSS//
VMA 513//CO/OPSO/MO/DSS//
VMA 542//CO/OPSO/MO/DSS//
MSGID/GENADMIN,USMTF,2007/COMNAVAIRSYSCOM PATUXENT RIVER//
SUBJ/AV-8B AIRCRAFT NATOPS PUBLICATIONS INTERIM CHANGE//
REF/A/MSGID:EML/COMMARFORCOM/26JAN2009//
REF/B/MSGID:DOC/NAVAIR/09SEP2008//
REF/C/MSGID:DOC/NAVAIR/15MAR2008//
NARR/REF (A) IS COG CONCURRENCE.
REF (B) IS AIRS 2008-165.
REF (C) IS AV-8B A1-AV8BB-NFM-000 NATOPS FLIGHT MANUAL DTD 15 NOV 2008.//
GENTEXT/REMARKS/1. THIS MESSAGE IS ISSUED IN RESPONSE TO REFS (A) AND (B). THIS MESSAGE ISSUES INTERIM CHANGE (IC) NUMBER 38 TO REF (C).
2. SUMMARY.
   A. THIS MESSAGE ISSUES NEW PARA 9.1.7.4, RENDEZVOUS TECHNIQUE, ADDRESSING USE OF NOZZLES TO CONTROL CLOSURE RATE, TO REF (C).
   B. REPLACEMENT PAGES CONTAINING THESE CHANGES FOR DOWNLOADING AND INSERTION INTO REF (C) WILL BE ATTACHED TO THIS INTERIM CHANGE MESSAGE WHEN IT IS POSTED ON THE NATEC AND AIRWORTHINESS WEBSITES (SEE LAST PARA BELOW).
3. THE REPLACEMENT PAGES IMPACT THE FOLLOWING NATOPS FLIGHT MANUAL. THE REPLACEMENT PAGE PACKAGE INCLUDES THE FOLLOWING PAGES:
      A. REF (C) (AV-8B NFM-000) PAGES 5/(6 BLANK), 9-17, 9-18, 9-18A/(B BLANK).
      B. TO ENSURE THE PDF PAGES PRINT TO SCALE: SELECT PRINT AND VIEWING PRINT SETUP WINDOW, ENSURE "NONE" IS SELECTED IN THE PAGE SCALING DROPDOWN.
4. POINTS OF CONTACT:
   A. AV-8B NATOPS PROGRAM MANAGER:
      (1) MAJ JOHN ROUNTREE, VMAT-203, (252) 466-4863 EXT 3151, DSN 582-4863 EXT3151, E-MAIL JOHN.D.ROUNTREE(AT)USMC.MIL.
   B. NAVAIR POCS:
      (1) MARTY SCANLON, NATOPS IC COORDINATOR, TEL DSN 757-6045

OR COMM (301) 757-6045, EMAIL: MARTIN.SCANLON(AT)NAVY.MIL

(2) LTCOL JASON MADDOCKS, PMA-257 APMSE, (301) 757-5458, DSN 757-5458, E-MAIL JASON.MADDOCKS(AT)NAVY.MIL

(3) KRISTIN SWIFT, AIR-4.0P, NATOPS CHIEF ENGINEER, (301) 995-4193, DSN 995-4193, E-MAIL KRISTIN.SWIFT(AT)NAVY.MIL.

(4) AIRWORTHINESS GLOBAL CUSTOMER SUPPORT TEAM, TEL: 301-757-0187, EMAIL: NAVAIR_4.0P_IFC@NAVY.MIL.

5. THIS MESSAGE WILL BE POSTED ON THE NATEC WEBSITE, WWW.MYNATEC.NAVAIR.NAVY.MIL WITHIN 48 HOURS OF RELEASE. NEW NATOPS IC MESSAGES MAY BE FOUND IN TWO PLACES ON THIS WEBSITE:

A. IN THE NATOPS IC DATABASE FOUND UNDER THE TMAPS OPTION.

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C. INFORMATION REGARDING THE AIRWORTHINESS PROCESS, INCLUDING A LISTING OF ALL CURRENT INTERIM FLIGHT CLEARANCES, NATOPS AND NATIP PRODUCTS ISSUED BY NAVAIR 4.0P, CAN BE FOUND AT OUR WEBSITE: AIRWORTHINESS.NAVAIR.NAVY.MIL.

D. E-POWER FOLDER 851943, TRACKING NUMBER 33118.//

Kristin Swift, NATOPS Chief Engineer, 4.0P, 02/05/2009

P 242006Z NOV 08
FM COMNAVAIRSYSCOM PATUXENT RIVER MD//4.0P//
TO ALL HARRIER AIRCRAFT ACTIVITIES
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MSGID/GENADMIN,USMTF,2007/COMNAVAIRSYSCOM/4.0P//
SUBJ/AV-8B AIRCRAFT PRELIMINARY NATOPS PUBLICATIONS INTERIM CHANGE /SAFETY OF FLIGHT//
REF/A/MSGID:EML/COMMARFORCOM/20NOV2008//
REF/B/MSGID:DOC/NAVAIR/19NOV2008//
REF/C/MSGID:DOC/NAVAIR/15MAR2008//
NARR/REF (A) IS COG CONCURRENCE.
REF (B) IS AIRS 2008-228.
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GENTEXT/REMARKS/1. THIS MESSAGE IS ISSUED IN RESPONSE TO REFS (A) AND (B). THIS MESSAGE ISSUES INTERIM CHANGE (IC) NUMBER 37 TO REF (C).

2. SUMMARY.
   A. THIS MESSAGE ISSUES AND ADMIN CORRECTION TO PAGE 18-5, PARA 18-20-2, IMMEDIATE ACTION ITEMS FOR OUT OF CONTROL FLIGHT/ SPIN/FALLING LEAF RECOVERY PROCEDURES.
   B. REPLACEMENT PAGES CONTAINING THESE CHANGES FOR DOWNLOADING AND INSERTION INTO REF (C) WILL BE ATTACHED TO THIS INTERIM CHANGE MESSAGE WHEN IT IS POSTED ON THE NATEC AND AIRWORTHINESS WEBSITES (SEE LAST PARA BELOW).

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4. POINTS OF CONTACT:
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      (1) MAJ MICHAEL HUNTING, VMAT-203, (252) 466-2638, DSN

582-2638, E-MAIL MICHAEL.HUNTING(AT)USMC.MIL
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D. EPOWER FOLDER NUMBER 848143, TRACKING NUMBER 32809.//

Kristin Swift, NATOPS Chief Engineer, 4.0P, 11/24/2008

Summary of Applicable Technical Directives

Information relating to the following technical directives has been incorporated into this manual.

Change Number	ECP Number	Description	Visual Identification	Effectivity
ASC-020	0102	Improves high speed roll rate	None	AV-8B (P)162942 and up (R)161573 thru 162746
AYC-836	Lucus-08	Mk 4 GTS/APU operational performance enhancement	None	No aircraft effectivity
AFC-286 AYC-873	141	Throttle grip modification	None	AV-8B (P)163659 and up (R)161573 thru 163519
AFC-287	85R1	Dual airspeed/altitude sensor arming incorp & removal of external initiated canopy fracturing system arming	None	AV-8B (P)163659 and up (R)161573 thru 163519
—	145	Voice warning	None	AV-8B (P)163519 and up TAV-8B (P)163856 and up
—	177	Landing gear blow down bottle gas change	Identification plate installed on bottle	AV-8B (P)163659 and up TAV-8B (P)163856 and up
—	162 Part 1	Provisions for incorporation of F402-RR-408 engine	15 sec caution light threshold for short lift dry is 684 $\pm 5^{\circ}$ vice 687 $\pm 5^{\circ}$	TAV-8B (P)164113 and up
AFC-253	075R1C2	Modification of data storage unit installation	Mount swings forward for removal and installation of DSU	AV-8B (P)163677 and up (R)163176 thru 163676

Change Number	ECP Number	Description	Visual Identification	Effectivity
AFC-328	217	Incorporation of two batteries for emergency backup power	Emergency battery/switch on left canopy sill and on left console	AV-8B (R)161573 thru 164150 TAV-8B (R)162747 thru 164542
AFC-332	231	Redundant DECS enable switch	Switch aft left console above fuel shutoff handle	AV-8B (P) 164139 and up (R)161573 thru 164135 TAV-8B (P)164540 and up (R)162747 thru 164138
—	162C3	Add F402-RR-408 engine	ENG ID -408 - Identification displayed on ENG display	AV-8B (P)164116 and up
ASC-043	DO 30	Incorporates OMNIBUS VII mission computer OFP	MC OFP 91-D0FE040K	AV-8B (R)161573 thru 163852 TAV-8B (R)162747 thru 164542
—	129C/C3	Adds new head up display	Wider field of view HUD	AV-8B (P)163853 and up
—	170C1	Power distribution redesign	Changes in circuit breaker panels	AV-8B (P)163853 and up
—	161C1/C2	Adds 100% LERX provisions	Forward ram air intakes moved	AV-8B (P)163853 and up
—	134C1/ C3/C4	Production night attack installation	Additional MPCD, night vision compatible main instrument panel	AV-8B (P)163853 and up
—	143C1C2	Stores management system enhancement	None	AV-8B (P)163853 and up
—	161	Adds upward firing dispensing system	Four additional dispensers near top of rear fuselage	AV-8B (P)163853 and up

Change Number	ECP Number	Description	Visual Identification	Effectivity
ASC-053	226	Incorporates OMNIBUS VI+ mission computer OFP	MC OFP 90-N0FE030P	AV-8B (P)163853 and up
—	199C1	Night attack enhancements	An IR source on the HUD video camera	AV-8B (P)163853 and up
—	200R1	Production incorporation of AN/APG-65 radar and wiring provisions for smart weapons	Radar switch on miscellaneous switch panel	AV-8B (P)164549 and up
AFC-326	180R1	Incorporation of provisions for ATHS	Addition of circuit breaker	AV-8B (R)164548 thru 165006
AFC-326 PART 3	180R1	Incorporation of provisions for ATHS	Addition of circuit breaker	AV-8B (R)163853 thru 164547
	180R2	Production incorporation of the ATHS	Addition of circuit breaker	AV-8B (P)165384 and up
AFC-354 REV A	168C1	Incorporation of GPS provisions and mini tacan	Addition of circuit breaker	AV-8B (R)163853 thru 164547
				TAV-8B (R)164113 thru 164542
AFC-354 PART 2	168C1	Incorporation of GPS provisions and mini tacan	Addition of circuit breaker	AV-8B (R)161573 thru 163852
				TAV-8B (R)162963 thru 163861
AFC-354 PART 3	168C1	Incorporation of GPS provisions and mini tacan	Addition of circuit breaker	AV-8B (R)164549 thru 165383
	168C1R1	Production incorporation of GPS provisions and mini tacan	Addition of circuit breaker	AV-8B (P)165384 and up
	161C3	Production incorporation of 100% LERX	100% LERX installed	AV-8B (P)163853 thru 164121
	200C2	Radar remanufacture for AV-8B	Same as radar aircraft	AV-8B (P)165305 and up

Change Number	ECP Number	Description	Visual Identification	Effectivity
AFC-368	RAMEC-13-91	Radar altimeter power distribution	Changes in circuit breaker panels	AV-8B (P)164549 and up AV-8B (R)163853 thru 164547 TAV-8B (R)164113 thru 164542
AFC-370	19R1	MIL-W-81381 wiring replacement	Addition of circuit breakers	AV-8B (R)161573 thru 163852 TAV-8B (R)162747 thru 163861
AFC-391	251R1	Production incorporation of Pilot Selectable Hi/Lo Gain Nose Wheel Steering (NWS)	Addition of NWS light on caution/ advisory panel	AV-8B (P)165354 and up
AFC-392	254	Incorporation of provisions for IGVC Digital Electronic Control (IDEC)	None	AV-8B (P)165354 and up (R)161573 thru 165312 TAV-8B (R)162747 thru 164542
AFC-394	256	Jet Pipe Temperature modification	None	AV-8B (P)165354 and up (R)161396 thru 165312 TAV-8B (R)162747 thru 164542
ASC-76	NWC-RJW-014D-5310	Incorporates Omnibus 7.1	MC OFP 96-D0FE060C	AV-8B (R) 161573 thru 163852 TAV-8B (R)162747 thru 164542

Change Number	ECP Number	Description	Visual Identification	Effectivity
AFC-395	257	Uninterupted power to DECU	Addition of circuit breakers	AV-8B (P)165354 and up (R)163853 thru 165312 TAV-8B (R)164113 thru 164542
ASC-78	JSSA-01	Incorporates Omnibus C1	MC OFP 96-C0FE060L	AV-8B (P)163853 and up
AFC-393	255R1	Incorporates DFC and FCEM	DFC OFP 75A870731-	AV-8B (P)165391 and up (R)161397 thru 165390 TAV-8B (R)164113 thru 164542
AFC-409	JSSA-01	Incorporates ARC-210 Radio	New Radio Set Control Panel	AV-8B (P)165384 and up (R) 163853 thru 165383
AFC-420	270R1	Incorporates MIL-STD-1760 Wiring	Added Circuit Breakers	AV-8B (P)165413 and up (R) 163853 thru 165412
AFC-422	CHPT-029	Incorporates 8mm Video Recorder	8mm Video Recorder	AV-8B (P) 165422 and up (R) 161573 thru 165421 TAV-8B (R)162747 thru 164542
AFC-373	246	Incorporation of Pyrotechnic Canopy Restraint	Addition of SMDC thruster on forward canopy aft arch	TAV-8B (R)162747 thru 164542

Change Number	ECP Number	Description	Visual Identification	Effectivity
ACC-667 PART 2	16416	Incorporation of personnel parachute Four-Line release system and over-inflation control line.	Addition of personnel parachute riser covers.	AV-8B (R)161573 and up TAV-8B (R)162747 thru 164542
AFC-449	303	Incorporation of Electronic Airspeed/Altitude Sensor	LEDs on sensor	AV-8B (R)161573 and up TAV-8B (R)162747 thru 164542
AFC-464	RAMEC-41-03	Modification of DC Emergency Panel Assembly	Relocation of W ON W circuit breaker	AV-8B (R)163853 and up
	285	Incorporation of OC1.2		
	312	Incorporation of H2.0		
AFC-456	306	Incorporation of Advanced Multipurpose Color Display	New MPCD	AV-8B (R)163853 and up
AFC-481		Emergency DC Wiring		
(P) Production (R) Retrofit				

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

Change Number	ECP Number	Description	Visual Identification	Effectivity

RECORD OF CHANGES

Record entry and page count verification for each printed change and erratum:

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

LIST OF EFFECTIVE PAGES

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PART XI — PERFORMANCE DATA

Refer to NATOPS Flight Manual Performance Charts A1–8V8BB–NFM–400.

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FOLDOUTS

LIST OF ABBREVIATIONS AND ACRONYMS

A

A/A. Air–to–Air.

A/C. Aircraft.

A/G. Air–to–ground.

A/R. Air refueling.

A/S. Air–to–surface.

AAC. Aviation armament change.

ABNG. Altitude bingo.

ABRT. Abort.

ACCEL. Acceleration.

ACNIP. Auxiliary communication, navigation, identification panel.

ACP. Armament control panel.

ACPT. Accept.

ACR. Altitude cruise.

ADC. Air data computer.

ADRL. Automatic distribution requirements list.

AFC. Airframe change.

AFC. Automatic flight control.

AFNSL. Auto flap fixed nozzle slow landing

AGL. Above ground level.

AHRS. Attitude heading and reference system.

AIL TRIM. Aileron trim.

AISI. Airborne instrumentation system internal.

AJ. Anti–jam.

ALDR. Altitude loss during recovery.

ALT. Altitude.

ALTM. Altimeter barometric pressure setting.

ALTHD. Altitude hold.

AMO. Aviation maintenance officer.

AMU. Advanced memory unit.

AMRAAM. Advanced medium range air–to–air missile.

ANTI COLL. Anti–collision.

APRCH. Approach.

AOA. Angle of attack.

APRCH. Approach.

APU. Auxiliary power unit.

ARBS. Angle rate bombing system.

ARTC. Air route traffic control.

ASC. Aircrew system change.

ASPD. Abort speed.

ASPJ. Airborne self–protection jammer.

ASRT. Air support radar team.

ASYM. Asymmetric.

ATC. Air traffic control.

AUT. Auto delivery mode.

AUT FLP. Auto flaps.

AUTO. Automatic.

AUX. Auxiliary.

AVC. Avionics change.

AWLS. All weather landing system.

AYC. Accessories change.

B

BAPS. Bleed air pressure switch.

BARO. Barometric.

BATT. Battery.

BAW. Basic aircraft weight.

BCN. Beacon.

BDI. Basic drag index.

BIT. Built-in-test.

BNGO. Bingo.

BRT. Bright.

BSSL. Braking stop slow landing.

BUNO. Bureau number.

C

CALT. Cruise attitude.

CAS. Calibrated airspeed.

CATCC. Carrier air traffic control center.

CBR. California bearing ratio.

CCIP. Continuously computed impact point.

CCW. Counterclockwise.

CFIT. Controled flight into terrain.

CG. Center of gravity.

cg. Center of gravity.

CIP. Computed impact point.

CLR. Clear.

CMBT. Combat.

CNI. Communication, navigation, identification.

CNIDC. CNI data converter.

COMM. Communication radio.

COMP. Compass.

CONSL. Console.

CRS. Course.

CRUS. Cruise.

CRT. Cathode ray tube.

CS. Crew station.

CTO. Conventional takeoff.

CW. Continuous wave.

D

DAT. Display alternate toggle.

DCRG. Descent range.

DDI. Digital display indicator.

DECM. Defensive electronic countermeasures.

DECS. Digital engine control system.

DECU. Digital electronics control unit.

DEP RES. Departure resistance.

DFC. Digital flaps controller.

DI. Drag index.

DIR. Direct.

DL. Dual.

DMC. Digital map computer.

DME. Distance measuring equipment.

DMT. Dual mode tracker.

DN. Down.

DSEL. Deselected.

DSL. Depressed sight line.

DSS. Data storage set.

DSU. Data storage unit.

DTX. Data transfer.

DVMS. Digital video mapping set.

E

EAAS. Electronic Airspeed/Altitude Sensor.

ECM. Electronic countermeasures.

ECS. Environmental control system.

EDP. Engine display panel.

EFC. Engine fuel control.

EHSD. Electronic horizontal situation display.

EHSI. Electronic horizontal situation indicator.

EMCN. Emission control.

EMCON. Emission control.

EMER. Emergency.

EMS. Engine monitoring system.

EMU. Engine monitoring unit.

ENG EXC. Engine exceedance.

ENG ST. Engine start.

ENT. Enter.

EPC. Emergency procedure checklist.

EPI. Engine performance indicator.

EQP. Equipment.

EVICS. Enhanced Variable Inlet Guide Vanes Control System.

EW. Electronic warfare.

EXT. Exterior.

F

FAA. Federal aviation administration.

FCC. Flight control computer.

FCF. Functional checkflight.

FCLP. Field carrier landing practice.

FDAT. Field data.

FEBA. Forward edge of battle area.

FELV. Field elevation.

FF. Fixed frequency.

FLD. Flood.

FLIR. Forward looking infrared.

FMU. Fuel metering unit.

FOD. Foreign object damage.

FOV. Field of view.

FPM. Feet per minute.

FREQ. Frequency.

FRZ. Freeze.

FWD. Forward.

G

GCA. Ground controlled approach.

GCI. Ground controlled intercept.

GEN. Generator.

GPS. Global positioning system.

GPWS. Ground proximity warning system.

GROL. Ground roll.

GTS. Gas turbine starter.

GWIND. Ground wind.

GWND. Ground wind.

GWT. Gross weight.

H

H_2O. Water.

HCLR. Hover clear.

HDG. Heading.

Hg. Mercury.

HOTAS. Hands on throttle and stick.

HP. High pressure.

HPC. High pressure compressor.

HMU. Hydromechanical unit.

HSI. Horizontal situation indicator.

HUD. Head-up display.

HVR. Hover.

HYD. Hydraulic.

I

IAS. Indicated airspeed.

IBIT. Initiated built-in-test.

ICAO. International civil aviation organization.

ICS. Intercommunication system.

IDEC. IGV digital electronic control.

IFA. In-flight alignment.

IFF. Identification friend or foe.

IFM. In-flight monitor.

IFOV. Instantaneous field of view.

IFR. Instrument flight rules, inflight flight refueling.

IGN ISO. Ignition isolation.

IGV. Inlet guide vanes.

IGVC. Inlet guide vane control.

IMC. Instrument meteorological conditions.

IMN. Indicated Mach number.

INBD. Inboard.

INOP. Inoperative equipment.

INS. Inertial navigation system.

INST. Instrument.

INT. Interval.

INTL PRF. Interleaved pulse repetition frequency.

IR. Infrared.

ISO. International organization for standardization.

ISA. International standard atmosphere.

ITER. Improved triple ejector rack.

J

JMPS. Joint mission planning station.

JMR. Jammer.

JPT. Jet pipe temperature.

JPTL. Jet pipe temperature limiter.

K

KCAS. Knots calibrated airspeed.

Khz. Kilohertz.

KIAS. Knots indicated airspeed.

KVA. Kilo volt-amperes.

L

LAT. Latitude.

LAW. Low altitude warning.

LBA. Limits of basic aircraft.

LDG. Landing.

LED. Light Emitting Diode.

LERX. Leading edge root extension.

LG. Landing gear.

LIDS. Lift improvement device system.

LONG. Longitude.

LP. Low pressure.

LPU. Life preserver unit.

LSO. Landing signal officer.

LSS. Landing sight supervisor.

LST. Laser spot tracker.

LT. Light.

LTS. Lights.

M

MAC. Mean aerodynamic cord.

MAGR. Miniaturized airborne gps receiver.

MAPM. Map menu.

MAX. Maximum.

MC. Mission computer.

MDC. Mild detonation cord.

MFS. Manual fuel system.

MFUL. Minimum fuel.

MH_2O. Minimum water.

MIC. Microphone.

MISC. Miscellaneous.

MK. Markpoint.

MLG. Main landing gear.

MPCD. Multipurpose color display.

MPD. Multipurpose display.

mph. Miles per hour.

MPS. Mission planning system.

MRNG. Maximum range.

MSC. Mission systems computer.

MSL. Mean sea level.

MUX. Multiplex data bus.

mux. Multiplex data bus.

MVAR. Magnetic variation.

N

NATOPS. Naval Air Training and Operating Procedures Standardization.

NAV. Navigation.

NGT. Night.

NLG. Nose landing gear.

nm. Nautical mile.

NRAS. Nozzle rotation airspeed.

NTRP. Navy Tactical Reference Publication.

NVG. Night vision goggles.

NWIP. Naval Warfare Information Publication.

NWP. Naval Warfare Publication.

NWS. Nose wheel steering.

NZ. Maximum load factor.

O

OATC. Outside air temperature celsius.

OATF. Outside air temperature fahrenheit.

OBNG. Optimum bingo.

OBOGS. On board oxygen generating system.

ODU. Option display unit.

OFP. Operational flight program.

OLX. Overlay transfer.

OPCR. Optimum cruise.

OPR. Operate.

OPSTA. Operator station.

OT. Over temperature.

OUTBD. Outboard.

OVHT. Over heat.

OVRD. Override.

OWT. Operating weight.

OXY. Oxygen.

P

PC. Pitch carets, procedure checklist.

PHOV. Performance hover.

PIO. Pilot induced oscillation.

PLA. Pilots lever angle.

PLN. Plain.

PNB. Power nozzle braking.

POS. Position.

pps. Pulse per second.

PRB HT. Probe heat.

PROP. Proportioner.

PSG. Post stall gyration.

PWR. Power.

Q

QA. Quality assurance.

R

RAD ALT. Radar altimeter.

RALT. Radar altimeter.

RANG. Range.

RBGM. Real beam ground map.

RCS. Reaction control system.

RCU. Remote control unit.

RCV. Receive, Reaction control valve.

RDHG. Runway heading.

RDR. Radar.

RDIS. Runway distance.

RDRY. Runway dry.

REC, RECV. Receive.

REJ. Reject.

REST. Range, endurance, speed, and time.

RET. Retract.

RF. Radio frequency.

RFUL. Remaining fuel.

RH. Right.

RHOV. Relative hover.

RIFA. Radar in-flight alignment.

RJPT. Relative jet pipe temperature.

ROC. Rules of conduct.

ROE. Rules of engagement.

RPM. Revolutions per minuter.

rpm. Revolutions per minute.

RPS. Rudder pedal shaker.

RSC. Radio set control.

RT. Right.

RUD SVO. Rudder trim and sas servo.

RVL. Rolling vertical landing.

RVTO. Rolling vertical takeoff.

RWET. Runway wet.

RWR. Radar warning receiver.

RWS. Range while scan.

S

SAAHS. Stability augmentation and attitude hold system.

SAM. Surface–to–air missile.

SAR. Search and rescue.

SAS. Stability augmentation system.

SDAT. System data.

SDST. Stopping distance.

SEAWARS. Sea water activated release system.

SEC. Second.

SEL. Select.

SHDG. Stored heading.

SL. Slow landing.

SLD. Short lift dry.

SLW. Short lift wet.

SMDC. Shielded mild detonation cord.

SMS. Stores management system.

SMSFF. Stores management system function fail.

SOP. Standard operating procedures.

SP BK. Speed brake.

SPD. Speed.

STA. Station.

Stab aug. Stability augmentation.

STAB TRIM. Stabilator trim.

STBY. Standby.

STBY TR. Standby transformer rectifier.

STO. Short takeoff.

STOL. Short takeoff and landing.

STP. Steer–to–point.

STRS. Stores.

SYM. Symbology.

T

TAMMAC. Tactical aircraft moving map capability.

TACTS. Tactical airborne combat training system.

TAS. True airspeed.

TCN. Tacan.

TDC. Target designator control.

TFOV. Total field of view.

TOO. Target of opportunity.

TOT. Total.

TPOD. Targeting pod.

TRU. Transformer–rectifier unit.

TR. Transformer–rectifier.

TVC. Thrust vector control.

U

UFC. Upfront control.

UFCS. Upfront control system.

UHF. Ultra high frequency.

UPC. Unique planning component.

V

Vdc. Volts direct current.

VHF. Very high frequency.

VIFF. Vectoring in forward flight.

VL. Vertical landing.

VNSL. Variable nozzle slow landing.

VREST. VSTOL, range, endurance, speed, and time.

VRS. Video recording system.

VRST. VSTOL REST.

VSTOL. Vertical short takeoff and landing.

VTO. Vertical takeoff.

VTR. Video tape recorder.

W

WINC. Waypoint increment.

WLG. Wing landing gear.

WORD. Wind oriented rocket deployment.

WOW. Weight on wheels.

WPN. Weapon.

WRA. Weapon replaceable assembly.

WSHLD. Windshield.

PREFACE

SCOPE

This NATOPS manual 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. It provides the best available operating instructions for most circumstances, but no manual is a substitute for sound judgment. Operational necessity 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-AV8BB-NFM-400 (Partial NATOPS Flight Manual)

A1-AV8BB-NFM-500 (NATOPS Pocket Checklist)

A1-AV8BB-NFM-600 (Servicing Checklist)

A1-AV8BB-NFM-700 (Functional Checkflight Checklist)

NATIP, NTRP 3-22.4 AV8B

ANTTP 3-22.1 AV8B

ANTTP AV8B Tactical Pocket Guide

HOW TO GET COPIES

Additional copies of this manual and changes thereto may be procured through the local supply system from NAVICP Philadelphia via DAAS in accordance with NAVSUP P-409 (MILSTRIP/MILSTRAP), or a requisition can be submitted to Naval Supply Systems Command via the Naval Logistics Library (NLL) website, www.nll.navsup.navy.mil. This publication is also available to view and download from the NATEC website, www.natec.navy.mil.

Automatic Distribution (with Updates)

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Note

Activities not coordinating with the NATOPS Model Manager unit for more than 12 months may be dropped from distribution.

UPDATING THE MANUAL

To ensure that the manual contains the latest procedures and information, NATOPS review conferences are held in accordance with the current OPNAVINST 3710 series.

CHANGE RECOMMENDATIONS

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

Change recommendations of any nature, URGENT/PRIORITY/ROUTINE should be submitted directly to the Model Manager via the NATOPS website (https://natops.navair.navy.mil) and the AIRS (Airworthiness Issue Resolution System) database. The AIRS is an application that allows the Model Manager and the NATOPS Office, Naval Air Systems Command (NAVAIR) AIR-4.0P to track all change recommendations with regards to NATOPS products. The Model Manager will be automatically notified via email when a new recommendation is submitted. A classified side of the website is available to submit classified information via the SIPRNET.

The address of the Model Manager of this aircraft/publication is:

Commanding Officer
ATTN: AV-8 NATOPS Model Manager
Marine Attack Training Squadron 203
2D Marine Aircraft Wing,
Marine Forces, Atlantic
Postal Service Center Box 8064
MCAS Cherry Point, NC 28533

Telephone:
Commercial (252) 466-2638
Autovon 582-2638
FAX 582-5161

YOUR RESPONSIBILITY

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

NATOPS MANUAL INTERIM CHANGES

Interim changes are changes or corrections to the NATOPS manuals promulgated by CNO or COMNAVAIRSYSCOM. 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 updated Interim Change Summary to ascertain that all outstanding interim changes have been either incorporated or canceled; those not incorporated shall be recorded as outstanding in the section provided.

CHANGE SYMBOLS

Revised text is indicated by a black vertical line in either margin of the page, like the one printed next to this paragraph. The change symbol shows where there has been a change. The change might be material added or information restated. A change symbol in the margin by the chapter number and title indicates a new or completely revised chapter.

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., that may result in injury or death, if not carefully observed or followed.

CAUTION

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

Note

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

WORDING

The concept of word usage and intended meaning adhered to in preparing this manual is as follows:

1. “Shall” has been used only when application of a procedure is mandatory.
2. “Should” has been used only when application of a procedure is recommended.
3. “May” and “need not” have been used only when application of a procedure is optional.
4. “Will” has been used only to indicate futurity, never to indicate any degree of requirement for application of a procedure.
5. Land immediately is self-explanatory.
6. Land as soon as possible means land at the first site at which a safe landing can be made.
7. Land as soon as practical means extended flight is not recommended. The landing and duration of flight is at the discretion of the pilot in command.

AIRSPEED

All airspeeds in this manual are in knots calibrated airspeed (KCAS) unless stated in other terms.

MANUAL DEVELOPMENT

This NATOPS Flight Manual was prepared using a concept that provides the aircrew with information for operation of the aircraft, but detailed operation and interaction is not provided. This concept was selected for a number of reasons: reader interest increases as the size of a technical publication decreases, comprehension increases as the technical complexity decreases, and accidents decrease as reader interest and comprehension increase.

To implement this streamlined concept, observance of the following rules was attempted:

1. The pilot shall be considered to have above average intelligence and normal (average) common sense.
2. No values (pressure, temperature, quantity, etc.) which cannot be read in the cockpit are stated, except where such use provides the pilot with a value judgement.
3. Only the information required to fly the airplane is provided.
4. Notes, Cautions, and Warnings are held to an absolute minimum, since, almost everything in the manual could be considered a subject for a Note, Caution, or Warning.
5. No Cautions or Warnings or procedural data are contained in the Descriptive Section, and no abnormal procedures (Hot Starts, etc.) are contained in the Normal Procedures Section.
6. Notes, Cautions and Warnings will not be used to emphasize new data.
7. Multiple failures (emergencies) are not covered.
8. Simple words in preference to more complex or quasi-technical words are used and unnecessary and/or confusing word modifiers are avoided.

CHANGE RECOMMENDATIONS

NATOPS/TACTICAL CHANGE RECOMMENDATION
OPNAV 3710/6 (4-90) S/N 0107-LF-009-7900 **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)*

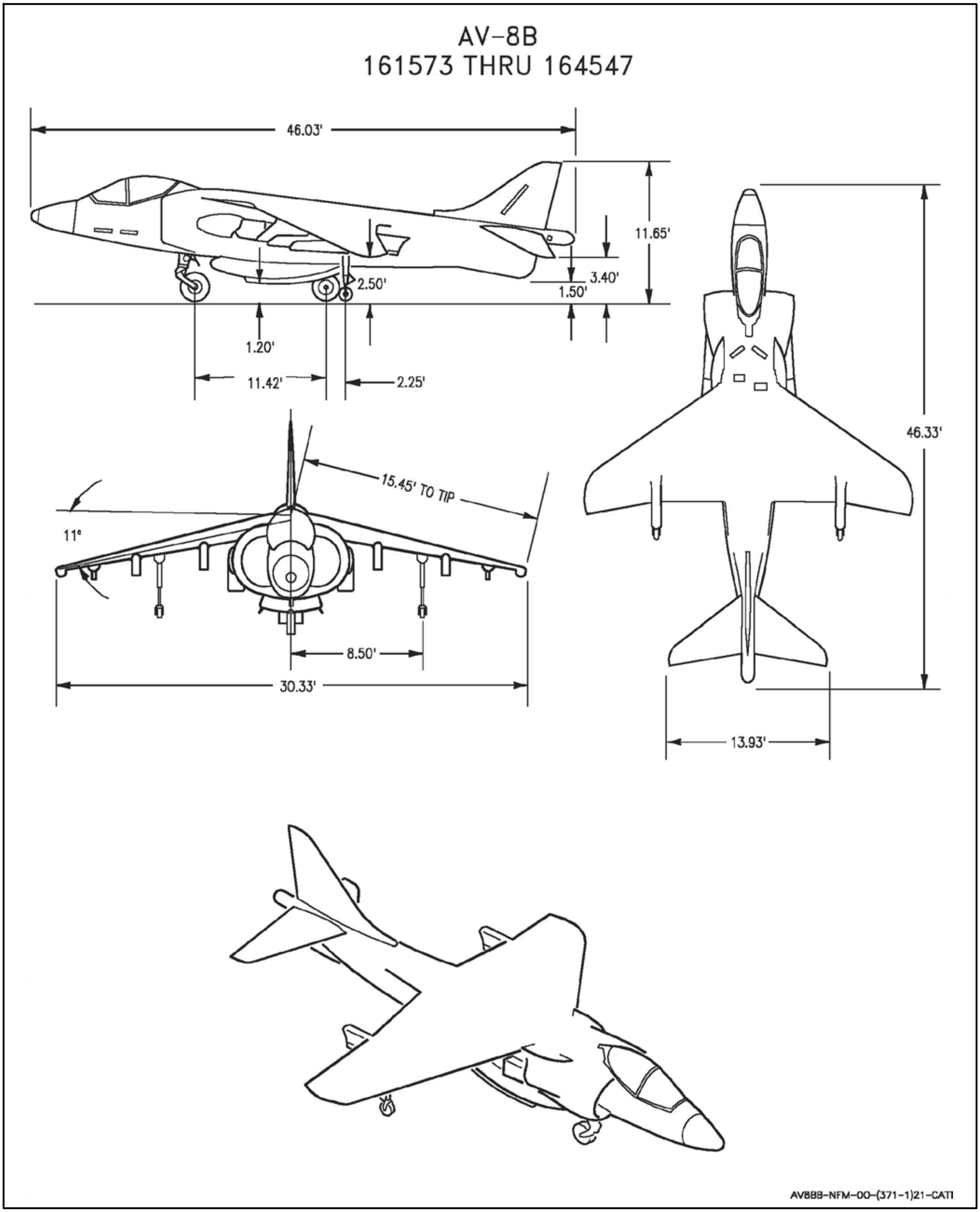
FROM	DATE
TO	

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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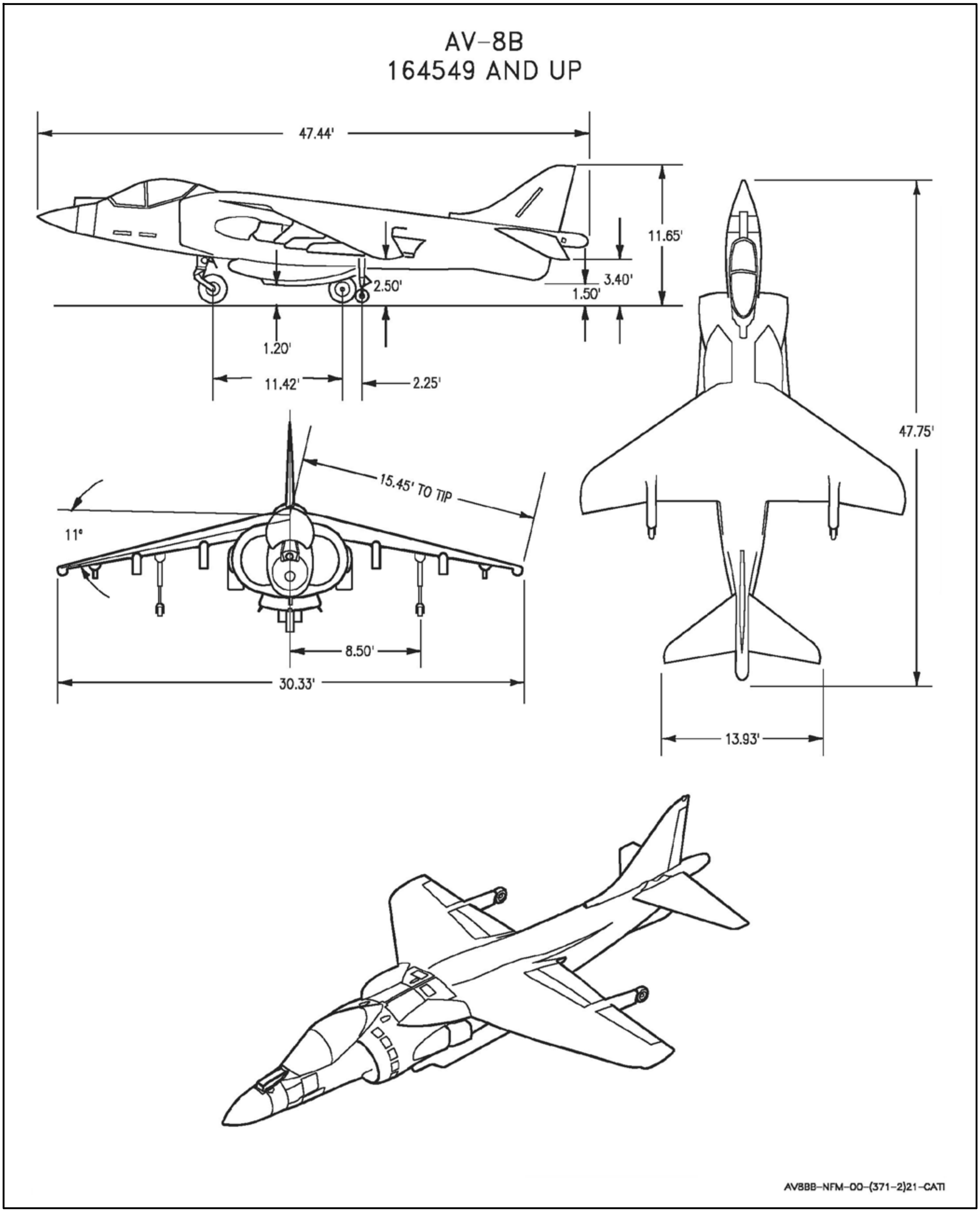
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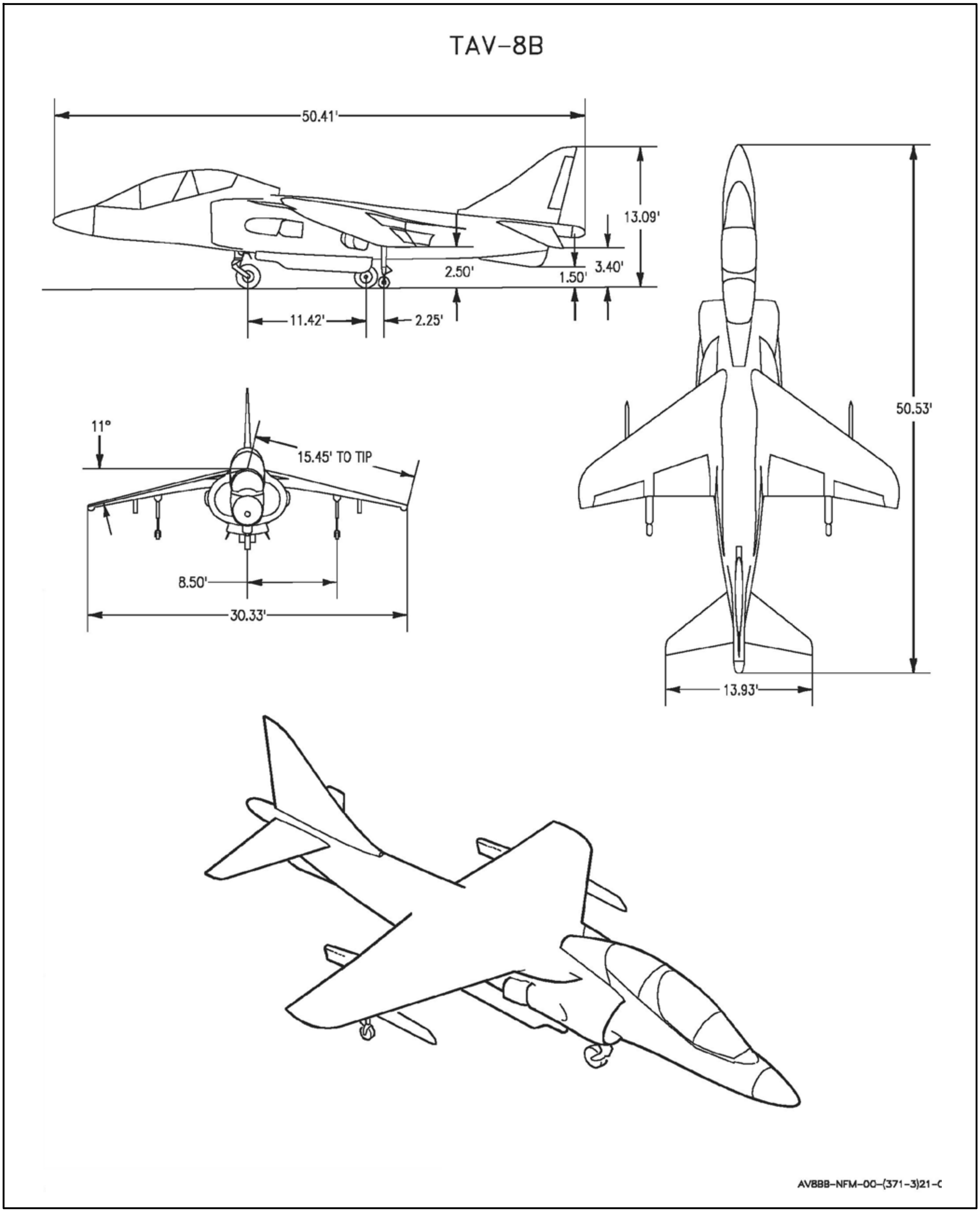
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AV8BB-NFM-00-(371-3)21-C

PART I

The Aircraft

CHAPTER 1

Aircraft and Engine

1.1 AIRCRAFT DESCRIPTION

1.1.1 Day Attack

The AV–8B day attack aircraft is a transonic, single cockpit, single engine, jet propelled day/night tactical fighter built by McDonnell Douglas Aerospace. Refer to Figure 1-1 for general arrangement. The aircraft is powered by a Rolls Royce axial flow, twin spool turbo fan engine. Four exhaust nozzles can be positioned and controlled for vertical/short takeoff and landing (V/STOL) operation. The aircraft features shoulder mounted swept back wings with trailing edge flaps and ailerons. The flight controls are hydraulically powered to provide the desired control effectiveness throughout the speed range. High pressure nitrogen/helium is provided for the landing gear system during emergencies. The cockpit is pressurized and enclosed by a sliding canopy. A rocket assisted seat is provided for pilot ejection. Refer to Cockpit illustration, Foldout Section, for instrument arrangement.

1.1.2 Night Attack

The AV–8B night attack aircraft is a modified day attack AV–8B aircraft with the additional capabilities to perform its mission at night by utilizing low–light attack capabilities.

1.1.3 Radar

The AV–8B radar aircraft is the same as the AV–8B night attack with the APG–65 radar incorporated. The addition of the APG–65 radar enhances mission effectiveness through improved navigation, air–to–surface, and air–to–air weapon systems capabilities.

1.1.4 Remanufacture

The remanufactured AV–8B aircraft is an AV–8B day attack aircraft remanufactured to the same configuration as the radar aircraft, except remanufactured aircraft do not have the electrical wiring to support outrigger pylons. All references to radar aircraft in this manual will include remanufactured aircraft unless specifically noted otherwise.

1.1.5 Trainer

The TAV–8B is a transonic, dual cockpit, single engine, day/night tactical fighter/trainer built by McDonnell Douglas Aerospace. Refer to Figure 1-1 for general arrangement.

1.2 AIRCRAFT DIMENSIONS

The approximate dimensions of the aircraft are as follows:

Wing Span	All	30.33 feet
Length	AV–8B AV–8B (Radar) TAV–8B	46.33 feet 47.75 feet 50.53 feet
Height (top of fin)	AV–8B TAV–8B	11.65 feet 13.09 feet
Wing gear spread	All	17 feet

1.3 AIRCRAFT GROSS WEIGHT

For specific gross weights, refer to the handbook of Weight and Balance Data NAVAIR 01-1B-40.

The basic weight of an aircraft includes all fixed operating equipment, all oils, and unusable fuel to which it is only necessary to add the variable or expendable load items for the various missions. Pylons gun/ammo pods, ALE-39, and fuselage strakes are not part of the Basic Weight.

The operating weight of an aircraft is the basic weight plus those variable items which remain constant for the type mission. This weight includes pilot, 180 lbs, and all other items except fuel, water, and expendables.

The gross weight of an aircraft is the total weight of an aircraft and its contents.

1.4 MISSION

The AV-8B aircraft is designed for offensive air support and air defense missions. It is equipped to carry and deliver an assortment of conventional stores, infrared (IR) missiles, laser and global positioning system (GPS)-guided munitions, and a precision targeting pod from six wing stations and a centerline station. A 25mm gun system may be attached to the lower fuselage. Refer to NATIP, NTRP 3-22.4-AV8B for additional information concerning armament deployment.

The AV-8B night attack/radar aircraft has night vision goggle compatible controls and displays.

The AV-8B radar aircraft provides day and night attack missions with improved navigation, air-to-surface and air-to-air weapon system capabilities.

The TAV-8B aircraft is designed for vertical short takeoff and landing (V/STOL) and Attack training. Refer to the NATIP, NTRP 3-22.4-AV8B for information concerning armament.

1.5 TECHNICAL DIRECTIVES

As technical changes are made to the aircraft, those that affect aircraft operation or pilot need-to-know operation will be incorporated in the appropriate sections and listed in the Summary of Applicable Technical Directives in the front of this manual. In some instances, Technical Directives may be incorporated on the aircraft while it is still on the production line before delivery. Check the Technical Directives Section of the Aircraft Log Book for applicable modifications. The following are types of technical directives used in this manual:

AAC – Aviation Armament Change.

AFC – Airframe Change.

ASC – Aircrew System Change.

AVC – Avionics Change.

AYC – Accessories Change.

1.6 BLOCK NUMBERS

See Figure 1-2 for production block numbers which correspond to aircraft bureau numbers (BUNO).

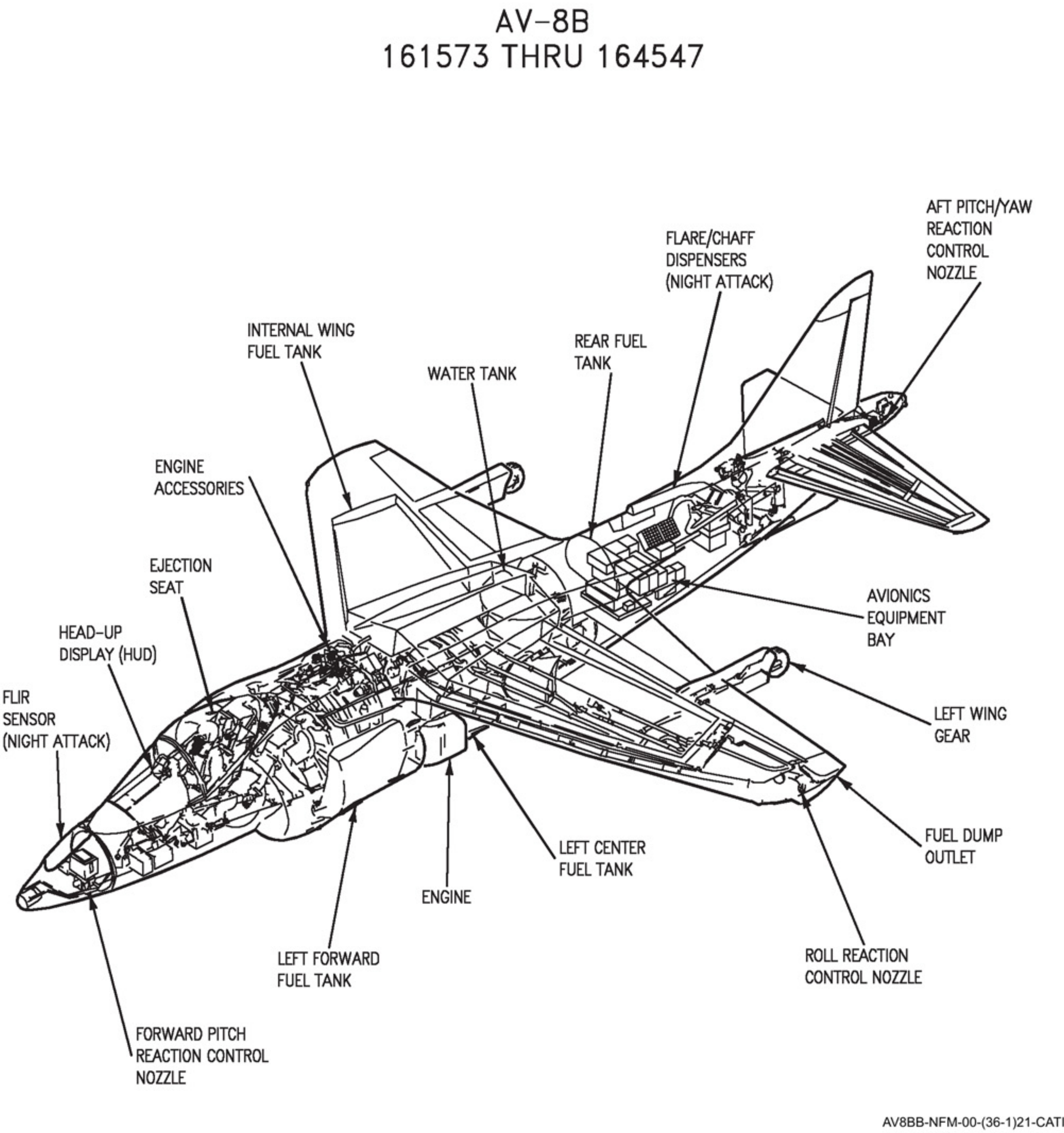
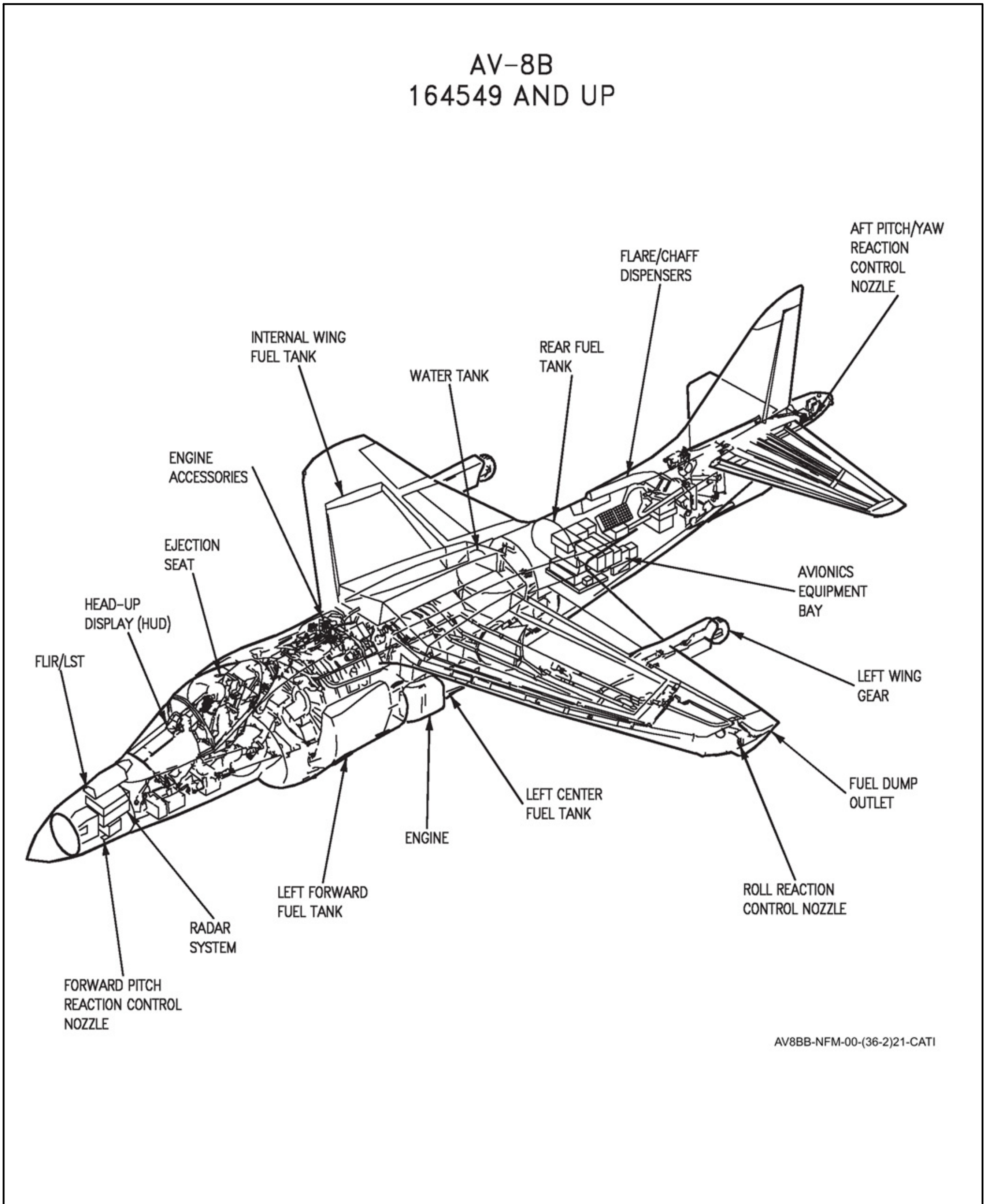


Figure 1-1. General Arrangement (Sheet 1 of 3)



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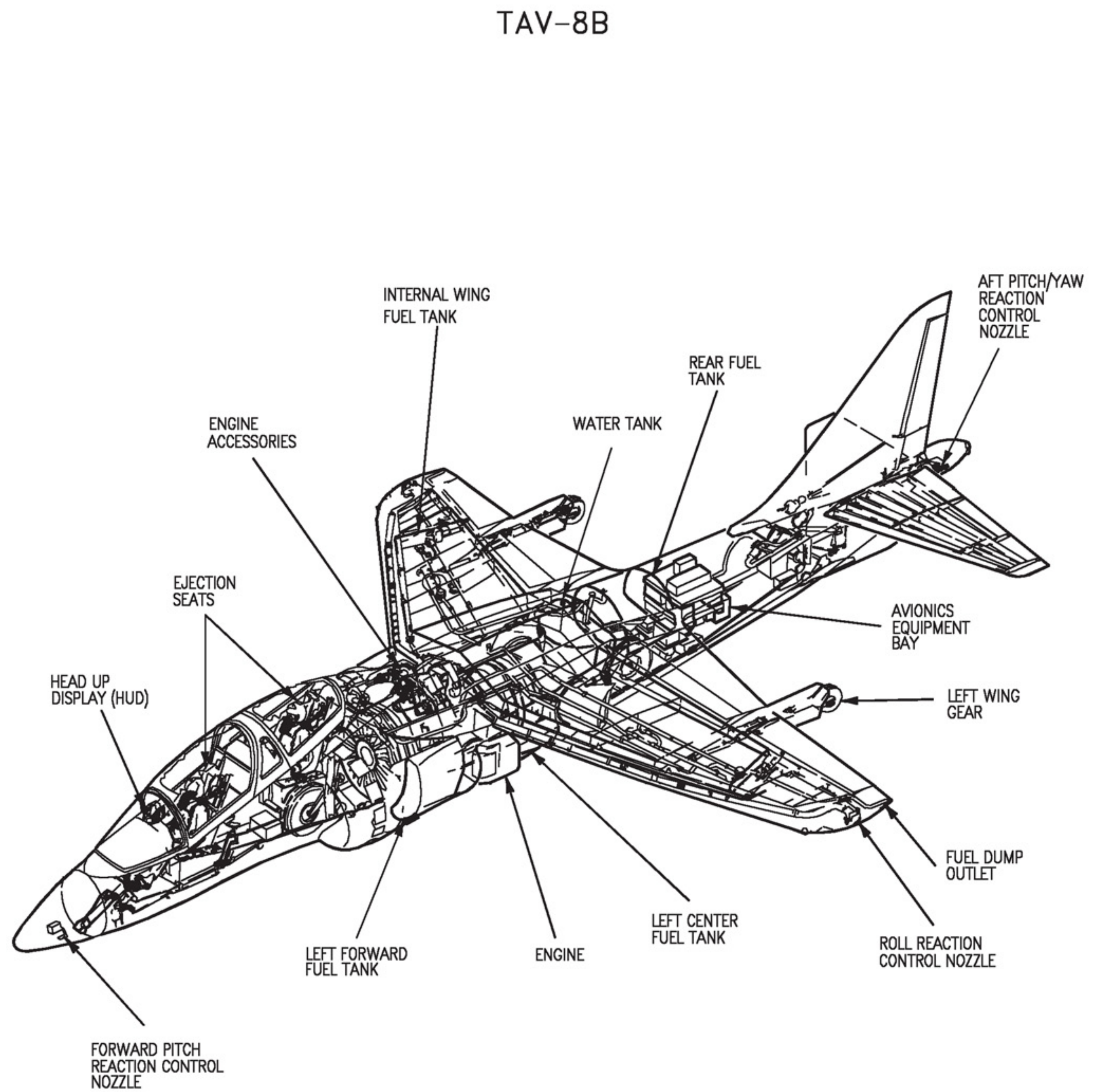

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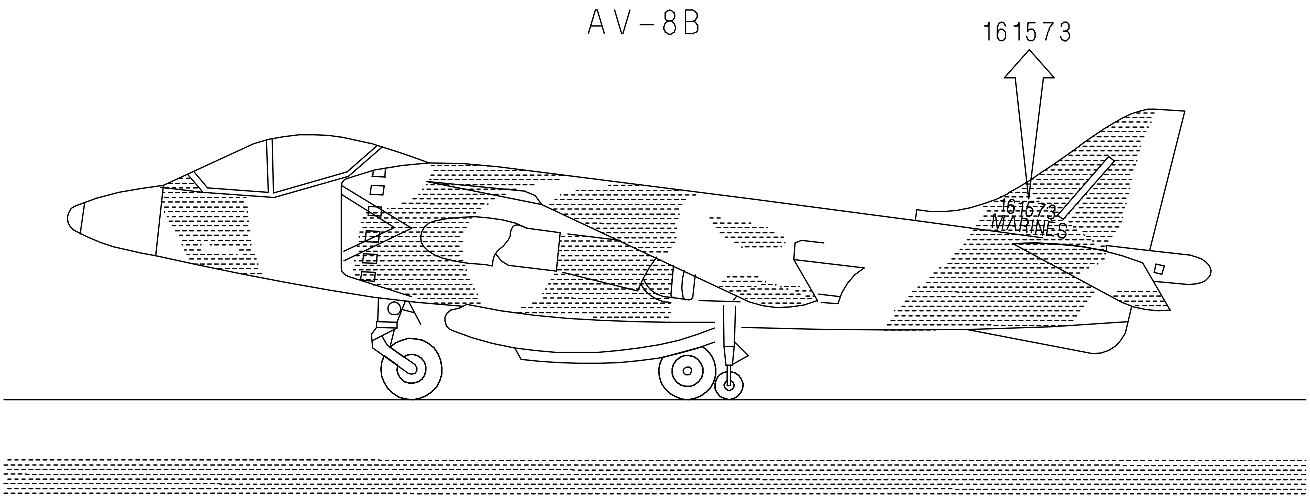

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BLOCK 4(9)
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BLOCK 6(14)
162721 THRU 162734

BLOCK 7(12)
162735 THRU 162746

BLOCK 8(22)
162942 THRU 162964

BLOCK 9(12)
162965 THRU 163020

BLOCK 10(17)
163176 THRU 163195

BLOCK 11(23)
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BLOCK 12(15)
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BLOCK 13(33)
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BLOCK 14(11)
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BLOCK 15(13)
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BLOCK 16(5)
164117 THRU 164121

BLOCK 17(13)
164123 THRU 164135

BLOCK 18(24)
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BLOCK 19(24)
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BLOCK 20(0)
NONE

BLOCK 21(6)
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REMAN (77)
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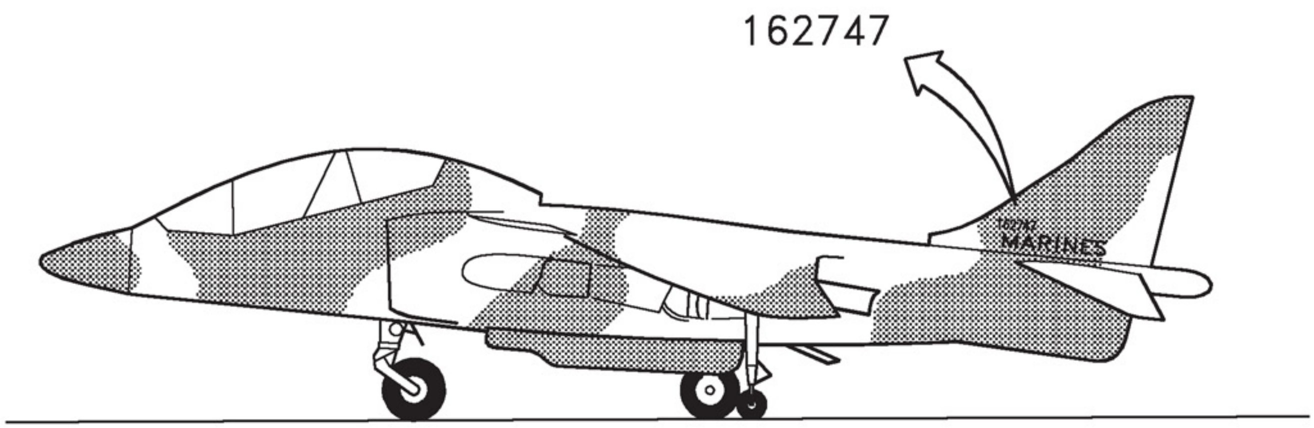
AHR602-343-1-035

Figure 1-2. Block Numbers (Sheet 1 of 2)

TAV-8B



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BLOCK 11 (3)
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BLOCK 12 (3)
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BLOCK 13 (3)
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BLOCK 16 (3)
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BLOCK 17 (3)
164136 THRU 164138

BLOCK 18 (3)
164540 THRU 164542

AV8BB-NFM-00-(343-2)20-CATI

Figure 1-2. Block Numbers (Sheet 2)

CHAPTER 2

Systems

2.1 POWER PLANT SYSTEMS

2.1.1 Engine

Each of the aircraft is powered by a Rolls Royce F402-RR-406A, F402-RR-406B, F402-RR-408, F402-RR-408A, or F402-RR-408B dual spool, axial flow, turbo fan engine with thrust-vectoring exhaust nozzles. See Figure 2-1. One of the spools is a 3-stage low pressure compressor (fan) driven by a 2-stage low pressure turbine and the other is an 8-stage high pressure compressor driven by a 2-stage high pressure turbine. Each spool is independent of the other, but they are coaxial and, to minimize gyroscopic effect, they counter-rotate.

The F402-RR-406A/F402-RR-406B engine, with water injection, develops a nominal (static test bed) thrust of 21,550 pounds in optimum International Civil Aviation Organization (ICAO) conditions or 20,280 pounds without water injection.

The F402-RR-406B engine uses improved turbine section materials that result in increased engine life. Functionally, the F402-RR-406B engine is the same as the F402-RR-406A engine.

The F402-RR-408 series engine, with water injection, develops a nominal (static test bed) thrust of 23,400 pounds in optimum ICAO conditions or 22,200 pounds without water injection.

In the remaining portions of this manual F402-RR-406 nomenclature will be used to indicate either the F402-RR-406A or F402-RR-406B engines, and F402-RR-408 engine nomenclature shall be used to indicate either the F402-RR-408, F402-RR-408A, or the F402-RR-408B engine.

Air drawn through two intakes enters the fan. Leaving the fan the air is divided, one flow passing to an annular plenum chamber from which it is ducted through front, left and right, cold nozzles. The other flow passes through variable inlet guide vanes, through the high pressure compressor (HPC) and a combustion chamber to the high pressure (HP) and low pressure (LP) turbines. It is then ducted through rear, left and right, hot nozzles. Thermocouples in the turbine exhaust sample gas temperature and supply data to a digital jet pipe temperature (JPT) indicator and to the engine fuel system for JPT limiter (JPTL). The digital signal is fed to the mission computer for engine life count.

The engine bay is ventilated by ram air intakes at the forward end of the front nozzle fairings and the wing roots. Air flow is assisted, whenever the engine is running, by flow inducer nozzles supplied by air bleed from the fan; this ensures that the bay is adequately ventilated in slow and hovering flight.

An engine mounted gas turbine starter/auxiliary power unit (GTS/APU), is used for engine starting or to supply electrical power.

2.1.1.1 Inlet Guide Vanes

Variable inlet guide vanes (IGV) direct airflow into the HPC to give optimum compressor performance. Their automatic control unit is adjusted by the HPC rpm and intake air temperature using engine fuel as a hydraulic medium. On aircraft with a -408B engine, the enhanced variable inlet guide vane system (EVICS) is used to control the IGV’s. EVICS consists of an inlet guide vane, digital electronic control (IDEC), and a hydromechanical unit (HMU). If the IDEC fails, the system will revert control of the IGVs to the HMU. At max power the IGVs will be 0 to -4 degrees. Normal IGV angle at idle will be 31 to 39 degrees. Because there are no inlet guide vanes in front of the fan, an engine anti-icing system is not necessary. A permanent magnet motor integral to the HMU provides electrical power supply for the IDEC and lane 2 digital electronics control unit (DECU) (29 Vdc) independent of the aircraft electrical system.

2.1.1.2 Interstage Blow-Off Valves

To promote rapid surge-free acceleration, two compressor interstage blow-off valves open at low rpm to bleed air from the high pressure compressor into the plenum chamber. The valves close automatically as rpm increases.

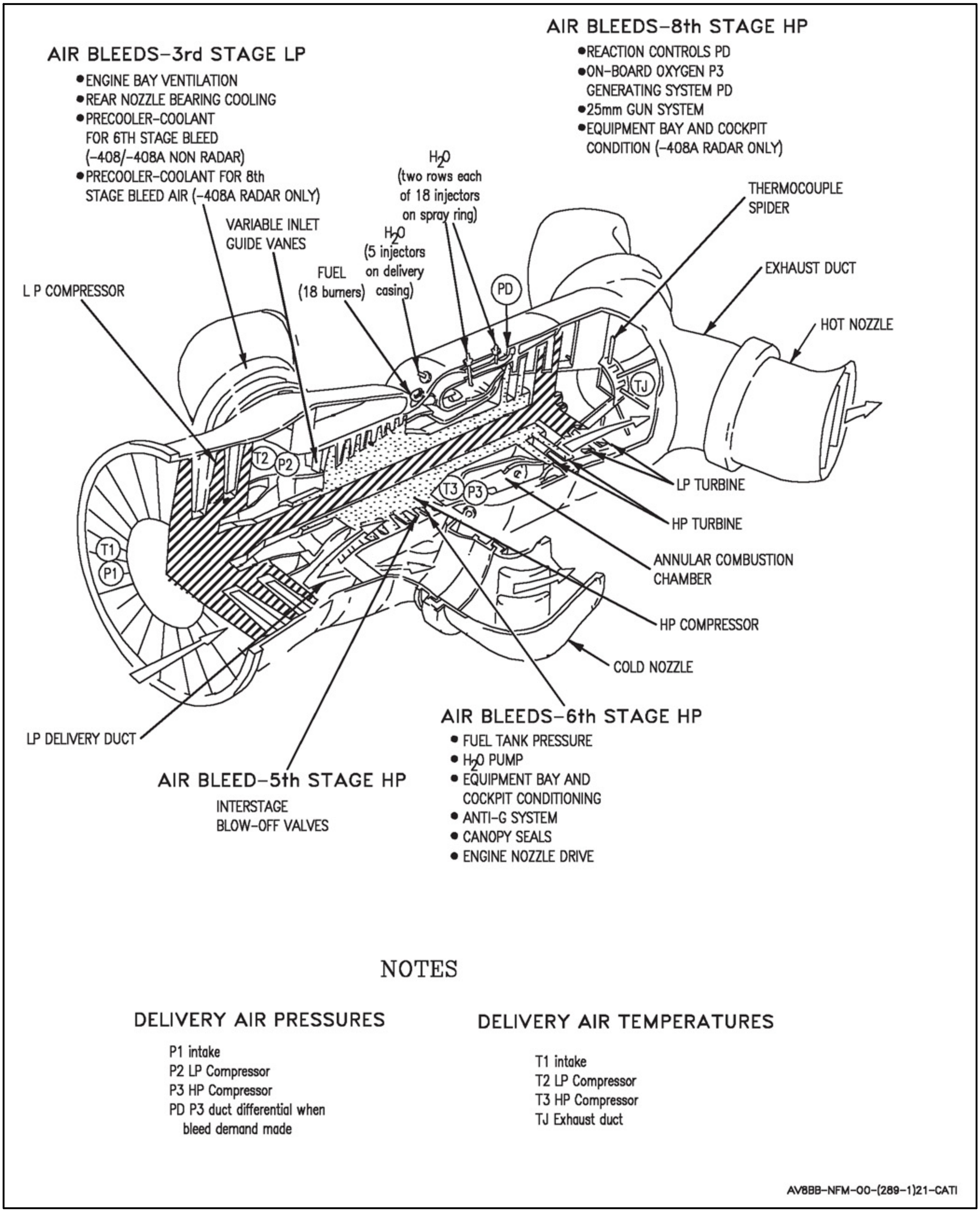


Figure 2-1. Engine

2.1.1.3 Lubrication Systems

Oil is drawn from a tank (on the left side of the engine) and circulated by a gear pump to the main engine bearings, seals, and accessory drives gears. A scavenge system returns the oil to the tank through a fuel-cooled oil cooler. Oil for the GTS/APU is also taken from the oil tank.

Two green engine oil level lights and a press-to-test button are on a panel (which also contains refueling controls and a GEN oil light) under an access panel on the left forward nozzle fairing. The lights provide a redundant check of oil quantity. If at least one of the engine oil lights comes on when the button is pressed, there is enough oil for at least a 3 hour flight (16 pints).

The tank is normally pressure refilled through a coupling on the left front side of the engine. Full is indicated by discharge from an overflow pipe beside the coupling. Ferry levels are obtained by capping the overflow pipe and gravity filling the tank through a filler neck under a panel on top of the fuselage. The various oil fill amounts are as follows:

One Light – 16 Pints – 3 Hrs.
Full – 19.2 Pints – 4 Hrs.
Ferry – 26 Pints – 7.5 Hrs.
Extended Ferry – 33 Pints – 10 Hrs.

Breather air is vented from the engine, the gearbox, and the oil tank through an air/oil separator to a discharge just forward of the right cold nozzle. Low oil pressure is indicated by an OIL caution light on the caution light panel.

2.2 AIR INDUCTION SYSTEM

The air induction system consists of two semicircular side inlet ducts that merge at the engine face. The inlet ducts utilize boundary layer doors and intake suction doors to compensate for the wide range of airflow requirements induced by the aircraft V/STOL and high speed flight capabilities.

2.2.1 Boundary Layer Doors

Two doors on the fuselage skin of each air intake are spring-loaded closed during slow and hovering flight. In high speed flight, when boundary layer pressure is high, the doors are forced open against their springs and air is bled from the intakes, thus preserving smooth airflow to the engine. The bleed air is ducted internally to exhaust behind the top of the cockpit canopy. The pairs of doors normally function together, but the doors of each pair can operate independently to improve airflow to the engine.

2.2.2 Intake Suction Doors

Auxiliary air inlets around the outside of each air intake are covered by unrestrained hinged doors, which are held open by suction to increase air flow to the engine during slow and hovering flight when air intake pressure is low. During high speed flight, the doors are held closed by increased intake air pressure.

2.3 ENGINE FUEL SYSTEM

The main components of the engine fuel system consist of the digital engine control system (DECS), two fuel manifolds, 18 flow distributors, two torch igniters, five primer jets, dump valve and tank. Fuel is available to the engine when the throttle lever is moved forward from the cutoff position, provided the fuel shutoff valve is open.

2.3.1 Digital Engine Control System

DECS is a nearly full authority digital engine control system (Figure 2-2). The DECS provides engine control throughout the engine operating range in response to throttle position, altitude, airspeed, angle of attack (AOA), inlet air temperature, and aircraft configuration. DECS automatically compensates for changes in fuel density, bleed air usage, and engine condition while maintaining engine performance. The four main components of the DECS are a pilot lever angle (PLA) assembly, two identical DECUs and a fuel metering unit (FMU). The PLA senses the throttle position through a mechanical linkage to the throttle. An electrical signal is sent from the PLA to the two DECUs. The two DECUs are each capable of full independent electronic control authority and command the mechanical FMU to provide properly metered fuel to the engine. Only one DECU is in control of the FMU at any one time. The EFC caution (amber) light illuminates (with audio warning) in the cockpit upon either DECU failing. In the event of the controlling DECU failing, engine control will automatically transfer to the other DECU. If the non–controlling DECU fails the EFC caution will still illuminate, but without a lane change occurring. Should the remaining DECU fail, engine control is lost and the EFC warning (red) light illuminates (with audio warning). Engine control can be regained by selection of the manual fuel system (MFS) which is incorporated within the FMU (provided fuel pressure and dc electrical power are available).

2.3.1.1 Digital Electronic Control Unit

Two identical DECU, each capable of nearly full control authority are bolted together to form a single unit and are mounted on the top right side of the engine (Figure 2-3). The DECU electronics are contained within a cast metal casing through which fuel is passed for cooling. Each is driven by a separate 28 Vdc power supply (LANE 1 – Switched Battery Bus, LANE 2 – Emergency DC Bus); on AV–8B 161573 through 163852, TAV–8B 162747 through 163861 after AFC–370 or AV–8B 165354 and up; also AV–8B 163853 through 165312, TAV–8B 164113 through 164542 after AFC–395, if a DECU's power supply is lost a crossover circuit allows it to be powered by the bus of the other DECU. On aircraft after AFC–392 LANE 2 is also provided 29 Vdc power from the inlet guide vane control (IGVC) digital electronic control (IDEC). When aircraft dc power is on, DECUs are enabled when the DECS enable switch is ON.

Any power fluctuation under 16 volts will disable the DECU and may cause any one of the following:

1. EFC Caution (amber) JPTL Warning (red)	Loss of power to either DECU
2. EFC Caution (amber) JPTL Warning (red) EFC Warning (red)	Loss of power to both DECU
Chapter 12 outlines procedures.	
JPTL and EFC lights are NVG green on Radar and Night Attack aircraft.	

Each DECU receives independent signals from engine and airframe transducers and switches, together with the pilot's throttle signal. Signals concerning the state of the aircraft (e.g. weight on wheels, JPTL switch, H_2O switch, etc.) are called STATE inputs. The validity of all these signals is cross–checked by dual microprocessors within each DECU (one active, one monitoring). If the validity is good, the controlling DECU outputs signals to the stepper motor which in turn controls a fuel metering valve in the FMU and thus controls engine rpm. If a discrepancy is detected between the processors, the DECU electrical output drive signal to the stepper motor is removed, an EFC caution is signaled, and the EFC dolls eye failure indicator in the refueling panel (22L) is tripped. The other DECU senses the removal of electrical drive signal from the stepper motor by the selected controlling DECU and immediately takes control by applying its drive signal to the stepper motor. In either case an EFC caution will illuminate and the EFC dolls eye failure indicator will be tripped.

In the event of a dual DECU failure being detected (EFC warning light and voice warning) electrical power to the FMU stepper motor will be lost. When electrical power is removed from the stepper motor, it remains magnetically latched in its last commanded position. FMU fuel metering valve position is dependent upon stepper motor position and the high pressure compressor discharge pressure (P3) signal. Therefore, even though the stepper motor is magnetically latched in the event of a dual DECU failure, actual engine speed may increase, decrease, or remain the same depending upon the engine condition at the time dual DECU failure occurred. If the failure occurs while the engine is either accelerating or decelerating, the engine will likely continue to accelerate or decelerate, and in the extreme case may either overspeed or run down sub–idle. If the failure occurs with the engine operating at a steady speed above approximately 90 percent, the speed will likely remain approximately constant, with changes in speed occurring with changes in altitude. If the failure occurs below approximately 90 percent, the speed may not remain constant. Engine control may be regained by selecting MFS.

Known susceptibilities to speed signal noise within the current configuration of DECU software (504) have resulted in multiple occurrences of dual DECU failure in service. The most significant failure mechanism occurs within in the last 1.0 seconds of demanded engine acceleration to short lift rating. In these instances, significant overspeeds in excess of 128 percent rpm have occurred. Engine control may be regained by selecting MFS, however, maximum scheduled fuel flow and therefore maximum engine thrust available may be less than that normally available under DECS control for the same prevailing conditions.

In the event of an aircraft electrical failure occurring on aircraft with AFC–392 incorporated, LANE 2 and the IGVC will both remain electrically powered by the IGVC dedicated generator and engine control will be maintained. LANE 1 DECU and the opportunity to select MFS will both be eventually lost as battery voltage drops below 16 volts. Aircraft with AFC–328 incorporated will maintain the opportunity to select MFS, if required, through actuation of the MFS emergency battery.

In the event of an aircraft electrical failure occurring on aircraft without AFC–392 incorporated, digital engine control and the opportunity to select MFS will both be lost as battery voltage drops below 16 volts. As battery voltage approaches 16 volts, FMU stepper motor movement and therefore engine response may become sluggish as battery power diminishes. On aircraft without AFC–328 incorporated, MFS should be selected as soon as possible and prior to battery voltage reducing below 16 volts. On aircraft with AFC–328 incorporated, MFS should still be selected as soon as possible and prior to battery voltage dropping below 16 volts. However, the emergency battery should provide an alternative power supply to allow MFS selection.

If the engine remains stable following EFC control loss the rpm will increase in a descent at constant Mach number and decrease during deceleration at constant altitude. A descent from high altitude cruise to pattern altitude and speed can result in a loss of rpm of up to 5 percent. As nozzles are selected and as bleed is demanded, rpm will decrease. If the initial rpm prior to nozzle selection is at 80 percent or below, the effect of bleed may run the engine to a sub–idle condition. At higher initial rpm and with maximum bleed the reduction in rpm may be up to 20 percent.

Pilot DECU selection is controlled by setting the EFC switch to POS 1 (LANE 1) or POS 2 (LANE 2) as required. Repositioning the EFC switch with a single DECU failure could reset a failed DECU that is now processing erroneous data.

2.3.1.1.1 Throttle Position Sensor Assembly

The pilot's lever angle (PLA) assembly provides each DECU with electrical throttle position signals. The PLA assembly is attached to the FMU and is driven by the throttle linkage.

2.3.1.2 Total Temperature Probes

Total temperature probes are mounted on the inboard wall of each main engine inlet. The probes are used by DECS to calculate corrected engine speed. Operation of the probe heaters is covered under Probe Heat Switch in the Instruments section.

2.3.1.3 Engine Fast Deceleration Solenoid

To avoid aircraft bounce on vertical landing, DECS incorporates a fast deceleration solenoid that is armed for 1 second by the weight on wheels (WOW) switch. A rapid throttle chop will activate the fast deceleration system and immediately reduce fuel flow. For aircraft with IPPC–227 incorporated, the engine fast deceleration solenoid is disabled.

2.3.1.4 Fuel Filter Blockage

If an abnormally high pressure drop is experienced across the FMU filter, a resettable low pressure fuel blockage indicator on the filter unit will pop–up and latch the engine fuel control fault indicator on the aircraft refueling panel. Excessive fuel pressure drop, caused by a complete filter blockage, will open the by–pass valve and activate a non resettable pop–up indicator on the filter unit.

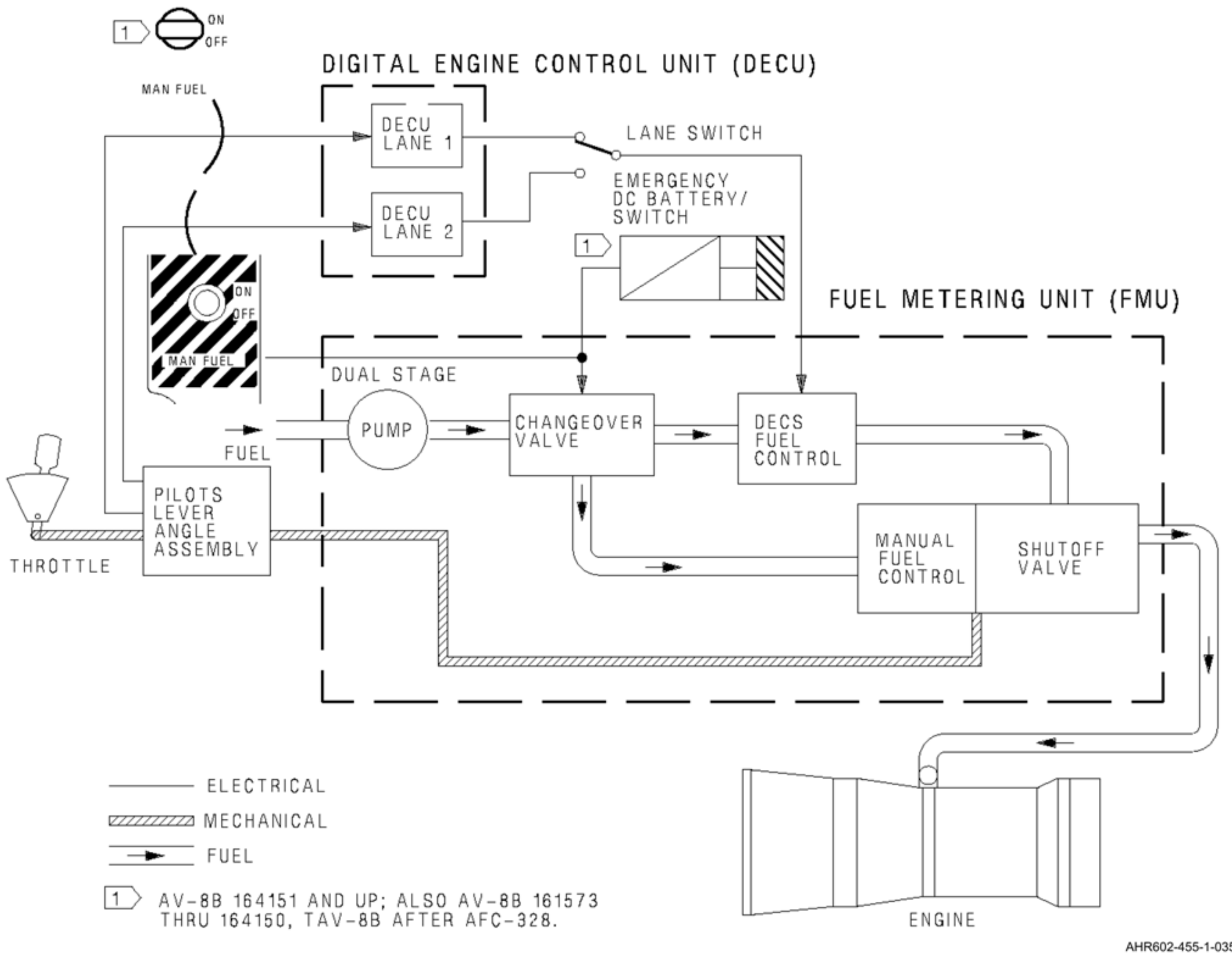


Figure 2-2. Digital Engine Control System

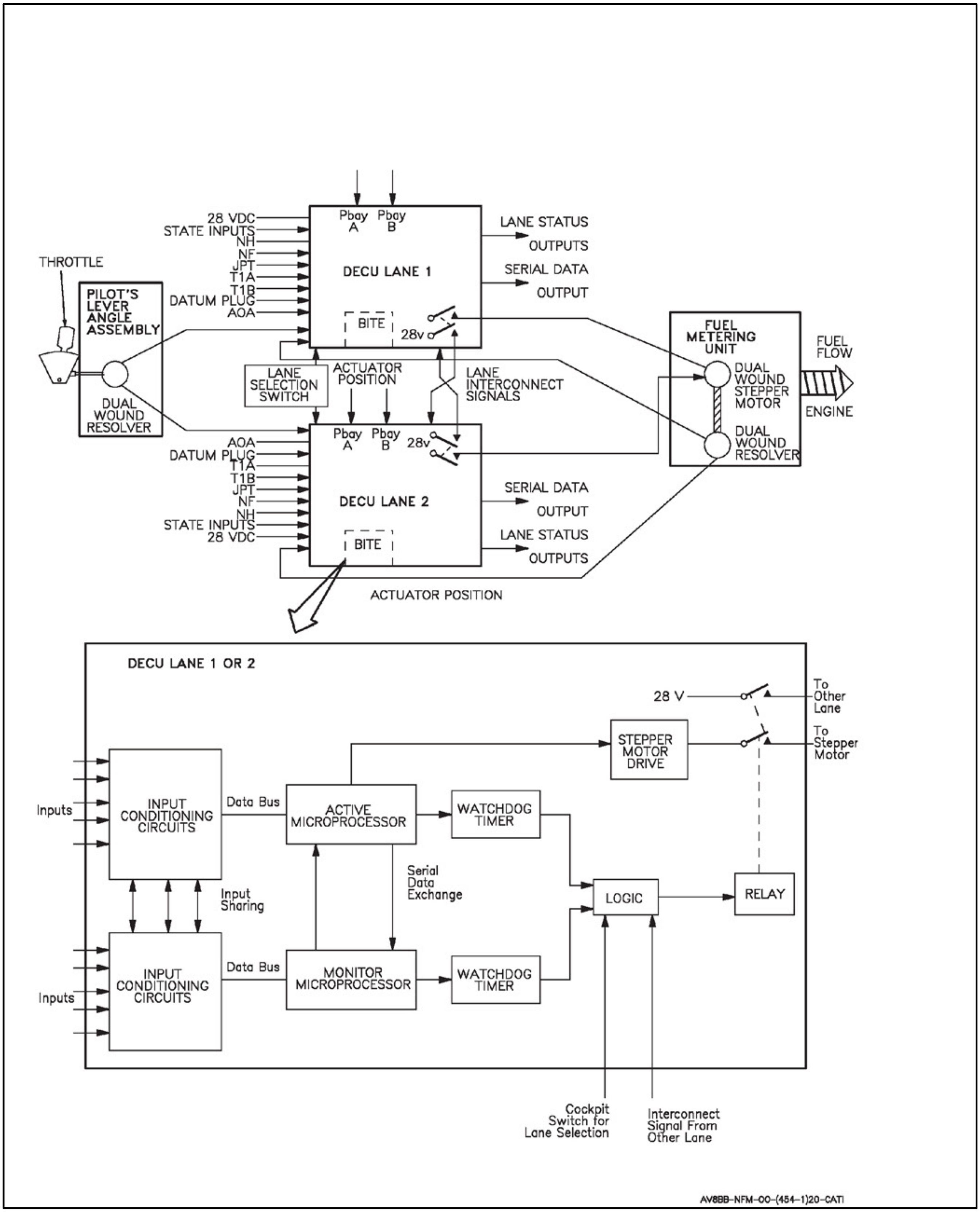


Figure 2-3. Digital Engine Control Unit

2.3.1.5 P3 Limiter

The P3 limiter (combustion chamber pressure limiter) vents the DECS P3 air pressure signal to the atmosphere when P3 pressure exceeds the limit value. The drop in the DECS P3 air pressure signal causes the FMU to reduce fuel flow thereby reducing engine internal operating pressure preventing possible engine overpressure resulting in structural damage. The engine is most likely to operate on the P3 limiter during low altitude, high airspeed conditions with cold ambient temperatures (-408 engine may include ISO standard ambient temperatures and below). P3 limiting may begin as airspeed exceeds 475 KCAS (standard day) and may be noticed by the pilot as rpm fluctuations on the order of one to three percent rpm. These fluctuations will occur at a rate of two to three per second. Reducing the throttle slightly will cause the fluctuations to stop.

2.3.1.6 DECS Limiting

For the F402-RR-406 engine the jet pipe temperature (JPT) is limited to 727 °C for short lift wet, 703 °C for short lift dry, 665 °C for Combat, and 625 °C for maximum thrust.

For the F402-RR-408 engine the JPT is limited to 800 °C for short lift wet, 780 °C for short lift dry, 750 °C for combat, and 710 °C for maximum thrust.

JPT limiting inputs include JPTL switch, gear position, nozzle position, water injection switch position, air data computer (ADC) airspeed, and combat mode switch position. With gear down, or nozzles greater than 16° down, the short lift wet or dry datum is selected depending on the water arming switch position, if the combat mode switch in the main wheelwell is in the ENABLE position. If the combat mode switch is in the DISABLE position, DECS will limit rpm to 99 percent for the -406 engine and 109 percent for the -408 engine when above 250 knots. With gear up, nozzles aft, and combat mode switch in the enable position, the maximum thrust or combat datum is selected by the combat select switch. Selecting limiter off, then reselecting limiter on will result in up to 15-second delay in active limiting of JPT under DECS control. During this time, the pilot must manually maintain JPT limits.

2.3.1.6.1 Compressor Speed Limiting at Altitude

DECS limits the corrected compressor speed based on altitude and angle of attack (AOA). Above 18,000 feet the DECS will reduce the limiting corrected compressor speed and slow the engine acceleration rate as AOA increases. This angle of attack cutback will reduce the likelihood of an engine surge. With an ADC failure (loss of AOA signal), DECS will control the corrected compressor speed and engine acceleration rate as though the aircraft were at maximum AOA. This backup schedule only impacts engine operation above 18,000 feet. In the event of AOA loss above 18,000 feet the cutback in corrected compressor speed and acceleration rate will reduce maximum available engine thrust and therefore impact aircraft performance. Engine surge protection will be at its highest level for the given aircraft altitude.

2.3.1.7 Bleed Air Pressure Switch

The bleed air pressure switch (BAPS) automatically compensates for the change in fuel flow demand due to reaction control system bleed.

2.3.2 Fuel Metering Unit

The FMU is located on the engine fan case aft of the DECU. The FMU contains the hydromechanical controls required to pump, filter, and meter fuel. It is divided into a primary (DECU controlled with P3 inputs) and a manual fuel system (MFS).

The DECU control inputs are provided to a stepper motor which in turn operates a fuel metering valve to properly meter fuel for a desired engine response. The fuel metering valve is also controlled by P3 pressure inputs. Partial or total loss of the P3 signal pressure due to line leakage can result in a large loss in thrust and fuel flow to the engine. The PLA unit is attached to the FMU and is driven by the pilots throttle input shaft. The PLA provides two electrically independent signals to each DECU. A solenoid operated change-over directs fuel to either the primary fuel control (DECU) or MFS.

The MFS enables the engine to continue operating following a failure within the primary fuel control system. The solenoid operated changeover valve must have fuel pump pressure and dc electrical power available to successfully select MFS. Below 16 volts, normal manual fuel selection cannot be guaranteed. In MFS the throttle lever is mechanically linked to the throttle valve on the FMU and the valve opening is governed strictly by throttle lever position.

2.3.3 Manual Fuel System

The MFS provides an alternate means of engine control if the primary fuel control system fails. Engine handling and relighting are adequate for emergency recovery. MFS is selected by actuation of the MAN FUEL switch located in the striped area of the throttle quadrant panel or on AV–8B 164151 and up; also AV–8B 161573 through 164150, TAV–8B 162747 through 164542 after AFC–328 by activating the MFS EMER BATT located outboard of the throttle nozzle quadrant.

With MFS control, the engine response is more sensitive to throttle movement because the MFS does not contain any automatic altitude compensation, acceleration controls, or limiters. See Figure 2-4 for a comparison between DECS and MFS. The MFS is basically a fuel tap and engine rpm is controlled only by the throttle and engine operating conditions (speed, reaction control system (RCS) bleed extraction and environment). MFS is fuel flow limited to a maximum scheduled flow of approximately 260 pounds per minute at maximum throttle position. Maximum throttle position in MFS at near sea level static conditions with nozzles at 10 degrees and neutral flight controls will provide approximately 111.0 percent corrected fan speed versus the 116.8 percent corrected fan speed limitation provided under DECS control. Actual mechanical speed and thrust achieved in MFS will vary with RCS bleed extraction rate, water injection usage and ambient conditions. Anticipate maximum achievable MFS performance equal to or slightly less than short lift dry performance under DECS control when operating near sea level static conditions. The throttle lever is mechanically linked to the throttle valve on the FMU and the valve opening is governed strictly by throttle lever position. Engine acceleration rate is controlled by throttle movement. Care should be taken to limit throttle operation to control the engine manually within its normal acceleration limitations. The engine is quite sensitive to over fueling when rpm is below 75 percent therefore throttle movement should be slow and smooth. Care should be taken not to move the throttle faster than the engine will normally accelerate when controlled by the primary fuel control system. At sea level, moving the throttle from the idle stop to the mid–throttle position in less than 6 seconds or, at any altitude, moving the throttle without appropriate engine rpm response, greatly increases the risk of engine surge. Since the possibility of surge is greater at low rpm, throttle movement must be slowest in the lower portion of the rpm band. (Approximately 4 seconds from idle to 55 percent and 2.5 seconds from 55 percent to 100 percent). Above 75 percent rpm the engine is quite tolerant to throttle movement at lower altitudes (semi–jetborne or jetborne flight).

The sensitivity of MFS increases with an increase in altitude since fuel flow remains constant with throttle lever position and approximates to that of the DECS only at sea level (Figure 2-4). Flight testing has shown that at 40,000 feet only one inch of throttle movement from idle may provide combat thrust. All throttle movements should be made with specific reference to the rpm indicator. Even at medium altitude, maximum rpm may be achieved with as little as half the full throttle lever travel. Preferably MFS selection should be accomplished at idle throttle, but in time critical emergencies may be selected up to full throttle. Selection of MFS with low engine rpm and high throttle lever angle position significantly increases the likelihood of engine surge. With MFS selected, the engine is cleared for operation in all flight regimes. Pilot should cross–check RPM, JPT, and corrected fan speed to maintain the engine within limits.

When operating in MFS the igniters and primer solenoid are continuously energized. They can be secured to either minimize the drain on the battery in a total electrical failure, or limit component wear by momentarily selecting either OFF or ALERT with the battery switch. This procedure requires that all other electrical power is off prior to momentarily securing the battery. Continuous ignition can be restored by momentarily selecting the MFS switch to ON. The igniters and primer valve can be operated at any time by pressing the airstart button. Operating in the MFS without continuous ignition gives a slightly increased chance of engine flameout on slam deceleration.

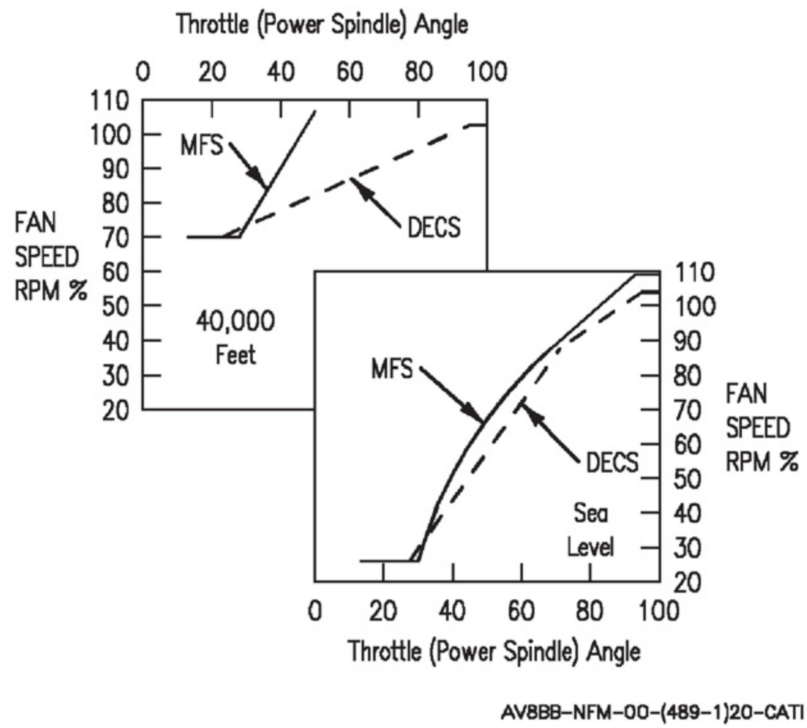


Figure 2-4. DECS/MFS Comparison

2.3.3.1 Effect of Water Injection on Thrust

When water is introduced into the engine, it runs less efficiently for a given metered fuel flow. Therefore, when water flows, the available thrust is reduced. In DECS, fuel flow is automatically increased to compensate for the power loss and to increase the rpm to the wet datum. An overall increase in rpm will be seen. In MFS, fuel flow is defined by throttle position and engine operating condition (speed, RCS bleed extraction and environment) and is flow limited to a maximum of approximately 260 pounds per minute at maximum throttle. Subsequently, at maximum throttle position, scheduled fuel flow available is constant and maximum rpm and thrust will decrease in response to the reduction in power resulting from water injection. The speed and thrust reductions may be up to approximately 2 percent corrected fan speed and 1000 pounds of thrust compared to the expected dry values. If the throttle is steady (at full power for example) then thrust will be reduced when water flows compared to the expected dry value. The thrust reduction may be up to 1,000 pounds. If water is flowing while operating in MFS and more thrust is required, the water must be selected off.

2.3.3.2 Manual Fuel Switch

The MAN FUEL switch is located in the striped area of the throttle quadrant and is a three position switch spring loaded to center. The switch must be actuated until the MFS caution illuminates or extinguishes to achieve MFS selection or deselection as appropriate. Up to one second may be required. The switch energizes a solenoid which magnetically latches in the MFS or DECS position. A minimum of 16 volts is required to move the solenoid, however, switching may be achieved with as low as 5 volts available. The solenoid directs fuel pressure to the changeover valve to achieve the required change, which is signalled by the MFS caution. Therefore, if MFS is selected or deselected with the engine off, the full change over will not take place until the engine is starting and fuel pressure becomes available, the MFS caution will then signal the change. The ignitors and primer solenoid will still operate according to the selection of the MFS switch. The igniters are not rated for continuous operation; therefore, if operational conditions permit, the MAN FUEL switch should be placed to OFF before engine shutdown. DC power is required to switch from DECS to MFS when using the MAN FUEL switch. Inflight, once manual fuel has been selected, it should not normally be deselected.

ON – Engine control transferred from DECS to MFS.
(Center) – Neutral position.
OFF – Engine control transferred from MFS to DECS.

2.3.3.3 MFS Emergency Battery

(AV-8B 164151 and up; also AV-8B 161573 through 164150, TAV-8B 162747 through 164542 after AFC-328). The MFS EMER BATT is located on the left cockpit left of the throttle grip. The MFS EMER BATT is a one shot battery device for selecting MFS when electrical power is lost or as an alternate means for selecting manual fuel. The battery is activated by extending the pull shaft forward approximately 1/2 inch. Once the battery is activated, the manual fuel solenoid is magnetically latched in the MFS ON position regardless of the position of the manual fuel switch. MFS cannot be deselected using the battery. However, if electrical power is restored MFS can be deselected using the manual fuel switch. The activation rod is mechanically locked to prevent reseating of the handle. A 1/2 inch white band on the exposed portion of the rod provides a visual indication that the battery has been activated. After selection, maintenance must replace the battery. See Figure 2-5 for MFS emergency battery.

2.3.3.4 MFS Caution Light

The MFS caution light, on the priority caution light panel, illuminates any time the engine fuel system is in the manual fuel mode. If the MFS caution light illuminates when operating under DECS control, MFS should be selected ON. On AV-8B 163519 and up, TAV-8B 163856 and up, a MANUAL FUEL, MANUAL FUEL voice warning, is provided in conjunction with the MFS caution light.

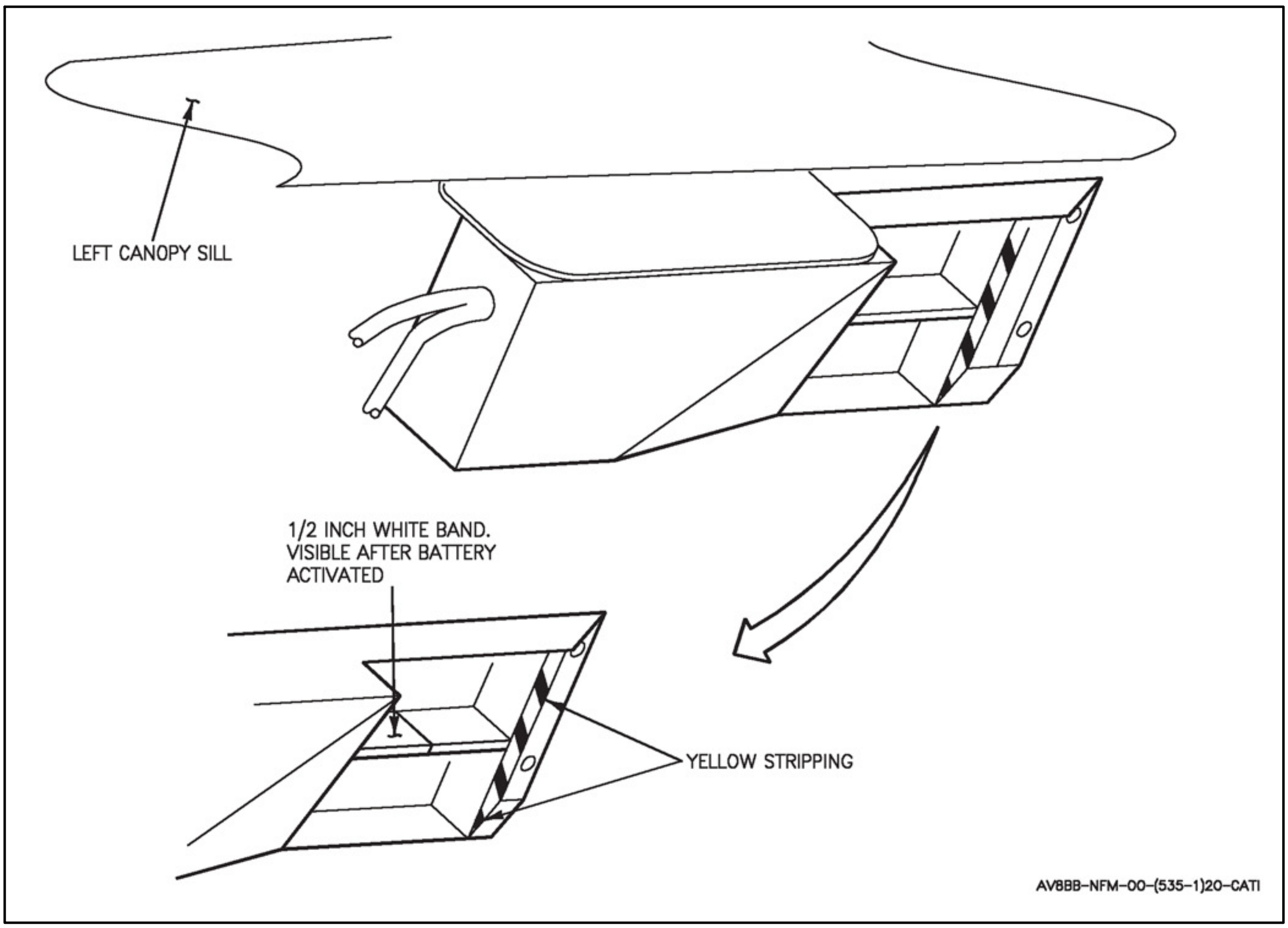


Figure 2-5. MFS Emergency Battery

2.3.4 Fuel Distribution System

The fuel distribution system consists of a fuel distribution valve, upper and lower manifolds, flow distributors and a dump valve. The fuel distribution valve is located on the FMU and functions to provide system back pressure and correct proportion of FMU scheduled flow between the upper and lower manifolds. The upper and lower manifolds are positioned around the circumference of the engine HP delivery casing and distribute the fuel to the 18 flow distributors arranged in pairs around the delivery casing. The distributors deliver fuel into the 18 combustion chamber vaporizer tubes with appropriate swirl to enhance vaporization.

2.3.4.1 Torch Igniter Valve and Primer Jets

This solenoid valve is open during the engine starting sequence and supplies fuel to five (–406) or two (–408) primer jets.

2.3.4.2 Dump Valve and Tank

A spring–loaded open dump valve is held closed by primary manifold pressure when the engine is running. During engine shut down, the valve opens and fuel from both the primary and secondary manifold drains into a dump tank. During wingborne flight, any fuel in the dump tank is automatically siphoned overboard. A normal start/stop cycle dumps approximately 1.2 pints of fuel into the dump tank. A tank overflow outlet dumps fuel overboard if more than 5 engine start/stop cycles are made between flights.

2.3.5 Engine Monitoring System (TAV–8B 163856 and up, AV–8B 163176 and up)

The engine monitoring system (EMS) consists of the engine monitoring unit (EMU) and advanced memory unit (AMU). While the engine is running, the EMU continuously monitors engine mounted sensors (vibration, pressure), the DECS and several airframe inputs to detect engine anomalies. Engine operations which exceed specific datum limits and component failures are detected and a summary of these incidents can be displayed on the DDI (MENU/ENG/EMS). Certain parameter exceedances activate the ENG EXC caution light on the caution/advisory light panel for the incident duration. Those exceedances are engine overspeed, overpressure, temperature and engine vibration exceedance. All incidents latch the mechanical EMU indicator on the aircraft refueling panel (door 22L). The EMU also processes data to calculate engine life counts which can be displayed on the digital display indicator (DDI) (MENU/ENG/EMS/CTS).

When the EMU detects a parameter exceedance (incident), a time–history of 36 engine and aircraft parameters is recorded and sent to the data storage set (DSS) or AMU Maintenance Card for storage and post–flight analysis. The length of time–history depends on the incident, but can vary from 16 seconds before to 4 seconds after incident detection for a Pilot Record and to 4 seconds before and 16 seconds after for an airstart. A summary of all in–flight incidents and engine life counts is automatically sent from the EMU to the DSS or AMU at the end of a flight for post–flight analysis and archive.

2.3.5.1 EMS Button (Pilot Record)

The EMS button provides a method of EMU manual initiation and is located on the throttle quadrant. When the button is depressed, the EMU records on the DSS or AMU Maintenance Card a time–history of 36 engine and aircraft parameters which will be available for post–flight analysis. The time–history stored on the DSS or AMU Maintenance Card contains data from 16 seconds prior to button depression and continues for a further 4 seconds.

2.3.6 Ignition System

During engine start, fuel is pumped, via the torch igniter valve, into a vaporizing chamber through two primer jets adjacent to the two torch igniters and three auxiliary primer jets. When the airstart button on the front of the throttle is pressed the ignition system is energized and will remain so until the button is released. The irregular crackle of the igniters can be heard if the airstart button is pressed before engine start up; this is a preflight check of the torch igniters. A regular crackle indicates failure of one of the igniters. Both DC powered pumps are automatically on while the airstart button is pressed. Ignition is automatic during starting cycle; it is also automatic and continuous when manual fuel is on.

2.3.6.1 Battery Switch

The battery switch is on the right console. The switch must be in the BATT position before the GTS and engine can be started. Three positions exist for the battery switch. Refer to DC Electrical Power for system description.

2.3.6.2 Ignition Isolation Switch

The ignition isolation (IGN ISO) switch on the ground power panel is lever–locked to the OFF position. With the switch in OFF, ignition is automatically provided during engine start. Placing the switch to ON disables the normal start ignition and allows the engine to be wet or dry cycled without ignition.

2.3.6.3 Engine Start Switch

The engine start switch is located on the right console. Placing the switch to ENG ST initiates the GTS and engine starting sequence (fwd cockpit only on TAV–8B aircraft).

2.3.7 Water Injection System

The water injection system enables rpm to be increased for a given turbine entry temperature to sustain short lift wet and normal lift wet ratings at temperatures up to ISA +15 °C. The main components consist of a water tank, air turbine pump, water filter and pressure switch, water manifold injectors, engine fuel control, bleed air supply, a short lift thrust relay, an airspeed relay and an H_2O control relay. A flow control valve allows warm air to heat the system components at low temperature to keep them from freezing.

2.3.7.1 Water Switch

The water injection switch is on the left main instrument panel. The switch is labeled H_2O and has positions of TO (takeoff), LDG (landing) and OFF.

TO or LDG	Water injection system is armed (engine JPTL datum changed) and the engine fuel control provides supplementary fuel resulting in an engine rpm rise at IDLE. The –406 engine increases 3.3 to 4.3 percent, and the –408 engine increases 6.0 to 7.0 percent.
TO	Water flows when the throttle is set above 95 percent rpm for the –406 engine and 105 percent rpm for the –408 engine. After takeoff, water continues to flow until airspeed exceeds 250 knots, water is depleted, OFF is selected, or the throttle is moved below 95 percent rpm for the –406 engine or below 103 percent rpm for the –408 engine.
LDG	Water flows when airspeed is below 250 knots, jet pipe temperature exceeds 684 °C (Night Attack aircraft with –406 engine and TAV–8B 164113 and up), 687 °C (Day Attack aircraft with –406 engine and TAV–8B 162747 through 163861), 765 °C (–408 engine), and the throttle is set above 95 percent rpm for the –406 engine or 105 percent rpm for the –408 engine. Water flow stops only if water is depleted, OFF is selected, or the throttle is moved below 95 percent rpm for the –406 engine or 103 percent rpm for the –408 engine. After initial water flow, water will flow each time the throttle is set above 95 percent or 105 percent rpm, as applicable, regardless of the JPT until the LDG mode datum is reset by cycling the H_2O switch.
OFF	Shuts off water injection system. The OFF position must be manually selected to reset the engine jet pipe temperature limiter datum and engine fuel system.

2.3.7.2 Water Injection Switch (AFT Cockpit)

The rear cockpit water injection switch is located on the lower left main instrument panel. The switch is labeled H_2O and has positions of TO and FWD.

TO – Overrides forward cockpit switch and arms water injection system.
FWD – System controlled by forward cockpit switch.

2.3.7.3 Water Flow Light

A green water advisory flow light on the engine display panel (EDP) comes on displaying a W when water injection is selected and water is flowing. If the flow light (W) does not come on, indicating no water flow, the lift rating JPT limit can be reached very quickly.

2.3.7.4 H_2O SEL Caution Light

The H_2O SEL caution light on the caution/advisory light panel comes on if the water switch is in TO or LDG and airspeed is above 250 knots.

2.3.7.5 H_2O Light

The H_2O caution light on the priority caution panel comes on when water injection is selected and less than 15 seconds of water remains. The light stays on after all water is consumed or until the water switch is placed to OFF. On TAV-8B 163856 and up, AV-8B 163519 and up, a WATER, WATER voice warning is provided in conjunction with the H_2O caution light.

2.3.7.6 Water Dump Switch

The water dump switch is on the left console and has positions of DUMP and OFF. The switch is lever-locked in the OFF position (fwd cockpit only on TAV-8B aircraft).

DUMP – Water is dumped.
OFF – Dumping is stopped.

2.3.7.7 Water Tank

The water tank is located in the engine bay, just aft of the engine. It contains approximately 500 pounds of distilled or demineralized water with flow duration of approximately 90 seconds. The tank is replenished by gravity filling via a filler cap on the top surface of the fuselage. A water quantity probe extends down into the tank. This signals a quantity gauge transmitter, operates an H_2O (approximately 15 seconds of water remaining) caution light on the priority caution light panel and also ensures, by deenergizing a low level switch, that the system cannot produce delivery pressure if initially there is less than approximately 25 pounds of water in the tank. The H_2O caution light also illuminates and the water pump shuts down during normal operation if the water pressure drops below acceptable limits or the quantity is less than approximately 25 pounds. Repeated use of water other than distilled or demineralized will cause engine performance to deteriorate.

2.3.7.8 Water Injection System - Conditioned Air

To prevent freezing in the water system, a thermal switch and flow control valve taps hot bleed air and circulates it around the system.

2.3.8 Thrust Vectoring

The four nozzles are mechanically interconnected and can be simultaneously rotated by a lever in the cockpit, from fully aft through a 98° arc to a forward braking position to vector the engine thrust. The nozzle mechanism (Figure 2-6) also operates a butterfly valve lever to supply bleed air to the reaction controls. The system is driven by an air motor supplied with air from the HP compressor. The air motor drives a gear box which positions all four nozzles through mechanical linkages. When the nozzles reach the selected position, the control valve is positioned to cut off the air supply so that the nozzles remain in the selected position. Air is supplied to the motor via a short double walled flexible pipe. If the inner wall fails, pressure to the air motor is maintained by the outer wall. Indication of this failure is given by an air motor feed pipe leak indicator, which then protrudes about 1/2 inch from the side of the lower left fuselage.

2.3.8.1 Reaction Control System Effects on Engine Performance

To provide flight stability and control to the AV-8B, the Reaction Control System (RCS) uses high pressure compressor bleed. This bleed air is taken from the last stage of the compressor through a manifold around the combustion chamber. As the pilot moves the stick to control the aircraft, bleed air is directed to the appropriate RCS nozzle(s) to impart control forces on the aircraft.

When bleed is used by the RCS, that amount of air is not available for flow through the engine's turbine. This starves the turbine of a little cooling air and takes away some mass flow for the turbine to use to provide rotational power for the compressor. When this happens, the Digital Engine Control System (DECS) instantaneously increases fuel flow to the combustion chamber to maintain fan speed at the demanded setting of the throttle position. This increased fuel flow raises the temperature of the flow leaving the combustion chamber and restores pressure entering the turbine that provides power to the turbine. Consequently, the JPT rises due to the higher fuel burn. When the reverse takes place, bleed decreases, fuel flow decreases, and the JPT lowers. Therefore, the primary consequence of engine bleed is higher JPT. With the increase in RCS bleed, total engine thrust remains fairly constant as the higher jet pipe temperature compensates for a slight loss in engine mass flow.

2.4 ENGINE CONTROLS

2.4.1 Throttle

The throttle is located on the left console (Figure 2-6). The throttle is mechanically linked to the PLA and the combined manual fuel valve and fuel shutoff cock within the FMU. When in DECS control the PLA sends an electronic signal to the DECUs based on the position of the throttle. When the throttle is fully aft, the high pressure fuel shutoff valve is closed and cuts off fuel supply to the engine. Forward movement to the idle rpm position opens the shutoff valve and a ratchet stop prevents movement back except when a spring loaded throttle cutoff lever, on the front of the throttle, is lifted. Inside the quadrant is a spring loaded full throttle stop. If the throttle is pushed hard against this and compresses it, the jet pipe temperature limiter (JPTL) switch is switched OFF; it must subsequently be switched ON by hand. The full throttle stop can be overridden if necessary by a push force on the throttle of 30 to 35 pounds. An interference catch ensures that the throttle lever cannot be moved past a parking BRAKE LOCK position when the lock is engaged. A throttle damper friction control is aft of the throttle quadrant.

2.4.1.1 Rear Throttle (TAV-8B)

The rear throttle and throttle cutoff lever are linked to the forward controls and permit full engine control from the rear cockpit. Stops and internal switches are located in the forward throttle quadrant. There is no throttle friction knob in the rear cockpit. Throttle grip switches are the same as the forward cockpit.

2.4.2 Nozzles Control Lever

The nozzles are controlled by a lever in a quadrant inboard of the throttle, see Figures 2-6 and 2-7. If the nozzle actuating air motor fails to move when the lever is moved, the initial 2 to 3 inches are taken up in opening the control valve. To prevent damage to the valve (if lever movement is continued) an override spring in the control linkage starts to compress so that a moderate force is felt. The spring will also be compressed if the air motor responds slowly to lever movement. When the lever is fully forward against a stop at the front end of the quadrant the nozzles are fully aft, and they rotate down as the lever is moved aft. As the nozzles are rotated down through 11° to 16° from fully aft, a microswitch changes the JPT limiter from maximum thrust to short lift. Maximum thrust datum is reselected as the nozzles are rotated up through 7° to 12° toward fully aft. When the lever is moved aft to the hover stop the nozzles are set for hovering. The position of this stop gives a fuselage hovering attitude of about 6 1/2°; i.e., the nosewheel slightly higher than the main wheels.

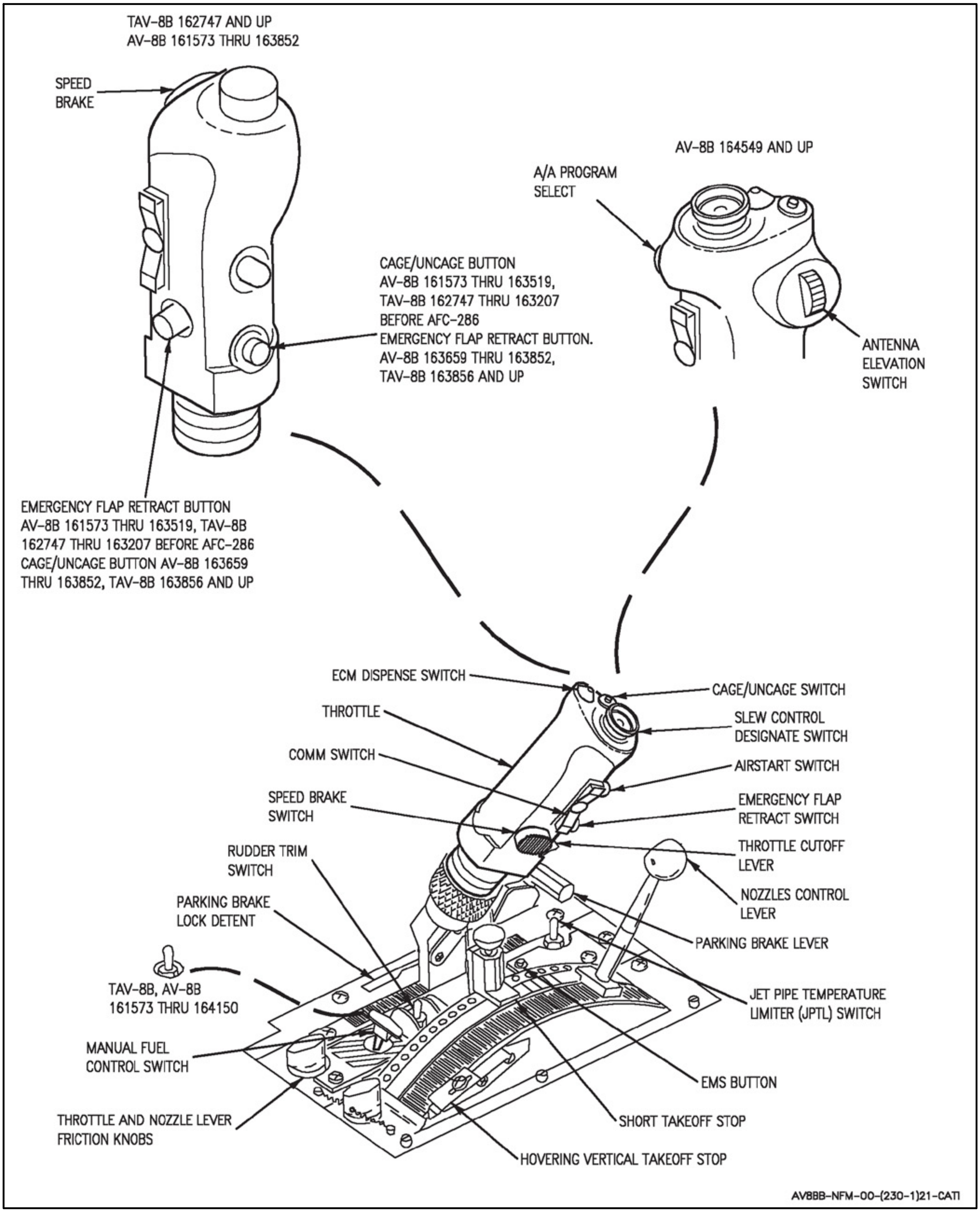


Figure 2-6. Throttle Nozzle Quadrant

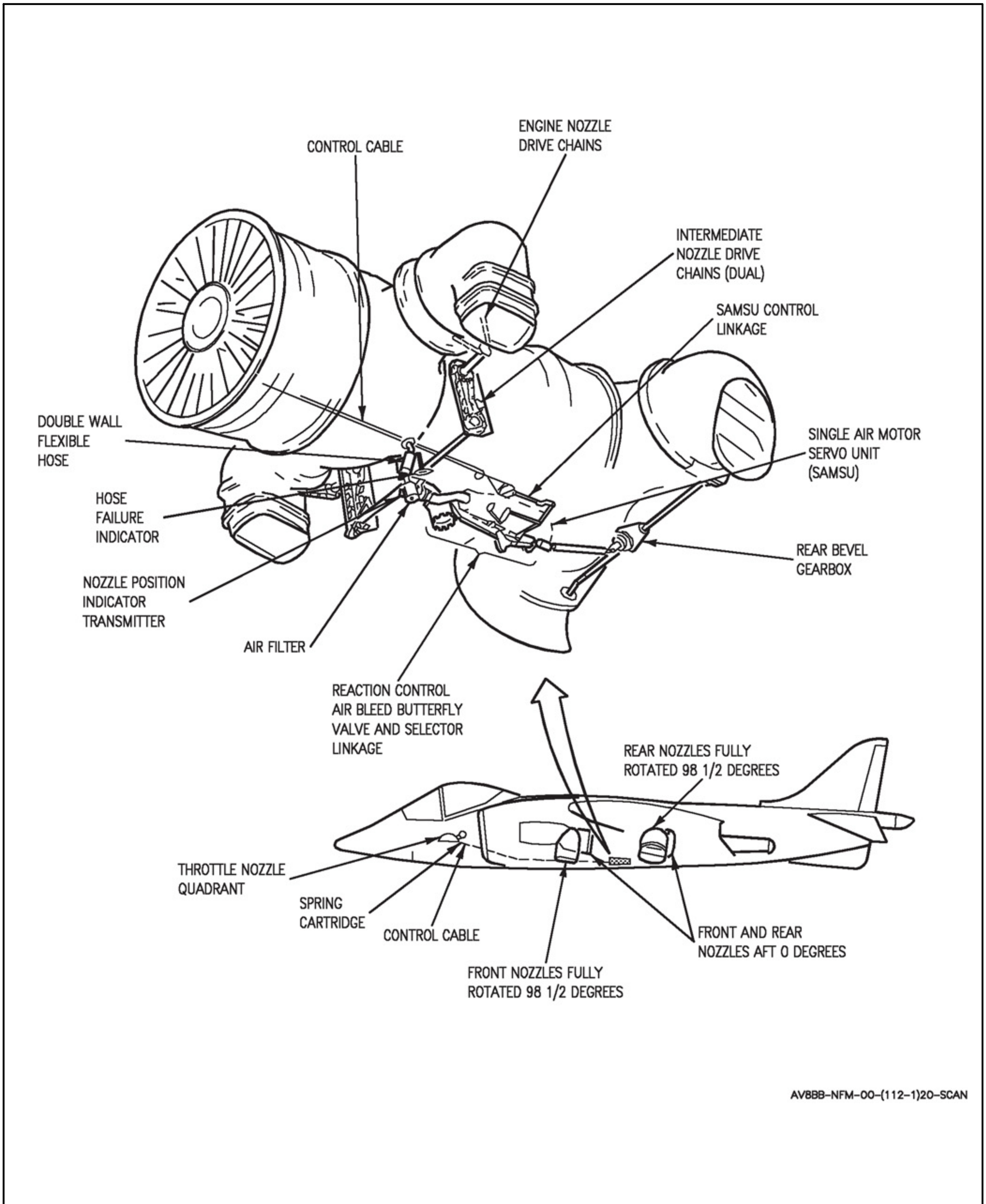


Figure 2-7. Nozzles Control Mechanism

The engine datum is at 1.5° to the fuselage datum. The nozzle angle for hovering is therefore 82° from the engine datum. A nozzle braking position, at 98.5° from the engine datum, can be selected by lifting the nozzle lever over the hover stop and pulling it back along a ramp. An adjustable short takeoff (STO) stop on the quadrant can be preset to allow rapid selection of nozzle angles from 35° to 75° (in 5° increments) as required, for STO or rolling vertical takeoff (RVTO). The stop has a spring loaded control knob and is set by lifting the knob and moving the stop to the desired position, then releasing the knob to engage the stop in a locating hole (5° increment) in the quadrant. The selected nozzle angle is indicated on a scale alongside the stop. The STO stop can be overridden, in both directions, by lifting the nozzle lever over the stop. When the stop is not in use it should be moved aft to a locating hole where it is clear of the lever's travel. A nozzle lever friction damper at the rear of the quadrant is shear wired to prevent lever creep. If the flaps switch is in STOL, the flaps move with the nozzles. Refer to Flaps, this section. When manually moving the nozzles during ground handling, the nozzle lever should be placed to correspond with nozzle position so as not to damage the air motor rotary control valve.

2.4.2.1 Rear Nozzles Control Lever (TAV-8B)

The rear cockpit nozzles control lever is linked to the forward cockpit lever and provides the same control as the forward lever. STO and vertical takeoff (VTO) stops are located only in the forward cockpit. There is no nozzle lever friction knob on the rear cockpit.

2.4.3 STO Stop Indicator (TAV-8B)

The STO STOP indicator is located on the rear cockpit lower left main instrument panel, next to the emergency landing gear handle. The forward cockpit STO stop setting is displayed from 35° to 75° in 5° increments. The 0° will be displayed when electrical power is removed from the indicator or for settings below 35° and a barber pole will be displayed for settings above 75°.

2.4.4 CMBT Switch/Light

The CMBT switch/light is on the CMBT/water panel. When the switch/light is first pressed, a green SEL light comes on indicating combat thrust rating is operational and armed for wingborne flight. With the SEL light on, gear up, and nozzles aft, a yellow (green on Radar and Night Attack aircraft) CMBT light comes on when JPT reaches 630 °C with the -406 engine or 715 °C with the -408 engine. If JPT remains at or above 630 °C or 715 °C, as applicable, for 2.5 minutes the CMBT light will flash.

Pressing the switch/light a second time disables combat thrust and turns off the light(s). If the SEL light does not come on when the switch/light is first pressed, the combat thrust limiter is disabled and cannot be selected until the combat mode switch in the main wheelwell is placed to ENABLE. With the combat mode switch in DISABLE, wet and dry rpm will be restricted to 99 percent for the -406 engine or 109 percent for the -408 engine, when above 250 knots during thrust vector control (TVC) (nozzles greater than 11° to 17°).

Use of the full 10 minutes combat rating must be carefully monitored to prevent premature engine removal due to count dissipation.

2.4.4.1 CMBT Switch/Light (AFT Cockpit)

The rear CMBT switch/light is on the master mode panel located on the left main instrument panel. The SEL and CMBT lights repeat the forward cockpit SEL and CMBT light indications. The rear CMBT switch is disabled.

2.4.5 JPTL Switch

The JPTL switch when selected OFF mutes the DECS JPT limiter function. The acceleration limit corrected fan speed, and corrected compressor speed limiting functions are retained. The AOA cutback function is not retained. With the JPT limiter muted, the mechanical fan speed schedule is reset to the short lift wet schedule and limit. This results in a 3.3 to 4.3 percent increase in engine rpm for the -406 engine, and a 6.0 to 7.0 percent rpm increase for the -408 engine. Selecting limiters OFF will only result in an increase in the full throttle rpm and thrust if the engine is actively being controlled on either a JPT limit or dry mechanical fan speed limit. If the engine is being actively controlled on the corrected fan speed limit or the short lift wet mechanical speed limit, selecting the JPTL switch to the OFF position will not result in an rpm or thrust increase.

2.4.6 JPTL Test Switch

The JPTL test (JPTL TEST) switch, on the ground power panel, has positions of OFF, MAX and AMPL. The switch is spring loaded to the OFF position. The MAX and AMPL positions are for maintenance use only and should not be selected by the pilot.

2.4.7 Engine Fuel Control Switch

The engine fuel control (EFC) switch, located on the left console, is labeled EFC. It has positions of POS 1 and POS 2 for selecting DECU 1 and DECU 2 respectively, as the engine controlling DECU.

2.5 ENGINE DISPLAYS

Engine displays are provided by the engine display panel (EDP), head-up display (HUD), and DDI. Various warning and caution lights are provided to notify the pilot of conditions which would hinder engine performance.

During a battery start, JPT and rpm are the only engine displays that are operative. The remaining displays will become operative or may be selected after the main generator comes on line.

2.5.1 Engine Display Panel

The EDP is on the right side of main instrument panel. The EDP has six drum type indicators for display of reaction control system duct pressure, fuel flow, stabilator trim position, engine rpm, jet pipe temperature (JPT), and water quantity. A dial type indicator displays nozzle position and a green FLOW light indicates water flow.

2.5.1.1 Duct Pressure Indicator

The duct pressure indicator displays reaction control system duct pressure in pounds per square inch. It displays units, tens, and hundreds.

2.5.1.2 Fuel Flow Indicator

The fuel flow indicator displays engine fuel flow in pounds per minute. It displays units, tens, and hundreds.

2.5.1.3 Stabilator Position Indicator

The stabilator position indicator displays stabilator position in degrees nose up or nose down. It displays units and tens on the right two drums and displays a vertical arrow pointing either up or down on the left drum.

2.5.1.4 Tachometer

The tachometer displays engine speed in percent rpm. It displays tenths, units, tens, and hundreds. A fixed decimal point is placed between the tenths and unit drums. An ENG RPM SEL (select) switch, on the left console, selects HI (compressor) or LO (fan) rpm display.

2.5.1.5 Jet Pipe Temperature Indicator

The JPT indicator displays JPT in °C. It displays units, tens, and hundreds. On AV-8B 165354 and up; also AV-8B 161396 through 165312, TAV-8B 162747 through 164542 after AFC-394 the JPT indicator displays 000 °C in the event of an open thermocouple input.

2.5.1.6 Water Quantity Indicator

The water quantity indicator displays pounds of water remaining in units of ten. The tens and hundreds digits change while the units digit is a fixed display indicating zero.

2.5.1.7 Nozzle Position Indicator

The nozzle position indicator displays nozzle position in degrees. The scale is graduated in units of ten and the range is from 0° to 120°.

2.5.1.8 Water Flow Light

Refer to Water Injection System, this chapter.

2.5.1.9 BIT Switch

Used to activate a test of the EDP. The display indicators are cycled through displayable numerals (111, 222, 333, 444, 555, 666, 777, 888 and 999) and some self-tests are done.

Note

The BIT switch can be activated in flight. This causes the MC to read JPT as 999, flag an overtemp and start adding engine life counts.

2.5.2 Engine HUD Displays

With the HUD V/STOL mode selected, engine rpm, JPT, nozzle position and water flow are displayed on the HUD. Engine power margin may be displayed in place of JPT and rpm. Refer to Figure 23-29.

2.5.3 Engine DDI Display

Engine displays available on the DDI include inlet guide vane angle, compressor rpm, fan rpm, corrected fan rpm, and JPT. To select the engine display, press MENU then ENG. See Figure 2-8 for a typical engine display. The engine identification appears at the top of the display (e.g. 406, 408 DR, 408, INVALID). Sortie JPT, maximum JPT, and overtemperature time are displayed at the upper right and engine life count, up to 10,000 for the -406 engine and 50,000 for the -408 engine, is displayed at the upper left. The sortie JPT displays the highest JPT for the current flight and may be reset by pressing the JPT button. The maximum JPT, overtemperature time, and engine life count are not pilot resettable. Water quantity is shown on the engine display with H4.0.

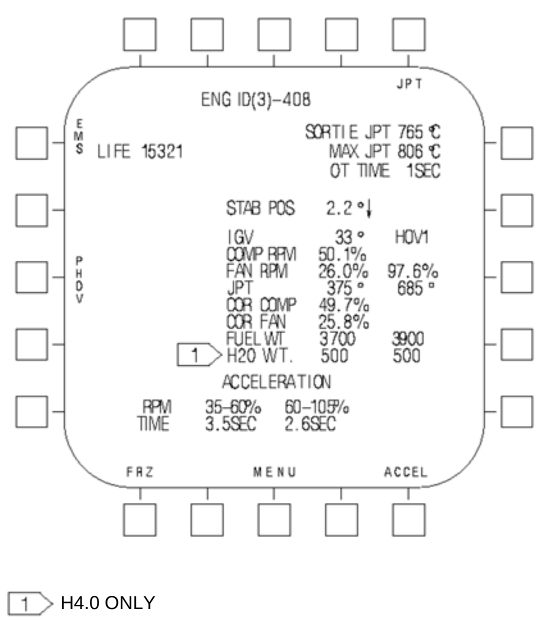


Figure 2-8. Engine DDI Display

Stabilator position, inlet guide vane angle, compressor and fan rpm, JPT, and fuel weight are displayed in the center. When the FRZ button is pressed the fan rpm, JPT, and fuel weight are recorded in the hover column and the ACPT (accept) and REJ (reject) options are enabled on the option display unit (ODU). Accepting or rejecting the data clears the hover column until FRZ is selected again.

The acceleration time for the applicable engine rpm range is displayed at the bottom of the display. The -408 engine display has two rpm ranges (35 to 60 percent, 60 to 105 percent) and the -406 engine display has three rpm ranges (27 to 55 percent, 55 to 100 percent, 100 to 104 percent). The display initializes with the last acceleration times displayed. The acceleration times are reset to 0.0 seconds by pressing the ACCEL button.

Pressing EMS button selects the incident summary display. Pressing the PHOV button selects the performance hover checks. Refer to performance hover checks in Chapter 10 for an illustration of the display and a description of the checks.

2.5.4 Engine Warning/Caution Lights

The engine warning/caution lights consist of the FIRE, OT, JPTL, and EFC warning lights on the warning lights panel and the 15 SEC caution light on the caution light panel.

The TAV-8B and AV-8B Day Attack aircraft have the warning lights on the warning/threat lights panel and the 15 SEC caution light on the priority caution light panel. The AV-8B Radar and Night Attack aircraft warning lights are on the warning lights panel and the 15 SEC caution light is on the caution light panel. Refer to paragraph 2.30 (TAV-8B, Day Attack aircraft) or paragraph 2.31 (Radar and Night Attack aircraft) for MASTER CAUTION and MASTER WARNING light operation.

2.5.4.1 OT Warning Light

The OT warning light, and OT XXX legend under the airspeed box on the HUD display, comes on if the JPT exceeds 765 °C for the -406 engine or 820 °C for the -408 engine. The OT warning light goes out after the JPT is reduced below 761 °C for the -406 engine or 816 °C for the -408 engine. The HUD OT XXX display can only be removed by changing reject levels on the HUD control panel. On TAV-8B 163856 and up, AV-8B 163519 and up, an OVERTEMP, OVERTEMP voice warning is provided in conjunction with the OT warning light.

2.5.4.2 JPTL Warning Light

The JPTL warning light comes on if the JPTL switch is OFF. On TAV-8B 163856 and up, AV-8B 163519 and up, a LIMITER OFF, LIMITER OFF voice warning is provided in conjunction with the JPTL warning light. Illumination of the JPTL warning light can signify any one of four faults:

1. JPTL switch OFF.
2. Failure of JPT limiter function within the DECU in use.
3. When illuminated in conjunction with an EFC caution, either electrical power to a DECU has been lost or a DECU has failed and the JPT limiter has failed in the DECU in use.
4. A failure has been detected in one or more of the DECU state inputs.

A state input failure could force the controlling DECU to default to a higher or lower JPT/RPM datum, cause a rpm fluctuation of about 3 to 5 percent, or cause the loss of the fast deceleration function on landing. Some state input failures will show no effect to the pilot.

In the event of a JPTL warning , placing the JPTL switch to OFF will ensure full short lift wet thrust will be available (i.e. a positive datum shift to short lift wet (SLW)).

2.5.4.3 15 SEC Caution Light (Day Attack Aircraft)

The 15 SEC caution light, on the priority caution light panel, comes on steady if the JPT exceeds the short lift dry(SLD) or short lift wet threshold of the particular engine installed. For the -406 engine the short lift dry threshold is 687 °C and the short lift wet threshold is 705 °C. If the JPT remains at or above the threshold over 15 seconds the 15 SEC light flashes. If the JPT decreases 4° below the threshold the 15 SEC light will go out. On AV-8B 163519 and up, a FIFTEEN SECONDS, FIFTEEN SECONDS voice warning is provided in conjunction with the 15 SEC caution light. The 15 SEC light is informative in nature and does not require immediate action from the pilot, however, as illustrated by Figure 11-8, excessive engine life counts result if engine JPT is not reduced.

2.5.4.4 15 SEC Caution Light (TAV-8B, Radar and Night Attack Aircraft)

The 15 SEC caution light operates the same as on the Day Attack aircraft except for the threshold at which the light comes on.

On TAV-8B 162747 through 163861 with the -406 engine installed, the 15 SEC caution light comes on steady if the JPT exceeds the short lift dry threshold of 687 °C or short lift wet threshold of 705 °C. On TAV-8B 164113 and up, and AV-8B Night Attack aircraft, with the -406 engine installed the 15 SEC caution light comes on steady if the JPT exceeds the short lift dry threshold of 684 °C or short lift wet threshold of 702 °C.

On aircraft with the -408 engine installed the 15 SEC caution light comes on steady if the JPT exceeds the -408 short lift dry threshold of 765 °C or short lift wet threshold of 780 °C.

On TAV-8B 163856 and up, AV-8B 163519 and up, a FIFTEEN SECONDS, FIFTEEN SECONDS voice warning is provided in conjunction with the 15 SEC caution light.

The 15 SEC light is informative in nature and does not require immediate action from the pilot, however, as illustrated by Figure 4-3, excessive engine life counts result if engine JPT is not reduced.

2.5.4.5 EFC Warning Light

The EFC warning light is located on the warning/threat panel (warning light panel for Radar and Night Attack aircraft). The light comes on when both DECUs have failed, or if both DECUs are not powered on. On TAV-8B 163856 and up, AV-8B 163519 and up, a FUEL CONTROL, FUEL CONTROL voice warning is provided in conjunction with the EFC warning light.

2.5.4.6 EFC Caution Light

The EFC caution light is located on the caution/advisory light panel. The light comes on when either DECU is failed regardless of the EFC switch position or if either DECU is not powered on. On TAV-8B 163856 and up, AV-8B 163519 and up, a CAUTION, CAUTION voice warning is provided in conjunction with the EFC caution light. The EFC caution light will come on momentarily when the EFC switch position is changed.

2.5.5 Engine Ventilation and Fire Warning System

The engine bay is divided into three ventilated zones. An engine mounted fireproof bulkhead separates zone 1 from zone 2. Zone 1 contains the engine compressor section, fuel system and accessories. Zone 2 contains the engine combustion, turbine and exhaust sections. Zone 3 is located beneath the fuselage heat shield in zone 2 and contains the reaction control system butterfly valve and ducting. Zones 1 and 2 are ventilated by ram air intakes at the forward end of the front nozzle fairings and at the wing roots. This airflow is assisted by a continuous flow inducer nozzle (supplied by engine fan bleed air) which provides ventilation during ground or vertical flight operation. Zone 3 is also ventilated by engine fan bleed air supplied by the flow inducer nozzle. A continuous fire sensing element is routed through zones 1 and 2, and a separate element is routed through zone 3. Both elements are connected to a single control unit. The elements sense heat around the engine, engine accessories, reaction control system butterfly valve and ducting, and the jet pipe. A FIRE warning is activated if a preset temperature is exceeded. System continuity can be checked by placing the compass/lights test switch to LTS TEST and noting that the FIRE warning light comes on. Two red fire access spring-loaded panels, one on each side of the fuselage above the engine give access to zone 1 for fire fighting equipment. Access to zone 2 is gained via the ventilation ducts at the leading edge of the wing roots.

2.5.5.1 FIRE Warning Light

The FIRE warning light, on the right main instrument panel, comes on if a fire condition is sensed in any of the engine bay zones. On TAV-8B 163856 and up, AV-8B 163519 and up, an ENGINE FIRE, ENGINE FIRE voice warning is provided in conjunction with the FIRE warning light.

2.6 GAS TURBINE STARTER/AUXILIARY POWER UNIT

The gas turbine starter/auxiliary power unit is used to start the engine or drive the APU generator. It consists of a gas generator, a free power turbine, reduction gear train, an ignition system, an electric starter motor, and electrical circuits for automatic control. Fuel for the GTS is supplied by the aircraft fuel system. With the battery switch in BATT, the electric starter motor is energized by placing the engine start switch to the electrically held ENG ST position which engages the GTS output shaft to the engine. The GTS ignition and fuel control systems are automatic and the GTS starts and accelerates to operating speed within 25 seconds. When the engine attains self-sustaining speed, the GTS automatically disengages and the engine start switch returns to OFF. If the GTS does not reach operating speed within 25 seconds or the main engine is not self-sustaining within 40 seconds, the GTS automatically shuts down and the engine start switch returns to OFF. If the GTS is operating in the APU mode (APU generator operating), engine start is accomplished by placing the engine start switch to ENG ST. In this condition, the APU generator drops off the line, the APU switch automatically returns to OFF, the 40 second GTS shut down protection circuit is activated and the main engine is automatically engaged for start. The APU advisory light comes on whenever GTS/APU operation is selected and the APU is ready to accept an electrical load. For APU mode operation, refer to APU, Electrical Power Supply System.

2.7 FUEL SYSTEM

The fuel system (see Aircraft and Engine Fuel System, foldout section) consists of seven integral tanks (five fuselage tanks and two internal wing tanks). Provisions are made for four externally mounted (droppable) tanks. The tanks are divided into two feed groups: the left feed group consists of the left external tank(s) (when installed), left internal wing tank, left and right front tanks and the left center feed tank. The right feed group consists of the right external tank(s) (when installed), right internal wing tank, rear tank and right center feed tank. A retractable air refueling probe may be installed for air refueling. Tank pressurization, by regulated engine bleed air, transfers fuel from the tanks of the left and right groups to their respective center feed tank, where fuel pressure to the engine is then increased by a boost pump in each feed tank and a fuel flow proportioner. The aircraft is fueled by using single point ground fueling. There are no gravity fueling provisions made for the internal or external fuel tanks. All tanks have fuel gaging probes which provide fuel quantity indications (in pounds) to the fuel quantity indicator. Each center feed tank is equipped with a refueling valve. The refueling valve can be manually selected to the open or closed position by the air refueling (A/R) switch on the cockpit fuel control panel. The refueling valve is automatically closed when the high fuel level thermistor, in each internal wing tank, senses a full condition. External tanks also contain a high fuel level thermistor which overrides the thermistor in their respective internal wing tank. With four external tanks installed, the outboard external tanks will override both internal wing and inboard external tanks. On the ground, the external tanks can be locked out to prevent refueling. Fuel may be dumped from the external and internal wing tanks.

2.7.1 Fuel Shutoff Handle

The fuel shutoff handle (fwd cockpit only) has positions of ON and OFF and is located on the left wall just aft of the left console. When the handle is OFF, the aircraft fuel system is isolated from the engine and the fuel flow proportioner is shut off. The handle can be moved down to the ON position where it will be locked. A button on the end of the handle must be pressed to release the ON lock.

2.7.2 Engine Driven Fuel Pumps

There are two engine driven fuel pumps in the fuel control unit. One is an impeller type backing pump and the other is a gear type main pump. The main pump is driven by the engine high pressure compressor shaft and the backing pump is driven by the main pump through an interconnecting shaft. The backing pump receives fuel from the fuel boost pumps via the fuel flow proportioner and then pumps this fuel to the inlet side of the main pump by way of a low pressure fuel filter.

On the -406 and -408A engines, a tapping down stream of the low pressure fuel filter supplies fuel (to be used as a hydraulic medium) to the IGV control unit. Fuel from the control unit is returned to upstream of the backing pump.

On the -408B engine, a tapping down stream of the main pump supplies fuel to the HMU of the EVICS. Fuel is returned to upstream of the backing pump.

The output of the pumps always exceeds engine demand and delivery is controlled by a mechanical pressure drop regulator which is sensitive to HP rpm. Excess pump supply fuel is bypassed to upstream of the backing pump. A pump pressure relief valve is in the bypass line.

If the flow proportioner and both boost pumps fail or are turned off at the same time, tanks pressurization will maintain fuel flow through the inoperative pumps and the flow proportioner bypass valves to the engine driven pumps, to enable engine operation.

2.7.3 Fuel Transfer System

Fuel transfer is automatic anytime the engine is running. Fuel transfer is normally accomplished by utilizing regulated sixth stage engine bleed air to pressurize the fuel tanks. Pressure is applied to, and transfer starts from, the outboard external tanks to the inboard external tanks (if installed) to the internal wing tanks and from them to the left and right front tanks (left feed group) or the rear tank (right feed group). From the front and rear tanks, fuel transfers to the respective, left or right, center feed tank where a boost pump supplies the engine via the flow proportioner. Pressurization can be shut off simultaneously in both groups by placing the air refueling switch, on the left console, to OUT. In this event, or if pressurization fails in either group, transfer will continue due to suction developed by the boost pump(s). While pressurization is operating, fuel is transferred to each center tank, in series from all tanks in the group, at the same rate at which fuel is being consumed from that tank. If pressurization is off and external tanks are installed, the transfer rate from the external tank(s) to the internal wing tank in each group may not equal the rate of fuel consumption from that group and the internal wing tank fuel quantity indication may show a decrease. Transfer from the external tanks can be verified by monitoring external tank fuel quantity. Transfer into the center tanks can be verified by monitoring feed quantity.

2.7.3.1 External Fuel CG Control

The external tanks are divided into three compartments to control center of gravity (cg) during fuel transfer or refueling. Fuel first transfers from the aft compartment, then the forward compartment followed by the center compartment. During refueling, the compartments fill in the reverse order.

2.7.3.2 Pressurization and Vent System

Sixth stage compressor bleed air pressurizes the system and transfers the fuel. The air enters the system through a check valve, a filter and two pressure control valves (one for each feed group). The control valve regulates tank pressure, provides vacuum relief when pressurization is off, and vents the tanks to atmosphere during ground or air refueling. Pylon fuel air valve(s), in each inboard and intermediate pylon, allow fuel and air to be transferred from the external tank(s) to the internal wing tank(s). When external tank(s) are jettisoned, a spring loaded poppet valve, in the pylon fuel air valve, allows pressurized air to continue to pressurize the respective tank group. A float operated vapor release valve in each feed tank dissipates air or vapor pressure to atmosphere, thereby preventing pressure in the feed tanks from building up and stopping fuel transfer. If feed tank pressure becomes excessive, the valve opens and discharges air (or fuel) regardless of float position. During negative g flight, weighted arms hold the valves closed to prevent fuel loss.

2.7.3.3 Transfer Caution Lights (L or R TRANS)

There are two TRANS caution lights located on the caution light panel. When illuminated, these L TRANS and R TRANS lights indicate that the fuel pressure at the inlet to the respective center feed tank has dropped to a point where fuel transfer into the center tank may be insufficient. When pressurization is ON (air refueling switch at IN or PRESS) the pressure is regulated so that sufficient flow of pressurized fuel is transferred to the feed tanks. After pressurization is OFF (either or both control valves failed closed or air refueling switch at OUT), either or both lights will come on, independently, as the residual pressure in the tanks decreases in a period of time dependent upon the fuel quantity and tank pressure (when pressurization was stopped) and the rate of fuel consumption. This may or may not occur within the flight endurance of the fuel remaining, but as long as the TRANS lights are off the fuel flow into the feed tanks is sufficient for any engine power demand. With the air refueling switch at OUT, and prior to actual refueling, the TRANS lights may come on but should go out soon after refueling begins.

2.7.3.4 Tanks Overpressurized/Overtemperature Warning Light (L or R TANK)

A L and R TANK warning light is located on the master warning lights panel and indicates that the pressure in the corresponding feed group is approaching a level where structural damage to the tank may occur or that the bleed air temperature is above a safe temperature level (i.e., near the flash point temperature of the fuel). If either light comes on, pressurization is automatically shut off for the corresponding feed group provided the air refueling (A/R) switch is in the IN position. On TAV-8B 163856 and up, AV-8B 163519 and up, a LEFT TANK, LEFT TANK or RIGHT TANK, RIGHT TANK voice warning is provided in conjunction with the L or R TANK warning light.

2.7.4 Fuel Boost System

Fuel is supplied to the engine by either ac powered or dc powered electrical boost pumps and a hydraulically driven fuel flow proportioner. The proportioner ensures that equal amounts of fuel are consumed from each feed tank. If both boost pumps fail, the flow proportioner (acting as a hydraulically driven pump) will continue to supply fuel to the engine. If the proportioner fails, the fuel levels will probably go slowly out of balance. In this case, the boost pump associated with the low level should be shut off until balance is regained. If the main generator fails or the ac boost pump(s) fails, the dc powered boost pump(s) may be selected for inflight emergency operation.

2.7.4.1 Boost Pumps

There are four electrically operated boost pumps, two in the lower portion of each center feed tank. The two pumps in each center feed tank are contained in a single housing, one is ac powered and the other is dc powered. Except during start, the ac powered pumps normally supply fuel to the engine. During ground engine start, only the right dc pump supplies fuel to the engine. After the engine reaches self-sustaining rpm, the right dc pump drops off line and both ac pumps supply fuel to the engine, providing the main generator is on line and the boost pump switches are in NORM. Each pump is enclosed in a negative g chamber for limited inverted flight. At maximum power and with at least 300 pounds of fuel in each feed tank, approximately 15 seconds of fuel is available to the boost pumps during negative g flight. A L or R PUMP caution light, on the caution light panel, comes on any time the associated pump output pressure is below acceptable limits. The ac driven pumps only operate with the main generator on line or external electrical power applied. The dc driven pumps will operate with external power, main generator, emergency generator, or battery. Both dc powered pumps are automatically ON when the airstart button is pressed.

2.7.4.2 Fuel Flow Proportioner

The function of the fuel flow proportioner is to equalize the flow of fuel from the two feed groups. The proportioner consists of two equal capacity vane type pumps with a common drive from a hydraulic motor. The hydraulic motor is driven by HYD 1 system pressure and is controlled by mechanically and electrically operated, shutoff valves. The mechanical valve is connected to the fuel shutoff valve and prevents the proportioner from operating whenever the fuel shutoff valve is closed. The electrical valve is controlled by the FUEL PROP switch on the left console. The valve is energized closed and deenergized open. The switch provides a means of shutting off the proportioner if a fuel out of balance correction is needed. If the proportioner fails or is turned off, the boost pumps will continue to supply fuel to the engine via bypass passages, with check valves, around the pumping elements of the proportioner. Whenever the flow proportioner is inoperative, the fuel quantities in the two tank groups may slowly go out of balance. In this event, the boost pump in the tank group with the lowest quantity should be shut off until balance is regained. During this period, the only fuel flow to the engine is from the tank group with the operating boost pump. Fuel balance should be maintained for the following reasons:

1. To prevent excessive lateral unbalance of the aircraft with fuel in the internal and external tanks.

2. To maintain the aircraft center of gravity within longitudinal limits after the wing tanks are empty.

3. To prevent one feed tank from becoming empty before the other.

A PROP caution light, on the caution light panel, comes on if the proportioner fails or is shut off electrically. If the electrical power supply to the PROP switch fails, the proportioner will come ON regardless of the switch position.

2.7.4.3 Fuel Prop Switch (TAV-8B)

The modified fuel prop switch, in the front cockpit, on the left console fuel panel has OFF, AUTO, DL (dual), and RT (right) positions. Normal operating position of the fuel proportioner switch is AUTO. The front cockpit pilot can manually balance the fuel by positioning the prop switch to DL or RT feed which operates the crossfeed valve or by placing the prop switch to off and turning off one of the pump switches.

The fuel prop switch in the rear cockpit is on the left console miscellaneous switch panel and allows the rear pilot to disable the automatic fuel proportioner by securing the proportioner.

2.7.4.4 Crossfeed Valve (TAV-8B)

Due to the space required by the aft cockpit, the left fuel group was reduced by approximately 450 pounds. A crossfeed valve has been added to the fuel system of the TAV-8B to compensate for the fuel imbalance in order to maintain cg limits. This valve has two positions, DUAL and RIGHT. In the DUAL position, the valve does not affect fuel system operation. In the right feed position, the valve allows fuel flow from the right fuel group only. The crossfeed system is spring loaded to the dual position if a failure occurs. The crossfeed valve is automatically controlled by level sensors when the prop switch is in the AUTO position. Sensors in the left feed group energize the valve to the right feed position when the fuel level in the left feed group is sensed to be less than approximately 300 pounds ±50. Sensors in the right feed group energize the valve to the dual feed position when fuel is sensed to be less than approximately 300 pounds ±50 in the right feed group.

2.7.4.5 Fuel Crossfeed Indicators (TAV-8B)

The R FEED advisory light, on the caution and advisory light panel, will be on when the crossfeed valve is in the RT feed position. The advisory light will be off when the crossfeed valve is in the DL feed position. With the Prop Switch in the AUTO position the advisory light will illuminate when the left fuel group senses less than approximately 300 pounds ±50 and the crossfeed valve is in the right feed position. The advisory light will remain on until the sensors in the right fuel group sense less than approximately 300 pounds and return the crossfeed valve back to the DUAL position. The advisory light should not illuminate when the Prop Switch is in the DL or OFF position.

The R FEED warning light indicates automatic control of the crossfeed valve has failed and the valve is in the incorrect position. Three situations can result in this warning light. In all situations, placing the Fuel Quantity Indicator to FEED and checking the fuel quantity remaining in the feed tanks will determine subsequent required actions. The fuel quantity will require monitoring.

1. R FEED warning with less than 300 pounds in the left feed tank and 300 pounds or greater in the right fuel system — set the fuel proportioner switch to RT and check the R FEED advisory light comes on and the R FEED warning light goes out.
2. R FEED warning with both feed tanks full, 300 pounds in each fuel system — set the fuel proportioner switch to DL and verify the R FEED warning and advisory lights go out.
3. R FEED warning light with both right and left feed tanks indicating less than 300 pounds — set the fuel proportioner switch to OFF and verify the R FEED warning and advisory lights go out.

2.7.5 Wing Fuel Dump

External and internal wing fuel may be dumped in flight by selecting the DUMP position on the wing fuel dump switches. There are two electro-magnetically held switches, on the left console, marked L (left) and R (right). Both switches may be used simultaneously (to reduce gross weight) or individually (to correct out of balance conditions). When dump is selected, a motor operated valve opens, and fuel is dumped overboard through fuel dump outlets. The fuel is forced out of the wing tanks by normal transfer pressure. Fuel continues to dump until the internal wing tanks are empty, the switches are placed to NORM, or if BINGO is set above fuselage fuel quantity, to the fuel setting in the BINGO window. Time required to empty a full wing tank in level flight is approximately 5 minutes.

2.7.6 Fuel Low Level Indicating System

The fuel low level indicating system is completely independent of the fuel quantity indicating system. Each feed group has a (L or R) FUEL caution light on the priority caution light panel. When the internal fuel level in either feed group drops to between 700 and 800 pounds of actual fuel (110 gallons), the corresponding (L or R) FUEL caution light illuminates steady and the digital fuel quantity indicator will indicate 750 ±250 pounds with INT selected. When the internal fuel level in either feed group drops to between 200 and 300 pounds of actual fuel (37 gallons), center feed tank only, the corresponding (L or R) FUEL caution light flashes and the digital fuel quantity indicator will indicate 250 ±100 pounds with FEED selected. On TAV-8B 163856 and up, AV-8B 163519 and up, a FUEL LOW LEFT, FUEL LOW LEFT or FUEL LOW RIGHT, FUEL LOW RIGHT voice warning is provided in conjunction with the flashing L or R FUEL caution light.

2.7.7 Fuel Quantity Indicating System

The fuel quantity indicating system provides readings, in pounds, of usable feed group and usable total fuel. Figure 2-9 shows the actual fuel quantity in each tank when fully serviced including non-usable fuel.

2.7.7.1 Fuel Quantity Indicator

The fuel quantity indicator is on the right main instrument panel. It has four display windows, a BINGO set knob, a seven-position selector switch, and an ON/OFF indicator. The window labeled TOT, continuously displays total usable fuel in increments of 100 pounds. The windows labeled L and R, display left and right usable fuel in the corresponding feed group in increments of 50 pounds. The window labeled BINGO displays the set fuel quantity that activates the BINGO caution light. The BINGO set knob is used to set the BINGO window in increments of 100 pounds. The selector switch provides individual tank monitoring of the left and right feed groups and a built-in-test (BIT) of the indicator. The ON/OFF indicator displays the word ON if the indicator is on or OFF if it is off.

2.7.7.2 Fuel Quantity Selector Switch

BIT – A spring loaded position that starts built-in-test of the system.
FEED – Fuel remaining in respective center feed tank is displayed.
TOT – Total fuel remaining in respective feed group is displayed.
INT – Fuel remaining in internal tanks of respective feed group is displayed.
WING – Fuel remaining in respective internal wing tank is displayed.
INBD – Fuel remaining in respective inboard external tank is displayed.
OUTBD – Fuel remaining in respective outboard external tank is displayed.

The fuel quantity selector switch should be placed to the position that best describes the aircraft state. If external tanks are used, the TOT position will present the most accurate fuel indication. With internal fuel only, the INT position is more accurate and should be used. When aircraft total fuel is below 750 pounds, the FEED position will most accurately indicate the fuel remaining in the respective center feed tank.

2.7.7.3 Bingo Caution Light

A BINGO caution light, on the left main instrument panel, comes on within ±200 pounds of a preset value controlled by the pilot. An adjustable fuel quantity display on the fuel quantity indicator may be set to any level up to 9,900 pounds. If BINGO is set above 2,800 and fuel dump is selected, fuel dumping will stop when the BINGO caution light comes ON. On TAV-8B 163856 and up, AV-8B 163519 and up, a BINGO, BINGO voice warning is provided in conjunction with the BINGO caution light.

2.7.7.4 Load Caution Light

The LOAD caution light on the caution light panel comes on if lateral fuel asymmetry exceeds 103,000 ±20,000 inch-pounds.

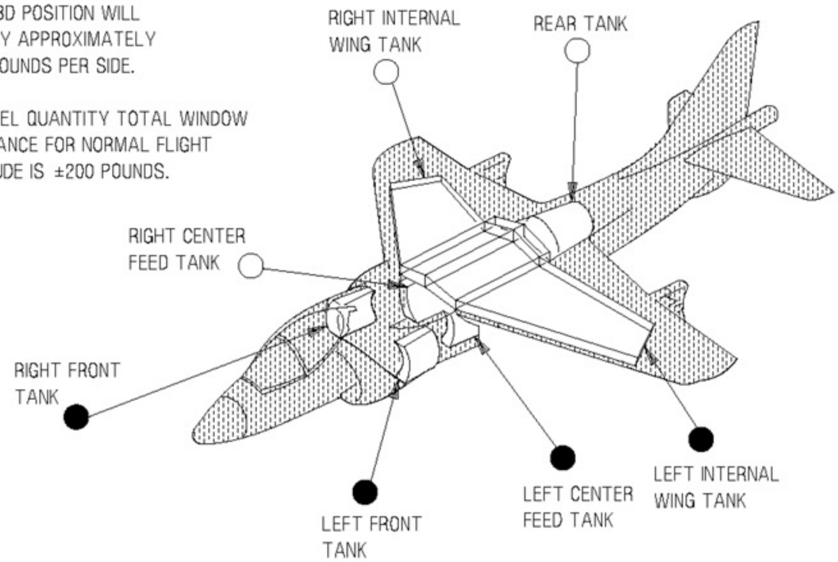
2.7.7.5 BIT Display

When BIT is selected, the fuel quantity indicator displays 1400 ±100 in the L window, 2400 ±100 in the R window, 3800 ±200 in the TOT window, the L and R FUEL low level cautions flash, the LOAD and MASTER caution lights come on and if the BINGO fuel is set above 4,000 the BINGO light comes on. LEFT and RIGHT full advisory lights (on the windshield arch) will also flash during BIT.

FUEL QUANTITY (AV-8B)

NOTES

- FUEL QUANTITY SHOWN IS ACTUAL FUEL QUANTITY STORED IN EACH TANK WHEN FULLY SERVICED, NOT THE INDICATED FUEL QUANTITY DISPLAYED IN COCKPIT.
- FUEL WEIGHTS ARE BASED ON JP-5 AVERAGE WEIGHTS OF 6.8 POUNDS PER GALLON AT 60 °F.
- EXTERNAL AND INTERNAL WING FUEL CAN BE DUMPED LEAVING FUSELAGE FUEL ONLY (APPROXIMATELY 2828 POUNDS).
- IF 4 EXTERNAL TANKS ARE INSTALLED AND FULL, THE OUTBD POSITION ON THE FUEL QUANTITY GAGE WILL DISPLAY APPROXIMATELY 1917 POUNDS PER SIDE AND THE INBD POSITION WILL DISPLAY APPROXIMATELY 2040 POUNDS PER SIDE.
- THE FUEL QUANTITY TOTAL WINDOW TOLERANCE FOR NORMAL FLIGHT ATTITUDE IS ±200 POUNDS.



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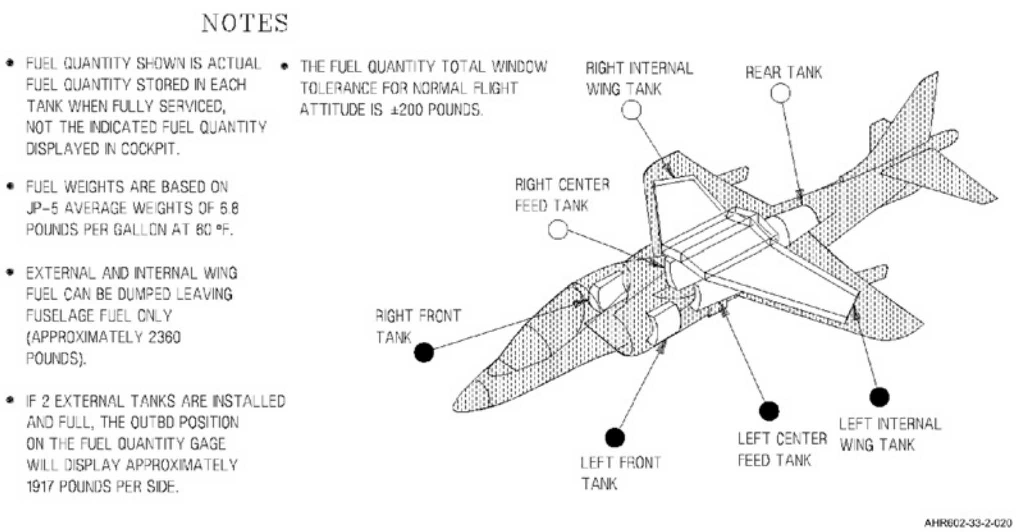
INTERNAL FUEL WITHOUT EXTERNAL TANKS						
LEFT FEED GROUP ONLY ●			LEFT AND RIGHT FEED GROUPS	RIGHT FEED GROUP ONLY ○		
GALLONS	TANK	POUNDS	POUNDS	POUNDS	TANK	GALLONS
47	Center feed	320	640	320	Center feed	47
80.5	Left front	547	2,188	1,094	Rear	161
80.5	Right front	547				
362.5	Internal wing	2,465.5	4,931	2,465.5	Internal wing	362.5
570	Total	3,879.5	7,759	3,879.5	Total	570.5
INTERNAL FUEL PLUS 2 EXTERNAL TANKS						
374	Internal wing	2,543	5,086	2,543	Internal wing	374
582	Total internal	3,957.5	7,915	3,957.5	Total internal	582
282	At station 2 or 3	1,917	3,834	1,917	At station 5 or 6	282
860	Total internal plus external	5,874.5	11,749	5,874.5	Total internal plus external	860
INTERNAL FUEL PLUS 4 EXTERNAL TANKS						
374	Internal wing	2,543	5,086	2,543	Internal wing	374
582	Total internal	3,957.5	7,915	3,957.5	Total internal	582
582	At station 2 and 3	3,957.5	7,915	3,957.5	At station 5 and 6	582
1,164	Total internal plus external	7,915	15,830	7,915	Total internal plus external	1,164

Figure 2-9. Fuel Quantity (Sheet 1 of 2)

FUEL QUANTITY (TAV-8B)



INTERNAL FUEL WITHOUT EXTERNAL TANKS						
LEFT FEED GROUP ONLY ●			**LEFT AND RIGHT FEED GROUPS**	**RIGHT FEED GROUP ONLY ○**		
GALLONS	**TANK**	**POUNDS**	**POUNDS**	**POUNDS**	**TANK**	**GALLONS**
47	Center feed	320	640	320	Center feed	47
46	Left front	312.8	1,719.6	1,094	Rear	161
46	Right front	312.8				
362.5	Internal wing	2,465.5	4,931	2,465.5	Internal wing	362.5
501.5	Total	3,411.1	7,290.6	3,879.5	Total	570.5
INTERNAL FUEL PLUS 2 EXTERNAL TANKS						
374	Internal wing	2,543.2	5,086.4	2,543.2	Internal wing	374
513	Total internal	3,489	7,447.2	3,958.2	Total internal	582
282	At station 2	1,917.6	3,835.2	1,917.6	At station 6	282
795	Total internal plus external	5,406.6	11,282.4	5,875.8	Total internal plus external	864

Figure 2-9. Fuel Quantity (Sheet 2)

2.8 AIR REFUELING SYSTEM

A retractable air refueling probe may be installed above the left air inlet. A discussion of the aerodynamic effects of the refueling probe can be found in paragraph 11.4.5.2 of this manual. The probe is extended and retracted using HYD 1 pressure. An A/R switch, READY light, and LEFT and RIGHT light provides control and indications for the air refueling system. At night the probe and drogue are illuminated by a probe light. After contact, refueling stops after all tanks are full. Refueling can also be stopped by withdrawing the probe from the drogue.

2.8.1 READY Light

The READY light is on the windshield arch. When the A/R switch is placed to OUT, the READY light comes on after the probe extends and locks. When refueling begins, the light goes out. After refueling, the light comes on and stays on until the A/R switch is placed to IN and the probe is fully retracted and locked. The light should not be on with the A/R switch in PRESS.

2.8.2 A/R Switch

The A/R switch (air refueling) is on the left console. The switch is lever-locked and has positions of IN, OUT and PRESS.

IN – Retracts the probe and pressurizes the tanks.
OUT – Stops pressurization to the tanks and extends A/R probe if installed. After contact is made and refueling begins the tanks depressurize.
PRESS – Leaves the probe extended and pressurizes the tanks. In this position, the automatic pressurization shut off associated with the L or R TANK warning lights is deactivated.

2.8.3 LEFT and RIGHT Full Advisory Lights

The LEFT and RIGHT full advisory lights are on the windshield arch. On a clean aircraft or when only two external tanks are installed, each light flashes when its corresponding feed group is full. However, when four external tanks are installed, the LEFT or RIGHT light comes on steady when the corresponding inboard external tank is full, then flashes when the feed group is full. The lights should not be on with the A/R switch set to IN or PRESS.

2.8.4 Air Refueling Probe Light

An air refueling probe light is installed on the probe. The light is used during night air refueling to illuminate the refueling probe and drogue. The light is controlled by a probe in limit switch. When the probe is extended, the air refueling probe light automatically comes on (provided the exterior master lights switch is in EXT LT).

2.8.5 Air Refueling/Dump System

The pilot can dump external and internal wing fuel only, leaving fuselage fuel of approximately 2,828 pounds for the AV-8B and 2,360 pounds for the TAV-8B. On TAV-8B the rear pilot cannot dump fuel or configure the aircraft for air refueling.

2.8.6 Fuel Quantity (TAV-8B)

The left and right front tanks size has been reduced in the TAV-8B. Refer to Figure 2-9 for TAV-8B fuel quantities.

2.9 GROUND REFUELING SYSTEM

The aircraft can be refueled on the ground through a standard refueling/defueling pressure coupling. Refer to A1-AV8BB-NFM-600.

2.10 ELECTRICAL POWER SUPPLY SYSTEM

The electrical power supply system consists of a main generator, an emergency generator (APU), two transformer-rectifiers, a battery, and a power distribution (bus) system. External electrical power can be applied to the bus system on the ground. On -408B engines, a permanent magnet alternator integral to the HMU provides electrical power supply for the IDEC and LANE 2 DECU. See Electrical System, foldout section, for electrical system simplified schematic.

2.10.1 AC Electrical Power

AC electrical power is supplied by a main generator or an emergency generator (APU). During normal operation the main generator powers the entire electrical system. The APU acts as a backup for the main generator and will power the critical buses after main generator failure. The APU can be operated in a standby mode whereby the APU automatically comes on the line after the main generator fails or it can be selected on after main generator failure. The APU is also used during ground alert to recharge the battery.

2.10.1.1 Main Generator

On TAV-8B 162747 through 163861, AV-8B 161573 through 163852, the main generator is an engine driven 15/20 KVA variable speed constant frequency generator which supplies 115/200 volt, 3 phase, 400 Hz alternating current to the aircraft main and essential ac buses, and to the main and standby transformer-rectifiers. On TAV-8B 164113 and up, AV-8B 163853 and up, the main generator output is increased to 30 KVA. The generator is cooled by oil from an oil cooler independent of the engine oil system. The generator is activated automatically when the generator switch is in the GEN position, and the generator is connected to the bus system when voltage and frequency are within prescribed limits (approximately 23 percent engine rpm). A green GEN light and a push-to-test button are located under an access panel on the forward left fuselage. When the push-to-test button is pressed and the light comes on, the main generator oil level is satisfactory. A protection system within the generator control unit protects against damage due to undervoltage, overvoltage, over and under frequency, and feeder faults. If a fault or malfunction occurs the control circuits remove the generator from the bus system. The generator control switch must be cycled from GEN to OFF and back to GEN to bring the generator back on the line after the fault or out-of-tolerance condition occurs. For an underspeed fault, the generator will come back on the line without cycling the generator, provided the underspeed condition is corrected. The generator may be removed from the bus system at any time by placing the generator control switch to OFF.

2.10.1.1.1 Generator Warning Light

A generator warning light, labeled GEN, is on the warning/threat lights panel on the instrument panel. The light comes on whenever the main generator is off the line. On TAV-8B 163856 and up, AV-8B 163519 and up, a GENERATOR, GENERATOR voice warning is provided in conjunction with the GEN warning light. On Radar and Night Attack aircraft, the light operates in conjunction with the MASTER WARNING light.

2.10.1.1.2 Generator Control Switch

The generator control switch is on the electrical panel on the forward right console.

GEN – Allows main generator to come on the line when all conditions are correct.

OFF – Removes main generator from the line. Position is also used when cycling generator protective functions after a malfunction to allow reset.

TEST – Position used for ground test (not operative).

2.10.1.2 Auxiliary Power Unit

A 6 KVA emergency generator, referred to as the APU, is installed as a backup for the main generator. The APU is driven by the GTS, provided the GTS is operating in the APU mode; that is, the GTS is not being used to start the aircraft engine. With the battery switch to BATT and the engine start switch to OFF, placing the APU generator switch to ON will start the GTS to drive the APU. The APU will then power all of the buses in the electrical system, except for the main 115 volt ac and the main 28 volt dc buses, provided the main generator is off the line. The APU can be operated in a standby mode by turning it on while on the ground or in the air with the main generator operating. If the main generator then drops off the line the APU automatically comes on the line. If the main generator is then restored to the line, the APU will revert to standby status. If the APU is turned on before takeoff and the main generator is operating, the APU will automatically shut down when the aircraft reaches 325 knots. If the APU is turned on while airborne, there is no automatic shutdown speed unless the WOW switch is cycled (i.e., after a landing). If the APU mode is selected and the engine start mode is then selected, a translation start will be made and the APU mode will be terminated. The APU mode may be re-selected after the engine start mode is terminated. The APU mode may be re-selected after the engine start mode is terminated. APU control circuits contain protection circuits which prevent the APU from coming on the line in the presence of overvoltage, overfrequency, and underfrequency. Should a fault occur and cause the APU to trip off the line (the essential ac bus contactors deenergizing and APU GEN caution light on), the APU can be brought back on the line if the fault clears by placing the APU generator switch momentarily to the RESET position.

The APU is used during ground alert to recharge the battery. Before the dc voltmeter indicates 24.5 volts or below, the APU is turned on by placing the battery switch from ALERT to BATT and then placing the APU GEN switch to ON. After charging, placing the APU GEN switch back to OFF turns off the APU.

On radar aircraft, with weight-on-wheels, a load shed function decreases the power requirements when operating on APU power. Systems not powered because of load shed are the radar warning receiver (RWR), TACAN, and exterior lights (except taxi lights and side slip vane lights).

2.10.1.2.1 APU Caution/Advisory Lights

Two lights on the caution/advisory lights panel are associated with operation of the APU. The APU GEN caution light comes on whenever the emergency generator system malfunctions with the APU on. Upon initial selection of the APU, a 16 second delay is provided in the light circuit to allow the gas turbine system and emergency generator system time to stabilize. The APU advisory light comes on whenever the GTS is operating in either the engine start or APU mode. On AV-8B 163659 and up, TAV-8B 163856 and up, also AV-8B 161373 through 163519, TAV-8B 162747 through 163207 after AFC-329, the APU advisory light comes on only when the APU is ready to accept an electrical load.

2.10.1.2.2 APU Generator Switch

The APU GEN switch on the electrical panel controls operation of the APU.

ON – With battery switch in BATT, GTS drives the APU provided it is not in the engine start mode.
RESET – Momentary position allows generator protective functions to reset.
OFF – Terminates GTS/APU operation.

2.10.2 DC Electrical Power

Two transformer-rectifiers (TRUs) and a battery are provided. The TRUs convert 3 phase 115 volt ac power from either the main or the emergency generator to 28 volt dc power. The main TRU is rated at 200 amperes and the standby TRU is rated at 50 amperes. With the main generator operating and the battery switch in BATT, the main TRU provides power to all dc buses, except the ground service and switched battery buses which are powered by the standby TRU. With the main generator off the line and APU on the line, the main, armament, master arm 28 volt dc buses automatically disconnect from the main TRU and become deenergized. Should the main TRU fail, the main, armament, master arm and essential 28 volt dc buses are deenergized, and the standby TRU assumes operation of the jett, emergency, and alert 24/28 volt dc buses after a short time delay. Should the standby TRU fail, the main TRU assumes operation of the switched battery and ground service 24/28 volt dc buses after a short time delay, and thus powers all of the dc buses. The 24 volt lead acid battery is connected directly to the ground service 24/28 volt dc bus. With the battery switch in BATT, the ground service bus is connected to the switched battery bus and the battery is charged by the standby TRU. If the standby TRU fails the battery is charged by the main TRU. Should both TRUs (or both generators) fail the following buses are powered by the battery for a limited time with the battery switch in BATT: ground service, switched battery, jett, alert, and emergency 28 volt dc buses. With the battery switch in ALERT, the battery connects to the alert 24/28 volt dc bus in addition to the ground service 24/28 volt dc bus. In ALERT, the battery is isolated from both TRUs and will completely discharge unless periodically charged by placing the battery switch to the BATT position with a generator and TRU operating.

2.10.2.1 DC Caution Light

Failure of the main TRU is indicated by the DC light on the caution/advisory lights panel coming on. The light operates in conjunction with the MASTER CAUTION light.

2.10.2.2 STBY TR Caution Light

Illumination of the STBY TR caution light indicates that the standby TRU is off the line and is not charging the battery. The light operates in conjunction with the MASTER CAUTION light. With the battery switch in BATT and the standby TRU output below 24.75 volts for a period of greater than 3.5 seconds, the STBY TR light comes on. During GTS start the standby TRU is temporarily tripped off the line and is prevented from coming on the line during the start, and the STBY TR light comes on.

2.10.2.3 DC Voltmeter

A dc voltmeter on the electrical panel indicates voltage on the alert 24/28 volts dc bus. The voltmeter indicates battery voltage when the battery switch is in ALERT and emergency dc bus voltage when the battery switch is in BATT. The most accurate indication of battery condition is with generators off and the battery switch in BATT.

2.10.2.4 DC Test Switch

A DC test switch on the electrical panel is used to check operation of the system by simulating failure of either the main or standby TRU. The switch travels inboard/outboard, rather than fore and aft, when it is actuated. The DC test switch can be latched in any of its three positions and used, in flight, to recover from most Emergency DC Bus failures (see paragraph 15.14).

Center Position – Switch operation is normal.
MAIN – Disables standby TRU and switches dc voltmeter to the ground service bus thereby indicating battery voltage. Battery being charged by main TRU is indicated by the STBY TR light coming on and a 25.5 volt or higher reading on the voltmeter.
STBY – Causes emergency dc bus contactor to deenergize, simulating failure of the main TRU. The DC caution light remains out.

2.10.2.5 Ground Alert

During ground alert with no ac power on the aircraft, the ALERT position of the battery switch can be used to provide battery power to the alert bus. Besides the dc voltmeter, the following equipment can be operated from this bus during alert status: utility light, knee board light, and UHF/VHF R/T no. 1 and no. 2, and KY-58 no. 1 and no. 2. In the alert mode, the dc voltmeter is used to determine when the APU must be used to recharge the battery.

2.10.2.6 External Electrical Power

External electrical power may be connected to the aircraft bus system through an external electrical power receptacle on the left side of the aft fuselage. The battery switch must be in the BATT position in order to apply external power. If the external power is not of the proper quality (within voltage, phase and frequency limits) the external power monitor disconnects or prevents the external power from being connected to the aircraft buses. Once external power is applied, the external power monitor will disconnect it from the aircraft buses if the external power quality limits are exceeded. The aircraft buses are energized by external power in the same manner as if the main generator were operating. However, some aircraft systems will not energize upon application of external power. Power control for these systems is provided by ground power switches.

2.10.2.7 Circuit Breakers

Seven circuit breakers are located on the cockpit circuit breaker panel on the lower main instrument panel. The remaining circuit breakers are inaccessible to the pilot. The cockpit circuit breaker nomenclature and functions are as follows:

AIL TRIM – Manual aileron trim.
STAB TRIM – Manual stabilator trim.
RUD SVO – Rudder trim and SAS servo shutoff valve.
FLAPS – Flaps, Channel 2.
SP BK – Speed brake.
LG – Normal landing gear control.
RH PROBE HEAT – Right pitot probe heat.

On AV-8B 161573 through 161584, the right pitot probe heat circuit breaker is labeled PROBE HEAT.

On TAV-8B aircraft, there are no circuit breakers located in the rear cockpit.

2.10.2.8 Alert 28V DC Bus

The alert bus receives power from two different distribution sources. The normal source is DC power provided by the main TRU or the standby TRU that runs through the emergency DC bus to the alert bus. If power to the emergency DC bus is lost, so is power to the alert bus. The second power source for the alert bus is the battery. If the battery switch is placed in ALERT, the alert bus receives power directly from the battery, even if the emergency DC bus is failed. With the battery switch in ALERT, the battery connects to the alert 24/28 volt dc bus in addition to the ground service 24/28 volt dc bus. In ALERT, the battery is isolated from both TRUs and will completely discharge unless periodically charged by placing the battery switch to the BATT position with a generator and TRU operating.

2.10.2.9 Emergency 28V DC Bus

During normal operation, the main generator or APU generator supplies AC power to the main TRU and standby TRU. The main and standby TRU are always operating. The output of the main or standby TRU is connected to the

DC emergency bus via contactors when certain conditions are met. If the main TRU is operating correctly, its output is connected to the DC emergency bus. If the main TRU fails, its output is disconnected from the DC emergency bus and the output of the standby TRU is connected. If both the main TRU and standby TRU fail, their outputs are disconnected and the battery provides power to the DC emergency bus.

2.10.3 Ground Power Panel

On TAV-8B, AV-8B 161573 through 164547, the ground power panel located on the cockpit seat rail has six ground power switches. These switches, labeled STORES, FWD EQP, COCKPIT, AFT EQP, IGN ISO, and JPTL TEST, are used by maintenance personnel to apply power to various equipment. See Figure 2-11 for equipment controlled by each switch.

On AV-8B 164549 and up, the ground power panel located on the interior lights controller on the right aft bulkhead has six ground power switches. These switches, labeled STORES, MISC, DISP/FLT, CNI, IGN ISO, and JPTL TEST, are used by maintenance personnel to apply power to various equipment. See Figure 2-11 for equipment controlled by each switch.

2.11 LIGHTING

2.11.1 Exterior Lighting

Exterior lights are controlled from the exterior lights panel, the trim panel and the exterior lights master switch.

2.11.1.1 Exterior Lights Master Switch

The exterior lights master switch, outboard of the exterior lights panel, provides a master control for the following lights: position lights, formation lights, anti-collision lights, landing/taxi lights, sideslip vane lights, and the air refueling probe light. There is no exterior lights master switch in the rear cockpit. See Figure 2-10.

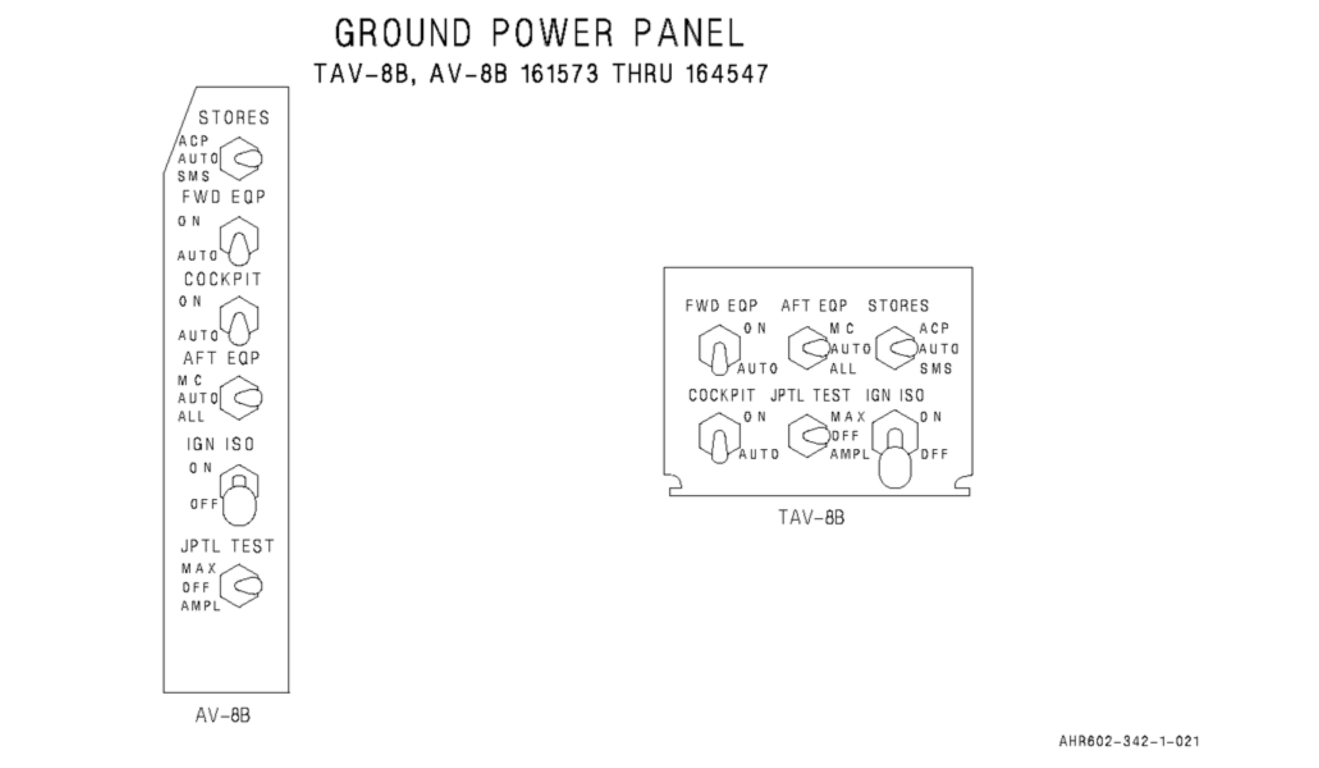
2.11.1.2 Position Lights

Three position lights are provided: a red light on the left forward wing tip, a green light on the right forward wing tip, and a white light on the tail of the aircraft. The position lights are controlled by the exterior lights master switch and by the POS lights switch on the exterior lights panel. Position lights operate in the visible mode only.

BRT – Lights illuminate at full intensity.
DIM – Lights illuminate at reduced intensity.
OFF – Lights are off.

TAV-8B, DAY ATTACK	RADAR, NIGHT ATTACK	RADAR, NIGHT ATTACK
EXT LT (fwd)	NORM (fwd)	Power available for: Position lights Formation lights Anti-collision lights Landing/taxi lights Sideslip vane lights Air refueling probe light
	NVG (center)	1. Same as NORM on AV-8B 163853 through 164116. 2. Power available for Anti-collision lights and Formation lights in the NVG (covert) mode on AV-8B 164117 and up.
OFF (aft)	OFF (aft)	Power for lights controlled by switch is cut off.

Figure 2-10. Exterior Lights Switch Function

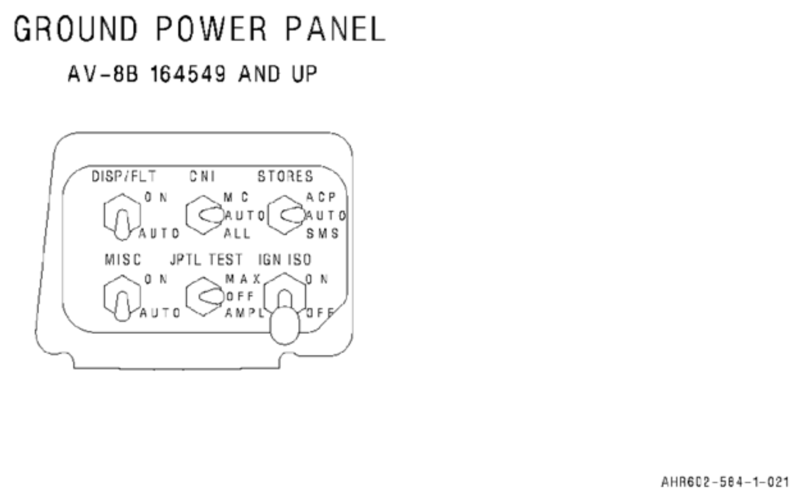


SWITCH	POSITION	EQUIPMENT
STORES	ACP	ARMAMENT CONTROL PANEL
	SMS	STORES MANAGEMENT COMPUTER ARMAMENT CONTROL PANEL
FWD EQP	ON	ARBS [2] FLIR INS
COCKPIT	ON	[1] DDI EDP HUD UHF [5] DISPLAY COMPUTER [2] L/R MPCD [2] VRS [2] DDS [1] HSI TURN AND SLIP INDICATOR STANDBY ATTITUDE INDICATOR STANDBY ALTIMETER [1] STANDBY REFERENCE ALTIMETER VIBRATOR [3] MOTION PICTURE CAMERA/VRS
AFT EQP	MC	MISSION COMPUTER
	ALL	MISSION COMPUTER CNI DATA COMPUTER RADAR ALTIMETER RADAR BEACON [4] DISPLAY COMPUTER [2] TACTS UHF/VHF NO.1 UHF/VHF NO.2 ECM RWR IFF [2] DECM/ASPJ TACAN [2] DVMS INVERTER
IGN ISO	ON OFF	REFER TO ENGINE FUEL SYSTEM, PARAGRAPH 2.3.6.2
JPTL TEST	MAX OFF AMPL	REFER TO ENGINE CONTROLS, PARAGRAPH 2.4.6

NOTES:

[1] TAV-8B, AV-8B DAY ATTACK
[2] AV-8B NIGHT ATTACK
[3] AV-8B DAY ATTACK
[4] TAV-8B
[5] AV-8B 161573 THROUGH 164547

Figure 2-11. Ground Power Switches and Equipment Controlled (Sheet 1 of 2)



SWITCH	POSITION	EQUIPMENT		
STORES	ACP	ARMAMENT CONTROL PANEL		
	SMS	STORES MANAGEMENT COMPUTER		TACTS
		ARMAMENT CONTROL PANEL		DECM/ASPJ
MISC	ON	TACAN	RWR	
		EXT LTS		
DISP/FLT	ON	HUD	L/R MPCD	TURN AND SLIP INDICATOR
		EDP	VRS	STANDBY ATTITUDE INDICATOR
		FLIR	DSS	STANDBY ALTIMETER
		INVERTER	DVMS	STANDBY REFERENCE
		UFC	ADC	ALTIMETER VIBRATOR
		VRS	SAAHS	DISPLAY PROCESSOR-GENERATOR
CNI	MC	MISSION COMPUTER		
	ALL	MISSION COMPUTER	UHF/VHF NO.1	INS
		CNI DATA COMPUTER	UHF/VHF NO.2	DVMS
		RADAR ALTIMETER	ECM	RADAR
		RADAR BEACON	RWR	DECM/ASPJ
		KY-58	IFF	
IGN ISO	ON OFF	REFER TO ENGINE FUEL SYSTEM, PARAGRAPH 2.3.6.2		
JPTL TEST	MAX OFF AMPL	REFER TO ENGINE CONTROLS, PARAGRAPH 2.4.6		

Figure 2-11. Ground Power Switches and Equipment Controlled (Sheet 2)

2.11.1.3 Formation Lights

Twelve formation lights are provided. One light on each side of the vertical tail fin, one light on each side of the fuselage just forward of the tail section, one on each upper wing tip aft of the position lights, two on the upper fuselage just aft of the canopy, and two on each side of the fuselage just below the canopy. The formation lights are controlled by the FORM lights knob on the exterior lights panel which provides variable lighting between positions OFF and BRT.

On Radar and Night Attack aircraft, the formation lights operate in the visible mode when the exterior lights master switch is set to NORM and in the covert (NVG) mode when the exterior lights master switch is set to NVG.

2.11.1.4 Anti-Collision Lights

Two anticollision lights are provided. One light is on the upper fuselage near the midpoint between the tail and canopy. The other light is on the lower fuselage just forward of the tail section. The anti-collision lights are controlled by the ANTI COLL lights switch on the exterior lights panel with positions OFF and ON.

On Radar and Night Attack aircraft, the anticollision lights operate in the visible mode when the exterior lights master switch is set to NORM and in the covert (NVG) mode when the switch is set to NVG.

2.11.1.5 Sideslip Vane Lights

Sideslip vane lights, consisting of a vertical light strip on the back of the vane and a horizontal light strip on top of the vane are provided to illuminate the vane in poor visibility conditions with the gear down. To illuminate the sideslip vane lights, the instrument lights must be turned on, the gear handle down and the exterior lights master switch in the EXT LT position on TAV-8B and Day Attack aircraft. On Radar and Night Attack aircraft, the exterior lights master switch must be in the NORM or NVG position.

On the TAV-8B, an additional sideslip vane light is installed on top of the front canopy bow.

2.11.1.6 Landing/Taxi Lights

There are two landing lights, both on the nose gear strut. The approach landing light has two filaments, one of 250 watts for full brilliance during landing and the other 150 watts for hovering. The approach light is controlled by the main landing light switch on the trim panel. The main landing gear (MLG) must be down and locked, and the exterior lights master switch must be on for the approach light switch to operate.

APPROACH (APRCH) – The 250 watt filament illuminates.
HOVER (HVR) – The 150 watt filament illuminates.
OFF – Lights are off.

The other landing light is the auxiliary landing light which contains a 70 watt lamp. The auxiliary landing light is used as a taxi light. The light is controlled by the auxiliary landing light switch on the exterior lights panel and does not require the exterior lights master switch to be on.

AUX – Auxiliary landing light illuminates.
OFF – Auxiliary landing light off.

2.11.1.7 Landing/Taxi Lights (Rear Cockpit)

A main landing light switch, similar to the front cockpit switch, is provided on the miscellaneous panel on the left console in the rear cockpit. The switch has positions APRCH, HVR, and FWD. The APRCH and HVR positions operate the same as for the corresponding switch positions in the front cockpit. With the rear switch in APRCH or HVR, the front switch is inoperative. The FWD position gives control of the landing lights to the switch in the front cockpit.

2.12 INTERIOR LIGHTING

Except for the utility flood, chart light, and kneeboard light, controls for the interior lights are on the interior lights control panel. On Radar and Night Attack aircraft, all lights are NVG compatible except for the chart and kneeboard lights and the utility floodlights when white is selected.

2.12.1 Front Cockpit

For console lights, console floodlights, emergency floodlights, and instrument lights in the front cockpit to operate, the front cockpit lights cutoff switch in the rear cockpit must be in the ON position. With the switch OFF, only the utility floodlight, chart and knee board lights, and the warning/caution/advisory lights in the front cockpit will operate. The TEST position of the lights test switch tests the warning/caution/advisory lights in both cockpits.

2.12.2 Rear Cockpit

The rear cockpit contains the same lighting as the front cockpit. An interior lights control panel, on the right console, is identical to the front cockpit panel. Operation of the rear cockpit lighting is identical to the front cockpit lighting, except as noted in the following paragraphs.

2.12.3 Instrument Lighting

Integral and light panel lighting for the main instrument panel is controlled by the INST PNL knob which provides variable lighting between positions OFF and BRT.

2.12.4 Console Lighting

Integral and light panel lighting for the left and right consoles, landing gear control and emergency jettison button panels, hydraulics indicator panel and the cockpit altimeter is controlled by the CONSL knob which provides variable lighting between positions OFF and BRT.

2.12.5 Floodlights

Three console floodlights are above each console and one (two on Radar and Night Attack aircraft, instrument floodlight is on each side of the windshield arch. There is also an additional instrument floodlight on each side of the fixed canopy in the rear cockpit of the TAV-8B. The instrument floodlights are also used for the emergency floodlights. The console floodlights and instruments floodlights are white lights (on the Radar and Night Attack aircraft they are night vision goggle (NVG) green, The lights are controlled by the FLD knob which provides variable lighting between positions OFF and BRT.

2.12.5.1 Emergency Floodlights

The instrument floodlights provide emergency lighting in the cockpit. These lights come on automatically whenever power to the 115 volt ac bus, which provides power for normal instrument lighting, is lost. With loss of the essential 115 volt bus and the INST PNL knob out of the OFF position emergency 28 volts is provided for operation of all console and emergency floodlights. The lights are controlled by the FLD knob in both normal and emergency operation. The knob provides variable lighting between positions OFF and BRT.

2.12.5.2 Utility Floodlight (TAV-8B, AV-8B Day Attack Aircraft)

A portable utility floodlight is provided and normally stowed above the right console. An alligator clip attached to the light may be used to fasten the light at various locations in the cockpit at the pilot's discretion. The light contains a knob which provides variable lighting between off and bright, and a button which when pressed causes the light to come on at full intensity. The light also contains a rotary selector for red or white lighting. The light is on the alert bus.

2.12.5.3 Utility Floodlights (AV-8B Radar and Night Attack Aircraft)

Two portable utility floodlights are provided and normally stowed above the right and left console. An alligator clip attached to each light may be used to fasten the light at various locations in the cockpit at the pilot's discretion. The lights contain a knob which provides variable lighting between off and bright, and a button which when pressed causes the lights to come on at full intensity. The lights also contain a rotary selector for green or white lighting. The lights are powered by the alert bus.

2.12.6 Warning/Caution Lights Knob

A knob labeled WARN/CAUT is provided on the interior lights control panel to switch the warning/caution/advisory lights from bright intensity to the low intensity range, and then vary the brightness within the low intensity range. Warning/caution/advisory lights can be switched to the low intensity range by placing the warning/caution lights knob momentarily to RESET, providing the instrument panel knob is out of the OFF position and the flood knob is less than half way to BRT. Once in the low intensity range, the warning/caution/advisory lights can be brought back to high intensity by turning the flood knob to BRT, turning the instrument panel knob to the OFF position, or removing and re-applying power to the aircraft.

2.12.7 Compass/Lights Test Switch

The COMP/LTS TEST switch is provided to control the standby compass light and test the warning/caution/advisory lights.

COMP – The compass light is on, provided CONSL knob is out of OFF position.
OFF – Compass light and test function are off.
TEST – Serviceable warning/caution/advisory lights come on. TEST position is spring-loaded to off.

2.12.7.1 Compass/Lights Test Switch (Rear Cockpit)

The COMP position is a dummy position, since the rear cockpit does not have a standby compass.

2.12.7.2 Front Cockpit Lights Switch (Rear Cockpit)

The front cockpit lights switch on the rear cockpit left console outboard of the miscellaneous panel is used to control operation of the console lights, console floodlights, emergency floodlights, and instrument lights in the front cockpit.

OFF – Controlled lighting inoperative.
ON – Full operation of controlled lighting by controls in the front cockpit.

2.12.8 Chart and Kneeboard Lights

A chart light is installed on the left windshield arch above the emergency floodlight and a knee board light is installed above the emergency floodlight on the right windshield arch. These lights swing out from their stowed positions and are turned on when positioned 17° or more from the stowed position. Once turned on, rotating the bezels varies lighting brightness. Returning them to within 17° of the stowed positions turns off the lights. The knee board light is on the alert bus and the chart light is on the emergency bus.

2.13 HYDRAULIC POWER SUPPLY SYSTEM

Hydraulic power is generated by two engine driven hydraulic pumps and is distributed by two independent 3,000 psi hydraulic systems; Hyd 1 and Hyd 2. Both systems provide power to the stabilator, aileron, and flap dual system flight control actuators. Either system is capable of providing the power necessary for actuator operation in the event of the loss of the other system. Hyd 1 provides power for the various utility functions, in addition to the flight control actuation systems. A flow control priority valve in Hyd 1 restricts the flow to the landing gear when the system pressure drops below 2,000 psi in order to maintain pressure for the flight control actuation system. Hyd 2 is dedicated to the flight control actuators except upon loss of Hyd 1, it is then used for emergency nosewheel steering when the aircraft is on the ground. The rudder automatically reverts to manual operation in the event of Hyd 1 pressure loss. Emergency wheel braking can be accomplished by stored accumulator power and emergency landing gear extension can be accomplished by stored pneumatic power if normal landing gear extension fails. Transient demands can exceed pump capacity. If this occurs, the extra demand is supplied by an accumulator in each system. Each system contains relief valves to prevent overpressurization. Pressure switches and electronic pressure transmitters are installed in each hydraulic system to sense pressure and transmit signals to the cockpit indicators. See Hydraulic System foldout for simplified schematic of the hydraulic power system.

Steady state Hyd 1 and Hyd 2 indicator readings of 3000 ±200 psi are normal throughout engine rpm range with no hydraulic system demands.

2.13.1 HYD 1 Power Generation System

The Hyd 1 loads can be divided into three groups:

1. PUMP OUTPUT AND ACCUMULATOR – Ailerons, stabilator, flaps, rudder, aileron droop, and auto stabilization servos.

2. PUMP OUTPUT – Fuel flow proportioner, nosewheel steering, wheel brake, Q-feel, LIDS, speedbrake, and in-flight refueling probe.

3. NON-PRIORITY – Landing gear functions.

The first group is supplied from the system accumulator section, downstream of the accumulator check valve. In the event of large simultaneous flow demands, in excess of the pump capacity, the accumulator provides additional power to this group of loads. The first group is isolated from the second group by the check valve to maximize the time available before discharge of the system accumulator following an engine shutdown. This allows more time for flight controls operation and improves aircraft control during an engine restart or pilot egress. The second group is supplied from the main system just downstream of the pressure filter. The loads have either relatively low flow demands, or the flow demands occur only on the ground. The landing gear is supplied from the main system via a priority valve. The priority valve starts restricting the landing gear flow when the system pressure drops below 2,000 psi. Landing gear flow is zero if system pressure drops below 1,600 psi. Emergency nitrogen/helium is available as a backup to operate the non-priority landing gear functions.

2.13.2 HYD 2 Power Generation System

The Hyd 2 loads are the aileron actuators, stabilator actuator, and flap actuators.

Hyd 2 also provides a back-up supply for the nosewheel steering, via a solenoid operated switching valve incorporated into the nose gear steering selector/switching valve. The use of Hyd 2 as a back-up for nosewheel steering is inhibited except with weight-on-wheels, with Hyd 1 pressure less than 1,400 psi, and with nosewheel steering selected. The back-up supply is flow limited to retard Hyd 2 depletion if a nosewheel steering line failure is the cause of the Hyd 1 failure. In addition to the Hyd 2 backup system, a Hyd 2 accumulator is included for temporary backup of nosewheel steering. The Hyd 2 accumulator will provide about 3 cycles (a cycle is from neutral to 3° L to 3° R and back to neutral) of nosewheel steering if both hydraulic pump outputs are lost. Steering reaction will be slower when operating on HYD 2.

2.14 FLIGHT CONTROL SYSTEM

2.14.1 Primary Flight Controls

The primary flight controls (see Figure 2-12) are the stabilator, rudder and ailerons for aerodynamic control and a reaction control system for jetborne control. The stabilator, rudder, and ailerons are hydraulically powered. Artificial feel systems simulate aerodynamic feel. The trim system moves the entire control surface through the actuator. Secondary controls are the flaps, drooped ailerons and speedbrake.

If the front and rear cockpit trim simultaneously in opposite directions, the resulting trim will be nose down, left wing down, and left rudder.

2.14.1.1 Aileron Control System

The lateral control system consists of the control stick, high speed aileron stop, spring feel unit, trim actuator, cables, control rods, two tandem hydraulic actuators, two ailerons and two roll reaction control valves. With the landing gear down, aileron travel due to stick movement is about 25° up and 10° down. With the landing gear up (except on AV-8B 162070 or 162071), or above 0.4 Mach, aileron travel is reduced because of the solenoid operated high speed stop at the base of the control stick; however, the stop can be overridden to obtain full aileron travel. On AV-8B 162942 and up, aileron deflection is increased between 0.88 and 0.96 Mach when angle of attack is between -2.6° and 9.1° to improve roll rate. At 0.92 Mach the roll rate is increased approximately 40° per second providing a 120° per second roll rate capability. Lateral stick movement is transmitted by control rods and cables to the aileron actuator control valves. The control valves meter hydraulic fluid to tandem power cylinders in proportion to the displacement. The tandem power cylinders allow simultaneous use of both hydraulic systems. If a single hydraulic system fails, the remaining system will supply adequate power for control.

2.14.1.1.1 Lateral Control Feel and Stop

Aileron feel is provided by a nonlinear spring unit. With the landing gear up, or above 0.4 Mach, solenoid operated aileron stops at the base of the control stick restrict lateral stick movement to about 75 percent of full throw. The stops are actuated by a switch in the air data computer. The stops are spring loaded and can be overridden.

2.14.1.1.2 Lateral Trim System

The lateral trim system consists of a trim switch on the stick grip (Figure 2-13) and an electric trim actuator. When the switch is actuated, the trim actuator repositions the spring feel unit which, in turn, moves the ailerons. An auto trim system automatically trims the aircraft when automatic flight control (AFC) is engaged. Manual trim overrides auto trim. Total trim travel is 5.6° trailing edge up/4.5° trailing edge down.

2.14.1.1.3 Aileron Trim Indicator

The aileron trim indicator, on the left console, indicates trim setting. The left end of the arc represents full left trim and the right end represents full right trim.

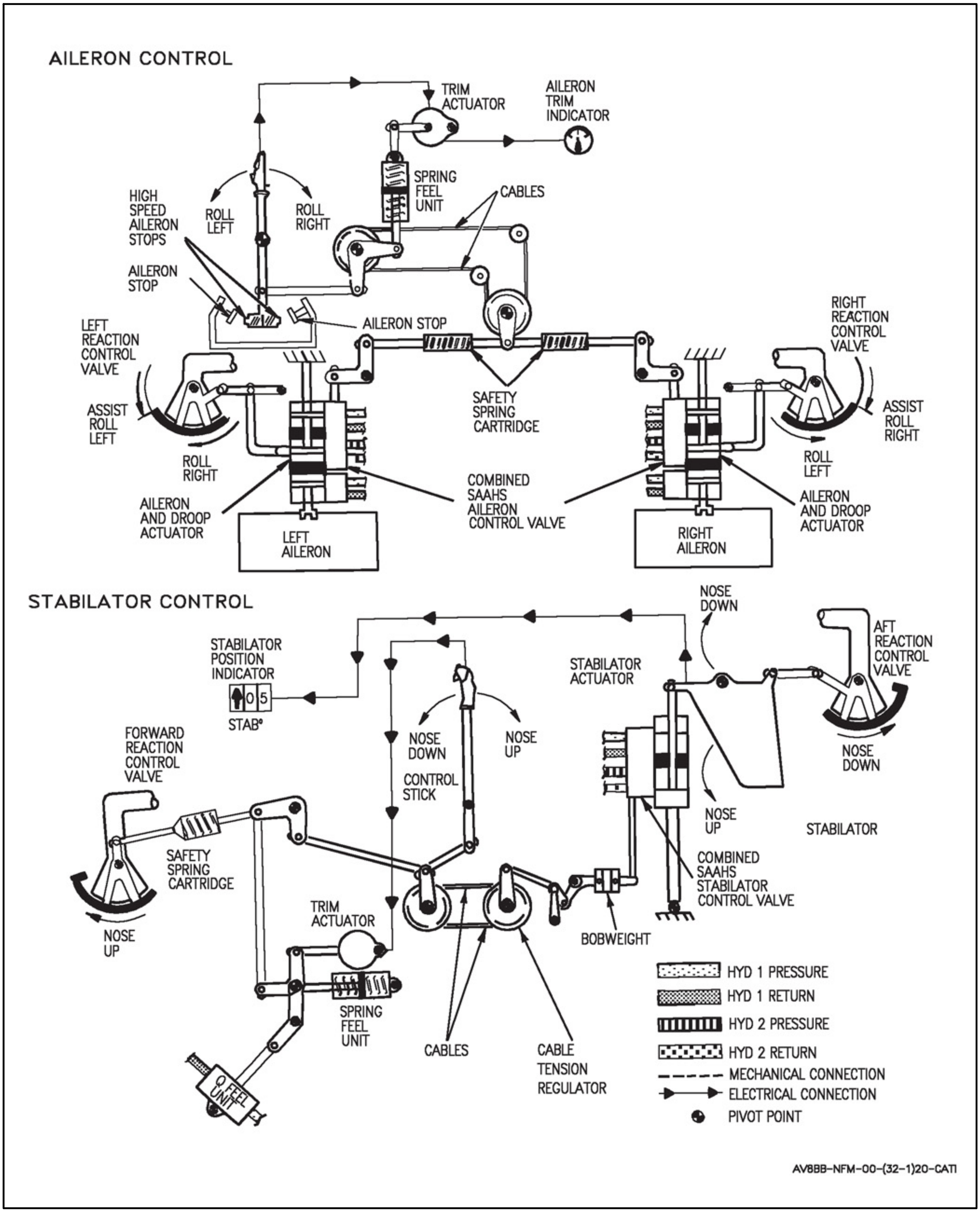


Figure 2-12. Flight Controls (Sheet 1 of 2)

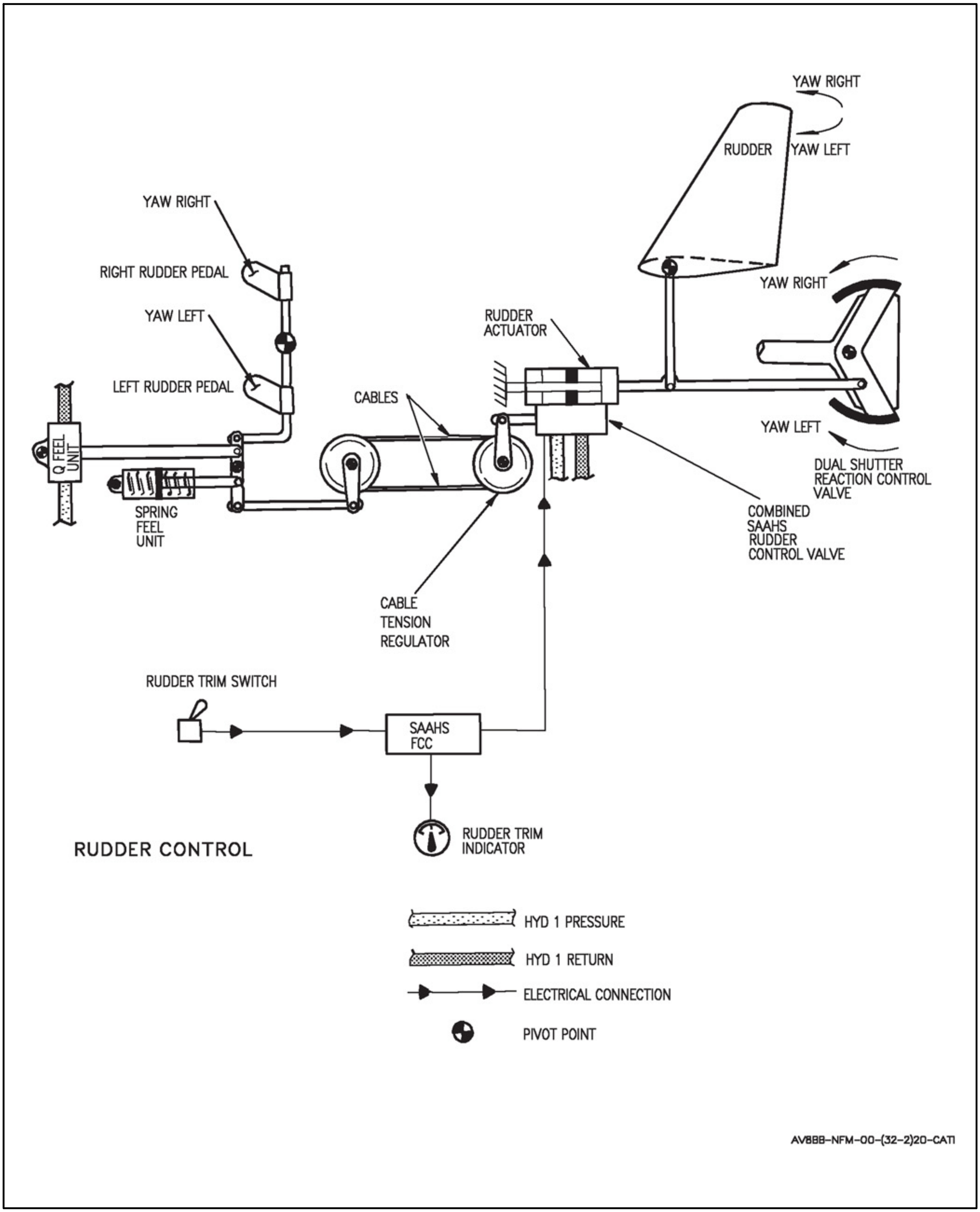


Figure 2-12. Flight Controls (Sheet 2)

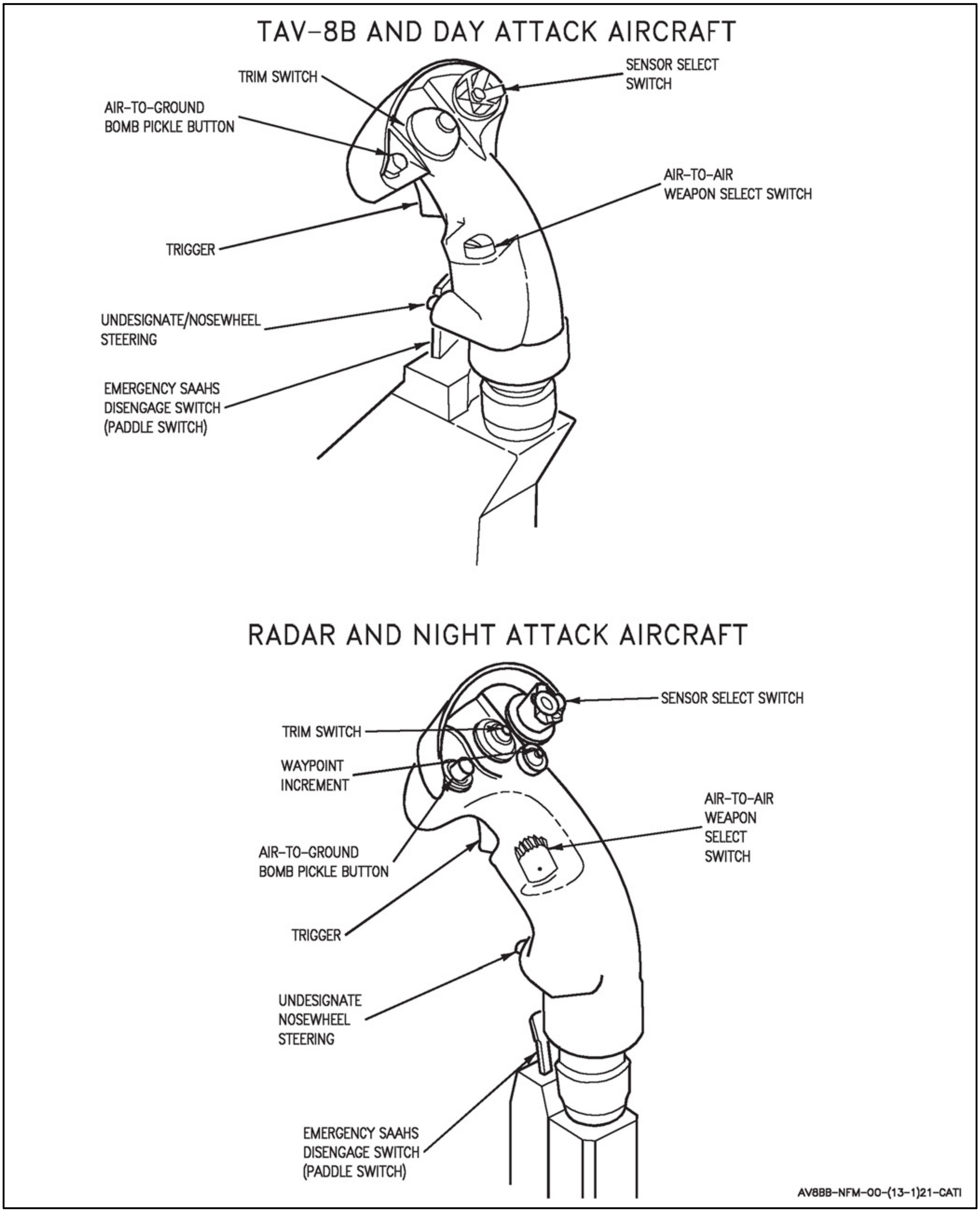


Figure 2-13. Control Stick Grip

2.14.1.1.4 Aileron Safety Cartridge Assemblies

An aileron safety cartridge assembly, located at the intersection of the fuselage and wing on each side of the aircraft, permits control of the aircraft by allowing operation of one aileron if the other is jammed. These assemblies normally act as a solid link. In the event of one wing's aileron becoming jammed, stick pressure will override that wing's cartridge assembly's spring tension, thereby allowing movement of the opposite wing's aileron. Stick pressure required will vary depending on the deflection angle of the jammed aileron. An increase in lateral stick pressures may be an indication of compression or extension of the aileron safety spring cartridge assembly. Reducing the air loads acting upon the aircraft will decrease the aircraft's roll rate tendency for a given jammed deflection.

2.14.1.2 Stabilator Control System

The longitudinal control system consists of the control stick, spring feel unit, hydraulically operated Q–feel unit, cables, control rods, a tandem hydraulic actuator, a stabilator, and two pitch reaction control valves. Stabilator travel is about 10° trailing edge up and 11° trailing edge down. Longitudinal movement of the stick is transmitted by control rods and cables to the stabilator actuator control valve. The control valve meters hydraulic fluid to the tandem power cylinders in proportion to the displacement. The tandem power cylinders allow simultaneous use of both hydraulic systems. If a single hydraulic system fails, the remaining system will supply adequate power for control.

2.14.1.2.1 Longitudinal Control Feel

Longitudinal control feel is provided by a hydraulic Q–feel unit powered by the HYD 1 system and a nonlinear spring unit. The spring unit provides stick forces independent of airspeed up to 165 knots. Above 165 knots, the Q–feel unit increases stick forces as airspeed increases. Hydraulic supply for the Q–feel is controlled by a valve which is energized open by the air data computer at 165 knots. The Q–feel system may be shut off by placing the Q–feel switch, on the left console, OFF. With the Q–feel off, airspeed over 500 knots may cause a pilot induced oscillation (PIO).

A bobweight is installed on the rear bellcrank (Figure 2-12) which controls the stabilator actuator control valve. The addition of the bobweight to the longitudinal flight control system improves the pilot's stick feel forces and the aircraft's pitch flying qualities.

2.14.1.2.2 Longitudinal Trim System

The longitudinal trim system consists of a trim switch on the stick grip and an electric trim actuator. When the trim switch is actuated, the actuator repositions the spring feel unit which, in turn, moves the stick neutral position. Total trim travel is 7.5° stabilator trailing edge down (nose down) and 4° stabilator trailing edge up (nose up). An auto trim system automatically trims the aircraft when AFC is engaged. Manual trim overrides auto trim.

2.14.1.2.3 Stabilator Position Indicator

Stabilator position is provided on both the EDP and the DDI. The EDP is located on the right side of the main instrument panel and the DDI on the left side (Day Attack aircraft) or either side of the main instrument panel for Radar and Night Attack aircraft. Both indicators display stabilator position in degrees with an arrow to indicate nose up or nose down. Stabilator position on the DDI is displayed on the engine data display and is accessible through the menu display by selecting ENG.

2.14.1.2.4 Forward RCV Safety Cartridge Assembly

A safety spring cartridge is located in the longitudinal axis between the forward reaction control valve (RCV) and the RCV servo. The double acting spring cartridge is designed to allow the RCV servo to function and to provide aft longitudinal control (stab) if the forward RCV jams, longitudinal stick force will override the cartridge assembly's spring tension, allowing the control linkages between the stick and stabilator actuator to move. Pitch authority will be reduced during jetborne or semi–jetborne flight. The reduced authority should be compensated for by increasing the airspeed, thereby increasing the pitch control authority of the stab. With nozzles aft (butterfly valve closed or no RCS pressure), the forward RCV jam will have no effect on controllability of the aircraft.

2.14.2 Control Stick

The control stick is mounted to permit left, right, fore, and aft movement for control of the ailerons and stabilator (see Figure 2-13). The stick grip contains seven controls (eight on Radar and Night Attack aircraft): a sensor select switch, a four way trim switch, an air-to-ground bomb pickle button, a trigger, an air-to-air weapon select switch, a nosewheel steering switch and an emergency SAAHS disengage switch (paddle switch). A waypoint increment switch (WINC) is added to the control stick on Radar and Night Attack aircraft.

2.14.3 Rudder Control System

The rudder control system consists of the rudder pedals, a spring feel unit, cables, control rods, rudder pedal shakers, rudder actuator, rudder and a dual reaction control valve. Rudder travel is 15° right and left. Movement of the rudder pedals is transmitted by control rods and cables to the rudder actuator control valve. The rudder actuator is powered by the HYD 1 system. Direct mechanical control of the rudder is provided if a hydraulic failure occurs.

2.14.3.1 Rudder Feel System

Rudder feel is provided by the Q-feel unit and a linear spring unit. The spring unit provides rudder forces independent of airspeed up to 165 knots. Above 165 knots, the Q-feel unit increases rudder forces as airspeed increases. The Q-feel system may be shut off by placing the Q-feel switch on the left console OFF.

2.14.3.2 Rudder Trim System

The rudder trim system consists of a trim switch on the left console which positions the rudder actuator and has about 2° authority.

2.14.3.3 Rudder Trim Indicator

The rudder trim indicator is on the left console. The left end of the arc represents full left trim and the right end represents full right trim. Rudder trim indication is furnished from the stability augmentation and attitude hold system (SAAHS) computer.

2.14.3.4 Rudder Pedal Shakers

At low speed, rudder pedal shakers give early warning of sideslip. In flight, at approximately 165 knots or below, if over 0.06 lateral g's occur, one of the two shakers will oscillate its associated pedal, giving a cue to the pedal that should be pushed.

The rudder pedal shaker is only enabled for the preceding conditions if the aircraft configuration is one of the following:

1. Gear down with STOL flaps selected.
2. Gear down and flaps AUTO/CRUISE at less than 0.3 Mach.
3. Gear up and flaps STOL at less than 0.3 Mach.
4. Nozzles greater than 10°.

Each shaker is an electric motor which drives an eccentric to shake its pedal. The shaker is activated through the SAAHS computer logic using inertial navigation system (INS) lateral acceleration inputs. The INS also provides lateral acceleration to the display processor to provide sideforce indication on the head-up display (HUD). The rudder pedal shaker (RPS) switch, on the left console allows the RPS system to be tested on the ground.

2.14.3.5 Rudder Pedals Adjustment

When the rudder pedals adjust knob is pulled, the rudder pedals can be pushed forward or allowed to move aft under spring pressure. The pedals should be restrained from snapping aft when the rudder pedal adjust knob is pulled. When the knob is returned, the pedals will lock in the selected position. Ensure the knob is returned fully without use of force, retaining no feeling of springiness. Press hard on both pedals to ensure they are locked.

2.14.3.6 Rudder Pedal Shaker Switch

The Rudder Pedal Shaker (RPS) switch is on the forward end of the left console and has three positions.

OFF – Rudder pedal shakers disables.
ON – Rudder pedal shakers enabled.
TEST – Allows the rudder pedal shakers to be tested on the ground. While taxiing with the nosewheel steering engaged, hold the RPS switch to TEST and turn the aircraft with nosewheel steering. This imposes a side force from the side with the forward deflected rudder pedal. Check that the rear rudder pedal oscillates briefly and the HUD sideforce symbol briefly indicates sideforce in the direction of applied rudder.

The RPS switch is not installed in the rear cockpit of the TAV-8B.

2.14.4 Reaction Controls

Control is maintained, when jetborne, by reaction control valves. These are shutter valves supplied with bleed air ducted from the HP compressor, through a master butterfly valve which is interconnected with the engine nozzles control mechanism. The master butterfly valve opens automatically when the nozzles are deflected from fully aft. Air supply is progressive as the nozzles are lowered from 0° to 36° down.

2.14.4.1 Duct Pressure Indicator

The duct pressure indicator indicates reaction control duct pressure. When the nozzles are full aft, the master butterfly valve is closed and the indicator indicates 0 to 3 psi. As the nozzles are rotated and the master butterfly valve opens, the duct pressure indicator will indicate duct pressure.

2.14.4.2 Lateral Control

Lateral control is provided by two wing tip reaction control valves which are interconnected with the aileron actuators. These blow downward when the associated aileron is trailing edge down. The downblowing valve becomes fully open at about half aileron travel and then the opposite wing reaction valve opens progressively and blows upwards.

2.14.4.3 Longitudinal Control

Longitudinal control is provided by two downblowing reaction control valves, one at the nose and one at the tail. The forward valve is linked to the control column through a safety spring cartridge. An actuator on the forward valve linkage is used for the stability augmentation system (SAS). The aft valve is linked directly to the stabilator. Neutral control coincides with 2° nose down trim, at which time both valves are just closed.

2.14.4.4 Directional Control

Directional control is provided by a double reaction control valve at the tail. This is connected to the rudder actuator and blows in accordance with rudder movement.

2.15 SECONDARY FLIGHT CONTROLS

2.15.1 Flaps

The electro-hydraulic operated trailing edge flaps (see Flap System foldout) are controlled by a dual channel electronic flap controller, a dual system hydraulic control valve and two dual tandem actuators. Flap positioning is provided by the flap controller in accordance with switch selection by the pilot. A STOL mode (25° to 62°), an AUTO mode (0° to 25°), and a CRUISE mode (5°) may be selected. Two cockpit switches, an air data computer, a landing gear down relay, a WOW relay, dual sensors on the engine nozzles, and dual sensors on the flaps, provide control inputs to the flap controller. Dual output commands to the hydraulic module control two hydraulic sources to two dual tandem hydraulic cylinders. Engine nozzle and flap positions are shown on the HUD. Flap position is also displayed on the flap position indicator. Nozzle position is also displayed on the engine performance indicator (EPI). The flap controller uses two electric inputs to provide two separate channels for flap control.

2.15.1.1 For Aircraft Without ECP-255 R1

Channel 1 is powered by the switched battery bus. Channel 2 is powered by the emergency 28 volt dc bus. The flap controller shuts down a failed channel depending on the detected fault source. Power interruption to the emergency 28 volt dc bus may cause loss of channel 2. This can occur when a generator or the main TRU comes on or goes off line, such as during engine start or when the DC test switch is used. Channel 1 will not be lost due to a power interruption if the battery switch is in BATT. Single failures do not affect flap system performance. If a dual channel controller failure or an asymmetric flap greater than 3° occurs, the dual shutoff valves will lock the flaps in place. With a dual channel controller failure, the flaps can then be retracted with the emergency retract button on the throttle. Figure 2-14 describes the flap and aileron droop logic.

2.15.1.2 For Aircraft With ECP-255 R1

The channel 1 primary flap power comes from the switched battery bus. The channel 2 primary flap power comes from the emergency 28 volt dc bus. The primary flap power is removed from the flap controller when the flap switch is in the OFF position. The digital flap controller is provided an additional source of switched battery bus power that is not routed through the flap ON/OFF switch. This additional power source allows the flap and nozzle displays to remain active when the flap switch is in the OFF position. This additional power source also reduces the likelihood of a nuisance flap system fault when a generator or main TRU comes on or goes off line, such as during engine start or when the DC TEST switch is used. Single failures do not affect flap system performance. If two similar controller failures occur or flap asymmetry exceeds 5°, the dual shutoff valves will lock the flaps in place. When the flaps are locked, the flaps can be retracted with the emergency retract button on the throttle. Figure 2-14 describes the flap and aileron droop logic.

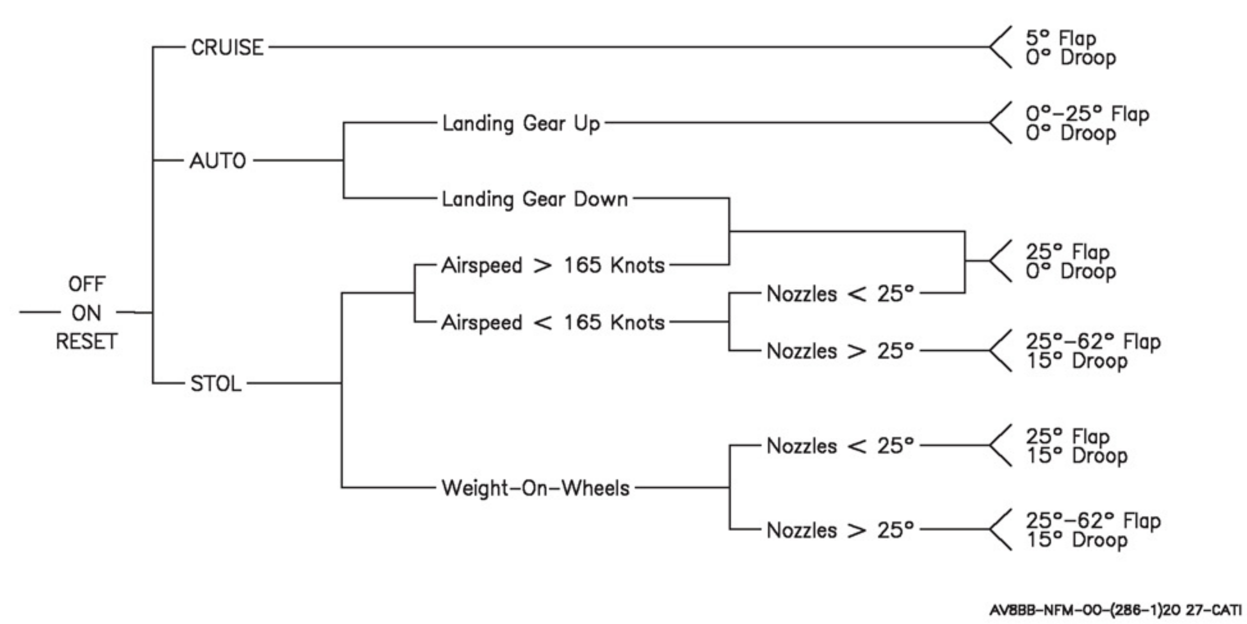


Figure 2-14. Flap and Aileron Droop Logic

2.15.2 Flap Select Switches and Indicators

2.15.2.1 Flaps Power Switch (AV-8B)

The flaps power switch is on the landing gear control panel.

OFF	For aircraft without ECP-255 R1: Shuts off power to the flaps mode switch and flap controller. Selecting flaps OFF causes a FLAPS warning and loss of flap and nozzle position indication.
OFF	For aircraft with ECP-255 R1: Shuts off power to the flaps mode switch. Selecting flaps OFF causes a FLAPS warning and removes primary flap power from the flap controller. Flap and nozzle position indications are still active.
ON	For aircraft without ECP-255 R1: Applies power to the flaps mode switch and flap controller.
ON	For aircraft with ECP-255 R1: Applies power to the flaps mode switch and provides primary flap power to the flap controller.
RESET	Momentary. Resets flap controller failure logic and stops an initiated BIT.

2.15.2.2 Flaps Power Switch (TAV-8B)

The flaps power switch is on the landing gear control panel.

OFF	For aircraft without ECP-255 R1: Shuts off power to the flaps mode switch and flap controller. Selecting flaps OFF causes a FLAPS warning and loss of flap and nozzle position indication.
OFF	For aircraft with ECP-255 R1: Shuts off power to the flaps mode switch and removes primary flap power from the flap controller. Selecting flaps OFF causes a FLAPS warning. Flap and nozzle position indications are still active.
FWD	Flaps power controlled by front cockpit switch.
RESET	Momentary. Resets flap controller logic and stops an initiated BIT.

2.15.2.3 Flaps Mode Select Switch

The flaps mode select switch is located on the landing gear control panel. See Figure 2-15 for flap schedules.

STOL	Provides 25° flaps if airspeed over 165 knots. Below 165 knots, flaps are scheduled from 25° to 62° as nozzles are rotated from 25° to 50°. Below 165 knots, with nozzles over 25°, provides 15° aileron droop. With weight-on-wheels, ailerons droop 15°.
AUTO	With the landing gear up, flaps are scheduled from 0° to 25° as a function of Mach number, airspeed, and angle-of-attack. With the landing gear down, provides 25° flaps even if an AUT FLP caution is present.
CRUISE	Provides 5° flaps.

On TAV-8B aircraft this switch is located in the front cockpit only. However, the flaps mode selected in the front cockpit is shown in the rear cockpit on an indicator on the landing gear control panel.

2.15.2.4 Flaps Schedule

Figure 2-15 covers both STOL and AUTO flap schedules. To use the chart to determine STOL flap angle with respect to NOZZLE ANGLE for airspeeds less than 165 KCAS use bottom chart and enter the NOZZLE ANGLE on the horizontal axis. From NOZZLE ANGLE entry angle rise vertically until you intersect the printed heavy black line. From this intersection move horizontally to vertical axis and record corresponding FLAP ANGLE.

To determine FLAP ANGLE in AUTO using the upper chart in Figure 2-15. This chart is actually three charts in a single display. Moving from left to right.

2.15.2.4.1 Using INDICATED AOA

The FLAP ANGLE as a function of INDICATED AOA is determined for both T/AV–8B using the heavy black solid line. Enter INDICATED AOA on the horizontal axis and rise vertically until the printed heavy black line is intersected. From this intersection move horizontally to the vertical axis and record corresponding FLAP ANGLE. The resulting FLAP ANGLE determined by INDICATED AOA chart may or may not yield the correct answer. The FLAP ANGLE must be determined as a result of MACH NUMBER and AIRSPEED. Use the lowest FLAP ANGLE result as the planned FLAP ANGLE for any particular condition of AOA, MACH No, and AIRSPEED.

2.15.2.4.2 Using MACH NUMBER

This chart contains a solid heavy line for use with TAV–8B and a dashed line for single seat AV–8B. Below 0.3 MACH and above 0.87 MACH the heavy line is used for both T/AV–8B. Entering the displayed MACH number on the horizontal axis and rise vertically until the heavy solid (TAV–8B) or dashed line (AV–8B) is intersected. From this intersection move horizontally to the vertical axis and record corresponding FLAP ANGLE. The resultant FLAP ANGLE determined by MACH NUMBER may or may not yield the correct answer. The FLAP ANGLE must be determined as a result of INDICATED AOA and AIRSPEED. Use the lowest FLAP ANGLE result as the planned FLAP ANGLE for any particular condition of AOA, MACH No, and AIRSPEED.

2.15.2.4.3 Using INDICATED AIRSPEED

This chart contains a solid heavy line for use with TAV–8B and a dashed line for single seat AV–8B. Below 200 KCAS to 50 KCAS the solid line is used for both. Entering the displayed airspeed on the horizontal axis and rise vertically until the heavy solid (TAV–8B) or dashed line (AV–8B) is intersected. From this intersection move horizontally to the vertical axis and record corresponding FLAP ANGLE. The resultant FLAP ANGLE determined by AIRSPEED may or may not yield the correct answer. The FLAP ANGLE must be determined as a result of MACH NUMBER and INDICATED AOA and use the lowest FLAP ANGLE result as the planned FLAP ANGLE for any particular condition of AOA, MACH No, and AIRSPEED.

2.15.2.5 Emergency Flap Retract Button

The emergency flap retract button on the throttle (Figure 2-6) retracts the flaps when held pressed when both flap channels have failed or flap power switch is OFF.

2.15.2.6 Flap Position Indicator

The left flap position indicator is on the landing gear control panel and is controlled by channel 1. If the indicator fails it will show “BARBER POLE”. Right flap position is shown on the HUD in the V/STOL mode and is controlled by channel 2.

2.15.2.7 Flaps Warning Light

For all aircraft with or without ECP–255 R1:

The FLAPS warning light, a red light, on the warning/threat light panel (green light on the warning light panel on AV–8B Radar and Night Attack aircraft), indicates a dual channel flap failure or flap power switch OFF. On TAV–8B 163856 and up, AV–8B 163519 and up, a FLAP FAILURE, FLAP FAILURE voice warning is provided in conjunction with the FLAPS warning light.

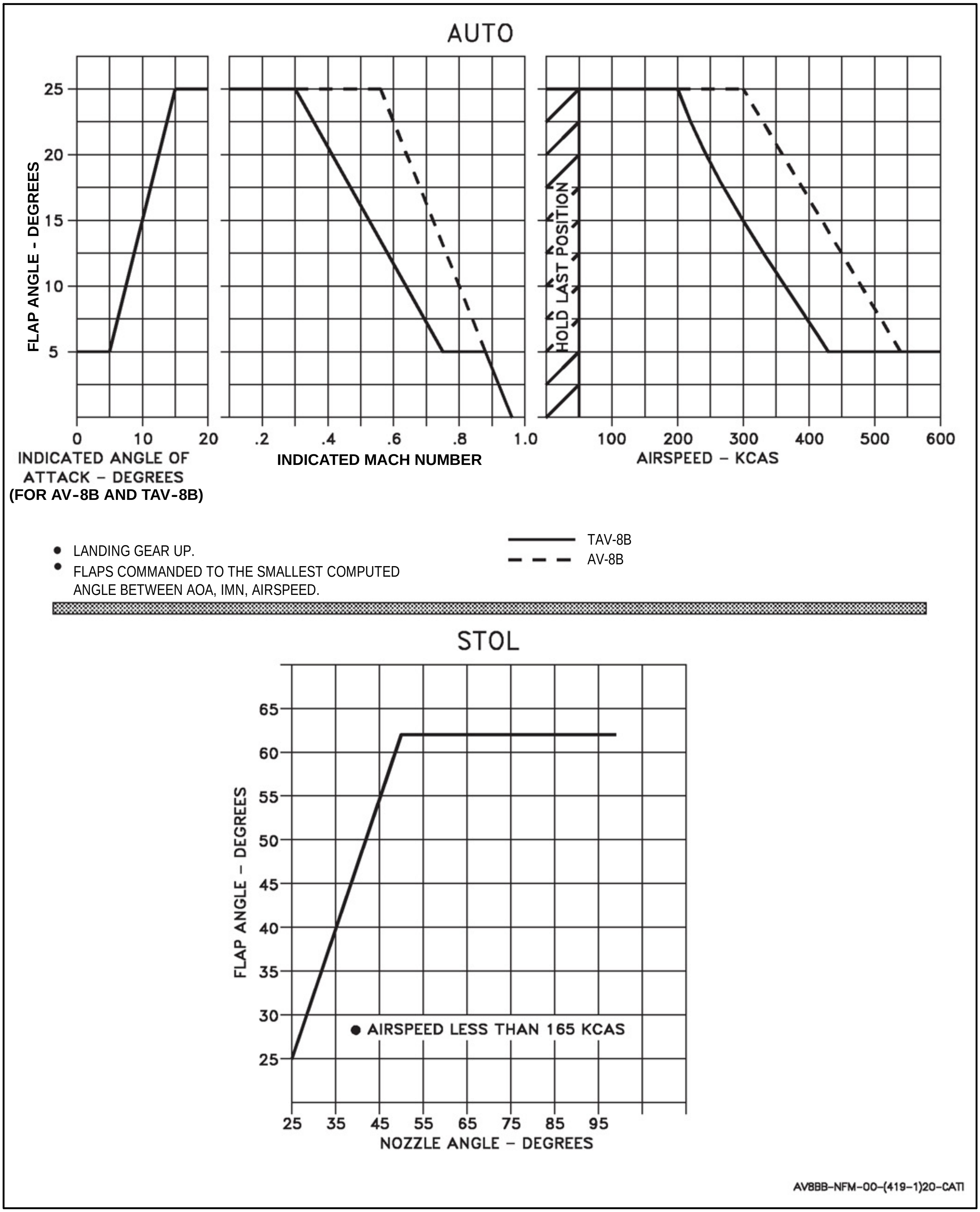


Figure 2-15. Flap Schedules

For aircraft with ECP-255 R1:

If the FLAPS warning light is not cleared, the FLAP FAILURE, FLAP FAILURE voice warning will reoccur once after 15 seconds if the flaps remain greater than 25°.

2.15.2.8 Flaps Caution Lights

For aircraft without ECP-255 R1:

The three flaps caution lights, (FLAPS 1, FLAPS 2, and AUT FLP) are on the caution/advisory light panel. FLAPS 1 or FLAPS 2 indicates a failure of flap channels 1 or 2. A FLAPS 2 caution may appear if the generator fails due to a momentary loss of power.

For aircraft with ECP-255 R1:

The three flaps caution lights, (FLAPS 1, FLAPS 2, and AUT FLP) are on the caution/advisory light panel. FLAPS 1 or FLAPS 2 (but not both) indicates a failure in the flap system but no loss of function. The digital flap controller will keep the flaps engaged as long as a valid signal path exists to control the flaps. A FLAPS 1 or FLAPS 2 caution means that one more failure could result in locked flaps.

For all aircraft with or without ECP-255 R1:

The AUT FLP caution light indicates the loss of AUTO mode computation or air data computer input. On TAV-8B 163856 and up, and on AV-8B 163519 and up, a CAUTION, CAUTION voice warning is provided in conjunction with either a FLAPS 1, FLAPS 2, or AUT FLP caution light. The flaps caution lights are yellow on the TAV-8B and AV-8B Day Attack aircraft and are green on the AV-8B Radar and Night Attack aircraft.

2.15.2.9 STO Advisory Light

The green STO advisory light indicates the flap mode select switch is in STOL.

2.15.3 Flap IBIT

A pilot initiated built-in-test (IBIT) may be performed. To accomplish an IBIT, place the flap power switch from OFF to ON. RESET will inhibit IBIT. Press the flaps BIT switch on the landing gear control panel. During the IBIT sequence, FLAPS 1, FLAPS 2, and AUT FLP caution lights and the FLAPS warning light must be on prior to initiation of the BIT. After a successful IBIT, the FLAPS caution and warning lights will go out and the flaps will go to the selected mode. Failure of a FLAPS caution light to go out within 25 seconds indicates a NO GO condition. If this occurs, place the flaps power switch OFF, beep the flaps up, place the flaps power switch ON, and again initiate IBIT.

For aircraft without ECP-255 R1:

The IBIT system is inoperative with weight off the wheels, landing gear up, airspeed greater than 165 knots or after RESET selected. If RESET is selected during IBIT, IBIT will immediately stop and the system will return to normal operation. Once IBIT is successfully completed, it will be inhibited unless the flaps power switch is cycled through OFF to ON. Post flight flap IBIT should not be performed since it clears the fault isolation indications on the flap controller.

For aircraft with ECP-255 R1:

The IBIT system is inoperative with weight off the wheels, landing gear up, airspeed greater than 165 knots, nozzles rotated less than 10°, or after RESET selected. If the AUT FLAP warning light flashes twice immediately after the flaps BIT switch is pressed, verify that the nozzles are rotated to at least 10°. If the nozzles were rotated less than 10°, rotate them to beyond 10° and place the flaps power switch OFF and then to ON before pressing the flaps BIT switch. If RESET is selected during IBIT, IBIT will immediately stop and the system will return to normal operation. Once IBIT is successfully completed, it will be inhibited unless the flaps power switch is cycled through OFF to ON.

2.15.4 Aileron Droop

Aileron droop is accomplished by a single-cylinder aileron droop actuator in tandem with each aileron actuator. The aileron droop actuators are powered by HYD 1. Aileron droop operation requires no pilot action. Inflight, with the flap switch in STOL, the ailerons droop 15° when airspeed is below 165 knots and nozzles are over 25°. This establishes a new aileron neutral position and aileron travel is 10° down to 25° up. After takeoff with the flap switch in STOL, the ailerons begin to reposition up (0° droop) 3 seconds after weight-off-wheels and nozzles less than 25°, or exceeding 165 knots. Aileron droop requires approximately 7 seconds to reposition 15° down after selection of STOL flaps with weight-on-wheels.

2.15.4.1 Aileron Droop Light

The aileron DROOP light on the caution/advisory light panel comes on when the ailerons are drooped.

2.15.5 Speedbrake

The electro-hydraulic operated speedbrake is hinged on the fuselage underside, aft of the main landing gear. With the landing gear up, the speedbrake has a maximum travel of 66°. This travel is progressively reduced with increased airspeed. With the landing gear handle down, the speedbrake is set to 25° regardless of any previous selection. Control is provided by a switch on the throttle. A SPD BRK light, on the caution/advisory lights panel, is off when the speedbrake is fully retracted with the landing gear up or when the speedbrake is at 25° with the landing gear down. Hydraulic power is from the HYD 1 system. Electrical power is from the main 28 volt dc bus. There is no specific speedbrake emergency operation; however, with an electrical or hydraulic failure, airloads will close the speedbrake. The speedbrake will not extend upon reduction of airspeed.

2.15.5.1 Speedbrake Switch

With the landing gear up, control of the speedbrake is by a thumb actuated switch on top of the throttle (day attack and TAV8B aircraft.) On Radar and Night Attack Aircraft, the switch is on the side of the throttle beneath the comm switch (See Figure 2-6). The switch has three positions: OUT, NORM and IN. The switch is spring loaded to NORM. When OUT is selected, the speedbrake extends. When IN is selected the speedbrake retracts.

2.16 STABILITY AUGMENTATION AND ATTITUDE HOLD SYSTEM

The two basic SAAHS modes of operation are the stability augmentation system (SAS) mode and the automatic flight control (AFC) mode. The mode selection controls are located on the SAAHS panel on the left console just forward of the throttle nozzle quadrant. Refer to FO-1 (AV-8B Day Attack), FO-2 (AV-8B Radar and Night Attack aircraft), or FO-3 (TAV-8B). The Q-feel switch on the SAAHS panel is not part of the SAAHS. For a description of this switch, see longitudinal control feel, paragraph 2.14.1.2.1.

2.16.1 Stability Augmentation System

The three SAS mode selection controls are the PITCH, ROLL and YAW switches which engage the stability augmentation in the corresponding aircraft axes. The stability augmentation system increases aircraft stability and improves the response to pilot inputs in maneuvering flight throughout the entire flight envelope. The yaw SAS also provides a lateral stick to rudder interconnect for improved turn coordination.

The SAS switches may be engaged and disengaged individually to provide stability augmentation in any desired combination of the three axes. Disengaging individual SAS switches degrades departure resistance (DEP RES) which greatly increases the possibility of violent departure in certain flight regimes. An interlock between the yaw SAS switch and the weight-on-wheels switch on the main gear inhibits the yaw stability augmentation when the aircraft is on the ground.

Pressing the emergency SAAHS disengage switch (paddle switch) located on the control stick grip interrupts the stability augmentation system in all three axes and also removes rudder trim. Releasing the paddle switch restores stability augmentation to those axes selected by the SAS switches and restores the rudder trim.

2.16.1.1 Departure Resistance

The DEP RES improves lateral/directional handling at low to moderate AOA and resists out-of-control departures at AOA below and above the maneuvering tone. DEP RES is at all AOA and varies in function depending on airspeed, Mach number and AOA.

Above 4° AOA, lateral stick commands increasing rudder in the direction of the roll and decreasing aileron in order to reduce adverse sideslip and improve high AOA roll performance. Lateral stick also commands nose-down stabilator to reduce AOA build-up from inertial and kinematic coupling. The maximum rudder commanded by the SAS is equivalent to 1/2 pedal and occurs at 8° AOA and above with lateral stick at the high speed stop. The departure resistance incorporates a roll rate feedback and increased gain to the ailerons at low airspeed that improve Dutch roll damping at high AOA and lessen wing rock. Wing rock is greatly reduced or eliminated above 120 KCAS above the maneuvering tone.

Above 3° AOA and 10° AOA respectively, rudder and ailerons are commanded in a direction to reduce sideslip excursions. To improve Dutch roll damping and lessen wing rock, rudder and ailerons are also commanded in the direction to oppose the rate-of-change of sideslip. The ability of DEP RES to control sideslip is degraded to varying degrees by overriding the lateral high speed stop, by large rudder pedal deflections, by large lateral weight asymmetries, and by installation of the inflight refueling probe. These effects are cumulative and in combination can overwhelm the ability of DEP RES to prevent departures. The departure resistance in the absence of the air refueling probe, eliminates rudder induced departures at all AOA.

Departures, when they occur, have been softened by the DEP RES. Autorolls may occur following recovery from post stall gyrations. These additional rolls have been termed positive AOA autorolls. Opposite rudder will aid recovery.

Departure resistance is intentionally inhibited at all airspeeds with the gear down and STOL flaps selected. It is also inhibited below 0.3 Mach if either the gear is down or STOL flaps are selected.

2.16.1.2 Spin Mode

Departure resistance is effective in preventing departures and/or reducing the severity of a departure. However, should a spin develop after departure, departure resistance will not resist the spin and could reduce ailerons and rudder authority needed by the pilot to recover from the spin. Spin logic disengages all feedback and interconnect paths (essentially SAS off) while recovering from a spin and reengages those paths once the spin is broken to resist a departure in the opposite direction. The spin logic is as follows:

1. Fade out all feedback and interconnect signals within 0.5 seconds if angle of attack is greater than 25° or less than -7° and absolute yaw rate is greater than 18° per second for 4 seconds.

2. Fade in all feedback and interconnect signals if absolute yaw rate is less than 15° per second.

2.16.1.3 DEP RES Light

Alternate roll rate, lateral acceleration, AOA, and yaw rate and some alternatives to other parameters are available. When the in-flight monitor (IFM) detects invalid sensor data, alternative inputs are selected automatically. When this results in significant degradation in handling qualities, the DEP RES light comes on.

2.16.2 Automatic Flight Control

The two AFC mode selection controls are the AFC and ALT HOLD solenoid held switches. All three SAS switches must be engaged in order to engage the AFC mode selection switches. Also, an interlock with the weight-on-wheels switch on the main gear inhibits engagement of the AFC mode switches on the ground and disengages the switches upon main gear touchdown on landings.

The AFC switch has three positions which provide the following functions:

AFC – Solenoid held position. Engages the AFC mode.
OFF – AFC mode is off.
RESET – Momentary position. SAAHS reset.

The ALT HOLD switch has two positions which provide the following functions:

ALT HOLD – Solenoid held position. Engages altitude hold option of AFC mode.
OFF – Altitude hold is off.

The AFC switch must be engaged with the INS switch in NAV or IFA in order to engage the ALT HOLD switch. The AFC mode may be disengaged by turning the AFC switch off. Disengaging the AFC switch also causes the ALT HOLD switch to return to the OFF position if it is engaged. Disengaging any of the three SAS switches will disengage the AFC mode. The AFC and ALT HOLD switches will return to the off position if they are engaged. Pressing the paddle switch also disengages the AFC and ALT HOLD switches if they are engaged. Both switches will remain in the off position when the paddle switch is released. The technique of “clicking” the paddle switch may be used to revert from the AFC mode to the SAS mode. Attitude references are to the aircraft waterline.

2.16.2.1 AFC Mode – AFC Switch Only Engaged

When the AFC switch is engaged and the ALT HOLD switch is in the off position, the AFC mode provides pitch attitude hold, roll attitude hold and heading hold. At airspeeds above 50 knots, the AFC will capture and hold pitch attitudes in the ±30° range and roll attitudes within ±60° which are outside of the ±5° range about wings level. Heading hold is provided inside the ±5° roll attitude range for airspeeds above 140 knots if gear and flaps are up or above 0.3 Mach if the gear is down or if STOL flaps are selected (but not both). Heading hold is inhibited at all airspeeds if both the gear is down and STOL flaps are selected. With heading hold inhibited, roll attitudes within ±5° are rolled to wings level. Neither pitch nor roll attitude capture will occur for attitudes which exceed one or both of the ±30° pitch attitude or the ±60° roll attitude ranges. The AFC switch will remain engaged, however, the pilot must control the aircraft in both pitch and roll as in the SAS mode until the attitudes are within both limits. No cockpit indication is given to the pilot when he has maneuvered the aircraft outside the attitude capture limits. With the AFC engaged, mild stick vibration or chatter in pitch may occur during landing approach due to abrupt movement of the forward reaction control valve caused by flight control computer noise. This is normal and should be disregarded.

At airspeeds below 50 knots, the roll attitude range is restricted to ±20° and the roll to wings level action extends to the full ±20° range. The pitch attitude capture and hold action is restricted to the +3° to +12° range. Pitch attitudes outside this range but within –15° to +20° will be driven to the nearest of the +3° to +12° range boundaries. The AFC switch will disengage and reversion to the SAS mode will occur if either the ±20° roll attitude range or the –15° to +20° pitch attitude range is exceeded. If the true angle of attack exceeds +15° with the airspeed greater than 60 knots, the AFC mode will be disengaged and reversion to the SAS mode will occur.

Automatic pitch and roll trim are provided the AFC mode. The automatic trim tracks the aircraft pitch and roll changes to keep the series servo actuators close to their neutral positions an effort to minimize disengage transients. On aircraft with departure resistance, the lateral stick to aileron interconnect may prevent the roll auto trim from keeping the aileron series servos near the center of the ±6° range. The automatic trim rates correspond to approximately 0.25° per second stabilator and aileron surface rates and cause the control stick to move in the direction the trim change.

2.16.2.2 AFC Mode – AFC and ALT HOLD Switches Engaged

The ALT HOLD switch permits selection of altitude hold in place pitch attitude hold in the AFC mode. The AFC switch must be engaged in order for the ALT HOLD switch to be engaged. In addition, the airspeed must be greater than 160 knots and the climb or descent rate must be less than 2,000 feet per minute for the ALT HOLD switch to be engaged. Altitude hold may be manually disengaged by “clicking” the pitch manual trim button as well as by turning the panel switch off. The operation of the roll attitude hold, heading hold and automatic pitch and roll trim is identical that with the AFC switch only engaged. If either the pitch attitude limits of ±30° or the roll attitude limits of ±60° are exceeded, the ALT HOLD switch will be disengaged and reversion to the AFC mode without altitude hold will occur. The ALT HOLD and AFC switches will also disengage if the displayed AOA exceeds +16° ±1°.

Altitude hold is also monitored by logic which will disengage the ALT HOLD switch and revert to AFC without altitude hold if any of the following events occur:

1. The altitude hold does not lock on to an altitude reference within ±250 feet following manual engagement of the trim switch or following interruption of altitude hold by longitudinal stick forces exceeding 1 pound. An altitude reference is established when the altitude rate is driven below 500 feet per minute by the altitude hold synchronization.
2. An excursion in altitude which differs by more than ±250 feet from the altitude reference.
3. The altitude changes due to stick or trim inputs by a cumulative total of more than ±250 feet following establishment of an altitude reference.
4. The altitude rate exceeds 2,000 feet per minute or the airspeed falls below 160 knots.

2.16.2.3 Maneuvering Flight In AFC Mode

The AFC mode includes a pitch and roll control stick steering (maneuvering) capability with the AFC switch engaged. The pilot can use the control stick and the manual trim switch to maneuver the aircraft and lock the AFC onto new pitch attitude, roll attitude and heading references without disengaging the AFC switch during the maneuvers. Pilot applied longitudinal and lateral stick forces in excess of approximately 1 pound interrupt the attitude and heading hold functions and inhibit the pitch and roll automatic trim allowing the aircraft to be maneuvered as in the SAS mode. Just as in SAS mode maneuvering, the pilot must trim out any stick forces prior to releasing the stick. This is important because the auto trim capability may have been exceeded when significant trim changes were made as a result of maneuvering.

Small attitude changes can be made with stick forces below the 1 pound level by inducing aircraft motion with small stick inputs and "clicking" the manual trim switch. Activating the pitch and roll manual trim switch interrupts the attitude and heading hold functions and automatic trim so that "clicking" the trim switch has the effect of updating the attitude hold references to the current aircraft attitudes. If altitude hold is engaged, changes in the roll attitude can be made in the same manner. "Clicking" the pitch manual trim switch disengages the ALT HOLD switch which provides a convenient method for reverting to pitch attitude hold for making altitude changes. ALT HOLD shall be disengaged whenever any pitch maneuvering is done. The ALT HOLD switch must be turned back on to re-engage altitude hold at the new altitude.

Heading changes can be made by banking outside the ±5° roll attitude range to interrupt the heading hold and rolling to wings level on the new heading. Small heading changes of a few degrees can be made without banking by sideslipping the aircraft to the new heading with the rudder pedals, "clicking" the roll manual trim switch to capture the new heading reference, and slowly releasing the rudder pedal input to minimize the heading transient. A tendency to hold a heading in a slight bank is indicative of a steady heading sideslip due to rudder mis-trim. This can be corrected by trimming the rudder.

AFC mode interrupts by stick force and manual trim switch inputs operate independently in pitch and roll within the AFC mode attitude limits of ±30° in pitch and ±60° in roll above 50 knots and -15° to +20° in pitch and ±20° in roll below 50 knots. The pilot can maneuver the aircraft in pitch without affecting the roll attitude hold and heading hold functions or maneuver in roll without affecting pitch attitude or altitude hold.

During significant aircraft trim changes, such as those produced by engine nozzle rotation and aileron droop, the action of the AFC mode is to hold the aircraft pitch and roll attitudes. The automatic pitch trim adjusts for the longitudinal trim change and the automatic roll trim adjusts for any roll trim changes due to asymmetric effects. If the pilot opts to control the aircraft manually during such trim changes, the attitude hold and automatic trim functions will be inhibited and it will be necessary to retrim the aircraft manually in pitch and roll to smoothly restore the attitude hold functions. Rapid acceleration or deceleration with asymmetric loaded stores may cause aircraft roll rates that exceed the response capability of AFC roll trim. If this happens the pilot should take control of the aircraft until the acceleration or deceleration is over, manually trim the aircraft and then reengage AFC. On aircraft with departure resistance, at the AOA where departure resistance becomes effective, a slow transition between AFC and departure resistance occurs.

2.16.3 Stability Augmentation and Attitude Hold System (TAV-8B)

There is no SAAHS panel in the rear cockpit. However, the rear cockpit crew member can disengage the AFC and ALT HOLD switches by pressing the emergency disengage switch on the control stick. He can also temporarily disengage the PITCH, ROLL, and YAW switches by pressing the emergency disengage switch. There is an AFC and ALT HOLD light which illuminates in the rear cockpit to the left of the DDI when the front crew member engages the respective modes. Both cockpits have caution lights for AFC, YAW, PITCH, and ROLL mode failures or disengagement. If AFC or ALT HOLD is engaged, command stick steering is not functional from the rear cockpit, and the emergency disengage switch must be depressed for the rear crew member to take control of aircraft.

2.16.4 Preflight Initiated Built-In-Test

With the weight-on-wheels and engine rpm less than 40 percent, preflight IBIT is initiated by pressing MENU, BIT, SAAHS on the DDI. Preflight IBIT tests all SAAHS functions which can be automatically checked. Pressing the paddle switch or increasing the rpm above 40 percent will stop the IBIT test.

2.16.5 In-Flight Monitor

The IFM operates when power is applied to the flight control computer. It checks series servo actuators, the flight control computer, rate sensors, accelerometers, plus data received from the air data computer and inertial navigation system. If the IFM detects a failure it will usually shut off the affected axis except that the departure resistance SAS is usually reconfigured when a failure is detected. The AFC and ALT hold will be disengaged if engaged when a failure is detected. A reset may be attempted by placing the AFC switch to RESET. If the failure was transient, the system will reset and the lost functions will again be available.

2.17 LANDING SYSTEMS

The landing systems consist of the landing gear, nosewheel steering, brakes, antiskid and a lift improvement device system (LIDS).

2.17.1 Landing Gear System

The aircraft is equipped with a fully retractable landing gear that consists of a nose gear, a main gear with twin wheels in tandem with the nose gear, and two single wheel wing gears. The nose gear retracts forward and the main gear retracts aft into fuselage bays. The wing gears retract aft and are partially enclosed in a fairing assembly just inboard of the ailerons. All four landing gear are electrically controlled by the emergency dc bus, and actuated by the Hyd 1 system. Accidental retraction, when the aircraft is on the ground, is prevented by a weight-on-wheels (WOW) switch on the main gear, and ground safety locks.

2.17.1.1 Main Gear

The main gear is hydraulically retracted and extended, and mechanically locked in the up and down positions. When the main gear is retracted, the fuselage bay is enclosed by flush fitting doors. The fuselage bay doors are mechanically connected to the main gear to open and close on gear retraction and extension. The main gear strut has a long stroke shock absorber to absorb impact due to high rates of descent during touchdown. The main gear doors can be opened on the ground by a release button and lever on the door operating strut adjacent to the main gear strut. Normally the doors are closed; however, if they are left open they will close on gear retraction.

2.17.1.2 Nose Gear

The nose gear is hydraulically retracted and extended. It is mechanically locked in the down position and hydraulically locked in the up position. The nose gear strut is mechanically shortened for stowage. Hydraulically operated doors are sequenced to close when the gear is fully extended or retracted. During high g flight, the hydraulic forces holding the nose gear up can be overcome and the nose gear may drop and rest on the nose gear door. When the g load is released, the nose gear will return to the retract position with an audible thump. The nose gear doors are held closed by mechanical locks and are opened on the ground by a T handle located forward of the lower left inlet duct. The doors are operated by wheel brake accumulator pressure.

Note

The T handle acts as a door safety lock and must be fully seated before engine start or the nose gear doors will not close.

2.17.1.3 Wing Gear

The two wing gears are hydraulically retracted and extended, and are mechanically locked in the extended and retracted position. The wing gear struts when retracted, are enclosed by the fairing doors attached to the wing gear fairing pods.

2.17.1.4 Landing Gear Handle

The landing gear handle is on the lower left main instrument panel. A mechanical downlock stop locks the landing gear handle in the down position when aircraft weight is on the main landing gear. The downlock stop is electrically retracted when aircraft weight is removed from the main landing gear. EMER extend can be selected from either the handle up or handle down position. To select EMER, rotate the handle 90° clockwise and pull out to the stop. After selecting EMER, the handle is locked in this position until maintenance restores normal operation.

DOWN – Extends landing gear.
UP – Retracts landing gear.
EMER – Rotated 90° cw and pulled. Actuates emergency pneumatic system to extend landing gear.

2.17.1.5 Emergency Landing Gear Handle (TAV-8B)

The emergency landing gear handle is located on the lower left main instrument panel and provides emergency extension of the landing gear from the rear cockpit. The handle is lever locked in the up (normal) and down (emergency) positions. When emergency is selected the landing gear handle in the front cockpit is disabled. To select emergency, pull the handle out and set to down position. The normal position can be selected from the emergency position by pulling handle out and setting to the up position, however, the landing gear will remain in the extended position by emergency nitrogen/helium pressure.

2.17.1.6 LDG Gear Emergency Battery

(AV-8B 164151 and up, also AV-8B 161573 through 164150, TAV-8B 162747 through 164542 after AFC-328). The LDG gear emergency battery is located on the left console below the landing gear position indicators. The battery is a one shot device for the emergency extension of the landing gear when electrical power is lost. The battery must be activated with the landing gear handle in the EMER position in order for the pneumatic system to extend the landing gear. The battery is activated by extending a pull shaft upward approximately 1/2 inch. The pull shaft is mechanically locked to prevent reseating of the handle. A 1/2 inch band of white paint on the exposed portion of the rod provides a visual indication that the battery has been actuated. After selection, maintenance must replace the battery. See Figure 2-16 for landing gear emergency battery.

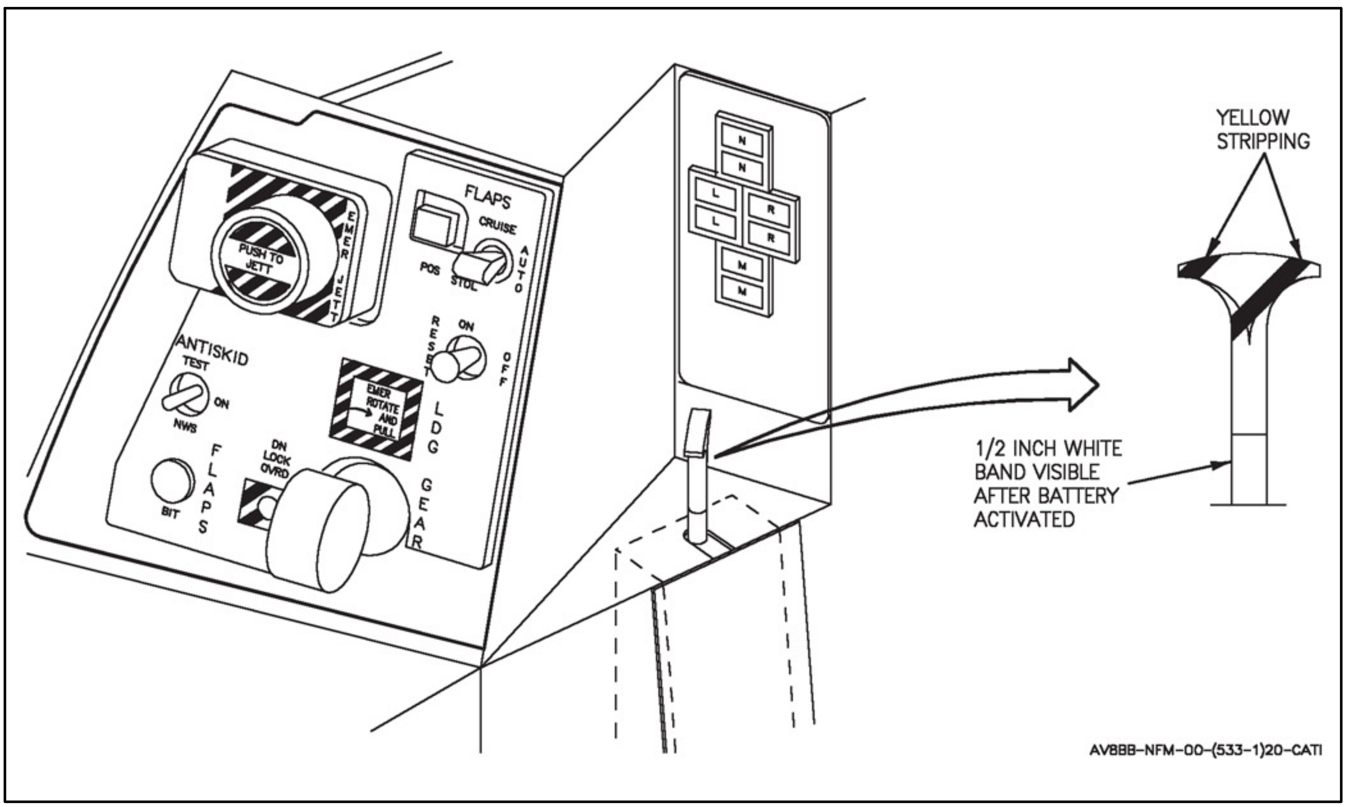


Figure 2-16. Landing Gear Emergency Battery

2.17.1.7 DN Lock OVRD Button

The DN LOCK OVRD button is on the lower left main instrument panel to the left of the landing gear handle. Pressing the DN LOCK OVRD button disengages the mechanical downlock stop and permits the landing gear handle to be set to the up position with aircraft weight on the main landing gear.

2.17.1.8 Landing Gear Position Indicators

The landing gear position indicators are on the lower left main instrument panel. The N (nose gear), L (left wing gear), R (right wing gear) and M (main gear) green indicators come on when the respective gear is down and locked. The N, L, R and M amber indicators are in-transit indicators and come on when the respective gear is not down and locked or up and locked. The N amber indicator will remain on if the nose gear is up and the nose gear doors are not closed.

2.17.1.8.1 Landing Gear Warning Lights and Aural Tone

The landing gear warning lights consist of the GEAR light on the upper right main instrument panel and the light in the landing gear handle. Both warning lights are red and come on simultaneously. The warning lights come on steady when any gear position disagrees with the landing gear handle position or with the landing gear up and either nose gear door is not closed. The warning lights and the N (nose gear) amber position indicator will both be on when the nose gear is up and either nose gear door is not closed. With the gear down and locked, improper door position will not cause the warning lights to illuminate.

With the landing gear handle in the up position both warning lights will flash and the aural tone will sound in the pilot's head set when the aircraft altitude is below 6,000 feet, airspeed is less than 160 knots and the sink rate is over 250 feet per minute. On TAV-8B 163856 and up, AV-8B 163519 and up, a LANDING GEAR, LANDING GEAR voice warning is provided in conjunction with the flashing GEAR warning lights.

2.17.1.8.2 Landing Gear Warning Lights (TAV-8B)

The landing gear warning lights operate as described for the AV-8B when the emergency landing gear handle is in the normal (up) position. When the emergency landing gear handle is set to emergency, the warning lights come on if any gear is not down and locked regardless of the landing gear handle (forward cockpit) position.

2.17.2 Emergency Pneumatic System

The pneumatic system consists of a single, hermetically sealed nitrogen/helium bottle, located in the main wheelwell, and provides the pneumatic power for emergency extension of the landing gear. When emergency gear extension is selected, the nitrogen/helium is released by ignition of an electrical pyrotechnic cartridge in the valve mounted on the bottle. This valve releases pressurized nitrogen/helium into the landing gear actuators only and also seals the pneumatic system. Various other valves operate to isolate the pneumatic system from the Hyd 1 system. An additional feature of the system is an external indicator on the bottle that pops out when pressure falls below 2,400 psi. This would normally indicate a low charge in the bottle. Once the emergency system is activated the emergency gear extension handle is locked in the emergency position and cannot be reset by the pilot.

2.17.3 Nosewheel Steering (Before AFC 391)

The nosewheel steering (NWS) system is an electro-hydraulic operated system that provides directional control for ground operations in three modes: steer, caster and center. The steering mode has a range of 45° left and right. A hydraulic shutoff valve blocks off hydraulic flow to the steering motor when this range is exceeded. The hydraulic flow is returned when the gear is back within the proper steering angle. The caster mode has a range of 179° left or right. Mechanical stops are used to contain this range. The center mode is automatic when UP is selected with the landing gear handle. The nosewheel will automatically steer to a center position at which point landing gear retraction will commence.

Rudder pedal movement is transmitted to the nosewheel steering input on the nose landing gear (NLG) via a selector actuator and a non-linear/vernier mechanism in the flight controls. With steering deselected, the selector actuator is retracted and pedal inputs are not passed to the non-linear/vernier mechanism.

The non-linear/vernier mechanism accommodates the requirements for a fine steering gain about neutral pedals for runway operations and a maximum steering range of 45° L/R for minimum turn radius turns. The non-linear/vernier mechanism provides a floating fine steering gain. When steering is initially selected, with rudder pedals neutral and zero crab, the fine steering gain is centered about neutral pedals (point ‘A’ in Figure 2-17). This provides fine steering control during landing rollouts. At approximately half pedal, fine steering ends (point ‘B’) and a coarse steering, which takes the nosewheel to 45° left or right, starts. When pedal travel is reversed, steering is again in fine steering (point ‘C’) which allows for precise steering control on taxiways and tight quarters. Note that after an excursion into the coarse steering, neutral pedals will likely not produce 0° steering angle. To regain 0° steering angle at neutral pedals, the system must be reset by deselecting nosewheel steering, letting the nosewheel caster to center (zero crab), neutralizing the pedals and reselecting nosewheel steering.

Steering selection technique is critical to eliminating a transient nosewheel steering output during landing rollout. Rudder pedals should be neutralized prior to steering selection as the nosewheel steering system will immediately move to the commanded rudder pedal position when steering is selected. Selecting steering at other than neutral pedals may result in a rapid heading change that can be towards or away from the desired direction of travel. Also, crab angle, while on the runway, must be eliminated or reduced as much as possible when selecting steering. Selecting nosewheel steering while crabbed will result in a steering output away from the desired direction of travel.

With antiskid system on, the nosewheel steering system is controlled by a two position springloaded switch on the stick grip. With the gear down, pressing the switch selects nosewheel steering. With the gear down and the antiskid system off, nosewheel steering operates at all times on the ground and in the air. In both these conditions the steering motor is controlled by rudder pedal movement. When the selector switch is released with the antiskid on, the nose wheel is free to swivel about an arc of ±179° from center and rudder pedal movement is isolated from the system.

A SKID light, on the caution light panel, comes on to indicate failure of nosewheel castering. However, this is a dual function light and a determination must be made as to type of failure, caster or antiskid. Refer to Part V, paragraph 16.3.1 for failure mode determination.

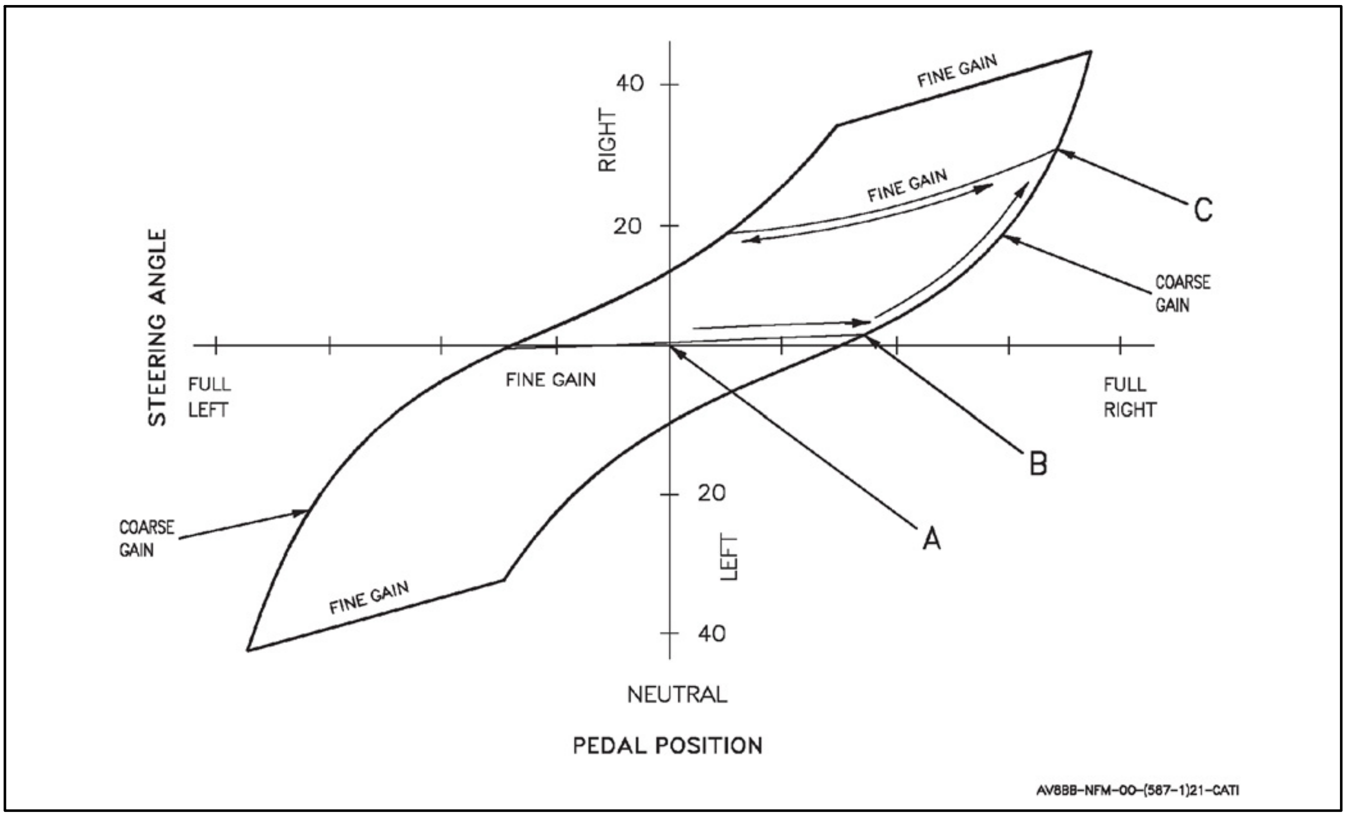


Figure 2-17. Steering Gain (Before AFC-391)

On TAV-8B 163860 and up, AV-8B 163677 and up, a CAUTION, CAUTION voice warning is also provided in conjunction with the SKID light.

Hydraulic power is normally provided by the Hyd 1 system. In the event that Hyd 1 pressure drops to less than 1,400 psi, the aircraft is on the ground and nosewheel steering is selected, a switching valve will cause the system to be powered by Hyd 2 pressure. The Hyd 2 accumulator will provide about 3 cycles (neutral to 3° L to 3° R and back to neutral) of nosewheel steering if both hydraulic pumps fail. If power is lost to the Essential 28 Vdc bus (i.e., DC caution light ON) then the antiskid will fail and nosewheel steering will be on at all times.

2.17.4 Nosewheel Steering (After AFC 391)

The nosewheel steering system is an electrohydraulic operated system that provides directional control for ground operations with three modes: caster, lo gain steering and hi gain steering. A fourth steering mode, centered, is used for gear retraction. Lo gain steering has a range of 14° left and right while hi gain steering provides 45° left and right. The caster mode has a range of 179° left and right. Mechanical stops are used to contain this range. When the landing gear handle is placed in the up position, the nosewheel will automatically steer to the center position at which time landing gear retraction will commence.

Rudder pedal movement is transmitted to the nosewheel steering input on the NLG via a ratio changer actuator and bellcrank in the nosewheel bay. With the actuator retracted, pedal movement is ratioed down to produce a 14° steering input to the NLG. With the actuator extended, pedal movement is ratioed up to produce a 45° steering input to the NLG.

In a TAV-8B, the front cockpit NWS button can command high or low gain steering normally with the exception that it can be overridden by the rear cockpit. The rear cockpit switch in a TAV-8B cannot select high gain NWS. When the nosewheel steering button is selected in the rear cockpit low gain steering will be enabled. If both the front cockpit and rear cockpit switches are pressed the rear cockpit switch will override the front cockpit selection enabling low gain steering.

With the landing gear handle DOWN, the nosewheel steering mode is controlled by the antiskid switch and the undesignate/nosewheel steering button on the stick grip. With antiskid set to ON, caster mode is selected. With antiskid set to NWS, lo gain steering is selected. Pressing the stick button increases the steering mode by one gain such that with antiskid on, pressing the stick button produces lo gain steering and with antiskid set to NWS, pressing the stick button produces hi gain steering.

Hi gain steering is undesirable above 20 KGS due to poor directional control characteristics. A Hi Gain Lockout, actuated by throttle position, has been added to deselect hi gain steering if it has been inadvertently selected during takeoff. If hi gain steering has been selected, advancing the throttle to approximately midway between IDLE and MAX (approximately 75 percent fan speed) will automatically select lo gain steering. Hi gain steering will automatically be reselected when the throttle is reduced through the mid point. The hi gain lockout feature has no affect when either lo gain steering or caster mode has been selected.

HUD indications provide cues as to steering position and mode. Whenever the nosewheel is within 3° of neutral, a C will appear inside the sideslip ball. A steering mode indication is provided in the lower right hand corner of the HUD. Display computer logic determines which mode the steering system is in via inputs from hydraulic pressure switches and relays. The indications are:

CTR – Centered.
CAST – Caster.
NWS – Lo gain.
NWS HI – Hi gain.

Illumination of NWS light on the caution/advisory panel is an indication of a NWS system failure. NWS failure mode is ascertained by comparing the mode selected by the pilot with the mode displayed on the HUD. If CAST displayed in the HUD with ANTISKID switch ON, engaging NWS button will result in either HI gain or centered steering mode. If NWS displayed in HUD with ANTISKID switch on, caster mode has failed to LO gain NWS (“hot” NWS) and will remain in LO gain when the NWS button is engaged. The mode displayed on the HUD is the active steering mode.

Hydraulic power is normally provided by the Hyd 1 system. In the event that Hyd 1 pressure drops to less than 1,400 psi, the aircraft is on the ground, and nosewheel steering is selected, a switching valve will cause the system to be powered by Hyd 2 pressure. The Hyd 2 accumulator will provide about 3 cycles (neutral to 3° L to 3° R and back to neutral) of nosewheel steering if both hydraulic pumps fail. Electrical power is provided by the emergency bus. In the event that all electrical power is lost, including the battery, the steering system will revert to lo gain steering.

2.17.5 Lift Improvement Device System

The lift improvement device system (LIDS) is part of the landing gear system. The LIDS, composed of fixed strakes and a retractable fence, increase the vertical lift 1,200 pounds by directing the jet fountain energy and reducing hot air reingestion in ground effects. The LIDS fence extends into the airstream and is powered and held up by Hyd 1 pressure. Mechanically actuated locks hold the fence in the retracted position with Hyd 1 loss. The fence normally extends and retracts with the landing gear. However, the fence may be retracted to reduce conventional takeoff drag with the LIDS switch. Fence retraction is automatic above 125 knots.

A LIDS light on the caution light panel indicates that the landing gear selector handle and fence position do not agree, the LIDS fence is down above 125 knots, is up below 125 knots or is unlocked with the gear handle up and the LIDS retracted. If the air data computer fails, the 125 knot auto extend/retract is lost and, the LIDS will operate with the gear.

2.17.5.1 LIDS Switch

The LIDS switch (fwd cockpit only) is located on the pilot's services panel on the left console and is a two position lever-locked switch.

RET – Retracts LIDS fence.
NORM – LIDS fence operates normally.

2.17.6 Brake System

The twin-wheel main landing gear is equipped with hydraulic operated carbon disc brakes. An antiskid system and parking brake are also incorporated into the brake system. Both brakes operate simultaneously and progressively as either brake pedal is depressed. Cables from each brake pedal and the parking brake lever operate a common cable to the brake control valve. Hydraulic pressure is supplied by the Hyd 1 system. A nitrogen charged accumulator provides limited hydraulic pressure for normal and antiskid braking if Hyd 1 pressure is not available. Two pressure indicators adjacent to the inboard side of the caution light panel, provide information on brake accumulator pressure, and applied brake pressure. The brake accumulator usable pressure range is 3,000 to 1,000 psi. When accumulator pressure drops below 1,000 psi, braking power is lost. The brakes are limited in the amount of energy they can absorb and dissipate in the form of heat without damage. The amount of heat added to the brakes for each braking effort during taxi-out and rejected take-off or a landing rollout and taxi-in is cumulative and is a function of the speed of the aircraft and its gross weight at the time the brakes are applied. The heat generated in the brakes is transferred to the wheel and tire and (depending on the severity of the stop) can cause the tire pressure to rise to dangerous levels. Thermal fuse plugs within the wheel are designed to prevent wheel explosion by relieving pressure from the tire when the wheels attains a particular temperature. There are no brake pressure or hydraulic pressure indicators in the rear cockpit.

2.17.6.1 Parking Brake

The parking brake handle is located outboard of the throttle (fwd cockpit only). When the throttle is in idle the handle can be moved into the parking detent. The throttle cannot be advanced until the parking brake is released from the detent.

Actuation of the parking brake applies brake pressure in the system. Ensure the aircraft is properly secured (chained or chocked as required) after shutdown as brake pressure will bleed off within approximately 3 hours to a level that is insufficient to keep the aircraft in place.

2.17.7 Antiskid System

The antiskid system is an electro-hydraulic system that controls hydraulic pressure to the brakes providing full skid protection above 16 knots. The system also provides partial skid protection from 16 knots down to 8 knots. An impending skid is detected by measuring wheel deceleration. Wheel speed information is provided by a wheel speed sensor, located on the right brake unit, and an exciter ring mounted on the wheels. As the exciter ring rotates, the sensor develops an electrical signal at the frequency of the wheel speed. This signal is routed to a control unit which develops and transmits a signal to operate the antiskid valve. The antiskid valve, when operating in conjunction with the control unit, relieves brake pressure to arrest tire skid.

The antiskid system is selected by the ANTISKID switch located on the landing gear/flaps control panel (fwd cockpit only). The switch is labeled TEST, ON, and NWS. Power is not supplied to the antiskid system when NWS is selected. A SKID light, on the caution light panel, comes on when the antiskid system is OFF or failed, providing essential 28 volt dc power is available.

2.17.7.1 Skid Caution Light

On AV-8B 161573 through 165312, TAV-8B, the SKID light also comes on when a nosewheel castering failure is detected. On the TAV-8B, the SKID light comes on in both cockpits. See nosewheel steering this chapter.

The TEST position on the ANTISKID switch, allows the pilot to check the antiskid system. Antiskid is inoperative when the parking brake is engaged or essential 28 volt dc power is lost.

2.18 INSTRUMENTS

Refer to foldout section for cockpit instrument panel illustration. For instruments that are an integral part of an aircraft system, refer to that system description in this section.

2.18.1 Pitot Static System

The pitot-static system employs dual pitot and static sources, one on each side of the forward fuselage near the leading edge of the windshield. Each tube contains one pitot source and two static sources. See Figure 2-18.

2.18.1.1 Probe Heat Switch

The probe heat switch on the miscellaneous switch panel on the lower main instrument panel has positions PRB HT (PROBE HEAT on some aircraft) and AUTO. The switch controls power to the left and right pitot-static probes, the total temperature probe, the case and probe heater of the angle of attack probe, and the DECS total temperature probes.

AUTO – With weight on wheels, power is removed from all heaters except AOA case heater. With aircraft airborne, all probe heaters receive power.

PRB HT – With weight on wheels, all heaters are energized but the left and right pitot static probes are energized at reduced power. With aircraft airborne, all probe heaters receive power same as AUTO. The switch is magnetically held in the PRB HT position. When power is removed, the switch drops into the AUTO position.

2.18.1.2 Pitot Pressure

Pitot pressure from the left pitot-static probe is supplied to the air data computer and the Q-feel system. Pitot pressure from the right pitot-static probe is supplied to the standby airspeed indicator and the ejection seat airspeed/altitude sensor.

2.18.1.3 Static Pressure

One static source from each pitot-static tube are tied together and the pressure is routed to the air data computer and the Q-feel system. The other static source from each pitot-static tube is tied together and the pressure is routed to the pressure-operated standby indicators and the ejection seat airspeed/altitude sensor.

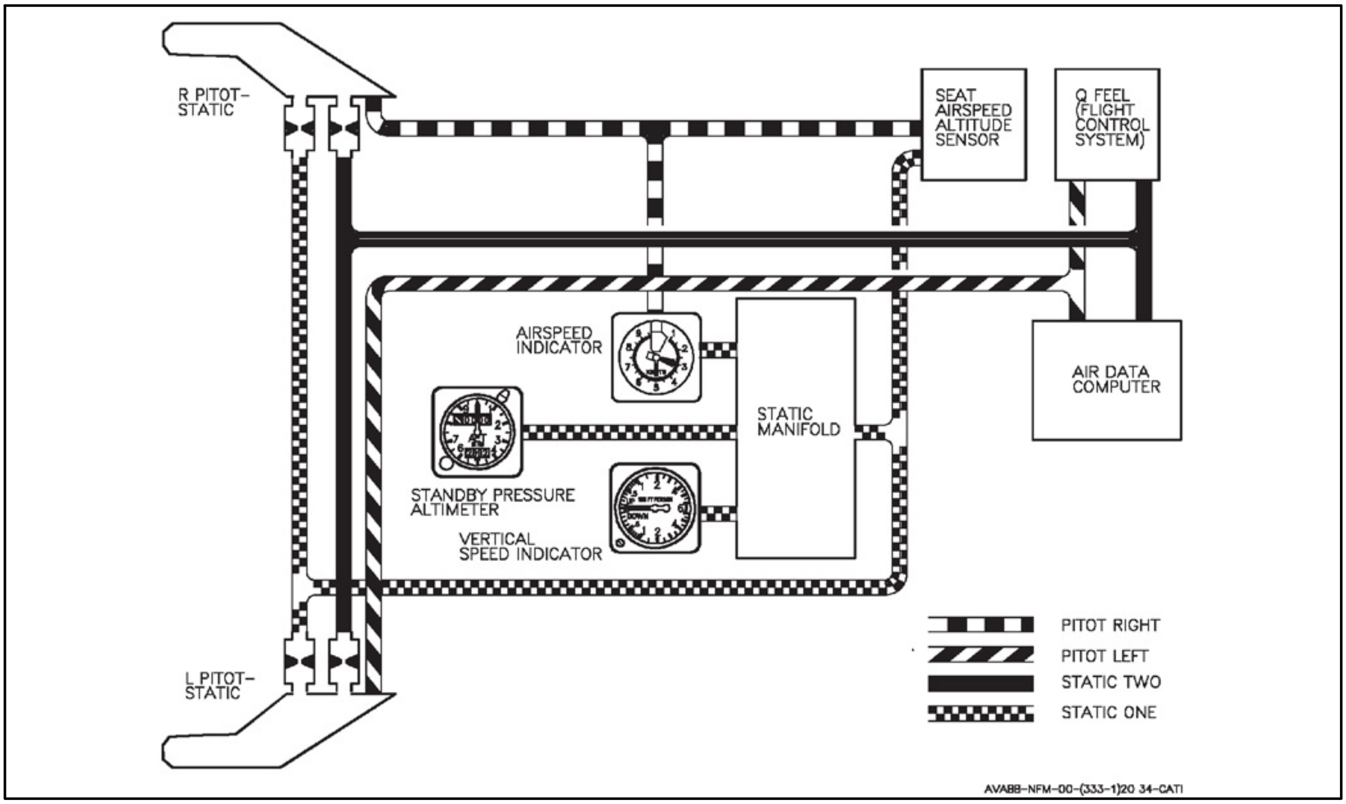


Figure 2-18. Pitot–Static System

2.18.2 Angle of Attack Probe

The angle of attack probe is an airstream direction sensing unit. The probe is located on the right forward fuselage below the windshield except on radar aircraft where it is located on the left forward fuselage below and forward of the windshield. It contains a case heater and a probe heater, operation of which is covered under Probe Heat Switch in Instruments procedures. The standby angle of attack indicator and the air data computer utilize signals from the angle of attack probe.

2.18.3 Standby Angle of Attack Indicator

The standby angle of attack (AOA) indicator (see cockpit, foldout section) is on the main instrument panel. The indicator is calibrated from –5° to +25° An adjustable reference index two degrees wide is centered on the 10° mark to indicate optimum speed approach angle of attack. When electrical power is interrupted, the word OFF appears in a window in the face of the indicator.

2.18.4 Turn and Slip Indicator

The turn and slip indicator contains a scale, turn pointer, power warning flag and inclinometer ball. A 2–minute turn is indicated with the needle over the index to the left and right of center. A 4–minute turn is indicated with the needle half way between the center and the right or left index. The gyro is driven by an inverter, which is powered from the emergency 28 volt dc bus. An OFF flag is provided to indicate loss of power.

2.18.5 Clock

A standard 8 day clock is installed in the cockpit and on the TAV–8B in the rear cockpit pedestal adjacent to the BUNO PLACARD.

2.18.6 Stopwatch

A mechanical stopwatch is located to the left of the glareshield near the canopy rail (not in rear cockpit of TAV–8B). The stopwatch contains one pushbutton for winding, starting, and stopping and one pushbutton for resetting.

2.18.7 Standby Magnetic Compass

A conventional aircraft magnetic compass is installed to the left of the main instrument panel (not installed in the rear cockpit). The standby magnetic compass is installed on the left archway.

2.18.8 Standby Vertical Velocity Indicator

The standby vertical velocity indicator displays rate of ascent or descent on a scale from 0 to 6,000 feet per minute.

2.18.9 Standby Attitude Indicator

The standby attitude indicator is a self-contained electrically driven gyro-horizon type instrument. The gyro is driven by an inverter which is powered by the emergency 28 volt dc bus. An OFF flag appears whenever power is lost or the unit is caged. The gyro cages to 0° pitch and roll regardless of aircraft attitude. Power should be applied for at least 1 minute before caging. The indicator displays roll through 360°. Pitch display is limited by mechanical stops at approximately 92° climb and 78° dive. The caging knob on the lower right hand corner, besides being pulled for caging, is used to adjust the pitch of the miniature aircraft. A pitch-trim scale measures displacement of the miniature aircraft. Pulling the caging knob and rotating fully clockwise to a detent locks the inner gimbal of the gyro. This position is for storage and transport, and should never be used during flight. A minimum of 9 minutes of reliable attitude information (error less than 6°) is available after power loss, even though the OFF flag is in view.

2.18.10 Standby Altimeter

The standby altimeter displays altitude from -1,000 feet to 50,000 feet. The altimeter is a counter-pointer type. The counter drum indicates altitude in thousands of feet from 00 to 99. The long pointer indicates altitude in 50 foot increments with one full revolution each 1,000 feet. A knob and window permit setting the altimeter to the desired barometer setting. This setting is also used by the air data computer. An electrical altimeter vibrator is provided to insure smooth travel of the internal mechanism.

Note

The standby altimeter may indicate in excess of 400 feet low at high airspeeds.

2.18.11 Standby Airspeed Indicator

The standby airspeed indicator displays airspeed from 20 to 600 knots. The indicator contains two pointers and a single scale graduated from 1 through 10. The pointers appear only one at a time. At low airspeeds the scale represents 0 to 100 knots and the thin pointer indicates the airspeed. At higher airspeeds the scale represents 100 to 1,000 knots and the thick pointer indicates the airspeed. However, the thick pointer will not proceed beyond the 600 knot indication.

2.18.12 Horizontal Situation Indicator

On TAV-8B and Day Attack aircraft the horizontal situation indicator (HSI) (see Figure 2-19) is on the main instrument panel. The HSI provides horizontal or plan view of the aircraft with respect to the navigation situation. The knobs, pointers, windows, and flags which are on the HSI are described in the following paragraphs.

2.18.12.1 Aircraft Symbol

The aircraft symbol in the center of the HSI is the aircraft superimposed on a compass rose.

2.18.12.2 Aircraft Heading

The aircraft magnetic heading is read under the lubber line.

2.18.12.3 Heading Marker

The heading marker is manually set to the desired heading.

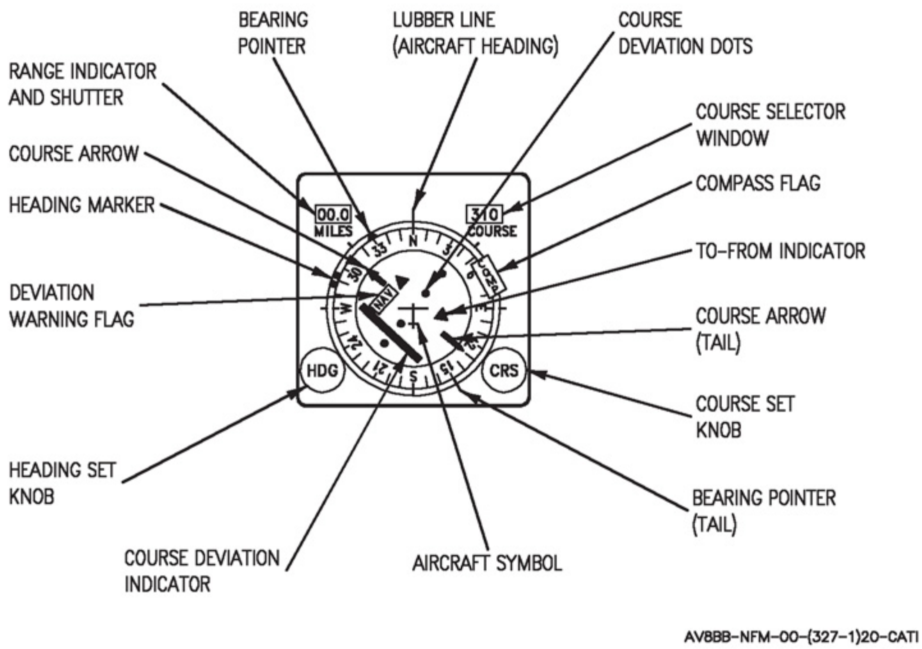


Figure 2-19. Horizontal Situation Indicator

2.18.12.4 Course Arrow

The course arrow and the course selector window are set manually with the course set knob to the desired tacan course.

2.18.12.5 Course Deviation Indicator

Any displacement of the aircraft from the selected course causes the course deviation bar to move to the right or left of the course arrow.

2.18.12.6 Bearing Pointer

The bearing pointer displays the bearing to a selected tacan station. The bearing tail indicates reciprocal course.

2.18.12.7 Range Indicator

Distance is displayed in nautical miles and has a range of 00.0 to 399. A shutter will cover the window if distance information is invalid.

2.18.12.8 To-From Indicator

The to-from indicator indicates whether the course selected, if intercepted and flown, takes the aircraft to or from the selected tacan station.

2.18.12.9 Deviation Warning Flag

The flag is in view when the bearing data is invalid.

2.18.12.10 Compass Flag

The flag is in view when the compass data is invalid.

2.18.12.11 Course Set Knob

The knob, labeled CRS, is used to set a predetermined course to be steered to a tacan station, all weather landing system (AWLS) station, or steer-to-point (waypoint, markpoint, or targetpoint).

CAUTION

The course line displayed on the EHSI/EHSD and the course in the Course Selector Window of the HSI is not necessarily the same. The bearing displayed in the Course Line Data block in the lower right corner of the EHSI/EHSD and the course line displayed on the EHSI/EHSD should be used instead of the bearing in the Course Selector Window of the HSI.

Note

With OMNI 7.1 and C1+, a predetermined course cannot be used to steer to an AWLS station or a targetpoint.

2.18.12.12 Heading Set Knob

The heading set knob, labeled HDG, is used to set the heading marker to a desired heading. If the knob is pulled out, the compass is disabled and the compass flag comes into view. Ensure the knob is pushed in fully.

2.18.13 Sideslip Vane

A sideslip vane is mounted externally forward of the windshield for use during slow or hover flight. It always points into the relative wind. The rear cockpit sideslip vane is mounted on the center top of windshield arch frame, externally.

2.18.14 Radar Altimeter

The radar altimeter indicates surface clearance directly under the aircraft from 0 to 5,000 feet up to pitch and roll attitude of ±45°. Operation is based on precise measurement of time required for an electro-magnetic energy pulse to travel from the aircraft to the ground terrain and return. Audio and visual warnings are activated when the aircraft is at or below a selected low altitude limit. When target of opportunity (TOO) function is engaged on the upfront control, the radar altimeter is turned on momentarily and the radar altitude is used by the mission computer to determine target elevation. The radar altimeter also has an update function available to adjust barometric altimeter error for mission computer navigation and air-to-ground calculations.

2.18.14.1 Controls and Indicators

The controls and indicators for operation of the radar altimeter are on the HUD, warning/threat lights panel, upfront control, option display unit and digital display indicator (DDI).

2.18.14.2 Altitude Switch

The ALT switch, on the HUD control panel, has positions of barometric (BARO) and radar (RDR). When the switch is set to RDR, radar altimeter altitude preceded by an R is displayed in a box in the upper right hand part of the HUD display. In BARO, barometric altitude is displayed without the R in the box. If radar altimeter altitude is invalid with switch in RDR, the R disappears and a flashing B appears to the right of the box indicating barometric altitude is being displayed. The flashing B remains until either radar altitude becomes valid again or the altitude switch is placed to BARO. In the backup mode, barometric altitude replaces radar altitude but will not flash. This switch is non-functioning in the rear cockpit. With H4.0, the box around the altitude is no longer displayed.

2.18.14.3 Low Altitude Warning Light

The Low Altitude Warning (LAW) light is located on the warning/threat light panel on the upper right of the instrument panel. If the system is operational and the aircraft descends below the preset low altitude threshold (0 to 5,000 feet above surface level) the LAW light will come on. The mission computer requires at least three radar altimeter returns above the threshold altitude to subsequently trigger the LAW during descent. Due to aircraft maneuvers during ascent or descent, variances in transmitter and receiver capabilities, or mountainous terrain, LAW thresholds above 4,500 feet may be unreliable. The LAW light will stay on until the aircraft ascends above the low altitude threshold, the pilot changes the low altitude warning threshold, the radar altimeter is turned off, or the MASTER CAUTION (or MASTER WARNING light button on Radar or Night Attack aircraft) light button is pressed. The MASTER CAUTION shutoff function resets when the aircraft ascends above the threshold altitude. With loss of the mission computer, the LAW light automatically operates at 200 feet above ground level. To eliminate false LAW indications with speed brake extended, radar altitude is invalid with gear handle up and radar altitude less than 20 feet. On TAV-8B 163856 and up, AV-8B 163519 and up, an ALTITUDE, ALTITUDE voice warning is provided in conjunction with the LAW light.

CAUTION

LAW thresholds above 4,500 feet greatly reduce the probability of the LAW being triggered during descent.

2.18.14.4 Upfront Control

The pushbuttons and indicators on this control are used for radar altimeter operation and display, to select altitudes for LAW light operation, and also to enable the BOMB option.

2.18.14.4.1 Altitude Function Selector Pushbutton

Pressing the altitude (ALT) function selector pushbutton enables the status window on the scratch pad to display ON if radar altimeter is turned on, and enables display of the LAW threshold altitude on the scratch pad when set in by the keyboard. The display on the scratch pad indicates the altitude that the LAW light will illuminate and the LAW warning tone or ALTITUDE, ALTITUDE voice warning will activate. Pressing the ALT pushbutton also enables display of BOMB on the option number 1 display window on the option display unit.

2.18.14.4.2 On/Off Selector Pushbutton

Pressing this pushbutton turns the radar altimeter system on after first pressing the ALT function selector pushbutton. This causes ON to appear on the scratchpad of the upfront control. To turn the system off the ON/OFF selector pushbutton is pressed after first enabling the altitude function with the ALT function selector pushbutton.

2.18.14.4.3 Scratchpad and Keyboard

With the ALT function enabled, the LAW altitude is displayed in the scratchpad window. A new LAW altitude is inserted by typing out the new altitude and then pressing the ENT pushbutton on the keyboard.

2.18.14.4.4 EMCON Pushbutton

Pressing the emission control (EMCON) pushbutton enables the EMCON functionality and EMCN is displayed in the Options Display Unit (ODU) number 1 display window. Pressing the EMCON pushbutton again disables the EMCON functionality and EMCN is removed from the ODU. With H4.0 EMCON can also be enabled or disabled by pressing down and holding the Sensor Select switch on the control stick for greater than 0.8 seconds. When EMCON is enabled, the RADAR, RADALT, IFF, and TACAN are inhibited. With H4.0, EMCON is overridden by the RADALT if the pilot connects a TOO or WOF.

2.18.14.4.4.1 Head-Up Display

EMCON shall be displayed in the middle of the HUD as an indication that EMCON is ON. It will display in all master modes and all of the reject levels.

2.18.14.5 Option Display Unit

The pushbuttons and displays on this panel which affect operation of the radar altimeter are option select pushbutton number 1 and option number 1 display window. They are used to enable the BOMB function.

2.18.14.5.1 Option Number 1 Pushbutton and Display Window

With the ALT function selector switch pressed, BOMB is displayed in the option number 1 display window. With the radar altimeter operating, pressing the option number 1 pushbutton causes a colon to be displayed to the left of BOMB on the option number 1 display window. The colon indicates that radar altitude is being used by the mission computer for ballistic computations. The last selected LAW altitude remains in the scratchpad window after the BOMB option is selected. With weight on wheels the system will initialize to BOMB option enabled so that radar altitude will be used for ballistic computations unless radar altitude becomes invalid. Pressing the option number 1 pushbutton again removes the colon from BOMB on the option number 1 display window and enables GPS altitude for ballistic computations if GPS is cued. Otherwise, barometric altitude is used for ballistic computations.

2.18.14.6 DDI Display

Radar altitude is displayed on the DDI when dual mode tracker air-to-ground (A/G) video, forward looking infrared (FLIR), air-to-air (A/A) radar or air-to-surface (A/S) radar program video is displayed, RDR is selected on the HUD control panel, and the radar altimeter is within operational parameters.

2.18.14.6.1 Radar Altimeter BIT Checks

To perform a radar altimeter BIT check, press the BIT pushbutton on the DDI menu display to initiate a BIT display. Press the CNI pushbutton and the word TEST appears next to RALT. After 5.5 seconds the word TEST disappears. Check LAW light off, and LAW and MASTER CAUTION tones in headset for one second. If a number 1 appears next to RALT the radar altimeter has failed the BIT check. If the space next to RALT remains blank the radar altimeter has checked good.

2.18.15 Upfront Control

The pushbuttons and indicators on this control are used for entering (ENT) or clearing (CLR) data (i.e. 0-9, .,-) for the selected function. (In TAV-8B aircraft), there are two UFCSs, one in the forward cockpit and one in the aft cockpit. If only one UFCS (forward or aft) is being used to enter data, the system shall accept data entry from that UFCS and cause that data to be displayed on both the entry UFCS and the non-entry UFCS as the entry is taking place. In the event of entries occurring on both UFCSs simultaneously, the system shall cause each UFCS to display its own entry as long as neither entry is completed. As soon as the first entry is completed, the data shall be displayed on both UFCSs.

Note

- If the first key is to be an alpha instead of a numeric, the first pilot to enter an alpha key will get the result as an alpha. The second pilot will get a number, which will result in an invalid entry.
- If the data format contains only one decimal point (a Comm frequency is an example), only the first pilot to enter a decimal point will get the decimal point.

2.18.16 Digital Display Indicator and/or Multipurpose Color Display

The digital display indicator (DDI), on the left main instrument panel on Day attack (TAV-8B and AV-8B Day Attack) aircraft or the multipurpose color display (MPCD), on either side of the main instrument panel (Radar and Night Attack aircraft), are the primary aircraft head down displays. They consist of a 5 by 5-inch CRT display surrounded by 20 multi-function pushbutton switches. DDI/MPCD mode selection is accomplished either automatically, as determined by the mission computer, or manually, as selected by the pilot on the DDI/MPCD or by the hands on throttle and stick (HOTAS). The display computer converts information received from the mission computer to symbology for display on the DDI/MPCD. Some of the displays options are: MENU, stores status (STRS), head-up display (HUD), engine parameters (ENG), electronic horizontal situation indicator/display (EHSI/EHSD), dual mode tracker (DMT) (trainer, day attack, and night attack only), built-in-test (BIT), VSTOL-REST (VRST), and electronic countermeasures/warfare (ECM/EW). Additionally, in the Radar and Night

Attack Aircraft (and Trainer aircraft with H4.0), four other pushbuttons are available, FLIR– when boxed the NAV/FLIR image is displayed on the MPCD; EMER– when boxed the emergency checklist menu page is displayed; CARD– when boxed the pre–programmed kneeboard cards are displayed; and CAS– when boxed the close air support page is displayed. With H4.0 four other pushbuttons are available; CONF– when boxed the software configuration page is displayed; TPOD– when boxed the Litening Pod video page is displayed; SDAT– when boxed the system data page is displayed; and COMM– when boxed the COMM data page is displayed, see Figure 2-20, Menu Display. The display options are selected by pressing the MENU pushbutton (center bottom pushbutton). The word MENU is displayed above the center bottom pushbutton for all displays except the MENU display itself and multipurpose display (MPD) test pattern. Use of the various displays are described in other parts of the manual where the affected system(s) is covered.

Note

The display computer in TAV–8B aircraft with OMNI 7.1 does not display the same page on the front and rear cockpit DDIs at the same time (other than the MENU page). TAV–8B aircraft with H4.0 display the same page on both the front and rear cockpit DDIs.

2.18.16.1 DDI Switches and Controls

A description of the various switches and controls are discussed in the following paragraph.

2.18.16.1.1 Brightness Selector Knob

This rotary knob is at the top of the DDI. Placing the knob to OFF prevents the indicator from operating. Placing the knob to NIGHT provides a lower brightness control range and no automatic contrast control. The knob in the AUTO position allows automatic brightness control circuits to compensate display brightness for changes in ambient lighting. Turning the knob to DAY provides higher brightness control range with no automatic contrast control.

2.18.16.1.2 Brightness Control

This knob varies the intensity of the presentation.

2.18.16.1.3 Contrast Control

This knob varies the contrast between symbology and the dark background on any level of brightness.

2.18.16.1.4 Pushbuttons

There are 20 pushbuttons on the DDI which are used to select the function and the mode for proper indicator display.

2.18.16.2 MPCD Switches and Controls (Before ECP 306)

There are four two–position rocker switches on the MPCD for display control. A description of the various switches on the MPCD follows.

2.18.16.2.1 DAY/AUT Switch

The day position of this switch turns the MPCD on and places it in the normal day operating mode. The AUT (automatic) position turns the MPCD on and selects the auto mode which automatically changes brightness levels to maintain a fixed contrast ratio based on outside ambience.

2.18.16.2.2 OFF/NGT Switch

The NGT (night) position of the OFF/NGT switch turns the MPCD on and selects the night operating mode. The OFF position turns the MPCD off.

2.18.16.2.3 BRT Switch

The BRT rocker adjusts the brightness of the display. The switch has a position feedback reference number indication on the display, which helps match one display to the other, providing consistent image brightness, when the display alternate toggle (DAT) function is used. The number is automatically removed after a few seconds. The BRT switch is inoperative with an EHSD display.

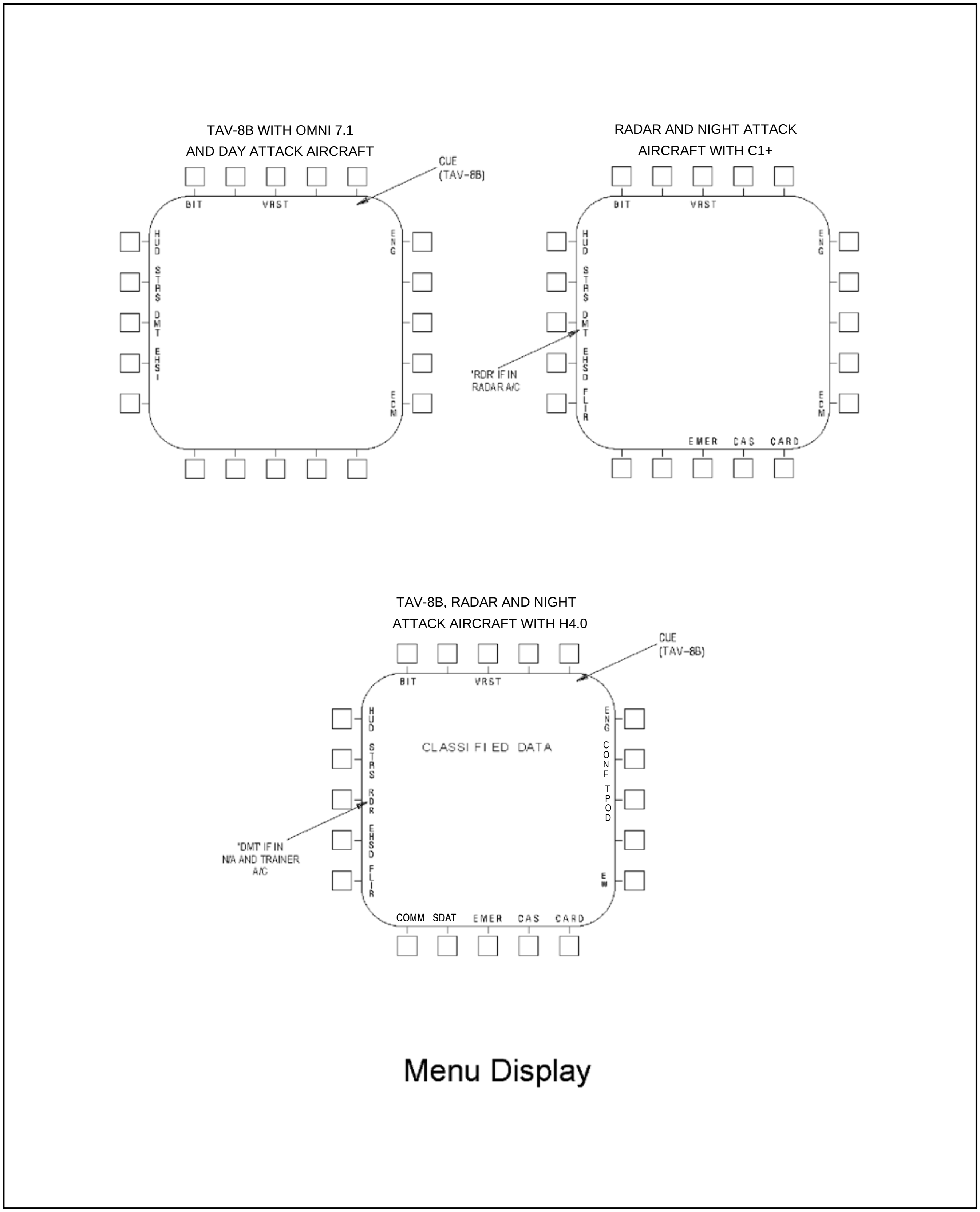


Figure 2-20. Menu Display

2.18.16.2.4 CONT Switch

The CONT rocker switch adjusts the contrast level of the display. This switch also has the position feedback reference number indication. Independent contrast settings for color and monochrome displays are stored in the MPCD.

2.18.16.2.5 Pushbuttons

There are twenty pushbuttons on the MPCD which are used to select the function and the mode for proper indicator display.

2.18.16.3 Digital Display Indicator (TAV-8B)

The displays on the DDIs in both cockpits are always the same. Both DDIs may be switched on from either cockpit, however, the brightness selector knob on each DDI must be placed to OFF to prevent both DDIs from operating. The last selection made in either cockpit with the perimeter pushbuttons determines the function selected for both. With the front cockpit DDI power switch in NIGHT, AUTO, or DAY, changing the position of the rear cockpit DDI power switch causes a momentary blooming effect on the rear cockpit display.

2.18.17 Multipurpose Color Display (After ECP 306)

The MPCD (Figure 2-21) is an NVG compatible digital display. Four momentary two position rocker switches and a rotary knob, located on the front of the MPCD, permit control of MPCD off/brightness, night/day viewing modes, symbology, gain, and contrast.

2.18.17.1 OFF/BRT Control

This rotary switch is located in the upper center of the MPCD and is used to turn the MPCD off (OFF position selected) or to select the brightness level.

2.18.17.2 NGT/DAY Brightness Selector

This rocker switch is located in the upper left corner of the MPCD and is used to select the lower brightness control (night) range and (NGT position selected) or to select the higher brightness control (day) range (DAY position selected). When NGT is selected, the display is NVG compatible. In either NGT or DAY, the display may be manually adjusted with the CONT, GAIN and SYM controls.

2.18.17.3 SYM Control

This rocker switch is located in the upper right corner of the MPCD. Momentary actuations of the lower half of the switch incrementally narrows the stroke symbology, making it sharper and dimmer. Momentary actuations of the upper half incrementally widens the stroke symbology, making it brighter and less sharp. If the switch is held in either position, the symbology is continuously adjusted to the upper or lower limits. The current level of the SYM control is displayed near the CONT switch. The range is from 0 to 15. Examples of stroke symbology are the MENU format or the pushbutton legends on the FLIR format.

2.18.17.4 GAIN Control

This rocker switch is located in the lower left corner of the MPCD. Momentary actuations of the upper half of the switch incrementally increases the black level of the sensor video and raster symbology. Momentary actuations of the lower half incrementally decreases the black level of the sensor video. If the switch is held in either position, the gain is continuously adjusted to the upper or lower limits. The current level of the GAIN control is displayed next to the GAIN switch when it is depressed. The range is from 0 to 15. The GAIN control is active on the EHSD page when the Map is selected even though the GAIN setting is displayed as an X when depressed. Examples of raster symbology are the EHSD format or the airspeed and altitude on the FLIR format. Examples of sensor video are FLIR and Map.

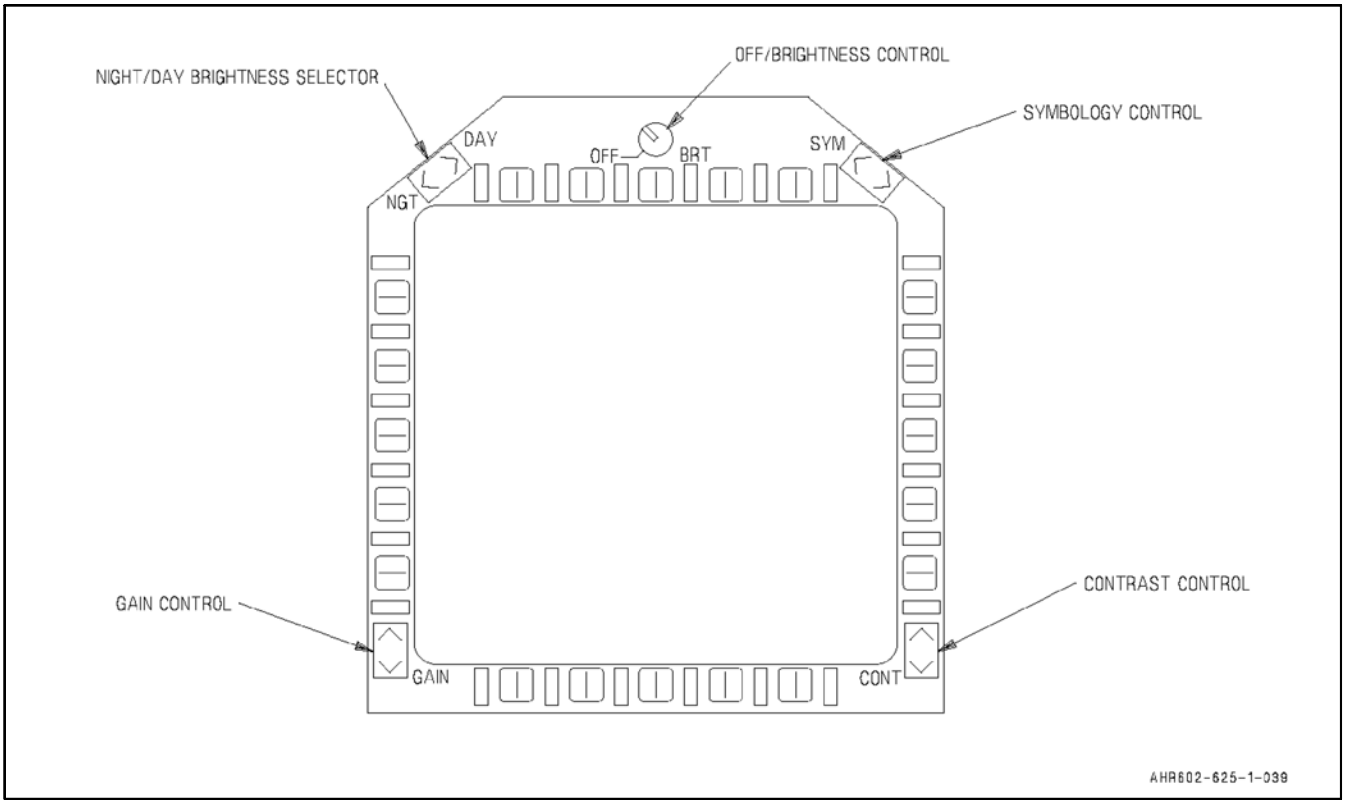


Figure 2-21. Multipurpose Color Display (After ECP 306)

2.18.17.5 CONT Control

This rocker switch is located in the lower right corner of the MPCD. Momentary actuations of the upper half of the switch incrementally increase the contrast of the sensor video and raster symbology. Momentary actuations of the lower half incrementally decrease the contrast of the sensor video and raster symbology. If the switch is held in either position, the contrast is continuously adjusted to the upper or lower limits. The current level of the CONT control is displayed next to the CONT switch when it is depressed. The range is from 0 to 15. Examples of raster symbology are the EHSD format or the airspeed and altitude on the FLIR format. Examples of sensor video are FLIR and Map.

2.18.17.6 MPCD Control Setting Retention

There are six different retained settings for the GAIN, CONT and SYM controls. They are:

1. Day Mode selected with all stroke display (examples are MENU and CAS formats).
2. Day Mode selected with monochrome video (examples are FLIR, TPOD, EHSD/EW when MAP is not selected).
3. Day Mode selected with Map selected (EHSD/EW with Map selected).
4. Night Mode selected with all stroke display (examples are MENU and CAS formats).
5. Night Mode selected with monochrome video (examples are FLIR, TPOD, EHSD/EW when MAP is not selected).
6. Night Mode selected with Map selected (EHSD/EW with Map selected).

The six settings are remembered and recalled as the operator cycles through different format types.

The MPCD retains the six settings of the GAIN, CONT and SYM controls plus the position of the NGT/DAY control when the MPCD is turned off or power is interrupted. Although, if power to the mission systems computer (MSC) is interrupted, the MSC may command a different type of format to be displayed on the MPCD than what was previously displayed, which could cause the MPCD to use a different set of retained values. The BRT setting is dependent on the position of the knob.

2.18.17.7 MPCD Adjustment

2.18.17.7.1 All Stroke (Examples are MENU, CAS or No Sensor Video on MAP)

1. Select NGT or DAY as appropriate.
2. Rotate the BRT knob to a comfortable position.
3. Adjust the SYM for the desired thickness of the symbology.

2.18.17.7.2 Monochrome Video (Examples are FLIR or EHSD without MAP Selected)

1. Select NGT or DAY as appropriate.
2. Rotate the BRT knob to a comfortable position.
3. Adjust the GAIN until the lowest level shade of gray is just visible.
4. Back the GAIN down until the lowest shade of gray just disappears. Do not touch the GAIN switch again.
5. Adjust the CONT to the desired level. Raster symbology should be same intensity as stroke symbology. FLIR format contains raster airspeed and altitude and stroke pushbutton legends.
6. Adjust the SYM for the desired thickness of the symbology.
7. Further adjustments primarily use the BRT knob.

2.18.17.7.3 MAP Selected

Note

The map display can be made unreadable if this is adjusted incorrectly.

1. Select NGT or DAY as appropriate.
2. Rotate the BRT knob to a comfortable position.
3. Adjust the GAIN all the way down. The GAIN switch is active even though an X is being displayed instead of the current level of the GAIN switch.
4. Adjust the GAIN up until the map colors look right. Do not touch the GAIN switch again.
5. Adjust the CONT to the desired level. Raster symbology should be same intensity as stroke symbology. The pushbutton legends are in raster. RWR symbols on the EW page are in stroke. If no RWR symbols are available, the level of the SYM switch is in stroke.
6. Adjust the SYM for the desired thickness of the symbology. On the EW format, verify that the stroke symbology (RWR symbols or level of the SYM control) can be easily seen on top of the map.
7. Further adjustments primarily use the BRT knob.

2.18.18 Head-Up Display

The head-up display (HUD) is on the top of the main instrument panel. The HUD is the primary attitude indicator, weapon status, and weapon delivery display for the aircraft under all selected conditions. Due to the way the INS information is translated for presentation in the HUD, the VSTOL Master Mode provides a more reliable IMC attitude presentation than the other master modes (NAV, AA, and AG). If INS velocity information begins to degrade, the other modes may present attitude information that is inaccurate. In IMC conditions this inaccurate presentation could result in an unrecognized spatial disorientation. This is a particular concern when operating the ASN-130 in a coupled mode with the GPS. Therefore, the VSTOL Master Mode should be the presentation of choice when flying in IMC conditions. Use of V/STOL helps to minimize attitude presentation errors when INS velocities are degrading and should provide a relatively stable attitude reference up to the point of INU failure. The HUD receives attack, navigation, situation, and steering control information and projects symbology on the combining glass for head-up viewing. Symbology is unique to the master mode selected. HUD symbology can also be presented head-down on the DDI/MPCDs by depressing the HUD pushbutton on the DDI/MPCD MENU display. On Radar and Night Attack aircraft, the HUD can display FLIR video in all master modes provided the HUD symbology brightness selector switch is in the NIGHT position.

Due partially to new weapons symbology incorporated with H4.0, there are situations where the display computer tries to write more HUD symbology than it has the time to write. This results in flickering HUD symbology. To minimize the occurrences of flickering HUD symbology, some symbology is written at a lower intensity so it appears slightly dimmer in the HUD and some symbology has been removed. Refer to NTRP 3-22.2-AV8B for a description of the changes that were made to the HUD symbology in the aircraft NAV and VSTOL master modes. See the A1-AV8BB-TAC-000 for changes that affect the A/G and A/A master modes.

The HUD displays collimated symbology projected into the pilot's forward field-of-view (FOV). The HUD has a 22° total field-of-view (TFOV) and an approximately 14° by 14° (16° by 20° on Radar and Night Attack aircraft) instantaneous field-of-view (IFOV). The optical center of the IFOV is located -6° below the horizontal vision line from the design eye position. The lower portion of the TFOV coincides with the pilots -17° over the nose vision line. The HUD is electrically interfaced with the upfront control and the HUD camera. The controls for the HUD are below the upfront control and are described in the following paragraphs.

2.18.18.1 Head-Up Display (TAV-8B)

The information displayed on both HUDs is identical in both cockpits. On the HUD control panel in the rear cockpit, the switches for reject level and radar altitude display selection are inoperative. These functions can only be selected from the front cockpit.

2.18.18.2 HUD Symbology Reject Switch

This three-position toggle switch has positions of NORM, REJ 1, and REJ 2. With the switch placed to NORM, the normal amount of symbology is provided for all HUD displays. Placing the switch to REJ 1 or REJ 2 changes the HUD symbology in the different modes. Reject level 1 is automatically selected when altitude alert cue is enabled. The following paragraphs define the reject levels for the four master modes:

2.18.18.2.1 NAV Mode

Reject level 1 removes AOA legend, FPM legend, airspeed box, altitude box, heading box, and replaces large heading numerics with nominal sized heading. Also adds AOA and feet per minute (FPM) analog scales. Reject level 2 removes the AOA, FPM, Mach, normal g's, and ground speed legends, and also removes the heading numerics, heading scale, altitude box, airspeed box, and heading box. With H4.0, the altitude box, airspeed box, and heading box are not displayed in any reject level.

2.18.18.2.2 VSTOL Mode

Reject level 1 removes AOA legend, FPM legend, airspeed box, altitude box, heading box, power margin indicator (digital rpm and JPT indications are displayed) and replaces large heading numerics with nominal sized heading. Reject level 2 removes AOA legend, FPM legend, airspeed box, altitude box, heading box, vertical flight path symbol, and nozzle, flaps, rpm, and JPT waterflow legends (power margin indicator if displayed). Also replaces large heading numerics with nominal sized heading. With H4.0, the altitude box, airspeed box, and heading box are not displayed in any reject level.

2.18.18.2.3 A/G Mode

Reject level 1 removes AOA legend, airspeed box, altitude box, heading box, and replaces large heading numerics with nominal sized heading. Also adds AOA analog scale. Reject level 2 removes AOA legend, airspeed box, altitude box, heading box, heading numerics, and heading scale. With H4.0, there is no difference between A/G reject level normal and reject level 1. With H4.0, the altitude box, airspeed box, and heading box are not displayed in any reject level.

2.18.18.2.4 A/A Mode

Reject level 1 removes AOA legend, airspeed box, altitude box, heading box, and replaces large heading numerics with nominal sized heading. Also adds AOA analog scale. Reject level 2 removes airspeed box, altitude box, heading box, heading numerics, heading scale, and pitch ladder. Also removes AOA, Mach, and normal g's legends. With H4.0, the altitude box, airspeed box, and heading box are not displayed in any reject level.

2.18.18.3 HUD Symbology Brightness Control

This knob is used to turn on the HUD and then varies the symbology display intensity.

2.18.18.4 HUD Symbology Brightness Selector Switch

This is a three-position toggle switch with positions of DAY, AUTO, and NIGHT. Placing the switch to DAY provides maximum symbol brightness in conjunction with HUD symbology brightness control. Placing the switch to AUTO allows automatic control of the contrast by the automatic brightness control circuit. With the switch to NIGHT, a reduced symbol brightness is provided in conjunction with the HUD symbology brightness control. The NIGHT position must be selected to have FLIR video on the HUD.

2.18.18.5 Video Brightness Control (Radar and Night Attack Aircraft)

This control is a rotary knob used to adjust the brightness of the HUD raster video. It is used to set the black reference level for FLIR video. Clockwise rotation increases brightness. The brightness control has a pushbutton feature which is used for the display alternate toggle (DAT) function. Selecting the DAT function swaps the displays on the MPCDs.

2.18.18.6 Video Contrast Control (Radar and Night Attack Aircraft)

This control is a rotary knob that adjusts the contrast of the HUD raster video. Clockwise rotation increases contrast.

2.18.18.7 Standby Reticle Brightness Control (Day Attack Aircraft)

This control turns on the standby reticle and adjusts the symbol's brightness.

2.18.18.8 Standby Depression Control (Day Attack Aircraft)

This control selects reticle depression angles over the range from 0 to minus 240 milliradians (in 20 milliradian increments) with respect to the aircraft waterline.

2.18.18.9 Altitude Switch

This is a two position toggle switch with positions of BARO and RDR. This switch is used to select either radar altitude (RDR) or barometric altitude (BARO) for display on the HUD. Refer to paragraph 2.18.14.2, Altitude Switch.

2.18.18.10 HUD Camera

The HUD video camera is mounted on the right side of the HUD. It is focused at infinity and records the scene as viewed by the HUD prism assembly through the HUD combiner assembly. The field of view is 16° vertically and 21° horizontally. This includes all HUD symbology in the camera's field of view. An exposure control automatically adjusts for changing light levels. The HUD camera is part of the Video Recording System (VRS). Two switches on the miscellaneous switch panel on the center pedestal control the VRS. In most aircraft, the MPCD/HUD switch determines which displays are recorded. In HUD, only the HUD camera video is recorded. In MPCD, video of the DDI/MPCD is recorded. The DDI/MPCD symbology is not recorded. The DDI/HUD switches on the miscellaneous switch panel on the center pedestal controls which displays are recorded. In HUD, only the HUD camera video is recorded. In DDI, video of the DDI is recorded. The DDI symbology is not recorded. The AUTO/RUN switch controls the video recorder mode of operation. In AUTO, the mission computer turns on the video recorder when A/A or A/G master mode is selected. In RUN, the video recorder is turned on for continuous recording, regardless of master mode. A VRS button is installed on the miscellaneous switch panel on the center pedestal in both trainer aircraft cockpits. The VRS is controlled by the last button change from either cockpit. Aircrew feedback is provided by the VRS lights integral to the VRS button. The AUTO light indicates the mission computer will turn on the video recorder when A/A or A/G master mode is selected. The RUN light indicates the video recorder is turned on for continuous recording, regardless of master mode.

2.18.18.11 Radar Switch

The RADAR switch is on the miscellaneous switch panel, directly above the INS controls. The switch has four positions:

OFF – Removes all radar set power.

STBY – All radar functions are operational except the radar transmitter and RF transmission circuits. Allows radar set to warmup before application of high voltage.

OPR – The radar is placed in the normal mode of operation. Commands radar to full operation if all safety interlocks have been satisfied and initial warmup and ORT (operational readiness test) is complete.

EMER – With weight–off–wheels, bypasses temperature and pressure interlocks and allows full radar operation. The radar is prevented from shutting down due to an overheat condition. If the radar overheats, it automatically shuts down 30 seconds after the overheat (OVHT) indication appears unless EMER is selected. Selection of EMER with weight–on–wheels turns the radar off.

CAUTION

Taxi the aircraft with the RADAR switch in STBY or OPR to prevent damage to the antenna.

2.19 MISSION COMPUTER

The mission computer is a standard general purpose stored program real–time computer with core memory. ECP 285 replaces the mission computer (MC) with a Mission Systems computer (MSC). The MSC is a higher speed computer with multiple expansion slots. The MSC provides essentially the same functionality as the MC.

2.19.1 Mission Computer Switch

The mission computer switch with positions labeled OVRD, AUTO and OFF is on the miscellaneous switch panel on the pedestal. Placing the switch to OVRD (override) inhibits the backup mode of operation. If in the backup mode at the time of placing the switch to OVRD, this allows power to be reapplied to the mission computer, enabling it to reassume control of the MUX BUS and operate normally. Placing the switch to OFF position turns off the mission computer and enables the display computer for backup mode of operation. When the switch is in AUTO position the mission computer will be normally utilized but the system automatically reverts to the display computer in case of MC failure.

2.19.2 DP Switch

This switch controls selection of mutually redundant display channels in the display computer. The display computer drives the HUD and DDI, providing display redundancy for attack, navigation, and approach to landing. Selecting the PRIM position on the DP switch selects a primary display channel for operation. The ALTER position selects an alternate display channel for operation. The AUTO position, which is the preferred switch position, randomly selects the operational channel for operation and provides automatic reselection if there is a display computer channel failure. If the switch is in PRIM or ALTER and a power interruption occurs, the display may go blank. To regain the display, cycle the switch from PRIM to ALTER and back to PRIM, or vice versa.

2.20 VREST COMPUTER

To determine the operational capability of the aircraft, the mission computer performs vertical takeoff, vertical landing, range endurance, speed and time calculations. These calculations are presented on the V/STOL REST displays. See Figure 2-22. These displays are available only in NAV or V/STOL master mode. To enable the displays, select VRST on the menu display.

The V/STOL–REST basic display appears with the last entered values for the basic aircraft weight (BAW), water weight (H2O) and basic drag index (BDI). Also the UFC and ODU are enabled for data entry. To ensure accuracy the displayed values for BAW, H2O, and BDI must be verified and new values entered if required. The H2O quantity, as indicated on the EDP, is displayed on the V/STOL–REST basic display in aircraft with H4.0 and cannot be altered.

2.20.1 VREST Displays

There are five VREST displays: vertical landing (VL), vertical takeoff (VTO), short takeoff (STO), cruise (CRUS), and bingo (BNGO). To enable the desired display select the appropriate pushbutton VL, VTO, STO, CRUS or BNGO. Selection is indicated by the box around the legend.

2.20.1.1 Vertical Takeoff and Landing Display

The vertical takeoff and vertical landing displays are identical in format. The displays show the maximum weight of fuel and water (F+W) aboard the aircraft at which the vertical takeoff or vertical landing can be performed. This data is computed for both WET (water injected in engine) and DRY operation. If the outside air temperature is below –5 °C/23 °F the WET data is not displayed.

The data displayed at the bottom of the display; outside air temperature Celsius/Fahrenheit (OATC or OATF), altimeter barometric pressure setting (ALTM), field elevation (FELV), and gross weight (GWT) is normally system generated and used in calculating maximum F+W. If any of these parameters are not valid then that parameter is not displayed. If the non–valid parameter is essential to calculations of maximum F+W, then the calculation is not performed and no data is displayed for maximum F+W.

Some data affecting the calculations may be entered by the pilot using the options on the ODU. The following options are available: GWT, OATC or OATF, FELV, and engine parameters (ENG). Selecting ENG enables the relative jet pipe temperature (RJPT), jet pipe temperature limit (JPTL) and relative hover (RHOV) options. If data is pilot entered (OATC or OATF, GWT, FELV) and asterisk (*) is displayed to the left of the applicable legend. Pilot entered data overrides system generated data.

The maximum F+W is calculated as follows: first the hover weight is calculated. This is done by calculating the maximum rpm limited by ambient temperature, then calculating the maximum rpm limited by jet pipe temperature limiter settings. Since either of these parameters may limit the maximum rpm, the smaller of the two is used in the equations to calculate the hover weight. The hover weight is then adjusted for either the takeoff or landing calculations. For a vertical takeoff 97 percent of the hover weight is used. For a vertical landing approximately 95 percent of the hover weight is used. The adjusted hover weight is used along with the aircraft gross weight, fuel weight, and water weight to calculate the maximum fuel plus water weight at which a vertical operation can be executed.

2.20.1.2 Short Takeoff Display

The short takeoff display shows the nozzle rotation airspeed (NRAS), nozzle setting in degrees (NOZ), minimum ground roll distance (GROL), distance required to clear a 50 foot obstacle (DT50), abort speed (ASPD), and stopping distance (SDST). Setting the nozzles to the displayed NOZ when NRAS is reached results in the displayed GROL, DT50, ASPD, and SDST. ASPD and SDST are computed and displayed when the abort (ABRT) push button is selected on the VRST page. The ASPD and SDST fields display asterisks (* * *) when ABRT is not selected, when relevant inputs change, and in any weight on wheels condition. The data is computed for both WET (water injected in engine) and DRY operation having no effect on ASPD or SDST. If outside air temperature is below -5 °C/23 °F the WET data is not displayed.

The value of OATC or OATF, FELV, and GWT shown at the bottom of the display is system generated but may be overridden by the pilot. The value for ALTM is equal to the barometric pressure setting set on the standby pressure altimeter. Runway data (RUNW) and ground wind (GWIND) are pilot entered inputs. If any of these parameters are not valid then that parameter is not displayed. If the non-valid parameter is essential to the calculations of NRAS, NOZ, GROL, and DT50 then the calculation is not performed and no data is displayed, with the exception of ASPD and SDST fields. These two fields display solid asterisks if they become invalid, and during initial fire up.

Data affecting the calculations may be entered by the pilot using the options on the ODU. The following options are available: GWT, OATC or OATF, FELV, field data (FDAT), ENG. Selecting the FDAT option enables runway distance (RDIS), runway heading (RDHG), runway wet/dry (RWET/RDRY), and ground wind (GWND) options; selecting the ENG option enables relative jet pipe temperature, jet pipe temperature limit, and relative hover options. The RDRY selection toggles between RDRY and RWET, with the default being RDRY. RDIS allows entries from 1,000 to 13,000 feet, with the default being 1,000 feet. If system generated data is overridden by pilot entered data (OATC or OATF, GWT, and FELV) an asterisk (*) is displayed to the left of the applicable legend.

Note

(ABRT USES 6,000) is displayed when field elevation is greater than 6,000 feet and (CALC 1,400) is displayed when runway condition is wet and runway length is less than 1,400 feet.

The nozzle rotation airspeed, nozzle setting in degrees, ground roll distance, and the distance required to clear a 50 foot obstacle are calculated as follows: first the hover weight is calculated based on the limiting rpm; maximum rpm limited by ambient temperature or maximum rpm limited by the jet pipe temperature limiter setting. Next, the gross weight to hover weight ratio is calculated. If the ratio is less than 1.35 the nozzle rotation angle is set to 55°. If ratio is greater than 1.35 the nozzle rotation angle is set to 50°. The airspeed for nozzle rotation is based on aircraft gross weight and the gross weight to hover weight ratio. If the aircraft gross weight is greater than 27,000 pounds and ambient temperature is greater than 35 °C/95 °F the nozzle rotation airspeed and ground wind are used to compute the ground roll distance. The ground roll distance and outside air temperature are used to compute the distance to clear a 50 foot obstacle. Refer to A1-AV8BB-NFM-400, see Short Takeoff Rotation Speed charts for additional details.

2.20.1.3 Cruise Display

The cruise display presents the best flight profile for altitude cruise (ACR) and optimum cruise (OPCR) performance. The ACR column displays the profile necessary to obtain the maximum cruise performance at the existing altitude. The OPCR column displays the flight profile at which maximum cruise performance can be obtained. The data in the ACR column is system generated as is most data in the OPCR column. In the OPCR column the exceptions are: system generated values for calibrated airspeed (CAS) and cruise altitude (CALT) can be overridden by pilot entries. The WIND entry must be pilot entered.

The ODU options available for data entry are gross weight (GWT), drag index (DI), optimum cruise wind (OWND), cruise altitude (ALT), and calibrated airspeed (CAS).

When the display is selected CALCULATIONS IN PROGRESS appears while the parameters are being generated. This may take as long as 12 seconds. The aircraft gross weight, drag index, current altitude, ambient temperature, wind direction and speed, and range to selected waypoint are computed for use in determining the parameters in the ACR and OPCR columns.

Altitude cruise calculations are performed first. The system tests for and calculates the Mach number which results in the best fuel efficiency at the current altitude. The average gross weight, total drag, dynamic pressure, and wind effects during the cruise are some of the factors considered when calculating the Mach number. The Mach number and equivalent calibrated airspeed are displayed in the ACR column. Fuel consumption is calculated by taking the cruise range and dividing it by the fuel efficiency. The remaining fuel, displayed in the ACR column, is the total fuel minus the fuel consumed during the climb, cruise, and descent. The maximum range allows for an 800 pound fuel reserve and is calculated by multiplying the available fuel by fuel efficiency.

Optimum cruise calculations are performed next. The system tests for and calculates the Mach number and altitude that results in the best fuel efficiency. First the fuel and distance to climb to the current altitude is calculated. Next, the optimum cruise altitude is calculated based on the weight and drag index of the aircraft. Altitudes between the current altitude and the optimum altitude are examined at intervals to see which one provides the greatest fuel efficiency. Next, fuel consumption calculations are done to determine how much fuel will remain when the waypoint or markpoint is reached. After all altitudes have been tested the calculated values for the optimum altitude and Mach number are displayed. The optimum Mach number is also converted to the equivalent calibrated airspeed for display.

The pilot can manually enter an altitude and/or airspeed for the optimum cruise calculations if threats or the weather dictate. The ALT and CAS options are displayed on the ODU when CRUS is selected on the DDI. Any altitude less than or equal to the optimum cruise altitude or any airspeed below 600 knots can be entered by selecting the applicable option, ALT or CAS, and keying the desired entry. Altitude entries greater than the optimum altitude and airspeed entries 600 knots or greater are disallowed and denoted by the flashing entry on the scratch pad. Manual entries of altitude or airspeed for optimum cruise calculations are denoted by an asterisk (*) preceding the CALT and/or CAS legend.

2.20.1.4 Bingo Display

The bingo display presents the best flight profile for altitude bingo (ABNG) and optimum bingo (OBNG) performance. The ABNG column displays the flight profile necessary to obtain maximum bingo performance at the existing altitude. The data in the ABNG column is system generated as is most data in the OBNG column. In the OBNG column the exceptions are: system generated values for CAS and CALT can be overridden by pilot entries. The WIND entry must be pilot entered.

The ODU options available for data entry are gross weight, drag index, optimum cruise wind, cruise altitude, and calibrated airspeed.

When the display is selected CALCULATIONS IN PROGRESS appears while the parameters are being generated. This may take as long as 12 seconds. The aircraft gross weight, drag index, current altitude, ambient temperature, wind direction and speed, and range to selected waypoint are computed for use in determining the parameters in the ABNG and OBNG columns. Constant altitude computations are done first. A minimum drag index is set, a fuel reserve (800 pounds) is subtracted from the total fuel on board and gross weight is adjusted based on fuel to be used. Maximum range is computed based on total fuel and fuel flow. Constant altitude data is stored for display.

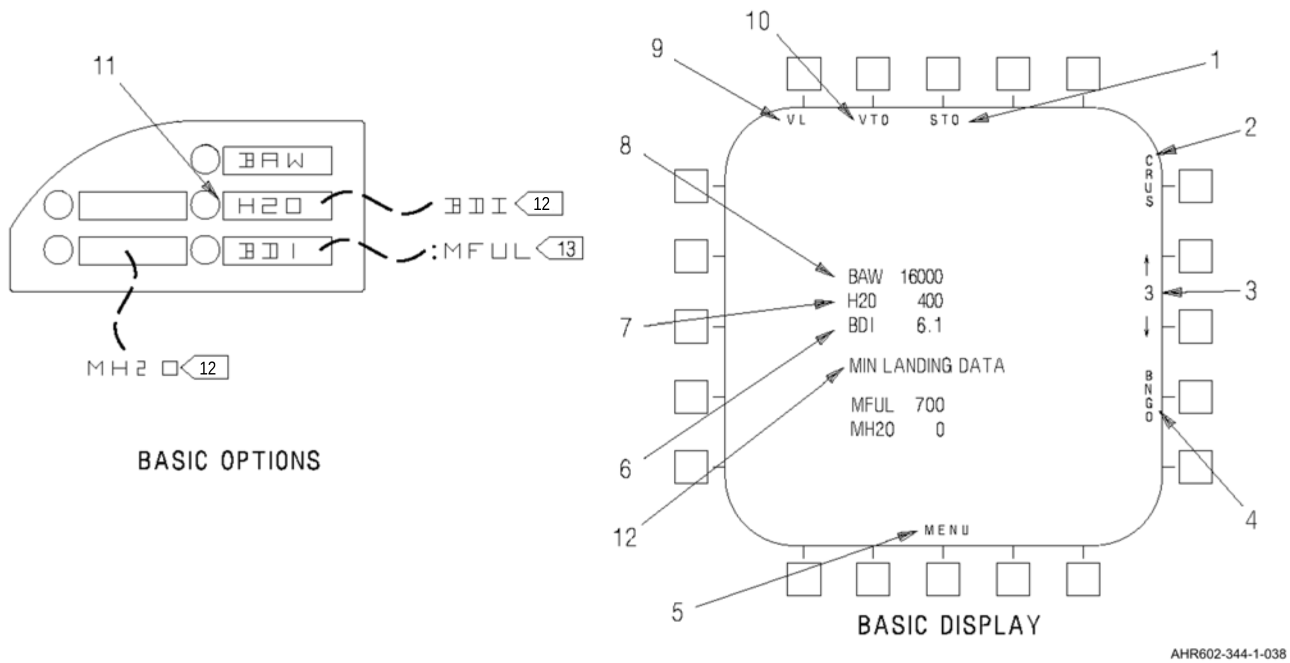
Optimum altitude computations are done next. The fuel required to climb from sea level to the existing altitude is computed. The optimum altitude is computed based on total fuel. If the optimum altitude is greater than the existing altitude, the amount of fuel and distance to climb to the optimum altitude is computed. The amount of fuel to be used for cruise leg is the total fuel minus the climb fuel. The constant altitude bingo computations are done and climb range is added to the cruise range to get maximum range. The amount of fuel and distance to climb from sea level to the existing altitude is computed. Then the amount of fuel and distance to climb from sea level to the optimum altitude is computed. The amount of fuel and distance to climb to the optimum altitude is the difference between the two values.

The pilot can manually enter an altitude and/or airspeed for the optimum bingo calculations if threats or weather dictate. The manual entries are accomplished in the same manner as previously described for the optimum cruise calculations.

2.20.2 Engine Data Entry

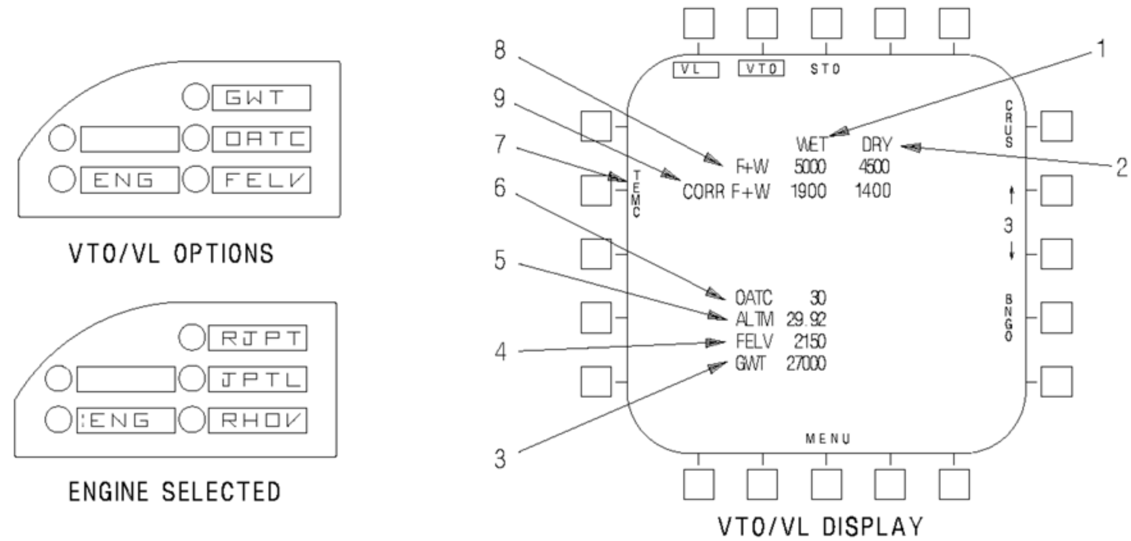
To receive the proper ODU displays for entering engine data, press the VRST pushbutton on the DDI basic menu display. The DDI shows the basic V/STOL-REST display (Figure 2-22). The ODU displays BAW, H2O (OMNI 7.1 and C1+ only), and BDI. Pressing the VL, VTO, or STO pushbutton on the DDI display causes OATC or OATF, FELV, GWT, and ENG to appear on the ODU option display windows. Corresponding displays appear on the DDI.

To enter engine data select the ENG option. A colon appears next to the ENG legend indicating selection. The relative jet pipe temperature, jet pipe temperature limit, and relative hover options are displayed. Selecting anyone of these options enables the UFC scratch pad and keyboard for data entry. A colon appears to the left of the selected option.



1.	Pressing this pushbutton selects short takeoff display and causes STO to be boxed, indicating selection.
2.	Pressing this pushbutton selects cruise display and causes CRUS to be boxed, indicating selection.
3.	Number (3) indicates selected waypoint. Waypoint can be changed by pressing the increment (↑) or decrement (↑) pushbutton. Changing waypoint does not change waypoint selection on EHSI/EHSD display. With H4.0, pressing the increment or decrement pushbutton for more than 0.8 seconds enables a quick access session allowing the pilot to select between all 60 waypoints, 10 markpoints, and 5 targetpoints.
4.	Pressing this pushbutton (BNGO) selects bingo display and causes BINGO to be boxed, indicating selection.
5.	Pressing this pushbutton (MENU) selects menu display.
6.	Basic drag index (BDI) is entered by the pilot for use in drag index computations. Drag index values from 0 to 30 may be entered. The displayed drag index is for aircraft in a clean configuration and does not include compensation for external stores.
7.	With OMNI 7.1 and C1+, water weight (H2O) is entered by the pilot for use in gross weight computations. The displayed water weight is the last entered value. With H4.0, the displayed water weight is the same as the EDP water weight.
8.	Basic aircraft weight (BAW). The operating weight (OWT) is entered here for use in gross weight computations. The maxi mum allowable entry is 20,000 pounds. The OWT is the BASIC WEIGHT plus those items which remain constant for the mission. These items include the pilot (180 lbs), ALE 39/47 (111 lbs), strakes, gun, pylons, probe, etc. This weight does not include expendable stores, empty ITERS, TPOD, water or fuel. The weight entered here should match the DSU Aircraft Weight at the bottom of section 3 on the AV-8B UPC generated Form F.
9.	Pressing this pushbutton (VL) selects vertical landing display and causes VL to be boxed, indicating selection.
10.	Pressing this pushbutton (VTO) selects vertical takeoff display and causes VTO to be boxed, indicating selection.
11.	With H4.0, ODU window 2 has changed to BDI. ODU window 3 and 5 are blank for Radar and Night Attack aircraft.
12.	Minimum Fuel (MFUL) and Minimum water (MH2O) can be entered by the pilot in TAV-8B aircraft with H4.0. This will allow the system to display VL performance that is corrected for RJPT shift.

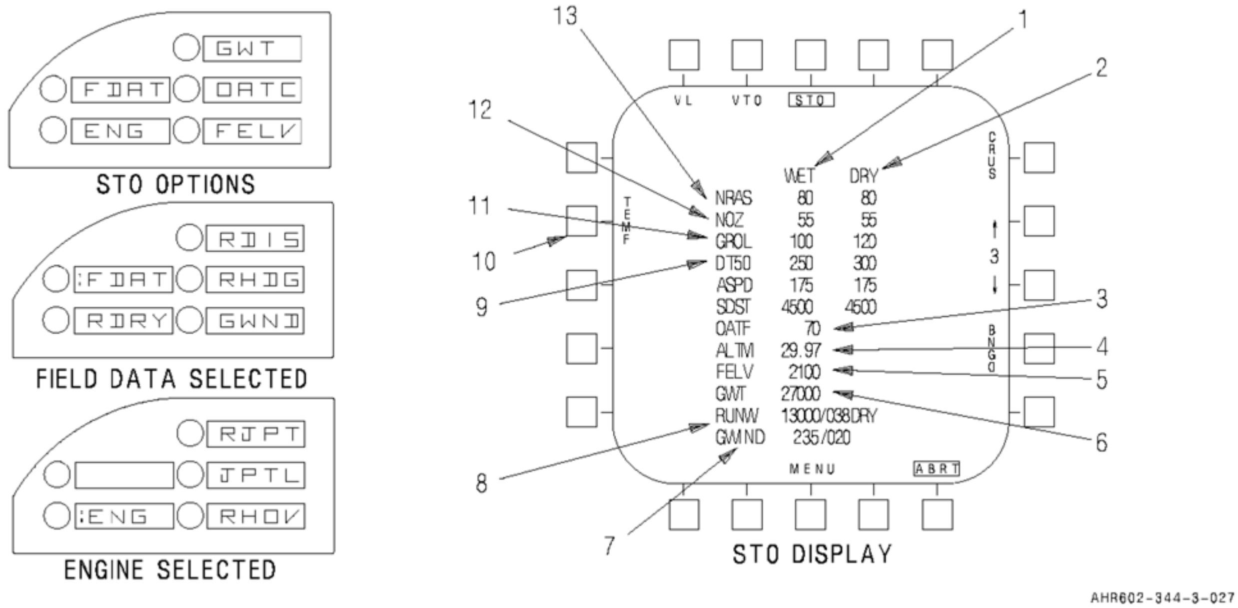
Figure 2-22. VSTOL – REST Displays (Sheet 1 of 5)



AHR602-344-2-038

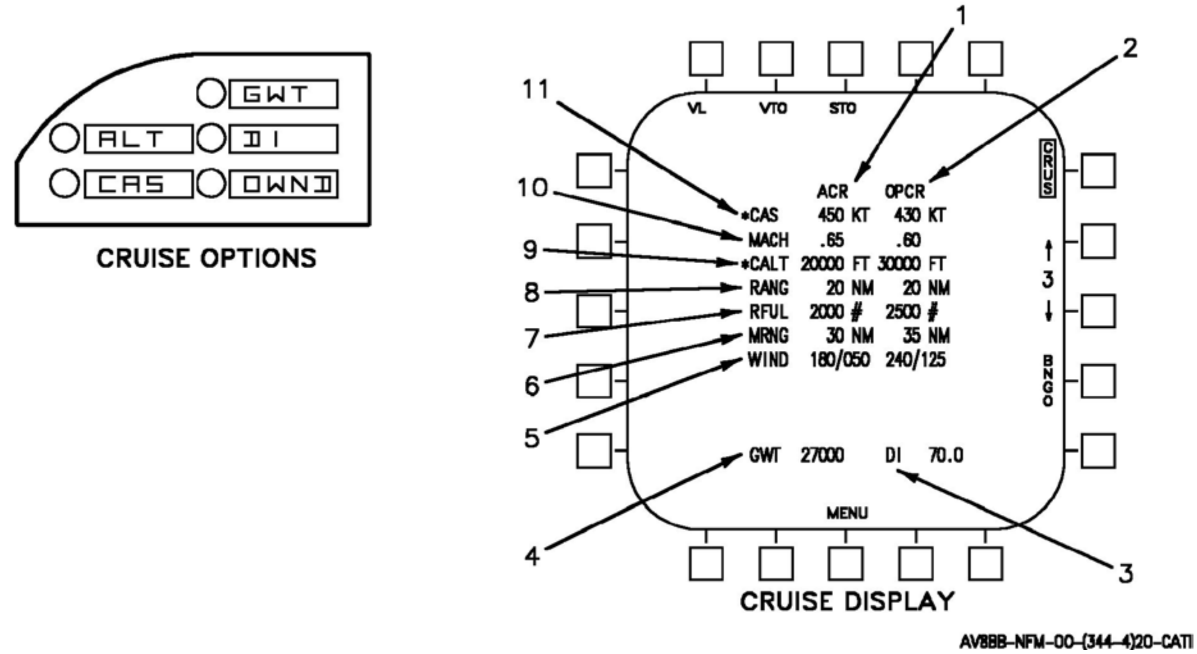
1. Wet is displayed above left column. The numerics listed below WET are the values to be used in a water injected takeoff or landing. WET data are not displayed if outside air temperature is below −5 °C.
2. Dry is displayed above right column. The numerics listed below DRY are values to be used in a DRY (not water injected) takeoff or landing.
3. Aircraft gross weight (GWT) is the total weight of the aircraft including fuel, water, stores including hung stores, and rounds remaining including spent casings. The GWT is used to compute F+W. If displayed GWT is pilot entered, an asterisk (*) is displayed to the left of GWT.
4. Field elevation (FELV) is used to compute the maximum allowable F+W weight. The displayed FELV is either computed or pilot entered. An asterisk (*) is displayed to the left of FELV if pilot entered field elevation is being used.
5. Altimeter barometric pressure setting (ALTM) is used to compute F+W. The displayed ALTM is equal to the barometric pressure setting that is set on the standby pressure altimeter.
6. Outside air temperature °C (OATC) or °F (OATF) is used to compute F+W. The displayed OAT is either pilot entered or is set equal to the last computed ground temperature. Once weight is off wheels, OAT is no longer automatically updated; however, the pilot may manually change the temperature if desired, at which time an asterisk (*) is displayed to the left side of OATC or OATF as applicable. The last recorded temperature is stored.
7. This pushbutton allows the outside air temperature to be entered and displayed in units Fahrenheit or Celsius. The pushbutton scrolls between TEMF and TEMC. The outside air temperature on the VL, VTO, STO and PHOV display is calculated and displayed as OATF or OATC.
8. Fuel and water weight (F+W) is computed for WET or DRY takeoff or landing. The displayed value is the maximum weight of fuel and water aboard the aircraft at which the vertical takeoff or landing can be done.
9. The corrected F+W display line indicates the vertical landing values (corrected for RJPT shift) based on the minimum landing fuel and water inputs for TAV−8B aircraft with H4.0.

Figure 2-22. VSTOL − REST Displays (Sheet 2)



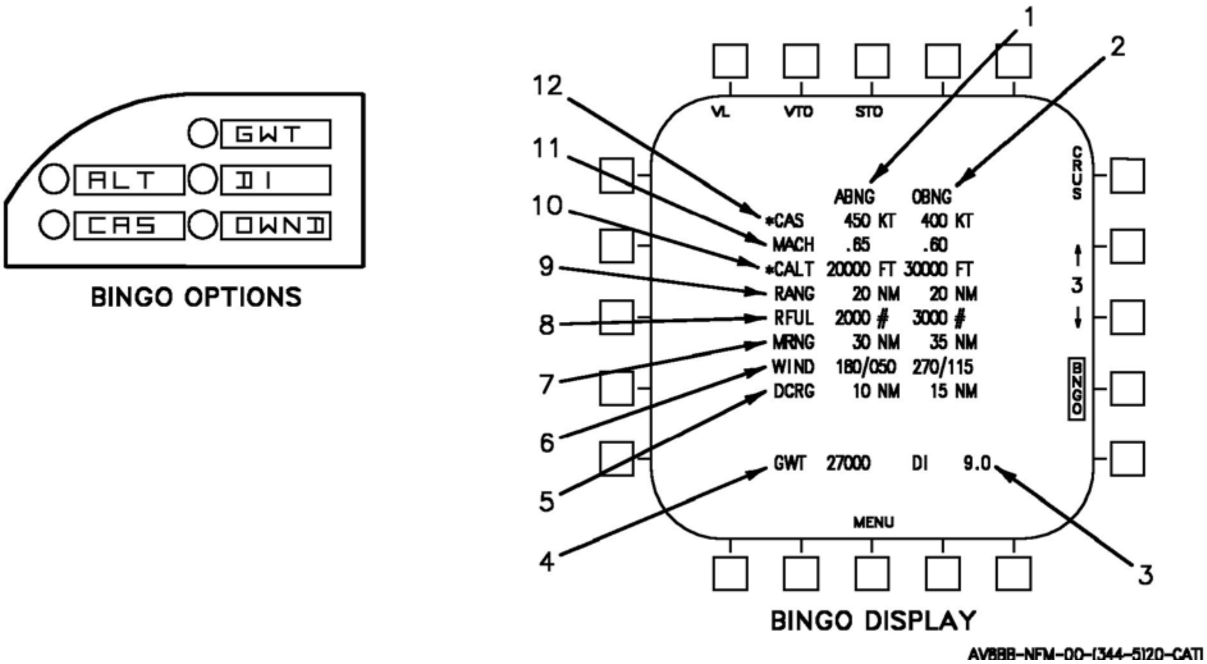
1.	WET is displayed above left column. The data in the WET column are the variables to be used if a water injected short takeoff is to be done. The data is always computed when STO is selected, but will not be displayed if outside air temperature is below -5 °C.
2.	DRY is displayed above right column. The data in the DRY column are the variables to be used if a dry (not water injected) takeoff is to be done.
3.	Outside air temperature °C (OATC) or °F (OATF) is used in performance computations to determine the variables required for a STO. The displayed OAT is either pilot entered or is set equal to the last computed ground temperature. Once weight is off wheels, OAT is no longer automatically updated; however, the pilot may manually change the temperature if desired, at which time an asterisk (*) is displayed to the left side of OATC or OATF as applicable. The last recorded temperature is stored.
4.	Altimeter barometric pressure setting (ALTM) is used in performance computations to determine the variables for the STO. The displayed ALTM value is equal to the barometric pressure setting that is set on the standby pressure altimeter.
5.	Field elevation (FELV) is used in performance computations to determine the variables required for STO. The displayed FELV is either computed or pilot entered. If pilot entered an asterisk (*) is displayed to the left side of FELV.
6.	Aircraft gross weight (GWT) is the total weight of the aircraft including fuel, water, stores including hung stores, and rounds remaining including spent casings. The GWT is used in performance computations to determine the variables required for STO. The displayed GWT is either computed or pilot entered. If pilot entered, an asterisk (*) is displayed to the left of GWT.
7.	Ground wind (GWIND) is displayed indicating wind direction and magnitude. It is pilot entered.
8.	Runway (RUNW) displays runway distance (RDIS), runway heading (RHDG), and runway condition (RDRY/RWET), which are all pilot entered.
9.	Distance to 50 feet (DT50) is displayed with entries in WET and DRY columns. Number indicates linear distance in feet required for a 50 foot obstacle clearance.
10.	This pushbutton allows the outside air temperature to be entered and displayed in units Fahrenheit or Celsius. The pushbutton scrolls between TEMF and TEMC. The outside air temperature on the VL, VTO, STO and PHOV display is calculated and displayed as OATC or OATF.
11.	Ground roll (GROL) is displayed with entries in the WET and DRY columns. Number indicates minimum ground roll distance required for short takeoff.
12.	Nozzle setting in degrees (NOZ) is displayed with entries in WET and DRY columns. The nozzle setting for a STO is 50° or 55° depending upon the hover weight ratio. NOZ displays the setting to which the nozzles should be rotated when NRAS is reached.
13.	Nozzle rotation airspeed (NRAS) is displayed with entries in the WET and DRY columns. The NRAS is the airspeed at which nozzles are rotated to do a STO. Setting the nozzles to displayed NOZ when NRAS is reached results in the displayed GROL and DT50.

Figure 2-22. VSTOL - REST Displays (Sheet 3)



1.	Altitude cruise (ACR) is displayed above left column. Numbers in this column are computed to indicate to the pilot the flight data required to obtain maximum cruise performance at existing altitude. An asterisk (*) next to the ACR legend indicates existing aircraft altitude is greater than optimum altitude. When this occurs data in the ACR column is extrapolated from the data in the OPCR column.
2.	Optimum cruise (OPCR) is displayed above right column. Numbers in this column are computed to indicate to the pilot the optimum altitude at which the maximum cruise performance can be obtained.
3.	Drag index (DI) is displayed to indicate total drag of aircraft and stores. The drag index is used in cruise computations. If an asterisk (*) is displayed to the left of DI, a pilot entered drag index is being used in computations.
4.	Gross weight (GWT) is displayed to indicate total weight of aircraft, including fuel, water, stores including hung stores, and rounds remaining including spent casings. The gross weight is used in cruise computations. An asterisk (*) to the left of GWT indicates that a pilot entered value is being used in computations.
5.	Wind is displayed in direction and magnitude in both the altitude cruise and optimum cruise columns. Displayed ACR wind is computed from aircraft sensors. OPCR wind is a pilot entered value.
6.	Maximum range (MRNG) is displayed in altitude cruise and optimum cruise columns. MRNG indicates maximum range that can be reached if the altitude, airspeed, and Mach of respective columns is followed. The MRNG computations allow a 800 pound fuel reserve.
7.	Remaining fuel (RFUL) legend is displayed with entries in ACR and OPCR columns. Number indicates remaining fuel in pounds after arriving at selected waypoint if ACR or OPCR profile is followed.
8.	Range (RANG) legend is displayed with entries in ACR and OPCR columns. Number indicates range in nautical miles to the selected waypoint. If range is more than 10,000 nautical miles, cruise data is blanked.
9.	Cruise altitude (CALT) legend is displayed with entries in ACR and OPCR columns. Number in ACR column indicates existing aircraft altitude. Number in OPCR column indicates best altitude for use with other OPCR variables to increase maximum cruising range. Aircraft can have a pilot entered altitude in the OPCR column, denoted by an asterisk (*) next to CALT legend.
10.	Mach legend is displayed with entries in ACR and OPCR columns. Number in ACR column indicates the best Mach to increase aircraft range at existing altitude. Number in OPCR column indicates best Mach for use with other OPCR variables to increase maximum cruising range.
11.	Calibrated airspeed (CAS) legend is displayed with entries in ACR and OPCR columns. Number in ACR column indicates the best airspeed to increase aircraft range at existing altitude. Number in OPCR column indicates best airspeed for use with other OPCR variables to increase maximum cruising range. Aircraft can have a pilot entered CAS in the OPCR column, denoted by an asterisk (*) next to CAS legend.

Figure 2-22. VSTOL – REST Displays (Sheet 4)



1. Altitude bingo (ABNG) legend is displayed above left column. Numbers in this column indicate to the pilot flight data required to obtain maximum bingo performance at existing aircraft altitude. An asterisk (*) next to the ABNG legend indicates existing aircraft altitude is greater then optimum altitude. When this occurs data in the ABNG column is extrapolated from the data in the OBNG column.
2. Optimum bingo (OBNG) legend is displayed above right column. Numbers in this column indicate to the pilot the optimum altitude at which the greatest bingo performance can be obtained.
3. Drag index (DI) is displayed to indicate total drag of aircraft. This drag index is used in computations and is set to a clean configuration for bingo flight. Aircraft can have pilot entered drag index.
4. Gross weight (GWT) is displayed to indicate bingo weight of aircraft including fuel, water, and spent casings but not including stores including hung stores, expendables, or rounds remaining. An asterisk (*) to the left of GWT indicates a pilot entered value is being used in computations.
5. Descent range (DCRG) is displayed to indicate the range to the waypoint at which descent should begin for altitude bingo or optimum bingo flight.
6. Wind is displayed in the altitude bingo and optimum bingo columns. Displayed ABNG wind is computed form aircraft sensors. OBNG wind is a pilot entered value.
7. Maximum range (MRNG) indicates maximum aircraft range in nautical miles in the direction of the selected waypoint, including cruise at the displayed altitude followed by an idle descent to sea level. Fuel remaining after descent is 800 pounds.
8. Remaining fuel (RFUL) legend is displayed with entries in ABNG and OBNG columns. Number indicates fuel remaining in pounds after arriving at selected waypoint, if ABNG or OBNG profile is followed.
9. Range (RANG) legend is displayed with entries in ABNG or OBNG columns. Number indicates range in nautical miles to selected waypoint. If range is more than 10,000 miles, bingo data is blanked.
10. Cruise altitude (CALT) legend is displayed with entries in ABNG and OBNG columns. Number in ABNG column indicates existing aircraft altitude. Number in OBNG column indicates best altitude for maximum cruising range. Aircraft can have pilot entered altitude in OBNG column, denoted by an asterisk (*) to the left of CALT.
11. Mach legend is displayed with entries in ABNG and OBNG columns. Number in ABNG column indicates the best Mach to increase aircraft range at existing altitude. Number in OBNG column indicates best aircraft Mach for use with other OBNG variables to increase maximum range.
12. Calibrated airspeed (CAS) legend is displayed with entries in ABNG and OBNG columns. Number in ABNG column indicates the best airspeed in knots to increase aircraft range at existing altitude. Number in OBNG column indicates best airspeed for use with other OBNG variables to increase maximum range. Aircraft can have pilot entered CAS in OBNG column, denoted by an asterisk (*) next to the left of CAS.

Figure 2-22. VSTOL – REST Displays (Sheet 5)

2.20.3 VREST Calculation Considerations

2.20.3.1 Lateral Asymmetries

The VREST computer does not account for performance degradations induced by lateral asymmetries. Therefore, for takeoffs with lateral asymmetries above 32,000 inch-pounds, increase VREST calculated STO NRAS by 10 KCAS. For takeoffs with lateral asymmetries above 80,000 inch-pounds, increase VREST calculated STO NRAS by 15 KCAS.

2.20.3.2 Gross Weight and Air Temperature

The VREST computer does account for aircraft gross weight in STO NRAS calculation, whereas the charts depicted in A1-AV8BB-NFM-400 do not. Therefore, there is no requirement to add 5 KCAS to VREST calculated STO NRAS for takeoffs at gross weights greater than 27,000 pounds when ambient air temperature exceeds 35 °C.

2.21 AIR DATA COMPUTER

The air data computer (see Figure 2-23) is a solid state digital computer which receives inputs from the magnetic azimuth detector, standby altitude Kohlsman setting, TOT probe, AOA transmitter, mission computer, and pitot/static pressure. Accurate air data and magnetic heading are computed. The air data provided to the mission computer accounts for air data compensation, position error calibration, and converts indicated airspeed to calibrated airspeed. Computed data is supplied to the mission computer system, altitude reporting function of the IFF, multipurpose display system, SAAHS, aileron high speed stops, flap controller, LIDS, Q-feel, stall warning, landing gear up warning, APU and DECS.

2.21.1 Total Temperature Probe

The total temperature probe is on the upper left side of the vertical stabilizer. Operation of the probe heater is covered under Probe Heat Switch in Instruments, this section. The air data computer uses total temperature to calculate ambient temperature.

2.21.2 ADC BIT Check

To perform an initiated ADC BIT check, press the BIT pushbutton on the DDI menu display to initiate a BIT display. Press the ADC pushbutton and the word TEST appears next to ADC. After several seconds the word TEST disappears. If a failure code then appears next to ADC the system has failed the BIT check. If the space next to ADC remains blank the system has checked good.

2.22 ENTRANCE/EGRESS SYSTEMS (AV-8B)

2.22.1 Canopy System/Boarding Steps

The cockpit area is enclosed by a sliding type canopy which consists of a cast acrylic transparency mounted in a metal frame. The canopy is mounted on rails which slope upward toward the rear of the aircraft. The canopy is counterbalanced to the open position by a spring and pulley system. Except for the aid provided by the counterbalance, the canopy is opened and closed manually. A canopy seal, routed around the canopy frame, is automatically inflated by a solenoid operated pneumatic valve whenever the WOW sensor indicates weight is off wheels.

Note

The windscreen birdstrike protection capability is analytically estimated at 350 knots for a one pound bird.

Normal entrance/egress is gained by four boarding steps on the right forward fuselage below the canopy. One step is mechanically linked to the canopy, and moves down when the canopy is opened and up when the canopy is closed. The other steps are in the moldline of the fuselage and provide steps/handholds for entrance/egress.

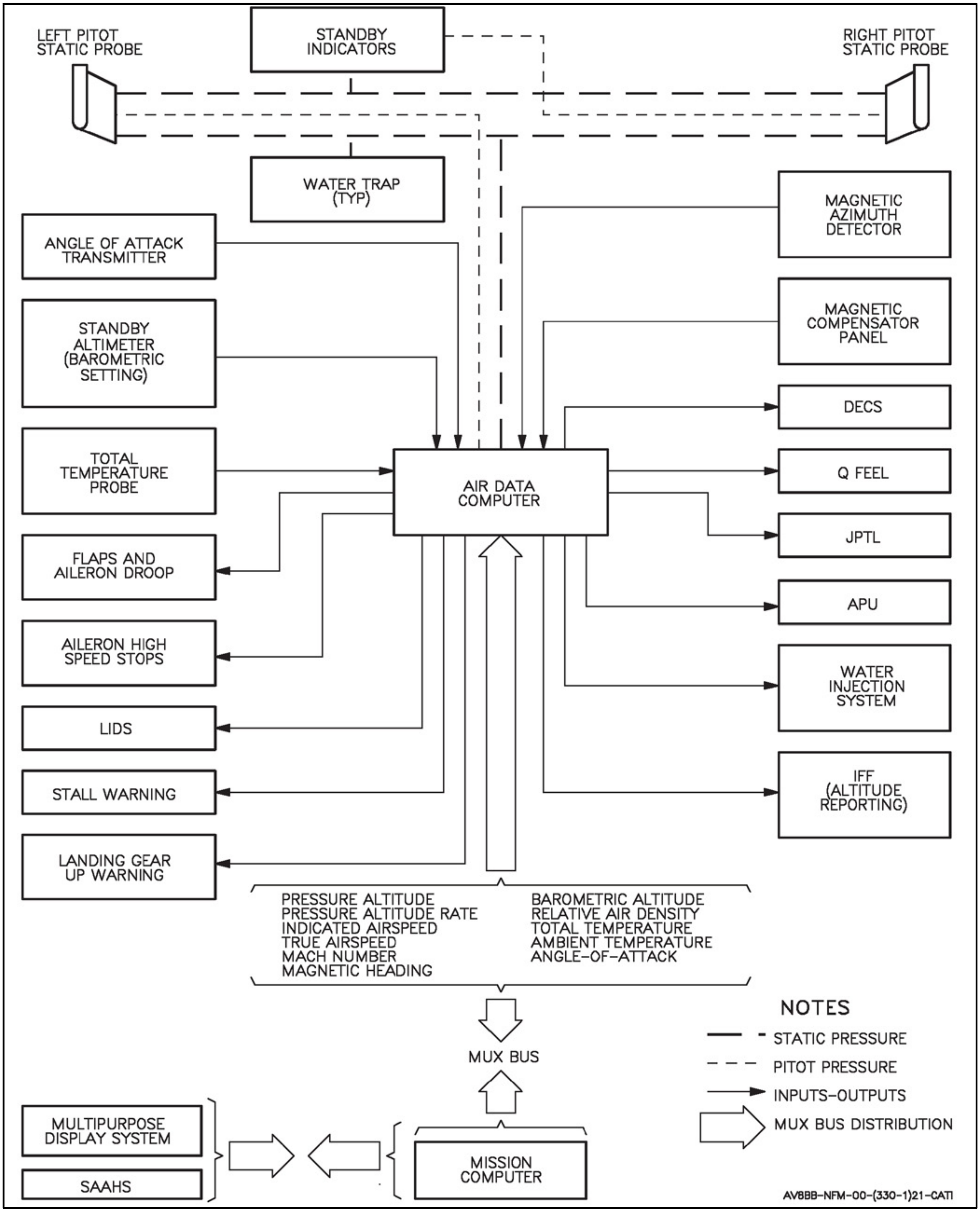


Figure 2-23. Air Data Computer Interface

2.22.2 Normal Canopy System

The canopy operating mechanism is mechanically linked to a boarding step on the right forward fuselage so that as the canopy opens the step extends and as the canopy closes the step retracts. When moved to the fully closed position, the canopy is automatically locked by two latches at the intersection of the lower leading edge of the canopy bow and the windshield frame. The controls for normal operation are the external canopy release handle, the internal canopy unlock handle and the canopy bow handles. The external canopy release handle and internal canopy unlock handle unlock the canopy and the canopy bow handles are used as grips to open and close the canopy. Close the canopy using both bow handles to ensure both canopy latches are properly engaged. Once unlocked externally, the canopy can be opened by applying downward force to the boarding step. Avoid use of the boarding step to close the canopy due to probability of disengaging the canopy/boarding step interlock described in paragraph 2.22.2.5, Canopy/Boarding Step Mechanical Link.

2.22.2.1 External Normal Canopy Release Handle

The external normal canopy release handle (Figure 2-24) is on the right side of the fuselage below the windshield. The handle is labeled NORMAL CANOPY RELEASE HANDLE. Operating a push–type latch causes the handle to pop out from a slot in the fuselage, and then pulling out and forward on the handle releases the two canopy locks. After the canopy is unlocked, the counterbalance system causes the canopy to slide back while partially extending the boarding step. Downward pressure on the step will fully open the canopy.

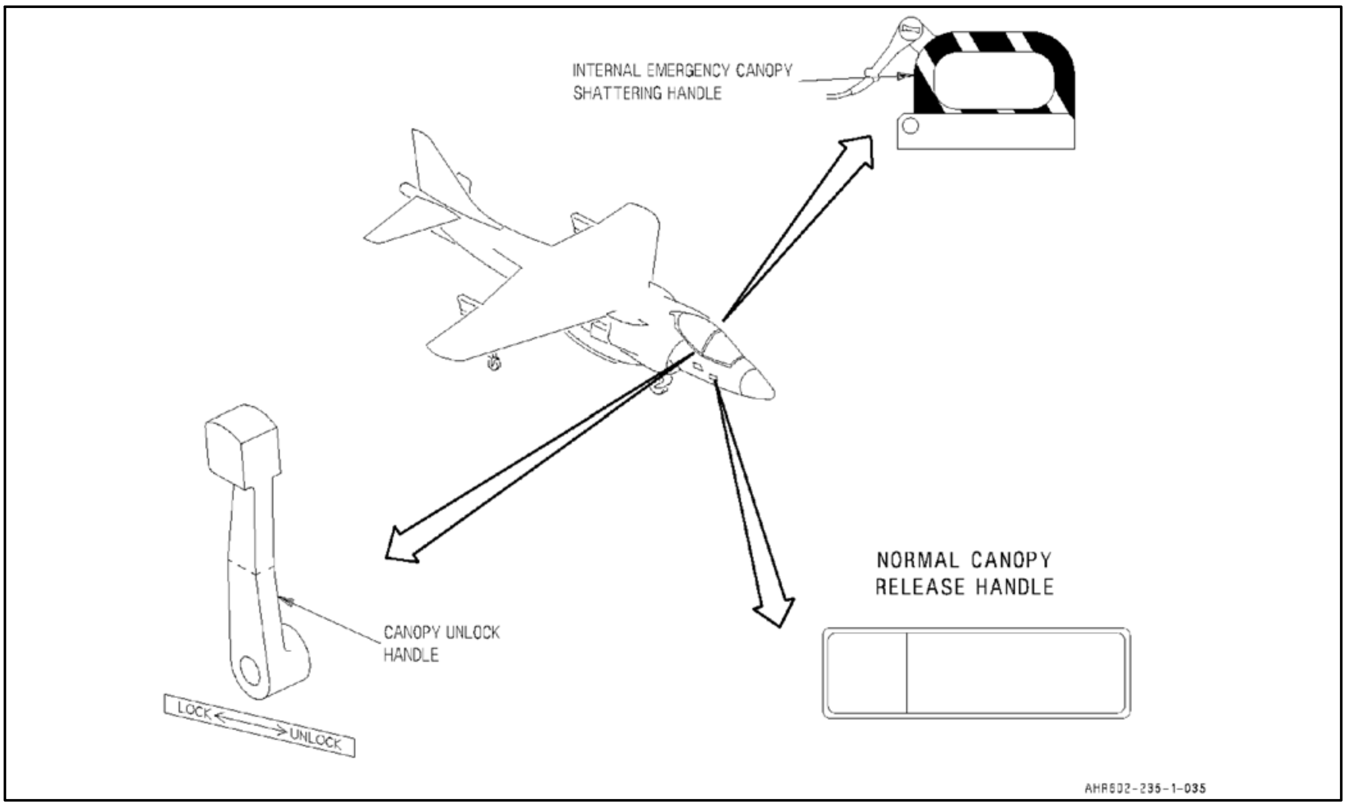


Figure 2-24. Canopy Controls (AV–8B)

2.22.2.2 Boarding Steps

In addition to the boarding step which extends when the canopy is opened externally, there are three boarding steps on the right side of the fuselage below the canopy. These steps, which are stowed flush with moldline of the fuselage, are easily located by three vertical lines extending down from the canopy to the steps. To use the steps as steps/handholds while entering or egressing the cockpit, the steps are unlocked by pushing PUSH buttons on the top part of the two upper stowed steps. The lower stowed step is interconnected with the upper right step and operation is controlled by the upper step. Unlocking the steps causes the steps to spring approximately 15° outboard and down to form a step/handhold. The steps must be stowed before flight. To stow, the steps are rotated upward and inboard by hand or foot. The steps lock in the stowed position when they become flush with the moldline of the aircraft.

On AV-8B prior to 162077, there are only two boarding steps in the moldline of the fuselage.

On AV-8B 162077 and up, a third step is added approximately 28 inches forward of the top step, and above and slightly to the right of the lower step. The step operates the same as the steps in the earlier aircraft and is interconnected to the lower step so that the latch of this step must be used to unlock both steps.

CAUTION

Egressing the cockpit without using the steps may cause injury. Pilots should be familiar with the location of the step release without requiring a visual so that the steps may be quickly unlocked and used in case of an emergency egress.

2.22.2.3 Canopy Internal Unlock Handle

The canopy internal unlock handle (Figure 2-24) is on the right side of the cockpit just forward of the lower part of the windshield arch. Pulling aft on the handle releases the canopy locks to allow the canopy to be moved manually. The handle is spring-loaded to the locked, or forward, position and there is no requirement to manipulate the handle when locking the canopy.

2.22.2.4 Canopy Bow Handles

Two canopy handles are on the inside of the canopy bow on either side of the cockpit. After the canopy is unlocked, the handles afford a means of opening or closing the canopy from within the cockpit.

2.22.2.5 Canopy/Boarding Step Mechanical Link

The mechanical link between the canopy and the drop down boarding step includes a disengagable interlock. Should the boarding step bind or jam for any reason, such as during a crash landing where the ground clearance is insufficient for the step to fully drop, the interlock can be separated from the step by applying a sudden aft force to both canopy handles. The interlock can be recoupled by holding the footsteps in the up position while moving the canopy forward until resistance is felt, then applying a sudden forward force to both canopy bow handles.

2.22.2.5.1 Canopy Latch Viewports

Canopy latch viewports (Figure 2-25) are located on the right and left sides just forward of the lower edge of the canopy. These viewports allow a visual check of the canopy latches to ensure that they are properly closed. If the latches are up (not properly closed), orange alignment lines will not be aligned.

2.22.2.5.2 Canopy Caution Light

A CANOPY caution light on the caution/advisory light panel comes on when the canopy is not closed and locked. The light operates in conjunction with the MASTER CAUTION light.

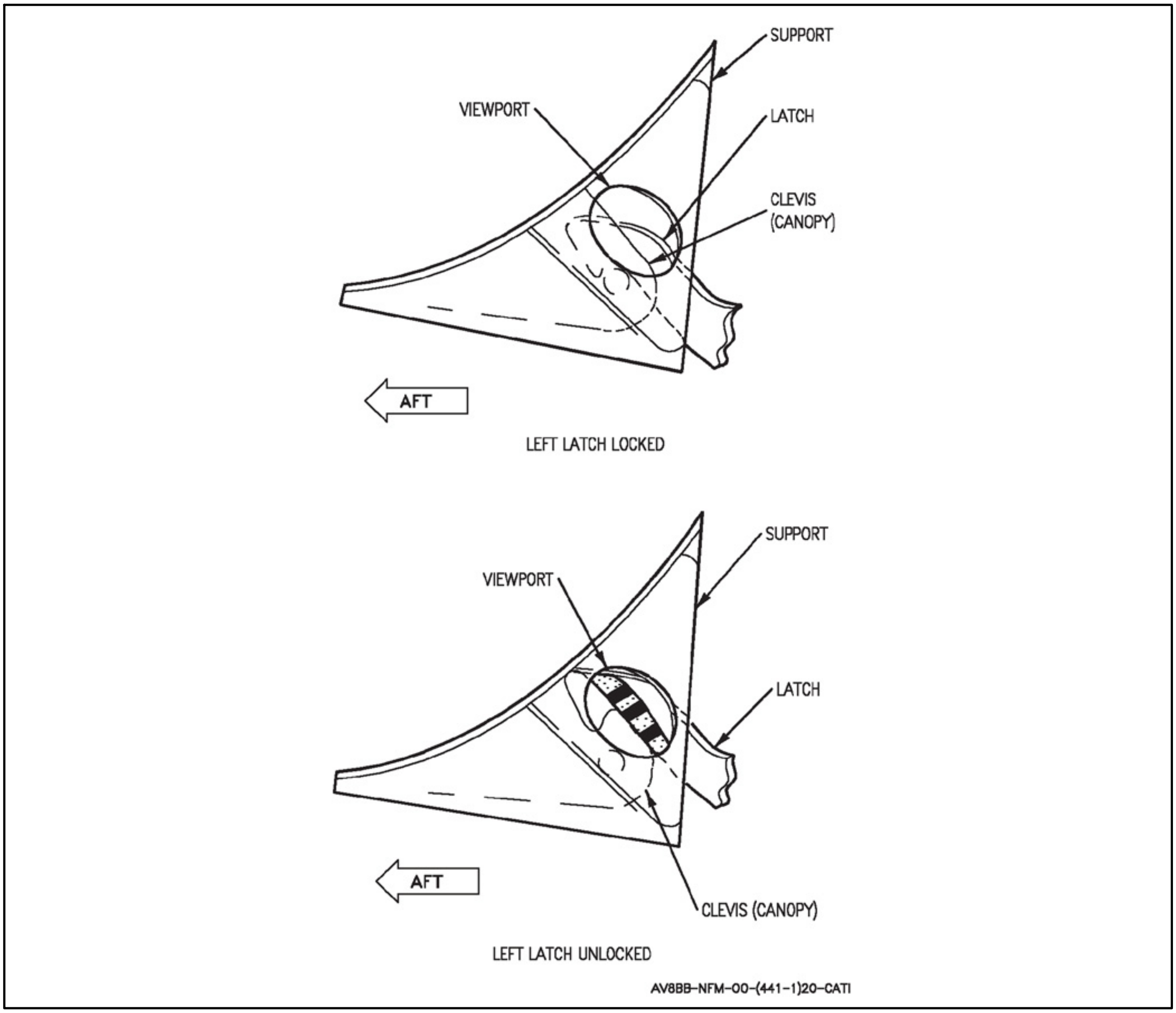


Figure 2-25. Canopy Latch Viewport

2.22.2.6 Emergency Canopy Shattering System

Emergency operation of the canopy consists of detonating a small explosive charge of mild detonating cord (MDC) which serves to break away or shatter the cast acrylic transparency. After the transparency is removed, the pilot can depart through the canopy frame during ground egress. The MDC is a small diameter explosive cord attached around the edge of the transparency near the canopy frame, and also attached in an overhead pattern on the top inside of the canopy. The explosive is fired by one of the three emergency controls. The emergency canopy control is the internal emergency canopy shattering handle inside the cockpit (Figure 2-24).

2.22.2.6.1 Internal Canopy Shattering Handle

The internal canopy shattering handle (Figure 2-24) is retained by a spring–loaded detent in a yellow and black striped housing at the left forward corner of the canopy frame. The handle, also striped yellow and black, is attached to a cable which is looped inside a cover to give approximately 5 inches of slack, before connecting to a mechanically actuated initiator. After the cable slack is taken up and the handle is pulled, the MDC fires to remove the canopy transparency. The purpose of the cable slack is to provide clearance for the pilot’s hand when the MDC fires.

2.23 CANOPY SYSTEM (TAV-8B)

Each cockpit (Figure 2-26) has a sideways opening, manually operated acrylic canopy, hinged on the right side. Each canopy has a counterbalance torsion bar and a damper strut to assist in opening and closing. The damper strut has a lock mechanism which locks the canopy when it reaches the full open position. Entry to each cockpit is normally gained from the left side of the aircraft by means of a boarding ladder. There are no boarding steps or handholds integral to the aircraft. Each canopy is locked independently by three interconnected latches which engage on the left side of the cockpit. The locks can be operated by interconnected external and internal controls. The external normal controls are the external canopy lock handles. The internal normal controls are the canopy internal lock handles. A CANOPY caution light, on the caution lights panel in both cockpits, provides indication that either or both canopies are unlocked. Each cockpit has an inflatable canopy seal which operates on air from the anti-g system. The two cockpit seals are interconnected and are inflated through an inflation control circuit when both canopies are closed and locked with the engine running. The canopy seal circuit is controlled by operation of weight-on-wheels switches. A clear polycarbonate blast shield is installed between the two cockpits. The shield serves to protect the rear seat occupant from wind blast in situations where the front canopy is removed during flight. After AFC-373, a canopy mounted shielded mild detonating cord (SMDC) actuated thruster is located on the forward canopy aft arch at the aircraft centerline. The thruster fires a pin into the support located on the aircraft structure during ejection, securing the aft canopy arch to the aircraft. This prevents the canopy arch from deflecting forward during ejection and damaging the drogue chute bridle on the main parachute container. Damage to the bridle could result in drogue failure with subsequent main chute damage and/or injury from high speed parachute deployment.

2.23.1 External Canopy Lock Handles

Each canopy can be unlocked by operation of the external canopy lock handle (Figure 2-26) on the left canopy frame. The external handle is first extended by pressing the handle lock button. Once extended, rotate the external handle clockwise till the open detent is engaged. The canopy internal lock handle rotates with the external handle. The canopy is now unlocked and can be opened as far as possible, about 87°, to engage the damper lock. Before entering the cockpit the external canopy lock handle should be stowed by pressing it flush with the mold line.

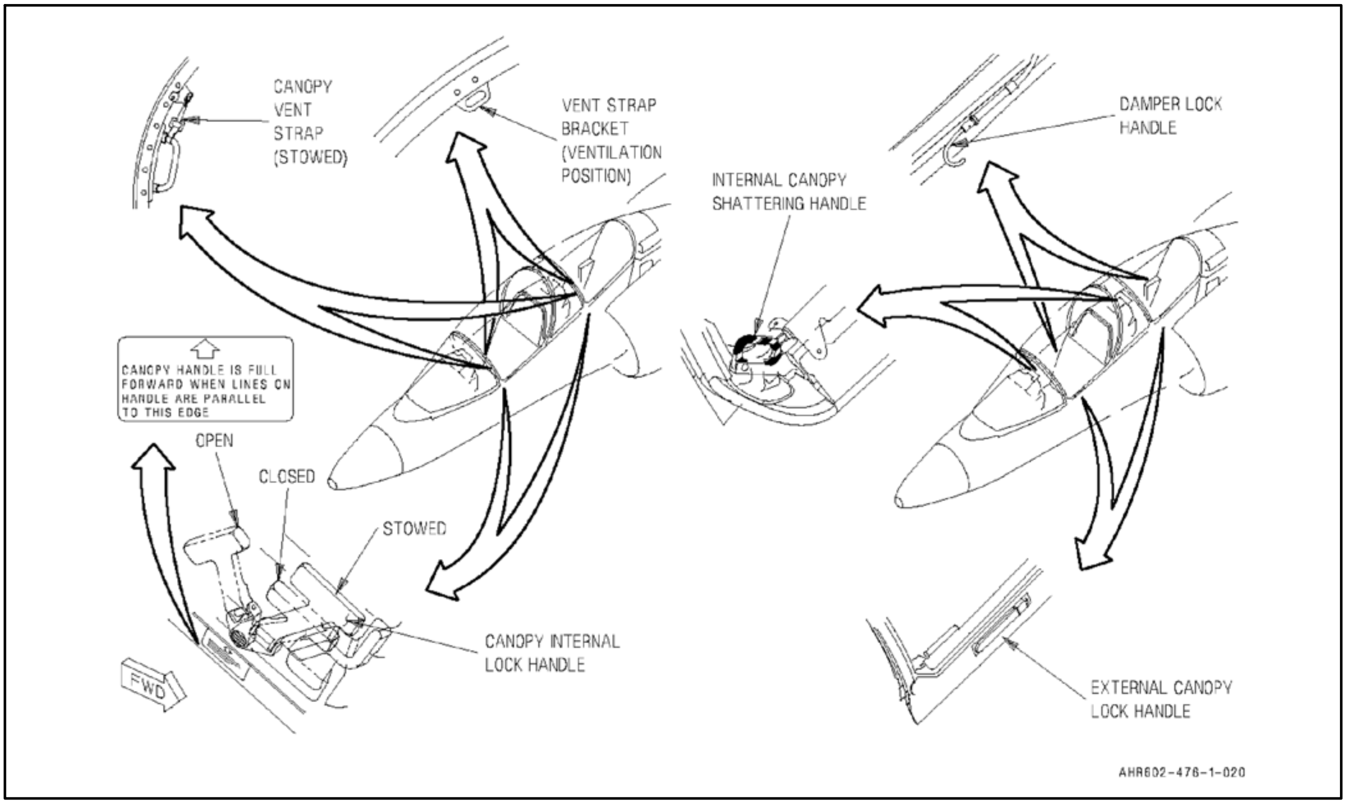


Figure 2-26. Canopy Controls (TAV-8B)

2.23.2 Damper Lock Handles

Once in the cockpit, the canopy can be unlocked from the fully opened position by pulling forward on the damper lock handle above the right canopy sill (Figure 2-26). The canopy can then be closed. If the canopy will not move, the damper lock handle is not fully disengaged. The application of excess force on the canopy with the damper lock handle engaged creates undue stress on the canopy acrylic and can lead to acrylic cracking and failure.

2.23.3 Canopy Internal Lock Handles

The canopy internal lock handle (Figure 2-26) is used to lock or unlock the canopy from inside the cockpit. Once the canopy is closed it is locked by rotating the handle forward till the closed detent is engaged. The top of the handle is hinged and spring–loaded outboard so that it can be stowed behind a guard as it reaches the forward position. This is to prevent inadvertent unlocking of the canopy. An indicator is provided with lines that are parallel to the canopy sill when the handle is full forward. To unlock the canopy, pull the handle top inboard away from the guard, and then rotate the handle back to engage the open detent. After the canopy is unlocked, normal cockpit egress is continued by fully opening the canopy to engage the damper lock and extending the external canopy lock handle by pressing the handle lock button. When opening the canopy care must be taken to slowly move the canopy to the full open position until the damper lock engages. The canopy should not be allowed to freefall to the full open position, additionally, the canopy should not be left open in windy conditions to prevent undue stress on the canopy acrylic. Disengage the damper lock by pulling forward on the damper lock handle and close the canopy. Lock the canopy by rotating the external canopy lock handle counterclockwise until the closed detent is engaged, and then stow the external handle by pressing it flush with the mold line.

2.23.4 Canopy Caution Lights

A CANOPY caution light on the caution lights panel in both cockpits comes on when either or both canopies are unlocked with power on the aircraft. The light circuits contain two micro switches which are actuated by the aft canopy latch in the forward cockpit and the center canopy latch in the rear cockpit.

2.23.4.1 Pilot Assist Handles

Two pilot assist handles are provided in each cockpit. They are on the windshield arch in the front cockpit and the forward canopy arch in the rear cockpit.

2.23.4.2 Canopy Vent Straps

On TAV–8B a canopy vent strap is provided on the assist handle in each cockpit. In utilization, the vent strap is unhooked from the stowed position bracket (Figure 2-26) next to the assist handle. The canopy is opened approximately 30° and the strap is hooked to a similar bracket on the canopy frame. The canopy is now secured in the ventilation position. As the canopy is opened, the vent strap stops the canopy opening at the ventilation position. The vent strap should be hooked back to the stowed position bracket when not in use.

2.24 EJECTION SEAT (AV–8B)

Each aircraft is equipped with an SJU–4/A ejection seat (Figure 2-27) which utilizes catapult cartridges and rocket thrust to propel it from the aircraft. The SJU–4/A provides escape capability during takeoff and landing emergencies at zero speeds, zero altitude, and throughout the remainder of the flight envelope of the aircraft, except for very unusual flight conditions. The SJU–4/A was qualified for use for aviators from 136 to 213 pounds. It incorporates a seat mounted personnel parachute and accommodates a survival package with a pararaft, and is designed for use with an integrated torso harness. An emergency oxygen supply and an emergency locator beacon are provided. A non–adjustable headrest with canopy breakers is part of the seat structure and houses the personnel parachute. The front surface of the seat bucket serves as a buffer for the calves of the legs. The sides of the bucket extend forward to protect the legs and a leg restraint system is incorporated to prevent flailing during ejection. The ejection sequence is initiated by pulling the ejection control handle to full travel with both hands. This fires the primary initiators (M99) which then ignites the catapult cartridges to eject the seat. The left primary M99 fires a thruster which removes an arming key from an airspeed sensor, and initiates the canopy MDC and IFF switch. A dual port thruster is fuzed by two SMDC assemblies which in turn arms the airspeed sensor. As the seat and outer catapult tubes travel upward the emergency oxygen and emergency locator beacon (AN/URT–33 or AN/URT–140 after ACC 689) systems are activated, the leg restraint lines are pulled to restrain the legs against the front of the seat bucket. After 31 inches of seat travel, two seat back rockets are ignited to provide the momentum necessary for man/seat combination to attain sufficient terrain clearance to permit parachute deployment. Seat stabilization, upon ejection, is controlled by the directional automatic realignment of trajectory (DART) system by the means of lanyards attached between the seat and aircraft feeding through tension brake assemblies to counteract excessive pitch and roll conditions. The ejection seat is capable of four modes of operation, depending on ejection airspeed and altitude. The modes are (1) Low Airspeed/Low Altitude, (2) High Airspeed/Low Altitude, (3) Intermediate Altitude and (4) High Altitude. See Figure 2-28. If ejection was initiated below 225 ±20 knots (180 ±20 knots with IACC 658, or below 165 ±5 knots depending on altitude after AFC–449 (Figure 2-29) and 7,000 ±750 feet, 7,000 ±100 feet after AFC–449, the airspeed sensor striker contacts the low speed selector valve, allowing gas flow to initiate low speed/low altitude mode of operation. The personnel parachute is deployed by a drogue chute and/or a wind oriented rocket deployment (WORD) rocket motor, depending on the mode of operation. Besides the ejection control handle, the following controls are incorporated on the seat: shoulder harness lock lever, the emergency restraint release handle, emergency oxygen release, ground safety control handle, and a seat positioning switch mounted above and outboard of the left console fuel panel. After AFC–449, an Electronic Airspeed/Altitude Sensor (EAAS) is used which has two Light Emitting Diodes (LEDs) to indicate the condition of the internal BATTERY (yellow) or a FAULT (red) condition. When aircraft power is initially applied to the sensor the LEDs come on for approximately 8 seconds and then go off if no failures are detected. The EAAS has two independently functioning modules which measure pitot–static pressure from the aircraft to determine either mode (1) Low Airspeed/Low Altitude or (2) High Airspeed/High Altitude operation. The FAULT LED indicates that either or both of the modules have failed the start–up self–test. If the FAULT LED is illuminated, assume the ejection seat mode of operation will be mode (1) Low Airspeed/Low Altitude.

Note

After AFC–449, any on/off cycle of the aircraft battery shall be of a sufficient duration to allow for the EAAS to finish its approximate 8 second self–test before turning the aircraft battery to the off position. Completion is indicated by the EAAS Battery and EAAS Fault LEDs turning off.

2.24.1 Front Cockpit Ejection Seat SJU–13/A

The SJU–13/A seat (Figure 2-27) is the same as the SJU–4/A except that it has two divergence rockets installed on the left side and canopy breakers installed on the top. The divergence rockets provide separation from the rear seat during dual ejection. The rockets ignite simultaneously during ejection with the two seat back rockets and they will fire during dual or single ejection. Because of the slope of the canopy transparency in the front cockpit, the canopy breakers provide break through capability if required during ejection. The SJU–13/A seat has a 0.4 second delay to provide front and rear seat separation.

2.24.2 Rear Cockpit Ejection Seat SJU–14/A

The SJU–14/A seat is the same as the SJU–4/A except that it has two divergence rockets installed on the right side. The divergence rocket motors operate the same as on the front seat except that the rocket action causes the seat's path to diverge opposite that of the front seat.

2.24.3 Survival Kit

The survival kit is a post ejection life support unit that also acts as a structural portion of the ejection seat. The primary structural member of the survival kit is the seat pan (attached to the seat bucket) which serves as a mounting base for the following post ejection life support equipment: survival package, emergency oxygen supply and emergency locator beacon. The seat pan also provides secure attaching points for the pilot's lap belts, and a contour/self–contouring cushion is fitted on top. The seat is released (separated) automatically during the ejection sequence and the survival kit is released manually after ejection. The entire survival kit is retained intact as a unit until the survival package is manually deployed.

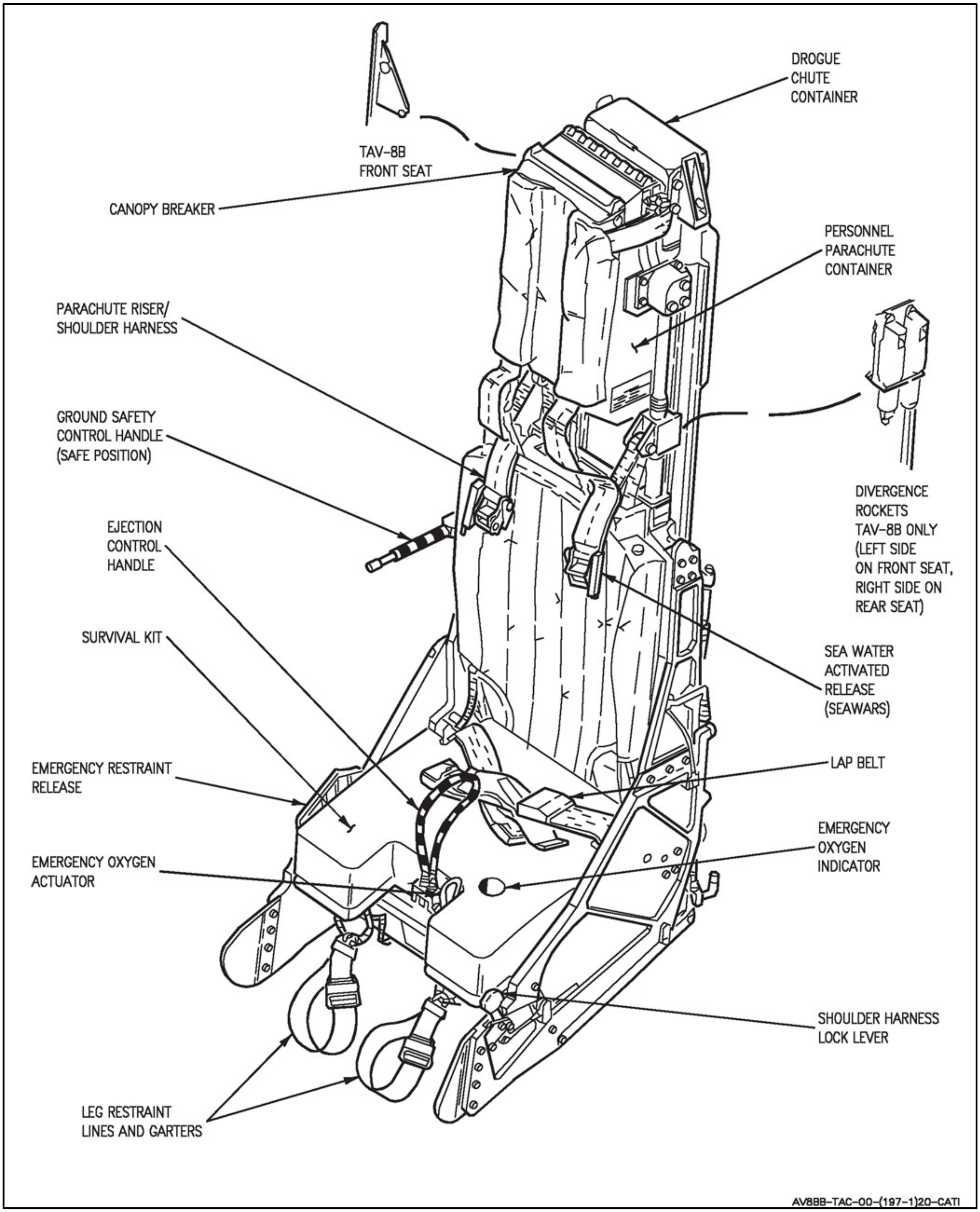


Figure 2-27. Ejection Seat

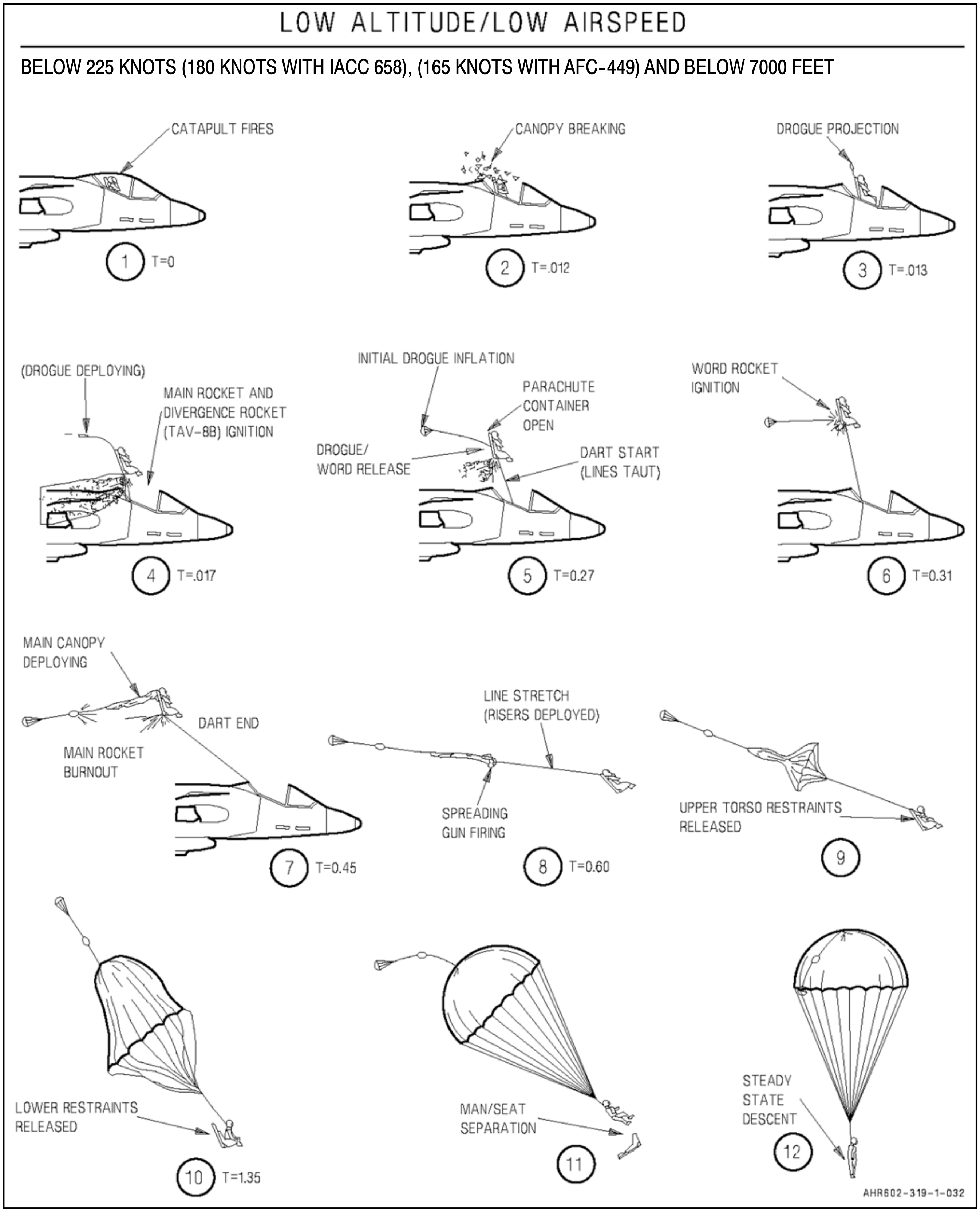


Figure 2-28. Ejection Sequences (Sheet 1 of 4)

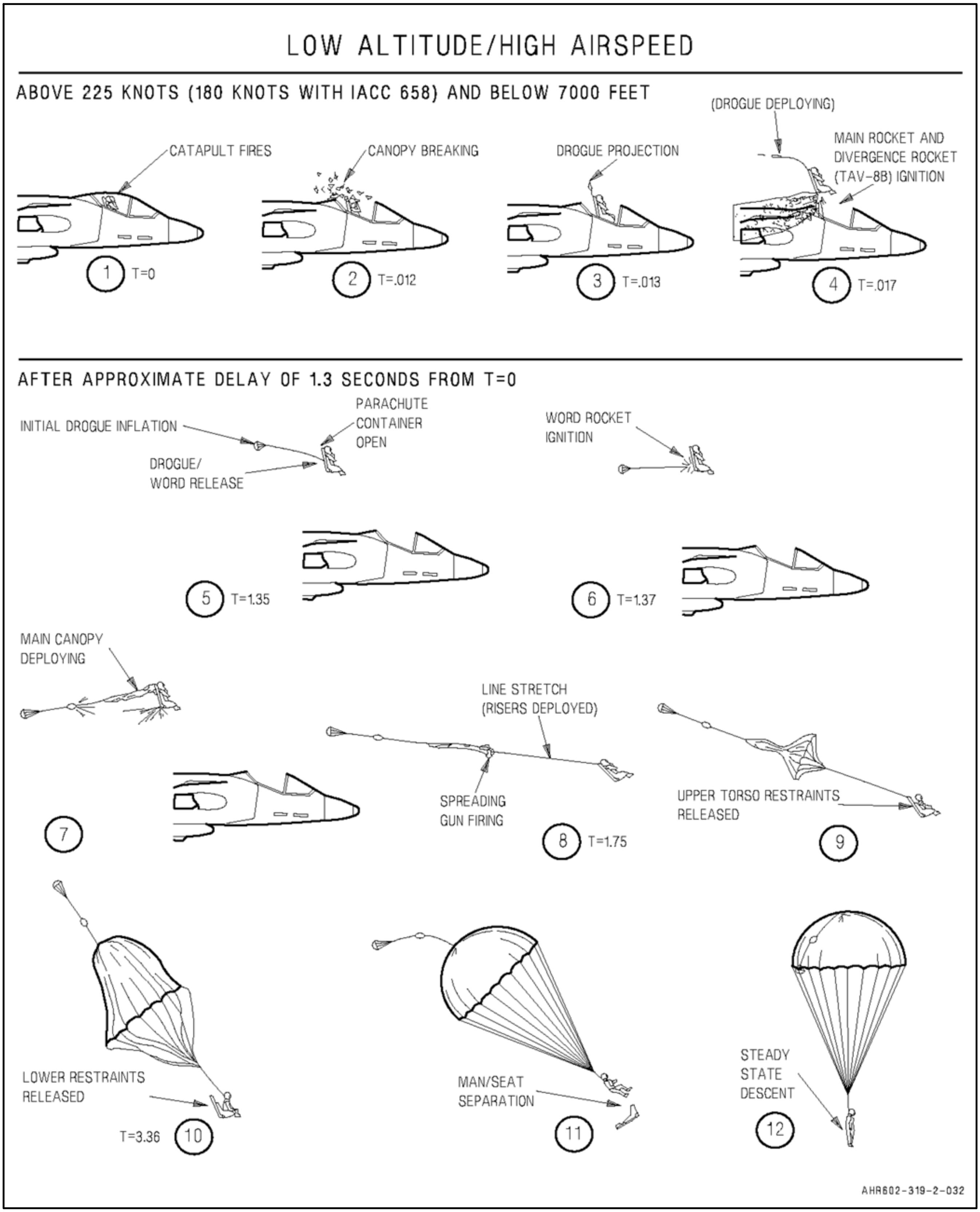


Figure 2-28. Ejection Sequences (Sheet 2)

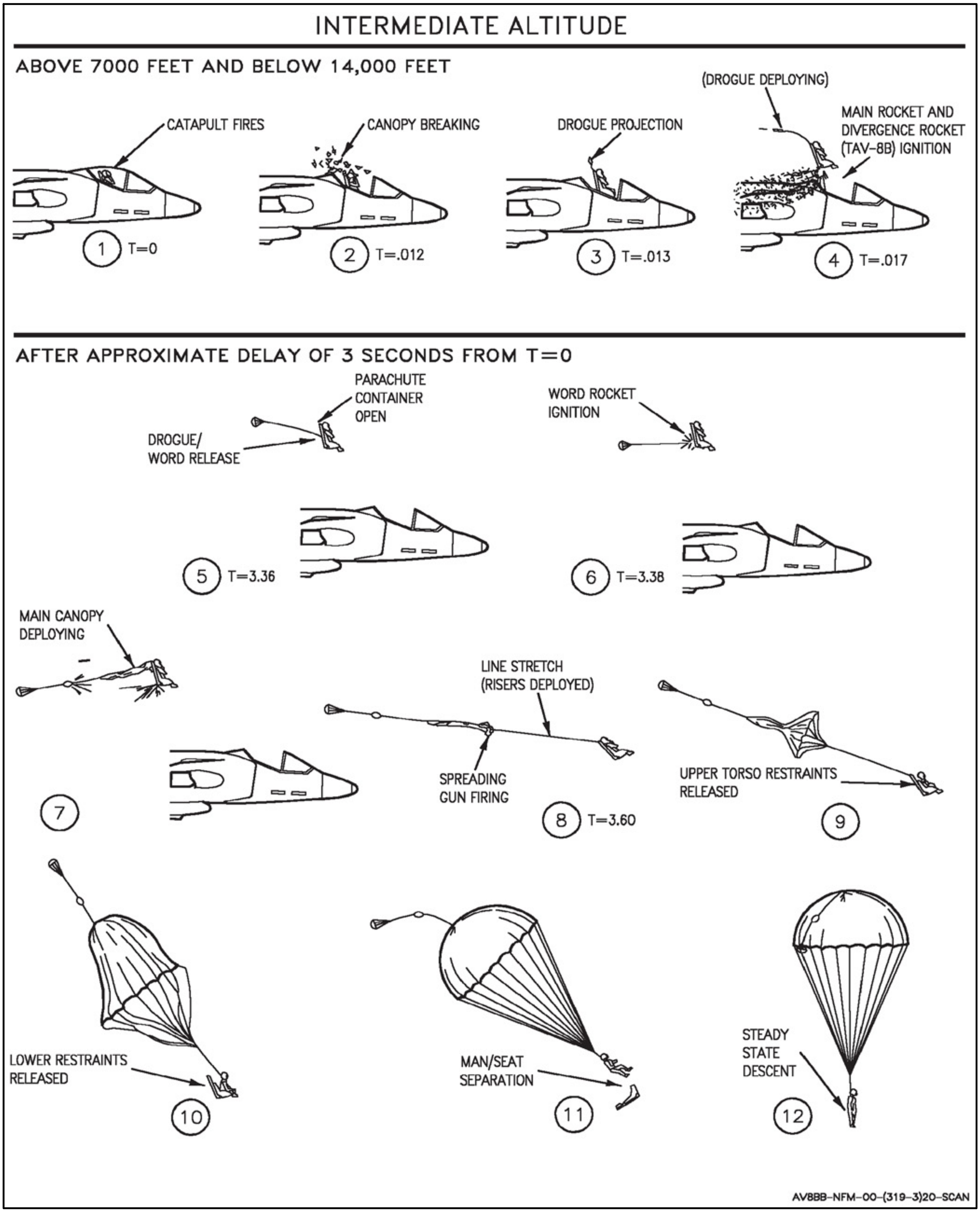


Figure 2-28. Ejection Sequences (Sheet 3)

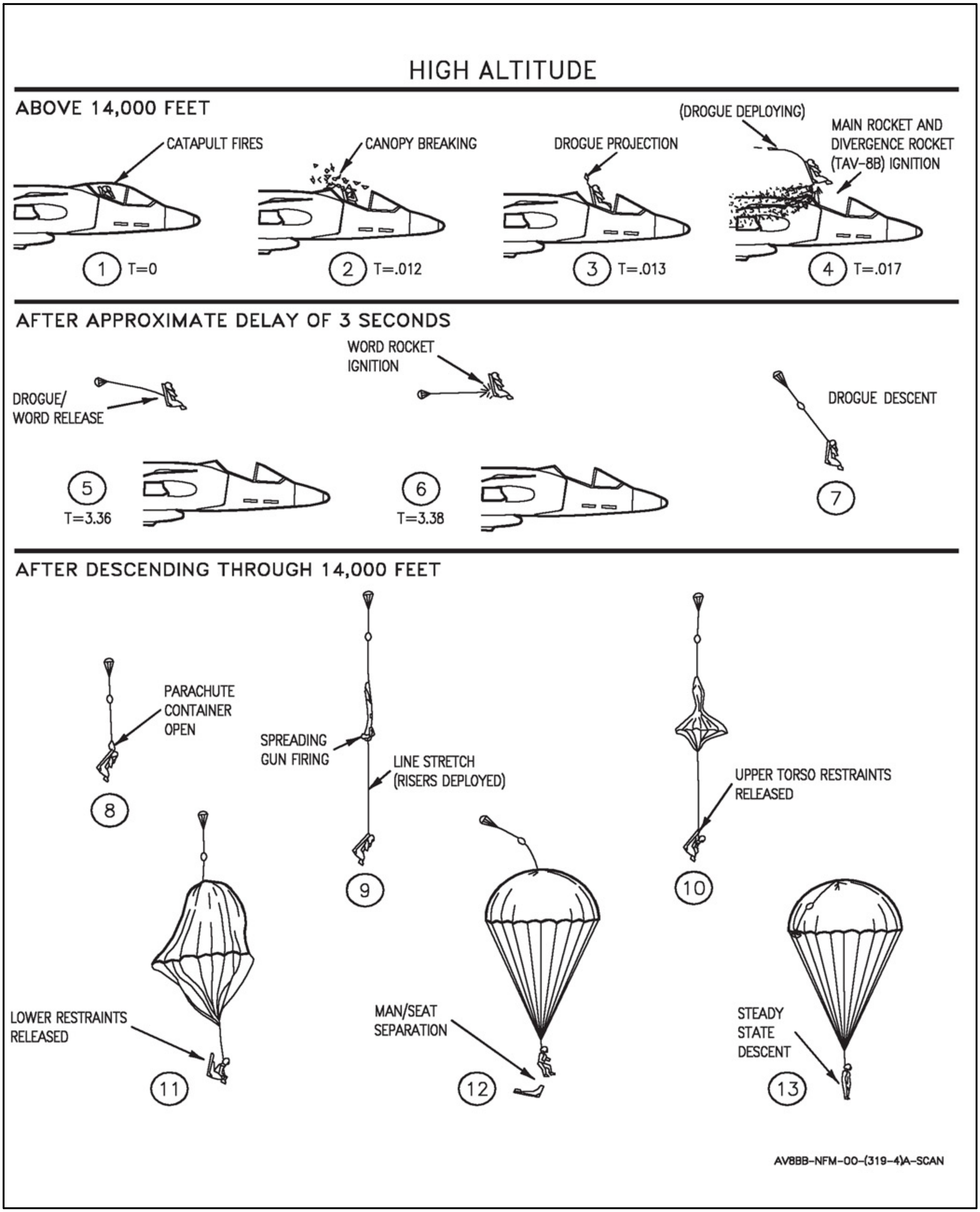


Figure 2-28. Ejection Sequences (Sheet 4)

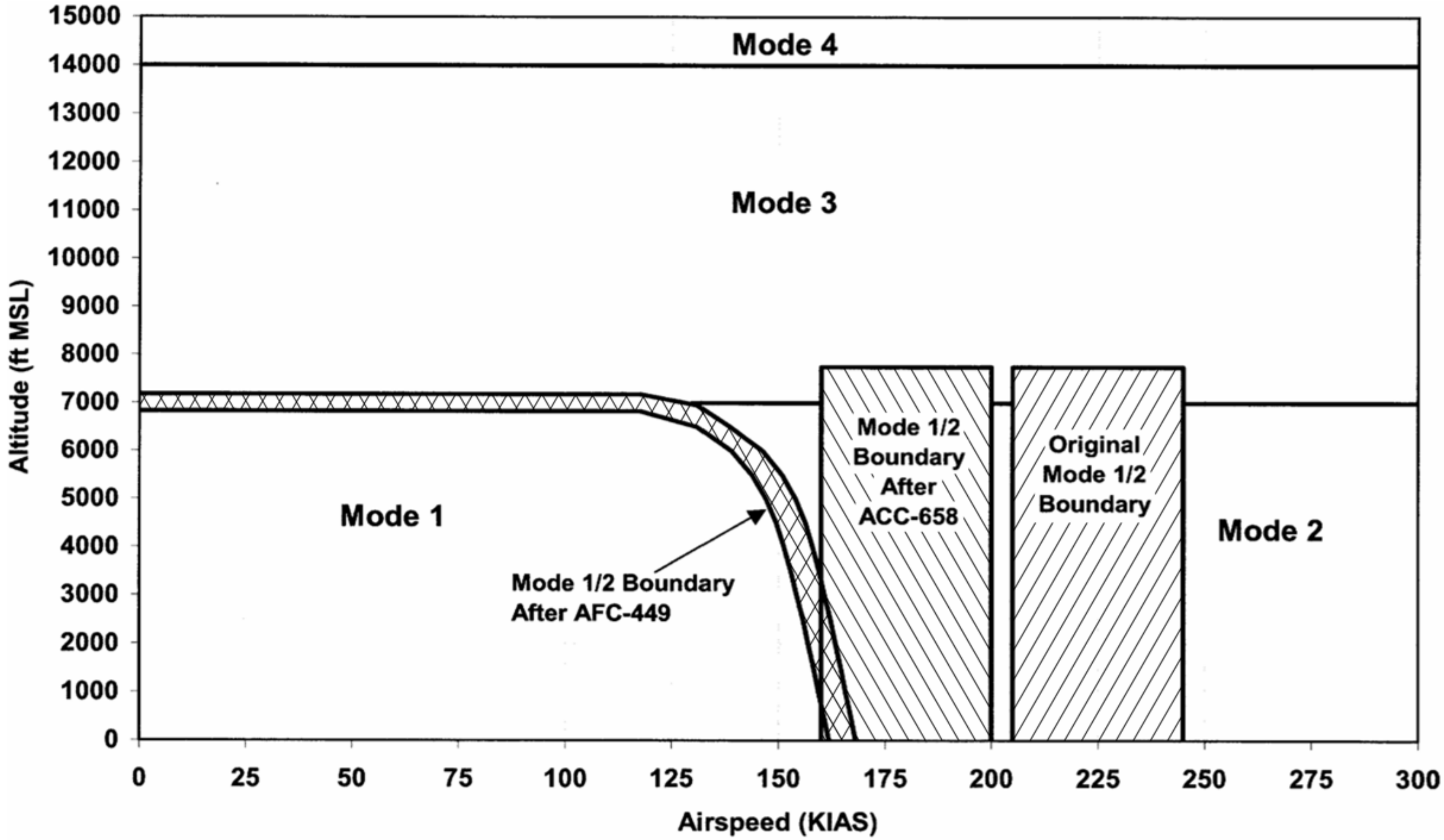


Figure 2-29. T/AV-8B Ejection Seat Modes of Operation

2.24.4 Pilot Harness and Seat Harness

The pilot's harness is a combined parachute harness and restraint garment that is put on before entering the cockpit. When seated, the pilot's upper harness is connected to the parachute risers by two Koch connectors, and the lower harness is connected to the two lap belt connectors. The parachute risers and lap belts remain in the aircraft between flights.

2.24.5 Shoulder Harness Inertia Reel and Gas Generator

A shoulder harness inertia reel and gas generator is installed on the ejection seat. The inertia reel provides the pilot with capability for locking his shoulder harness to prevent forward motion and also capability for unlocking his shoulder harness so that he is free to move forward or aft. In addition, the reel will lock automatically, although the shoulder harness lock lever is in the unlocked position, whenever high g conditions are encountered. The shoulder harness gas generator operates only during ejection to pull the shoulder straps back so the pilot is positioned for ejection. The seat also contains an inertia reel guillotine which when activated, severs the shoulder straps to free the pilot's upper torso automatically following ejection, or manually when the emergency restraint release handle is operated during manual separation or emergency ground egress.

2.24.5.1 Shoulder Harness Lock Lever

Located on the seat bucket just outboard of the pilot's lower left thigh, the shoulder harness lock lever has two positions, forward and aft. The forward is the manual locked position and prevents forward movement of the shoulder harness. The aft position is the unlocked/auto lock position, and forward movement is provided except for high g conditions. Once locked automatically while in the aft position, the harness can be unlocked by cycling the handle forward and then aft to the unlocked position.

2.24.5.2 Seat Adjust Switch

The seat adjust switch, on the left console above and outboard of the fuel panel, operates the actuator. The operating cycle is 30 seconds on and 1 minute off to permit cooling.

2.24.6 Leg Restrainers

The leg restraining system is designed to prevent leg flailing during ejections. The system consists of leg garters, leg garter straps, and ratchet/snubbing assemblies. The leg garters are adjustable and worn at the mid-calf on each leg. The garters are hooked to a key on each leg strap, and the garters can be detached from the keys and thus they can be worn to and from the aircraft. The leg garter straps are routed through the leg garter keys so that the legs will be restrained against the front of the seat when the straps are pulled taut during ejection. The garter straps are routed through the ratchet/snubbing assemblies on the front of the seat, through the garter keys, and the upper end of the garters are secured to locking devices in the ratchet/snubbing assemblies by releasable pins. The pilot can increase strap length for adequate leg motion by pulling out a springloaded release pin on the ratchet/snubber assembly and then pulling the strap forward. To decrease strap length, the pilot reaches behind the ratchet/snubber assembly and pulls the strap through. During the ejection sequence, the straps are pulled back through the ratchet/snubber assemblies, drawing the pilot's legs aft and restraining them against the seat structure. As the seat travels upward, tension is applied to the rip stitch. The lanyards are sheared at the rip stitch, severing the connection between seat and aircraft. At seat/man separation, as the pilot is extracted from his seat by his parachute, the pins in the ratchet/snubber assemblies are released to free the pilot's legs. Operation of the emergency restraint release handle also releases the pins during manual separation and emergency ground egress.

2.24.7 Ejection Control Handle

The ejection control handle, on the forward seat pan, is mechanically connected to the ejection initiation system. When the handle is pulled fully upward, the ejection sequence is initiated. After actuation, the handle remains attached to the seat and the handle must be released before or during man/seat separation. Initiators will fire before maximum handle travel of approximately 3.25 inches so that the pilot can retain his grip and prevent arm flailing when exposed to windblast.

2.24.8 Ground Safety Control Handle

The ground safety control handle on the right forward side of the seat at shoulder level provides a means for safetying or arming the seat. The armed position is down and back against the seat. The safetied position is up and forward away from the seat. Prior to moving the handle from one position to the other, a handle lock must be released. The lock is released by pulling on the spring-loaded lower end of the handle.

2.24.9 Post Ejection Sequencing System

The post ejection sequencing system includes all gas operated and cartridge actuated devices required to initiate the sequencing functions of the four post ejection modes. The system includes a parachute container opener assembly which is activated by gas pressure from either the 7,000 foot or 14,000 foot aneroid activated initiators or gas pressure from the man/seat separation initiator. When activated, the opener assembly opens the container so that the personnel parachute can be deployed. The system also includes the wind oriented rocket deployment (WORD) rocket which is mounted on the back of the seat and is connected on one end to the WORD bridle assembly (personnel parachute withdrawal line) and on the other end to the drogue bridle assembly (drogue suspension lines). The WORD rocket is attached to the back of the seat by means of the WORD motor/drogue release assembly. The WORD motor/drogue release assembly actuates to release the rocket motor (and with it the personnel parachute withdrawal line) from the back of the seat during all four modes of operation of the post ejection sequencing system. After release, the WORD rocket motor is then fired by inertia (I - WORD deployment sequence) for low speed ejections, or the WORD rocket motor is fired by the pull of the drogue suspension lines (drogue - WORD deployment sequence) for higher speed ejections. See Figure 2-28 for each of the four modes of operation of the post ejection sequencing system.

2.24.10 Parachute

The personnel parachute system includes a WORD bridle assembly (parachute withdrawal line), riser assemblies with snubbing lanyards which initiate the ballistic spreading gun and initiate man/seat separation, a spring-loaded internal pilot parachute, a main canopy, a ballistic spreading gun, and an override disconnect assembly. Parachute deployment begins, propelled via the WORD bridle, by force generated by means of drogue-WORD, I-WORD, or in the event of WORD bridle failure, by the internal pilot parachute. When the main canopy and suspension lines are fully deployed, line stretch pulls a lanyard which, in turn, exerts tension on a spring-loaded firing pin in the ballistic spreading gun assembly. The pin is withdrawn, igniting the spreading gun cartridge. Cartridge energy expels 14 pistons which, in turn, expel 14 slugs, attached to alternate suspension lines, in a 360° pattern, thus spreading the main canopy. Should the spreading gun cartridge fail to fire, continued pull on the firing lanyard will remove a piston-retaining band, freeing the pistons, slugs and suspension lines to allow conventional canopy inflation.

The parachute is a 28 foot flat canopy type parachute with alternating colored panels (white, olive green, international orange, and sand shade). The parachute is rated for suspension of 100-300 pounds with a descent rate of 13.3 to 23.1 feet per second.

2.24.10.1 Four-Line Release System

With ACC-667 PART 2, the four-line release system is a feature used to reduce canopy oscillation and provide limited forward motion and directional control of the parachute during descent. Suspension lines 1, 2, 27 and 28 are rigged so that when the four-line release lanyards are pulled sharply down, the lines are released from the left and right connector links. Release of the lines allows four gores of the canopy to billow free creating a vent at the rear of the canopy. Canopy oscillations are reduced or eliminated upon actuation of the four-line release system. The escape of air through the vent imparts a horizontal motion to the parachute assembly. The two four-line release lanyards, one attached to each rear riser, are used for directional control.

2.24.11 Sea Water Activated Release System

On TAV-8B, AV-8B 162721 and up, an automatic backup method of releasing the parachute canopy when landing in sea water after an emergency egress is installed. The sea water activated release system (SEAWARS) system consists of two releases mounted outboard of the Koch connectors on the parachute risers. Each release contains an electronics package (sensor), battery, cartridge, and canopy release fitting. Immersion in sea water activates the sensors which mechanically release the parachute risers from the pilot’s restraint harness. With SEAWARS installed, the normal procedures for connecting and releasing the Koch fitting are unchanged.

2.24.12 Man/Seat Separation System

After ejection, as aerodynamic drag is imposed on the personnel parachute, tension on a lanyard sewn to the right hand and left hand riser assemblies fires a man/seat separation initiator, producing gas pressure which is directed to an inertia reel guillotine. The guillotine severs two inertia reel shoulder straps, releasing restraint on the pilot's upper torso. Simultaneous actuation of the man/seat separation mechanical linkage by the right hand and left hand riser assemblies lanyard releases the survival kit and the pilot from the ejection seat. The pilot and survival kit are then withdrawn from the seat assembly by the aerodynamic drag on the personnel parachute.

2.25 MANUAL SEPARATION AND EMERGENCY GROUND EGRESS

2.25.1 Manual Separation

If any component should fail during any of the four automatic ejection modes, the occupant can operate the man/seat separation system manually. By operating the emergency restraint release handle, the man/seat separation initiator fires and the following sequence takes place: the inertia reel guillotine actuates to sever the inertia reel shoulder straps, the torque release rod rotates to release the survival kit and leg restraints, the WORD motor actuates and the parachute container is opened. The personnel parachute then deploys, aided by either the drogue-WORD or I-WORD sequence, depending upon airspeed at the time the emergency restraint release handle is pulled.

2.25.2 Emergency Ground Egress

During emergency ground egress when it is desired to evacuate the cockpit with the survival equipment, as part of the procedure the pilot must actuate the emergency restraint release handle in order to release the survival kit and leg restraints.

2.25.3 Emergency Restraint Release Handle

The emergency restraint release handle on the seat bucket just outboard of the pilot's right lower thigh is actuated by first squeezing the handle and then pulling up and aft. Once actuated, the handle locks up in the released position and will remain there until the handle is reset. During ground egress when the handle is pulled the following occurs: the ejection initiation system is safetied, the inertia reel shoulder straps are severed, the leg restraint straps and survival kit are released, the main parachute container is opened and the WORD motor/drogue release assembly is actuated. During manual separation after ejection, the above occurs plus the WORD rocket motor fires to deploy the main parachute.

2.25.4 Survival Package

The survival package is attached to the survival kit seat pan through a lanyard system which allows the package to fall free of the seat pan, yet remain in close proximity to the pilot. When the survival package is manually released by actuating the survival package release, it is allowed to fall approximately 12 feet, where its fall is snubbed by a lanyard which causes inflation of the life raft. The package then falls another 13 feet below the raft, giving stability to the raft during parachute descent. The survival package contains: a life raft, signal devices, medical aids and miscellaneous post ejection survival aids.

The following is a representative list of items contained in the survival package:

Cord, (Nylon), Fibrous Type I 50 feet.
Signal, (Flare), Smoke and Illumination, MK-124 MOD 0.
Sea (Dye) Marker, Fluorescent 2.
Sponge, (Bailing), Cellulose Type II, Class 2.
SRU-31/P Survival Kit, Packet (#1) (Medical).
SRU-31/P Survival Kit, Packet (#2) (General).
SRU-31A/P Optional.
Bag, Drinking Water (50 ml).
Opener, Can, Hand.
Ground/Air Emergency Code Card.

Blanket, Combat Casualty, (3 oz).
Clear Vinyl Envelope 2 00–334–4120 or Equivalent.
Beacon Set, Radio AN/URT–140.
Liferaft, Inflatable.

2.25.4.1 Survival Package Release

The survival package release is a loop on the back, right side of the survival kit. Pulling the loop releases the survival package from the seat pan.

2.25.5 Emergency Oxygen

The emergency oxygen supply is a completely self–contained unit, attached to the bottom of the seat pan, that provides 100 cubic inches of breathing oxygen. It can be operated either automatically (during ejection) or manually if a failure occurs in the aircraft main oxygen system. Automatic emergency oxygen control is provided by a lanyard assembly located on the underside of the seat panel left thigh support and is connected to the seat catapult cartridge manifold. Upon upward movement of the seat panel, as in an ejection, automatic actuation is provided. A pressure gauge, visible through the cutout on the forward left hand side of the seat cushion, should register 1,800 psi (needle in the green area) with full bottle. Duration of emergency oxygen supply is approximately 15 minutes, depending upon altitude (the higher the altitude, the longer the duration), since oxygen is delivered by the mask regulator only upon demand. Oxygen from the bottle is supplied by release of a valve in the pressure regulator at the forward left edge of the survival kit. Two keeper yokes on the valve shaft keep the valve in the closed position until emergency oxygen is required. One of these yokes is attached by a cable to the manual release (emergency oxygen actuator), which is stowed on the forward left–hand inboard edge of the survival kit. The other is attached by cable, through a quick disconnect fitting to a lanyard attached to the ejection seat catapult cartridge manifold. Either cable will dislodge a yoke and actuate the emergency oxygen supply valve to provide oxygen from the bottle and shut off the main aircraft supply. When the seat is ejected or the pilot leaves the aircraft still attached to his survival gear, the cable attached to the catapult cartridge manifold is pulled and emergency oxygen is supplied automatically. Manually pulling the emergency oxygen actuator provides emergency oxygen at any time.

2.25.5.1 Emergency Oxygen Release

Manual emergency oxygen release (emergency oxygen actuator) is provided by a handle/pull ring located on the inboard side of the left thigh support. An upward pull on the handle provides emergency oxygen to the pilot in the event of a failure in the aircraft main oxygen system or a failure of the emergency oxygen actuation system during ejection. Once activated, the emergency oxygen supply can not be turned off.

2.26 EMERGENCY LOCATOR BEACON (AN/URT–33 OR AN/URT–140 AFTER ACC–689)

An emergency locator beacon on top of the seat pan, is automatically actuated during emergency egress via the auto–actuation lanyard that is connected to the radio, emergency oxygen supply, and cockpit deck fitting.

2.26.1 Canopy/Interseat Sequencing System

A canopy/interseat sequencing system is provided to allow dual or single ejection initiated from either cockpit depending on the position of the ejection sequence selector.

2.26.1.1 Ejection Sequence Selector

Through use of the ejection sequence selector on the left side of the rear main instrument panel (foldout FO–2), six modes of ejection sequencing can be selected. The selector has three positions: DUAL, FWD and AFT/SOLO. The DUAL position is with the selector handle aligned horizontally. The FWD position is with the handle in the 45° counterclockwise position from the horizontal. The FWD position can only be maintained by use of a collar placed around the shaft of the handle. The AFT/SOLO position is with the handle aligned vertically. If the handle is released at any point other than the AFT/SOLO position, the handle will return to the DUAL position.

DUAL (horizontal)	Dual ejection results from ejection initiation in either cockpit. Rear seat ejects first, followed by front seat after a 0.4 second delay.
FWD (45° ccw)	Dual ejection results from ejection initiation in front cockpit. Rear seat ejects first, followed by front seat after 0.4 second delay. Single ejection results from ejection initiation in rear cockpit. Front cockpit can then eject solo, with a 0.4 second delay.
AFT/SOLO (vertical)	Dual ejection results from ejection initiation in rear cockpit. Rear seat ejects first, followed by front seat after a 0.4 second delay. Single ejection results from ejection initiation in front cockpit, with a 0.4 second delay. Rear cockpit can then eject solo.

2.27 ENVIRONMENTAL CONTROL SYSTEM

The environmental control system (ECS) provides conditioned air and pressurization for the cockpit and avionics equipment. The ECS also provides conditioned air to the windshield defog, anti–g and canopy seal systems. See Environmental Control System, foldout section, for environmental control system schematics.

2.27.1 ECS Air Sources

2.27.1.1 Bleed Air

The normal source of ECS air is the 6th–stage engine bleed air except for radar equipped aircraft which use 8th–stage engine bleed air. Through a series of manifolds and valves this air is cooled and mixed to reduce temperature and pressure to usable levels.

2.27.1.2 Ram Air

A secondary source of ECS air is ram air which can be used to ventilate the cockpit and provide cooling air to avionics equipment requiring forced air cooling.

2.27.2 Cockpit Air Conditioning

High temperature engine bleed air is routed through the cabin pressure regulator and shutoff valve and venturi to the primary heat exchanger where it is cooled. The cooled output of this heat exchanger is applied to the compressor turbine. The compressed air is run through the secondary heat exchanger, and then expanded in the expansion turbine section, resulting in cold air that is mixed with hot bleed air from the cabin temperature control valve. This valve is modulated by the temperature controller on the ECS panel. The conditioned air passes through a water separator and vent/defog changeover valve to the cockpit ECS louvers and windshield defog ducts.

Ram air across the heat exchanger is used for initially cooling the bleed air. The ram air discharge from the heat exchangers is routed to the engine inlet or vented to the ECS bay on nonradar aircraft or vented overboard on radar aircraft depending on the flight conditions encountered. At high air speeds the ram air is vented to the ECS bay or vented overboard as applicable. At lower airspeeds and during ground operation airflow across the heat exchangers is augmented by the engine turbine fans which pull ambient air across the heat exchangers into the engine inlet.

2.27.2.1 Temperature Management

The pilot can control cockpit temperature by selecting either a manual (MAN) mode or automatic (AUTO) mode with the temperature controller on the ECS panel.

In the MAN mode, holding the cabin temperature control knob to the COOL or WARM settings applies a control signal directly to the cabin temperature control valve to open or close the valve as desired. The signal is applied to the valve as long as the knob is held in the COOL or WARM setting. In this mode, the cabin temperature control knob is spring loaded to the center position and returns to the center position when released.

In the AUTO mode the temperature is electronically regulated by the cabin temperature control. The control continuously monitors onboard temperature sensors and compares the sensed temperature to the selected temperature. If an imbalance exists, too hot or too cold, a signal is applied to position the cabin temperature control valve to maintain the selected temperature. In this mode the cabin temperature control knob, when released, remains in the position selected.

2.27.2.2 Temperature Controller

The temperature controller is on the ECS panel.

AUTO	With knob in automatic section, counterclockwise rotation decreases cockpit and windshield defog air temperature. Clockwise rotation increases temperature. In AUTO mode, temperature is electronically regulated. This is the normal mode of operation. In AUTO mode, knob will remain in position selected when released.
MAN	In MAN mode, knob is springloaded to the center position. With knob in manual section, counterclockwise rotation increases cockpit air and windshield defog temperature. Clockwise rotation decreases temperature. In MAN mode temperature is controlled through direct operation of the cabin temperature control valve.

Note

Should chunks of ice and/or snow be detected discharging from the cockpit ECS louvers, a higher cockpit air temperature should be selected to restore the system to normal operation. The ice/snow condition is caused by too cold a selection of the temperature controller resulting in a freeze-up condition of the water separator coalescer and operation of the internal coalescer bypass relief.

2.27.3 Defog System

The defog system uses the same air for defogging as passes to the cockpit ECS louvers. When defog is selected, a larger portion of airflow is diverted from the pilot to the windshield defog ducts. Temperature of the defog air is automatically increased when MAX DEFOG is selected and the temperature controller is in the AUTO mode. Temperature of the defog air may be increased or decreased by the pilot by changing the temperature controller position in either the AUTO or MAN mode.

2.27.3.1 Defog Switch

The defog switch, labeled CABIN, is on the ECS panel.

NORM	The vent/defog changeover valve is energized to provide the majority of conditioned airflow to the pilot.
DEFOG	Increased airflow is directed to windshield. Vent/defog changeover valve deenergized.
MAX DEFOG	Increased airflow is directed to windshield at an increased temperature. MAX DEFOG position inoperative with temperature in MAN mode.

Note

For extreme windshield fog conditions, place defog switch to MAX DEFOG and increase the temperature in the AUTO range on the temperature controller.

2.27.3.2 Defog Shutoff Valve

A defog shutoff valve provides for increased pilot cooling during periods of low system pressure (e.g. engine at idle) by directing all system airflow to the ECS louvers. A pressure switch monitors the primary heat exchanger outlet pressure and provides a signal to close the defog shutoff valve when pressure is less than 20 psi.

2.27.3.3 Windshield Overheat Caution Light

When the windshield temperature limit of the defog air is exceeded, the WSHLD overheat caution light comes on. The WSHLD caution light is on the caution/advisory light panel and operates in conjunction with the master caution light. When the WSHLD overheat caution light comes on power is automatically supplied to the cabin temperature control valve to drive it to the closed (low temperature) position.

2.27.4 Cockpit Pressurization

Cockpit pressure scheduling is maintained by the cabin pressure regulator/discharge valve on the forward cabin bulkhead. From sea level to 8,000 feet altitude the cockpit is unpressurized. Between altitudes of 8,000 feet to 23,000 feet the system maintains a constant cockpit pressure altitude of 8,000 feet. At altitudes above 23,000 feet, the cockpit pressure regulator maintains a constant 5 psi pressure differential greater then ambient pressure. The cockpit pressure can be dumped by setting the cockpit pressure switch, on the ECS panel, to DUMP. On the TAV–8B the air communication duct connects the two cockpits for pressure equalization and air circulation.

2.27.4.1 Safety Relief Valve

If the cockpit pressure regulator/discharge valve malfunctions the cockpit safety relief valve will open to vent excess cabin pressure. The valve also provides negative pressure relief. This occurs during rapid aircraft descent. Normal operation of the system cannot always react to change cabin pressure as fast as the aircraft can descend. When this occurs, the safety relief valve will open and allow ambient pressure to enter the cabin to equalize pressure.

2.27.4.2 Cockpit Altimeter

A cockpit altimeter is mounted to the right of the caution light panel on the main instrument panel (see cockpit, foldout section) and indicates cockpit pressure altitude from 0 to 50,000 feet.

2.27.4.3 Cockpit Pressure Switch

The cockpit pressure switch, labeled PRESS, is on the ECS panel on the right console.

NORM	Pressure regulator and shutoff valve open, with normal conditioned air and pressure provided to system.
DUMP	Cabin safety/dump valve control valve energized to dump cockpit pressure. Pressure regulator and shutoff valve still open, supplying normal conditioned air to the crew station.
RAM	Cabin pressure is dumped as in the DUMP position, and pressure regulator and shutoff valve energized to shut down engine bleed air to system. Nose ground cooling/ram air valve opens to supply ram air to entire system. Switch position also energizes the ground cooling fan to facilitate flow of ram air to forward avionics equipment.

2.27.5 Radar Waveguide Pressurization

On radar aircraft the forward ECS system provides positive pressure to the radar waveguide to prevent arcing at high altitude. The cooled output of the secondary heat exchanger is split and a portion is provided for waveguide pressurization. The ECS system provides pressure regulated, clean, dry air to the waveguide.

2.27.6 Anti-g System

With the cockpit air conditioning and pressurization system operating, the anti-g suit remains deflated up to approximately 1.5g's. Above this acceleration, the air pressure applied to the suit increases in proportion to increasing g's. While acceleration is constant, the suit remains inflated at a constant pressure and, as acceleration decreases, the suit will deflate in proportion to the decrease in g's. A manual inflation button in the anti-g suit valve on the aft left console allows the pilot to manually inflate the suit for purposes of checking the system or for fatigue relief. The anti-g system is inoperative with the cockpit pressure switch in the RAM position.

2.27.7 Canopy Seal

The canopy seal inflates automatically on takeoff when the canopy seal control valve deenergizes open with weight-off-wheels. The valve energizes closed and vents canopy seal pressure with weight-on-wheels. With the cockpit pressure switch in the RAM position, the canopy seal is inoperative.

2.27.8 Cockpit Equipment Cooling

Cockpit conditioned air is also used to cool cockpit installed avionics equipment. A cooling fan, which operates continuously, pulls cockpit air through the following cockpit installed equipment: ODU, HUD, DDI(s), and on non-radar aircraft the DC.

2.27.8.1 Crew Station Cool Caution Light

Failure of the cockpit equipment cooling fan causes the CS COOL caution light to come on. The light is on the caution/advisory lights panel and operates in conjunction with the master caution light. To protect the avionics equipment should the CS COOL light come on, the cockpit temperature should be adjusted to a setting as cold as practical and any unneeded avionics equipment should be turned off.

2.27.9 Forward Equipment Cooling

2.27.9.1 Normal Operation

On non-radar aircraft part of the cold expansion turbine discharge air is combined with cockpit conditioned air and routed to a plenum for normal INS cooling. Discharge air from the cabin pressure regulator valve is ducted into the nose cone to cool the angle rate bombing system (ARBS) which contains internal cooling fans.

On radar aircraft the bleed air output from the primary heat exchanger is mixed with the cold air output of the expansion turbine by way of the avionics cooling valve. This modulating valve is driven by the airflow temperature/sensor controller and is positioned to maintain a 40 °F supply temperature to the forward avionics systems (radar, INS, FLIR). The radar system is also cooled by a liquid cooling system. See paragraph 2.27.11.

2.27.9.2 Emergency/Ground Operation

On non-radar aircraft, when the aircraft is on the ground, a ground cooling fan operates through the weight-on-wheels switches to provide cooling air to forward equipment. The ground cooling fan operates in flight when the RAM position of the cockpit pressure switch is selected. When RAM is selected, ram air is supplied to the entire system, except for the canopy seal and anti-g system.

On radar aircraft the ground cooling fan also operates through the weight-on-wheels switch to provide cooling air to the INS, FLIR, and radar. In flight, when the temperature sensor/controller detects an out of tolerance condition (FWD BAY caution) or the RAM position of the ECS pressure switch is selected, the ground cooling fan operates to provide cooling air to the forward equipment, and the emergency ram air valve is opened to provide ram air to the INS cooling plenum and to the cockpit. The canopy seal, anti-g system, and radar waveguide pressurization system are not affected.

2.27.9.3 Forward Equipment Bay ECS Switch

On radar aircraft the forward equipment bay ECS switch, labeled FWD EQUIP, is on the ECS panel.

NORM – Switch is spring loaded to this position. System operation is normal.
RESET – Restarts system after temporary malfunction and shutdown.

2.27.9.4 Forward Equipment Bay Caution Light

On radar aircraft the FWD BAY caution light comes on whenever the airflow temperature sensor/controller senses inadequate cooling, temperature out of tolerance and/or low or no system airflow. The light is on the caution advisory light panel and operates in conjunction with the master caution light.

2.27.10 Aft Fuselage Equipment Cooling

2.27.10.1 Normal Operation

High temperature and pressure engine bleed air is routed through the aft equipment pressure regulator and shutoff valve. This valve functions automatically but can be controlled manually by the EQUIP switch (non-radar aircraft) or the AFT EQUIP switch (Radar aircraft) located on the ECS panel. With the valve open, the bleed air passes through a heat exchanger cooled by ram air from the intake at the base of the vertical stabilizer. From the heat exchanger, the air is expanded in a turbine which drives a fan in the ram air exhaust. The fan induces ram air flow through the heat exchanger, particularly during ground operation. The discharged cool air from the turbine is warmed to the proper temperature by mixing it with hot bypass bleed air which is regulated by a thermostatically controlled temperature control valve. The mixed air is then routed to the aft equipment cooling plenum for distribution to avionics equipment.

2.27.10.2 Emergency/Ground Operation (Radar Aircraft)

On the ground with engine not running, or in flight and aft equipment cooling system pressure is lost or system shut down, the avionics auxiliary cooling fan will operate to supply ambient air to the aft equipment cooling plenum. The cooling fan turns on automatically (assuming electrical power is available) whenever any of the following occurs: main system turned off, turbine inlet pressure too high, bleed air overpressure, incorrect two way valve position, equipment delivery air temperature outside limits of control system, incorrect auxiliary cooling valve position. Any of the above actions result in the avionics auxiliary cooling valve opening to allow ambient air from the ram air duct to go to the aft equipment cooling plenum via the cooling fan.

2.27.10.3 Aft Equipment Bay ECS Switch

The aft equipment bay ECS switch, labeled EQUIP on non-radar aircraft or AFT EQUIP on Radar aircraft, is on the ECS panel.

OFF – The equipment pressure regulator and shutoff valve is energized close to shutdown the system.
ON – A neutral switch position. This is normal position for switch.
RESET – Restarts system after temporary malfunction and shutdown.

2.27.10.4 Aft Equipment Bay Caution Light

The AFT BAY caution light comes on whenever the cooling fan is operating (except on the ground) and/or in the emergency/ground cooling mode. The light is on the caution/advisory light panel and operates in conjunction with the master caution light.

2.27.11 Liquid Cooling System

The aft ECS system is an integral part of the radar liquid cooling system. The liquid/air heat exchanger extracts heat from the liquid coolant flowing in the closed loop system. A thermostatic temperature control valve set in parallel with the heat exchanger core, senses coolant temperature and mixes bypass and core fluid flows to maintain delivery temperatures to the transmitter at 80 ±10 °F. During normal operation ram air is routed through the transmitter auxiliary cooling valve through the heat exchange, windmills the transmitter auxiliary cooling fan and is then vented overboard. During ground operation and/or during periods of low ram air pressure, the transmitter auxiliary cooling fan is used to draw air through the system.

During abnormal operation, ram air temperature too hot or too cold, conditioned bleed air is applied across the heat exchanger. This occurs when the ram air temperature switch senses an out of tolerance condition. The conditioned bleed air is routed through the bypass two-way valve, the heat exchanger, and the transmitter two-way valve to the aft equipment cooling plenum.

2.28 EMERGENCY EQUIPMENT

2.28.1 Jettison Systems

The jettison systems consist of the emergency jettison system and the selective jettison system.

2.28.1.1 Emergency Jettison Button

The emergency jettison system utilizes the emergency jettison button to jettison all stores and suspension equipment from BRU-36 bomb racks (bomb rack) on stations 1 through 7. AIM-9 missiles are not jettisoned as normal loading practice does not install the impulse cartridges in the bomb rack.

The landing gear handle must be up, or the weight must be off the aircraft landing gear, or the armament safety override switch (inaccessible from cockpit) must be in the override position, to enable the emergency jettison button. When the landing gear handle is in the UP position, the armament safety override switch will be disengaged if previously engaged. The emergency jettison button, labeled EMER JETT, is on the landing gear control panel and is painted with alternating black and yellow stripes. Emergency jettison is performed by pressing the button with the proper ground interlocks satisfied. All weapons are jettisoned in a safe condition, however, there is no guarantee fuzes will not arm during release or detonate on impact. Jettison occurs at 50 millisecond intervals starting with stations 1, 4 and 7, then stations 2 and 6, and then stations 3 and 5. Stores are not jettisonable from the outrigger pylons.

On the TAV-8B, an emergency jettison button is provided in the rear cockpit outboard of the landing gear/flaps control panel. The rear cockpit button parallels operation of the front cockpit button.

2.28.1.2 Selective Jettison

Selective jettison is performed by the selective jettison select knob in conjunction with the selective jettison (JETT) pushbutton, and in some cases, in conjunction with the station select buttons. Selective jettison can only be performed with the landing gear handle up and the weight off the aircraft landing gear, or with the armament safety override switch in the override position. All weapons are jettisoned in a safe condition, however, there is no guarantee fuzes will not arm during release or detonate on impact. AIM-9 missiles are not jettisonable as normal loading practice does not install the impulse cartridges in the bomb rack.

On TAV-8B, no selective jettison capability exists from the rear cockpit.

2.28.1.2.1 Selective Jettison Select Knob

The selective jettison select knob on the armament control panel to the left of the station select buttons has rotary positions STA, STOR, SAFE, CMBT and FUEL, and a center push-to jettison (JETT) pushbutton. The STA and STOR positions are used in conjunction with the station select buttons. With STA selected, all stores and suspension equipment hung on BRU-36 bomb racks on selected stations are jettisoned. With STOR selected, jettison is the same as in the STA position, except that all stores mounted on improved triple ejector racks (ITER) are released while retaining the ITERs. The CMBT position jettisons all stores, including suspension equipment, suspended from bomb racks, except that all AIM-9s and suspension equipment are retained. Jettison occurs at 50 millisecond intervals starting with stations 1, 4 and 7, then stations 2 and 6, and then stations 3 and 5, skipping any AIM-9 station. The FUEL position jettisons fuel tanks from four stations in pairs, first from stations 2 and 6, then, 50 milliseconds later, stations 3 and 5. The center JETT pushbutton, when pushed, activates the jettison circuits after the stations and jettison modes are selected. CMBT/FUEL can be selected before takeoff. If STA/STOR is selected, weapon programming will be inhibited. The SAFE position prevents any selective jettison.

2.28.1.2.2 Station Select Buttons

The station select buttons are on the armament control panel on the lower left corner of the main instrument panel. The buttons are numbered 1 through 7 corresponding to the aircraft external stores stations. Pressing a button, or combination of buttons, selects stations for jettison with the STA and STOR positions of the selective jettison knob.

The word SEL is displayed in the station window when the station is selected. Nonselected stations display a dash in their windows.

2.29 MANEUVERING TONE

An aural maneuvering tone based on AOA and Mach is installed to advise the pilot of the existing aircraft flight characteristics. A 1,600 Hz–10 pps tone (area B, Figure 2-30) is provided when above 0.45 Mach and 225 knots on AV–8B aircraft and above 0.11 Mach on TAV–8B aircraft. No tone (area A on the chart) denotes a region where full high speed stop roll inputs will result in positive aircraft response with no concern for departure. The onset of the 1,600 Hz–10 pps tone marks the maximum turn capability of the aircraft and requires near full back stick. Above the onset of the 1,600 Hz–10 pps tone (area B on the chart), the roll response is sluggish. Large lateral inputs will result in a correct initial response followed shortly by a roll reversal. If the roll reversal stall warning cue is ignored and the roll input maintained, a mild rolling departure will occur. Area B is sometimes characterized by a building wing rock which will end with a departure. This departure can be avoided and the wing rock stopped by releasing back stick until the tone stops.

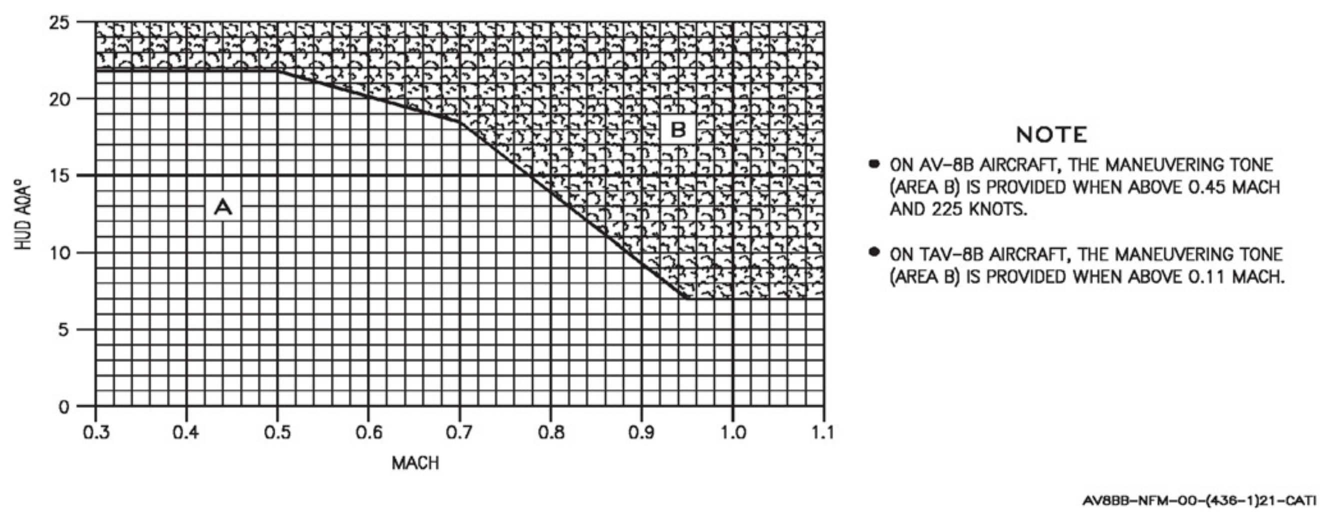


Figure 2-30. Maneuvering Tone (with DEP RES)

2.30 WARNING/CAUTION/ADVISORY LIGHTS AND TONES (TAV–8B AND AV–8B DAY ATTACK AIRCRAFT)

The warning/caution/advisory lights and displays system provides visual indications of normal aircraft operation and system malfunctions affecting safe operation of the aircraft. The lights are on various system instruments and control panels in the cockpit (Figure 2-31).

The red warning lights indicate a hazardous condition requiring immediate action. There are two categories of caution lights, both of which are yellow. The six priority caution lights are located to the left of the upfront control panel and below the master caution light. They are L FUEL low, R FUEL low, 15 SEC, MFS, BINGO fuel and H_2O. The other caution lights are on the caution/advisory light panel in addition to the landing gear in–transit lights and the combat thrust selection light on the water switch panel. All caution lights indicate the existence of an impending dangerous condition requiring attention but not necessarily immediate action. Illumination of a priority caution light may require immediate corrective action in certain flight conditions. The green advisory lights indicate safe or normal configuration, condition of performance, operation of essential equipment, or information for routine purposes. The advisory lights are on the caution/advisory light panel and on various other panels throughout the cockpit.

Illumination of most warning lights is accompanied by a warning tone in the headset. The exceptions are the GEAR and landing gear handle lights. Steady illumination of these indicators will not initiate a warning tone. The (hooter) tone for most warning lights, except LAW, is a 700 to 1,700 Hz sweep for 0.85 second, with an interruption interval of 0.12 second. The LAW warning tone is a 1,000 Hz tone with an on and off rate of 2 pulses per second for a duration of 3 seconds and has a priority over the hooter warning tone for the 3 seconds. The hooter warning tone will be shut off if the cause for the warning light coming on goes away, or by pressing the MASTER CAUTION light. In addition, the red threat lights on the warning/threat lights panel have special tones associated with their illumination. The characteristics of these tones are covered elsewhere. Except the CW NOGO and P NOGO, all caution lights on the caution/advisory light panel flash when they first come on at a flash rate of three to five flashes per second. Pressing the MASTER CAUTION light causes these caution lights to go to steady illumination, but they will remain on as long as the cause for the light coming on exists. Except the L FUEL, R FUEL and 15 SEC lights, the priority caution lights come on with a steady illumination and remain on until the cause for the light coming on goes away. All caution lights that activate the MASTER CAUTION and all priority caution lights are accompanied by a tone (tweedle dee) which consists of a 0.3 second, 1,900 Hz signal followed by a 0.15 second, 2,600 Hz signal. The steady (750 pound) L FUEL and R FUEL lights do not activate the tweedle dee tone. The signals are repeated twice for a total time of 0.9 second. No warning/caution/advisory lights are operational until one of the following occurs: GTS started, engine started, or compass/lights test switch activated (ground alert). A thermostat will cause the lights to flash if they overheat on the ground. The thermostat is inoperative in flight and there is no indication if the lights overheat. Dimming of the warning/caution/advisory lights is covered under Lighting, this chapter.

On TAV-8B 163856 and up, AV-8B 163519 and up, the warning tones (hooter) and caution tones (tweedle dee) for many of the warning and caution lights are replaced by voice warnings. Refer to Voice Warning in this chapter for list of lights that have associated voice warnings instead of tones.

2.30.1 Master Caution Light

A yellow MASTER CAUTION light, on the main instrument panel to the left of the upfront control panel, comes on flashing and is accompanied by the tweedle dee tone when any of the caution lights on the caution/advisory light panel come on, except for the following: CW NOGO and P NOGO. The MASTER CAUTION light goes off when it is pressed (reset), will cause all flashing caution lights on the caution/advisory light panel to go from flashing to steady and will silence the caution/warning tones. For voice warnings, pressing the MASTER CAUTION light will silence only one warning at a time. The stall warning/maneuvering tones are not silenced.

2.31 WARNING/CAUTION/ADVISORY LIGHTS AND TONES (AV-8B RADAR AND NIGHT ATTACK AIRCRAFT)

The warning/caution/advisory lights (Figure 2-31) and displays system provides visual indications of normal aircraft operation and system malfunctions affecting safe operation of the aircraft. The lights are on various system instruments and control panels in the cockpit. Eleven green warning lights located to the right of the upfront control panel and below the red MASTER WARNING light indicate a hazardous condition requiring immediate action. Six green priority caution lights are located to the left of the upfront control panel and below the yellow MASTER CAUTION light. They are L FUEL low, R FUEL low, 15 SEC, MFS, BINGO fuel, and H_2O. The other green caution lights are on the caution/advisory light panel in addition to the yellow landing gear in-transit lights and the green combat thrust selection light on the water switch panel.

All caution lights indicate the existence of an impending dangerous condition requiring attention but not necessarily immediate action. Illumination of a priority caution light may require immediate corrective action in certain flight conditions. The green advisory lights indicate safe or normal configuration, condition of performance, operation of essential equipment, or information for routine purposes. The advisory lights are on the caution/advisory light panel and on various other panels throughout the cockpit.

Priority caution lights and the MASTER CAUTION light come on flashing when the cause for the light exists (except for the 750# L/R FUEL lights and the 15 SEC caution light). The 750# L/R FUEL lights come on steady without illumination of the MASTER CAUTION light. Pressing the MASTER CAUTION light or the MASTER WARNING light will reset the priority caution lights and MASTER CAUTION light (except 15 SEC caution light). When the lights are reset the priority caution lights remain on steady as long as the condition continues to exist and the MASTER CAUTION light goes off. The 15 SEC caution light comes on flashing after 15 seconds if condition still exists (the MASTER CAUTION light remains off).

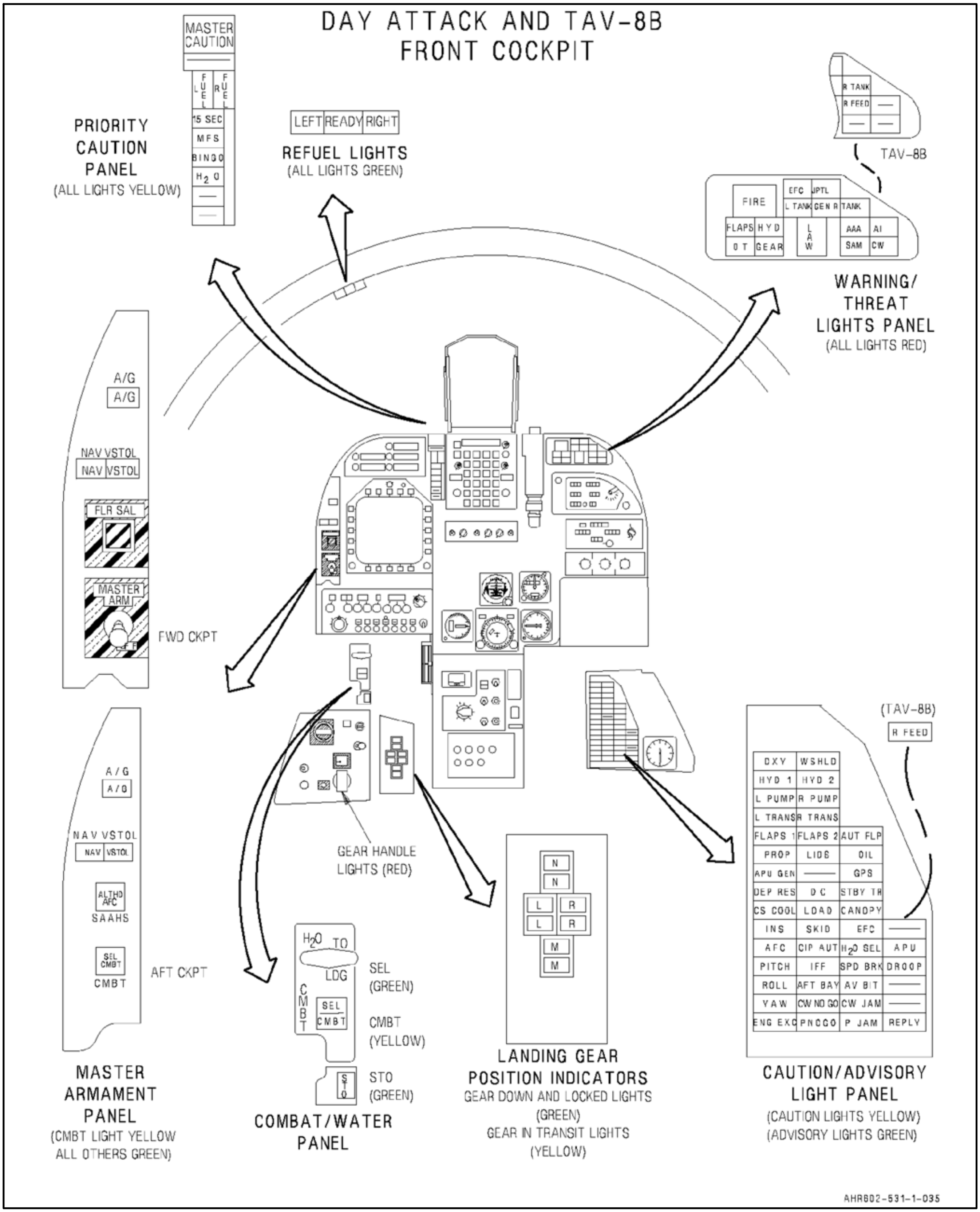


Figure 2-31. Warning/Caution/Advisory Lights (Sheet 1 of 2)

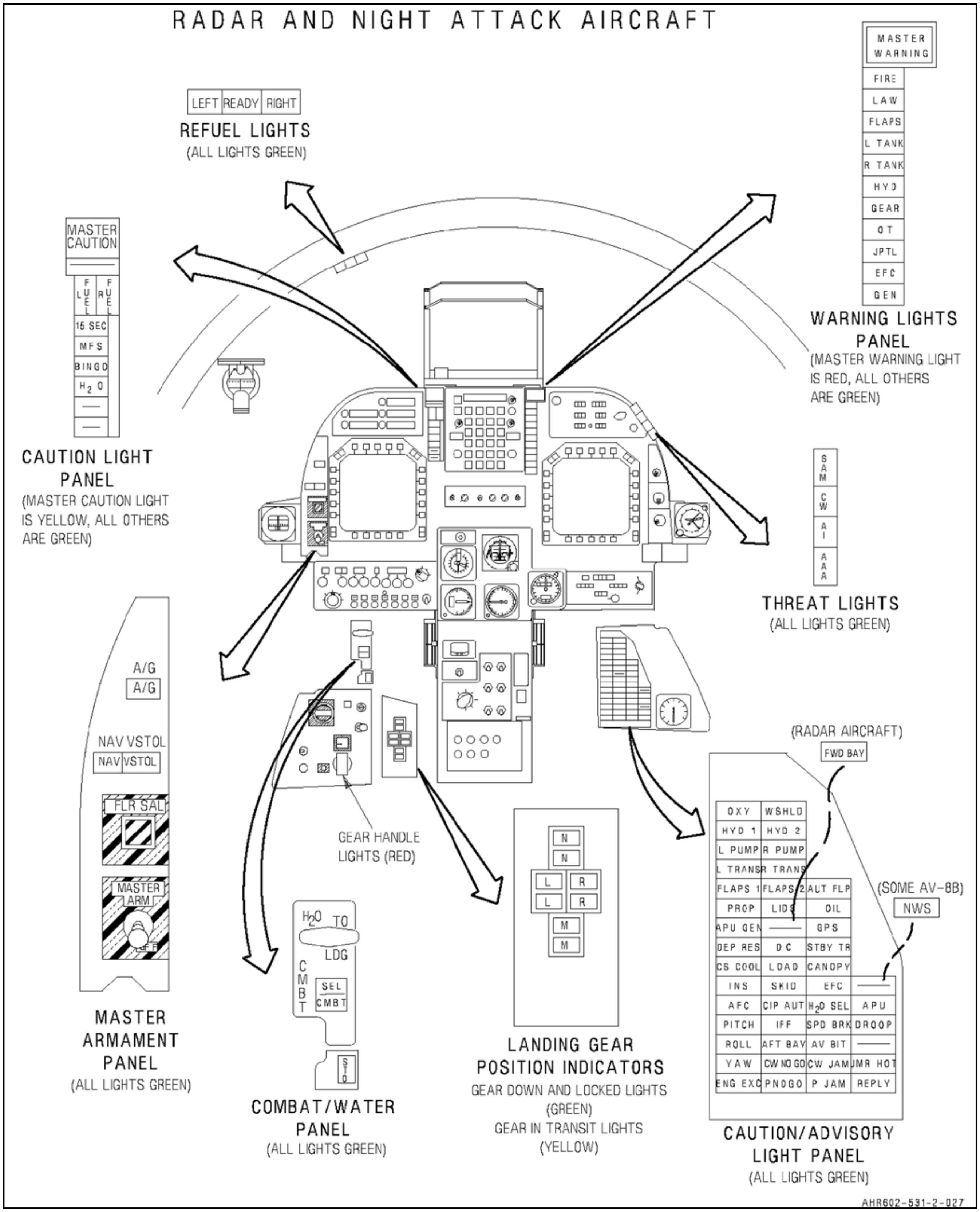


Figure 2-31. Warning/Caution/Advisory Lights (Sheet 2)

The warning lights come on flashing and are accompanied by a voice warning in the headset. Pressing the MASTER WARNING or MASTER CAUTION light causes the warning light to go steady and halts the voice warning. The light will remain on as long as the cause for the light exists.

The green threat lights have special tones associated with their illumination. The characteristics of these tones are covered elsewhere.

Except the CW NOGO and P NOGO, all caution lights on the caution/advisory light panel flash when they first come on at a flash rate of three to five flashes per second. Pressing the MASTER WARNING or MASTER CAUTION light causes these caution lights to go to steady illumination, but they will remain on as long as the cause for the light exists.

A thermostat will cause the lights to flash if they overheat on the ground. The thermostat is inoperative in flight and there is no indication if the lights overheat. Dimming of the warning/caution/advisory lights is covered under Lighting. Refer to Voice Warning in this chapter for list of lights that have associated voice warnings instead of tones.

2.31.1 Master Warning and Master Caution Light

The red MASTER WARNING light on the right side of the upfront control unit comes on flashing and is accompanied by the appropriate voice warning when a warning light comes on. The yellow MASTER CAUTION light comes on flashing and is accompanied by the appropriate voice warning/audible tone when any caution light on the right console caution/advisory light panel comes on, except CW NOGO and P NOGO. Either master light will go out when it or the other master light is pressed (reset), and will cause all flashing warning or caution lights to go from flashing to steady. Pressing either master light will also silence the current voice warnings. For voice warnings, pressing the MASTER CAUTION or MASTER WARNING light will silence only one warning at a time. The stall warning/maneuvering tones are not silenced. Voice warnings are listed in the following table and are stated twice (e.g., ALTITUDE, ALTITUDE).

2.31.2 Voice Warnings

TAV-8B 163856 and up, AV-8B 163519 and up. Voice warnings are provided in conjunction with certain warning/caution lights in place of special tones, Figure 2-32. The voice warnings also replace some other tones not associated with warning/caution lights. The following table provides a list of voice warnings and the associated warning/caution light, or in the case of no light, the applicable implication. Refer to Warnings, Cautions, and Advisories in Chapter 12 for implications of the lights.

All voice warnings are presented twice; e.g., the voice warning associated with the FIRE warning light will be presented as ENGINE FIRE, ENGINE FIRE. In the case of multiple voice warnings, the highest priority voice warning is sounded first. Before sounding the next voice warning, the priority list is checked to see if any higher priority warnings have become active. If so, the appropriate voice warning is sounded. If not, the lower priority warning is then sounded only if it is still active. The purpose of this mechanization is to keep the pilot informed of the most important failure as well as keep him from being overloaded with unnecessary voice warnings. Once CAUTION, CAUTION has been sounded, it cannot be repeated for another sounding for a 5-second period. Once a FUEL LOW, LEFT, FUEL LOW, RIGHT, or BINGO warning is sounded, it will not be permitted to sound again for a 60-second period.

2.31.3 Ground Proximity Warning System (Trainer with H4.0, Night Attack and Radar Aircraft)

Ground proximity warning system (GPWS) is a safety backup system that alerts the aircrew of an impending controlled flight into terrain (CFIT) condition. It operates when the MC is powered on and sensor data is available. The GPWS option window 4 on the ODU with ALT option selected allows the pilot to disable/enable the system. A colon in the option window indicates selection. GPWS can be deactivated. Deactivation of GPWS starts a 20 minute timer which automatically activates GPWS when the 20 minutes has expired. GPWS provides warnings of potentially unsafe maneuvering flight conditions, such as excessive bank angles, excessive sink rates, gear-up landings, floor altitude violations, limited protection against flight into rising terrain, diving flight depending on flight stages that include takeoff, cruise, or landing, and Altitude Loss During Recovery (ALDR). ALDR includes the loss of altitude due to persistency timers, pilot reaction, rolling to wings level, g-onset, steady state dive recovery, variable safety buffer and clearance altitudes for this warning condition. GPWS also provides for terrain compensation over downward sloping terrain.

VOICE WARNING AND ASSOCIATED WARNING/CAUTION LIGHTS				
VOICE WARNING	**PRIORITY NUMBER**	**WARNING LIGHT**	**CAUTION LIGHT**	**IMPLICATION**
ENGINE FIRE	1	FIRE	—	Same as warning light.
OVERTEMP	2	OT	—	Same as warning light.
HYDRAULICS	3	HYD	—	Same as warning light.
FUEL CONTROL	4	EFC	—	Same as warning light.
FLAP FAILURE	5	FLAPS	—	Same as warning light.
1 RIGHT FEED	5	R FEED	—	Same as warning light.
LANDING GEAR	6	GEAR	—	Same as flashing GEAR warning light.
ALTITUDE	7	LAW	—	Same as warning light.
LEFT TANK	8	LTANK	—	Same as warning light.
RIGHT TANK	8	RTANK	—	Same as warning light.
FIFTEEN SECONDS	9	—	15 SEC	Same as caution light.
BINGO	10	—	BINGO	Same as caution light.
LIMITER OFF	11	JPTL	—	Same as warning light.
OBSTACLE	12	—	—	Aircraft is at or below the set obstacle clearance elevation angle for AWLS.
WATER	13	—	H_2O	Same as caution light.
FUEL LOW, LEFT	14	—	L FUEL	Same as flashing caution light.
FUEL LOW, RIGHT	14	—	R FUEL	Same as flashing caution light.
GENERATOR	15	GEN	—	Same as warning light.
MANUAL FUEL	16	—	MFS	Same as caution light.
CAUTION	17	—	MASTER CAUTION	A caution light on the caution/advisory light panel has illuminated.
ACNIP GO	—	—	—	ACNIP BIT passed.
ACNIP FAIL	—	—	—	ACNIP BIT passed.
1 TAV–8B 163856 and up.				

Figure 2-32. Voice Warnings and Associated Warning/Caution Lights

The GPWS is a look–down system with no forward look capability. GPWS uses the radar altimeter as the primary altitude source with ADC and INS as backup altitude sources when the radar altitude is invalid. GPWS calculates terrain slope with inputs from the INS and radar altimeter. When radar altimeter information is invalid, the system switches from operational mode to coast mode for up to 2 minutes. In coast mode, GPWS calculates an estimate of current aircraft altitude. Coast mode can only be enabled while the aircraft is not transonic and is over a flat surface (<2° of slope). Warnings can be generated while in coast mode. If there is insufficient valid sensor data, GPWS transitions to the bypass state. No warnings are generated in the bypass state. Sensor hierarchy defines which combinations of sensors are required to keep the GPWS valid and providing full protection. When GPWS does not have sufficient sensors to provide full protection, degraded level of protection is provided (i.e. Coast mode).

All GPWS warnings should be treated as imminent flight into terrain, unless reassessed situational awareness dictates otherwise. Pilot response to a valid warning should be instinctive and immediate, using the maximum capabilities of the aircraft to recover until safely clear of terrain.

2.31.3.1 GPWS Warning Cues

GPWS provides unambiguous directive aural and visual cues to the aircrew for each potential CFIT condition. A HUD recovery cue, Figure 2-33, indicating the correct direction to recover the aircraft, and voice warnings are provided. GPWS voice warnings are: ROLL OUT, CHECK GEAR, PULL UP, and POWER. When an excessive bank angle condition exists, the ROLL OUT aural warning is heard twice every 2 seconds and the visual recovery cue appears. When an excessive landing or take off sink rate exists, the POWER aural warning is heard twice every 2 seconds and the visual recovery cue appears. When a potential gear up landing condition exists (greater than 60 seconds after takeoff, gear up, altitude less than 150 feet above ground level (AGL), airspeed less than 200 KCAS, and rate-of-descent greater than 250 FPM), the CHECK GEAR warning is heard once every 8 seconds but the visual recovery cue does not appear. When the aircraft flies below the floor altitude or an Altitude Loss During Recovery warning is generated, one of three aural warnings POWER, ROLL OUT, or PULL UP is heard, based on the aircraft situation. The ALDR alert is heard twice every 2 seconds along with the visual recovery cue. The floor altitude alert is also heard every two seconds. The aural cue is silenced when corrective action is sensed.

2.31.3.1.1 Recovery Cue

The recovery cue is a steady arrow that is used in conjunction with all GPWS warnings except the CHECK GEAR warning. The on/off condition of the arrow is warning dependent. The arrow displayed on the HUD shows the direction of the horizon. The recovery cue is displayed over the existing data on the HUD. When the potential CFIT condition no longer exists, the recovery cue is removed from the HUD. The aural and visual cues come on together and normally go off independently.

2.32 ON-BOARD OXYGEN GENERATING SYSTEM

The on-board oxygen generating system (OBOGS) provides a continuously available supply of breathing gas for the crew while the aircraft's engine is operating. Engine compressor bleed air is cooled and conditioned through the use of a heat exchanger and is directed to the concentrator.

The concentrator contains an electrical motor, powered by the emergency dc bus, and molecular sieves which remove most of the nitrogen from the bleed air and provides an oxygen rich gaseous mixture for the pilot. A temperature sensor, upstream of the oxygen concentrator, turns on the OXY caution light if the bleed air temperature exceeds the design operating limits. The oxygen rich gaseous mixture is then routed to a plenum, located in the cockpit, where the temperature is stabilized and a limited supply is stored for use during peak demands.

2.32.1 OBOGS Monitor

The OBOGS monitor is mounted on the left side of the seat bulkhead in the forward cockpit. The monitor continuously monitors oxygen concentration and initiates the OXY caution in the event of OBOGS system failure. The CRU-99 digital monitor has two test buttons; a test plunger and momentary test button. The monitor performs a power-up BIT during a 2 minute warmup period and periodic BIT on 60 second intervals during normal operation. No indication of power-up BIT or periodic BIT is provided. The monitor can be tested using the test plunger by momentarily pressing the test button.

2.32.2 Oxygen Switch

The OBOGS system is turned on and off by an oxygen switch located on the pilot services panel on the left console. The switch is labeled OXY and OFF.

2.32.3 Rear Oxygen Knob (TAV-8B)

The rear oxygen switch is located on the rear pilot services panel, and controls OBOGS airflow to the rear pilot when the OBOGS is turned on by the forward oxygen switch.

2.32.4 Oxygen Breathing Regulator

The pilot's chest mounted oxygen breathing regulator delivers the oxygen enriched air to the pilot at positive pressure, the limits of which increase with altitude. It is designed to interface with the hose assembly which connects with the pilot's survival kit oxygen disconnect.

2.32.5 Oxygen Caution Light

An OXY caution light, on the caution/advisory light panel, comes on if the bleed air temperature is too high or the oxygen concentration level is too low.

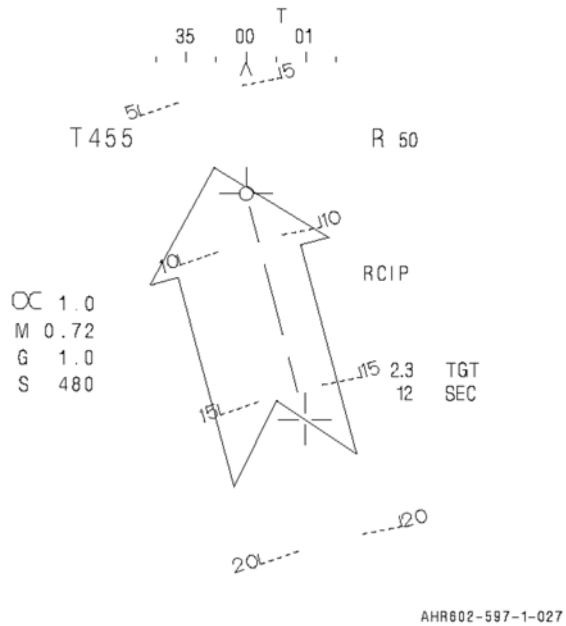


Figure 2-33. GPWS HUD Warning Symbology

2.32.6 Emergency Oxygen

An emergency supply of gaseous oxygen is contained in an emergency oxygen bottle located in the survival kit. During emergency operation, emergency oxygen is routed through the pilot's breathing regulator to the pilot's mask.

2.32.6.1 Emergency Oxygen Actuator

The emergency oxygen actuator can be actuated by pulling up the green ring on the inboard side of the left thigh support.

2.32.6.1.1 Emergency Oxygen Supply Gauge

The pressure gauge is mounted on the pressure reducing and shutoff valve on the top of the emergency oxygen bottle. The gauge has a red refill sector from 0 to 1,800 psi and black full sector from 1,800 to 2,500 psi.

2.33 BUILT-IN-TEST

The built-in-test (BIT) mechanization provided within each avionics subsystem forms the basis for fault isolation. This provides both the pilot and maintenance personnel with the status of the avionics subsystems. The BIT system provides the pilot with simple displays of system status without interfering with other essential functions. The mission computer (MC) displays the subsystem BIT results on the DDI and BIT messages delineate the system failure/anomaly. Two types of BIT are mechanized, periodic and initiated. Periodic BIT begins functioning upon equipment power application. It provides a failure detection capability that is somewhat less than that provided by initiated BIT in that it does not interfere with normal equipment operation. Two forms of BIT derived data are supplied to the MC. One form is validity information associated with selected data. The second form is the equipment failure information which identifies failed weapon replaceable assembly (WRA). The MC uses these two forms of BIT data to implement reversion operation and advisories for the pilot, as well as equipment status displays for both the pilot and maintenance personnel.

2.33.1 Reversion

When the BIT equipment determines, through either periodic or initiated BIT, that a function has exceeded a predetermined threshold, the data derived from that function is immediately indicated as not valid. The MC, upon receiving this indication, reverts to the next best available source or to a backup mode of operation. This reversion is maintained as long as the data remains invalid from the primary source. Automatic tactical reversion mechanized for flight aids, navigation, air-to-air and air-to-ground weapons delivery are shown in Figure 2-34. When a reversion from a primary path occurs, the pilot is provided with the appropriate cuing on the HUD and DDI only if the reversion results in some loss of capability or performance. If no reversion path exists, displayed data is removed.

2.33.2 BIT Display

A MENU selectable BIT display (Figure 2-35) contains the status of all avionics equipment which interface with the MC. During BIT display, messages are displayed next to each affected equipment legend on the DDI. No indication (blank) adjacent to equipment legend indicates periodic BIT has detected no faults. Messages displayed as a function of equipment status are listed as follows:

1. OFF indicates no multiplex response and no equipment ready signal (equipment not turned on, equipment not present, power supply failure, etc., and for RWR it could also mean avionics mux failure between the digital data computer and RWR computer).
2. Asterisk(*) indicates a single mux bus failure on the ground or double mux bus failure during flight.
3. WRA fail numeral 1 through 16 indicating which WRA within an equipment group is failed.
4. TEST indicates initiated BIT is commanded but not completed for the equipment (during AUTO BIT, TEST next to stores management system (SMS) indicates failures are removed from mission computer because the SMS does not perform an initiated BIT). When there are SMS failure codes, a post-flight IBIT should not be performed or SMS failures will be cleared from the MC. Inspect failures through the MAINT mode. With H4.0, SMS will no longer be a part of the AUTO BIT.
5. DSEL is unique to the GPS indicating the equipment has been deselected. If GPS is deselected during flight the BIT page will indicate GPS DSEL, until the next power up.
6. M is unique to the DSS indicating the DSS memory is full.
7. D is unique to the DSS indicating the DSS has failed check sums.
8. 0 indicates a software compatibility problem and is unique to the SAAHS and ADC BITs. There are two instances in which a 0 would be considered normal. One instance is the transfer of the MC between any two of the following platforms: Radar, Night Attack, and Trainer Aircraft without a reload. The other instance would be a fresh MC load in a Night Attack or Trainer Aircraft. When either of these two instances occurs, 0 may be displayed, but the altitude box does not flash. If this is the case, an Auto BIT should be performed. If 0 clears, the mission can be continued. If 0 never clears or is not the result of these instances, the mission should be aborted. A 0 also causes the Altitude Box Symbol to flash on the HUD, this should never be considered normal.

The following applies with H4.0.

9. NOT LOADED is displayed next to ALMANAC if the miniaturized airborne gps receiver (MAGR) does not have the GPS Almanac loaded. It is also displayed next to CRYPTO if the MAGR does not have crypto loaded.
10. LOADED is displayed next to ALMANAC if the GPS almanac is loaded into the MAGR. It is also displayed next to CRYPTO if the MAGR has crypto keys loaded but has not locked onto a GPS signal yet.
11. INCORRECT is displayed next to CRYPTO if the MAGR determines that the loaded crypto keys are incorrect.
12. OK is displayed next to CRYPTO if the MAGR determines that the loaded crypto keys are correct.

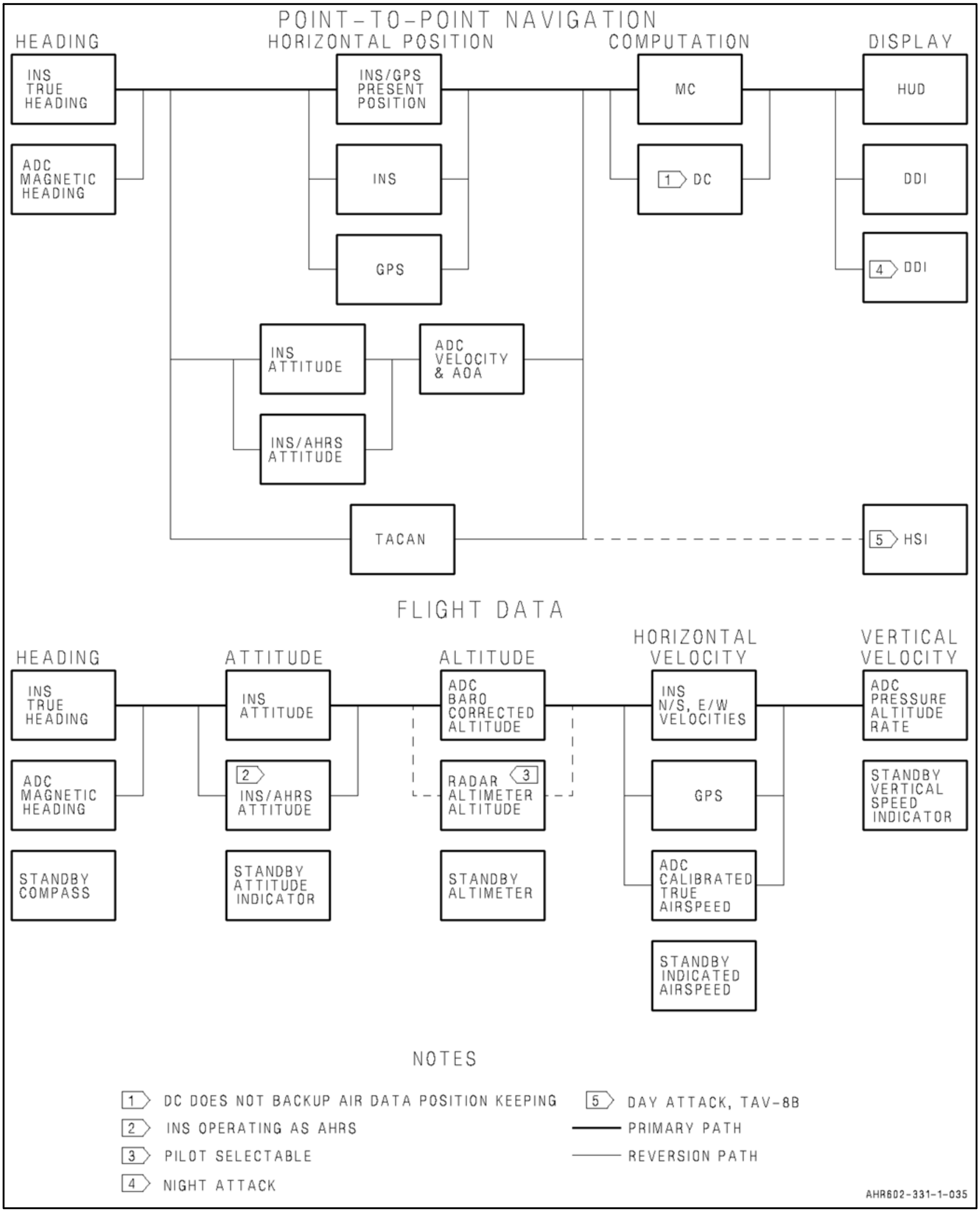


Figure 2-34. Reversions

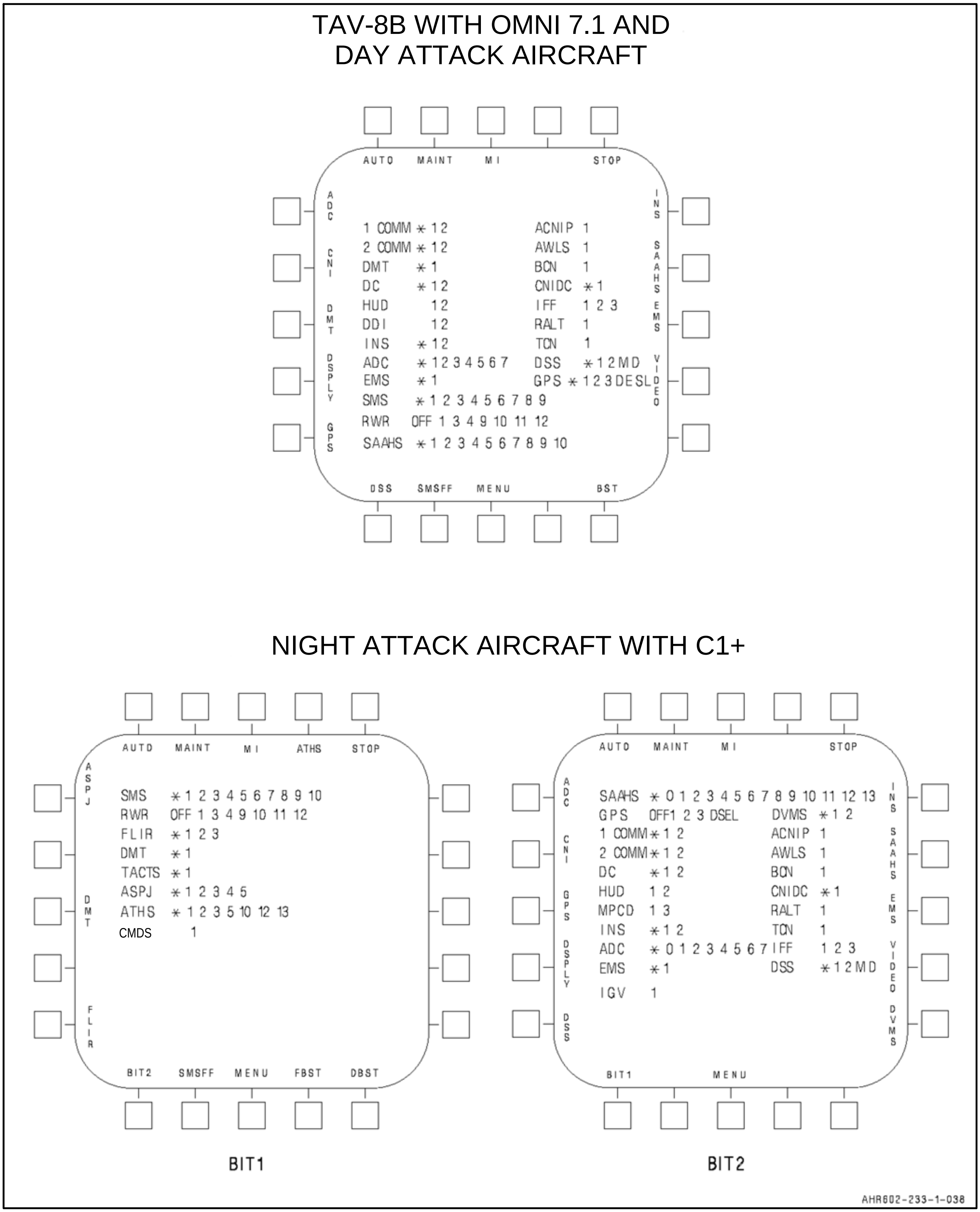


Figure 2-35. BIT Displays (Sheet 1 of 4)

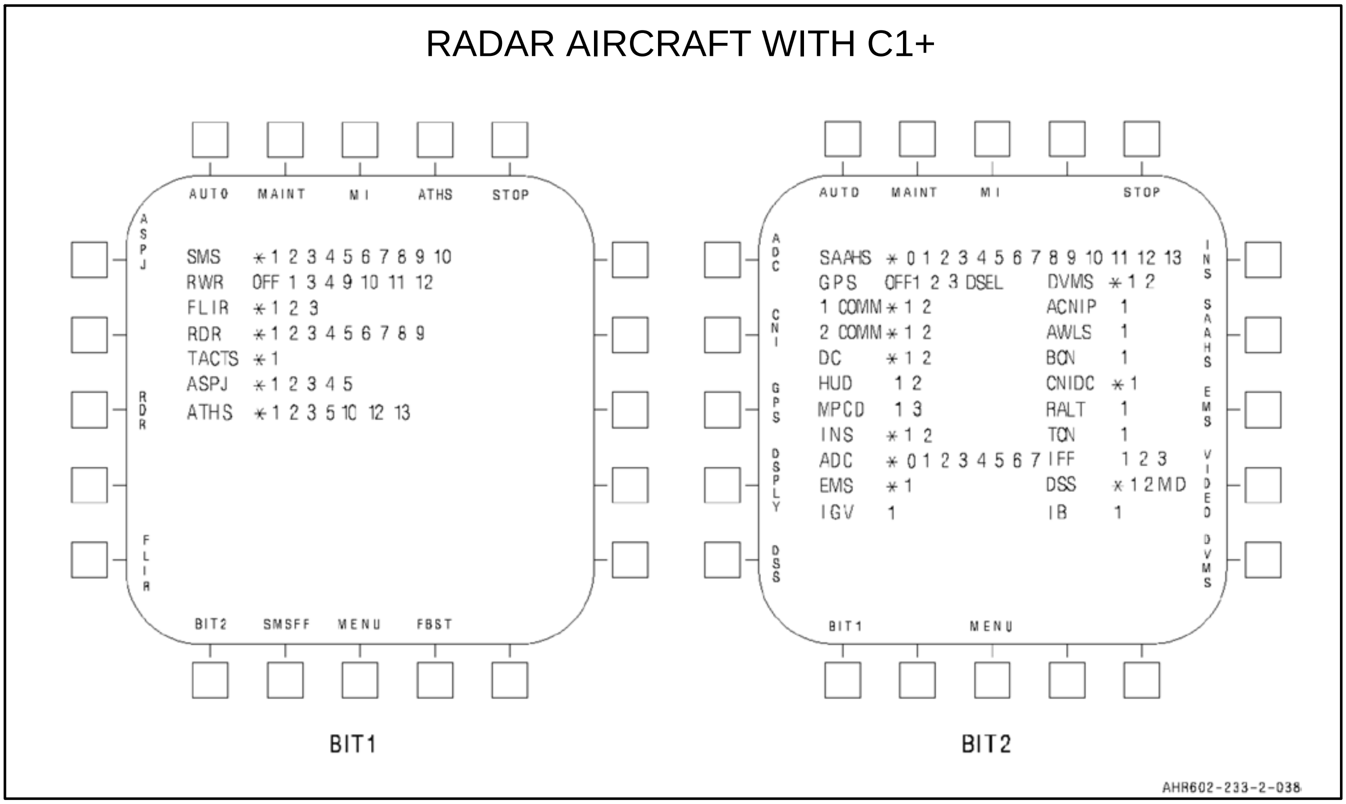


Figure 2-35. BIT Displays (Sheet 2)

The following applies to H4.0 with tactical aircraft moving map capability (TAMMAC) installed only.

13. OPEN is unique to the Advanced Memory Unit (AMU) indicating the AMU door is open.
14. MAP is unique to the AMU indicating that a MAP formatted card is installed.
15. F1 is unique to the AMU indicating mandatory files are missing from the installed mission card.
16. F2 is unique to the AMU indicating mandatory files are missing from the installed maintenance card.
17. D1 is unique to the AMU indicating the mission card has failed checksums.
18. D2 is unique to the AMU indicating the maintenance card has failed checksums.
19. M1 is unique to the AMU indicating the mission card memory is full.
20. M2 is unique to the AMU indicating the maintenance card memory is full.
21. U is unique to the AMU indicating the Fatigue Tracking User Program is present on the maintenance card but the program is not running in the AMU.

Note

If U is displayed the operator should initiate an AMU BIT. If the U persists, the maintenance card should be reloaded on an AMS system.

Pressing the MENU, then the BIT pushbutton on the DDI selects the BIT display which displays the appropriate message next to the affected equipment. For the SAAHS, of the 17 possible WRA failures only 10 can be displayed at a time on TAV-8B (with ONMI 7.1) and Day Attack aircraft or 14 on Radar and Night Attack aircraft. If more failures are reported than can be displayed only the first 10/14 are displayed (any combination totaling not more than 33 spaces).

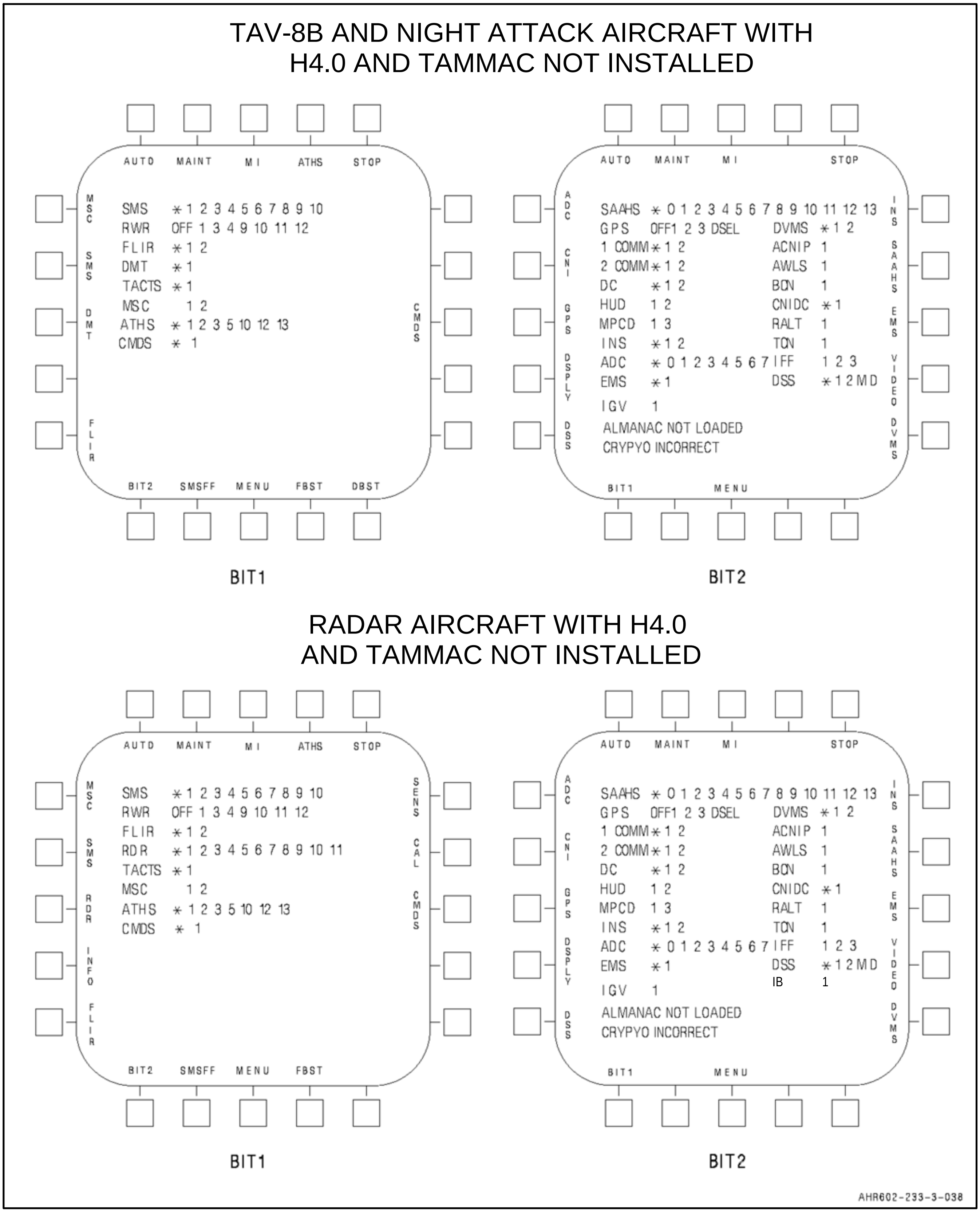


Figure 2-35. BIT Displays (Sheet 3)

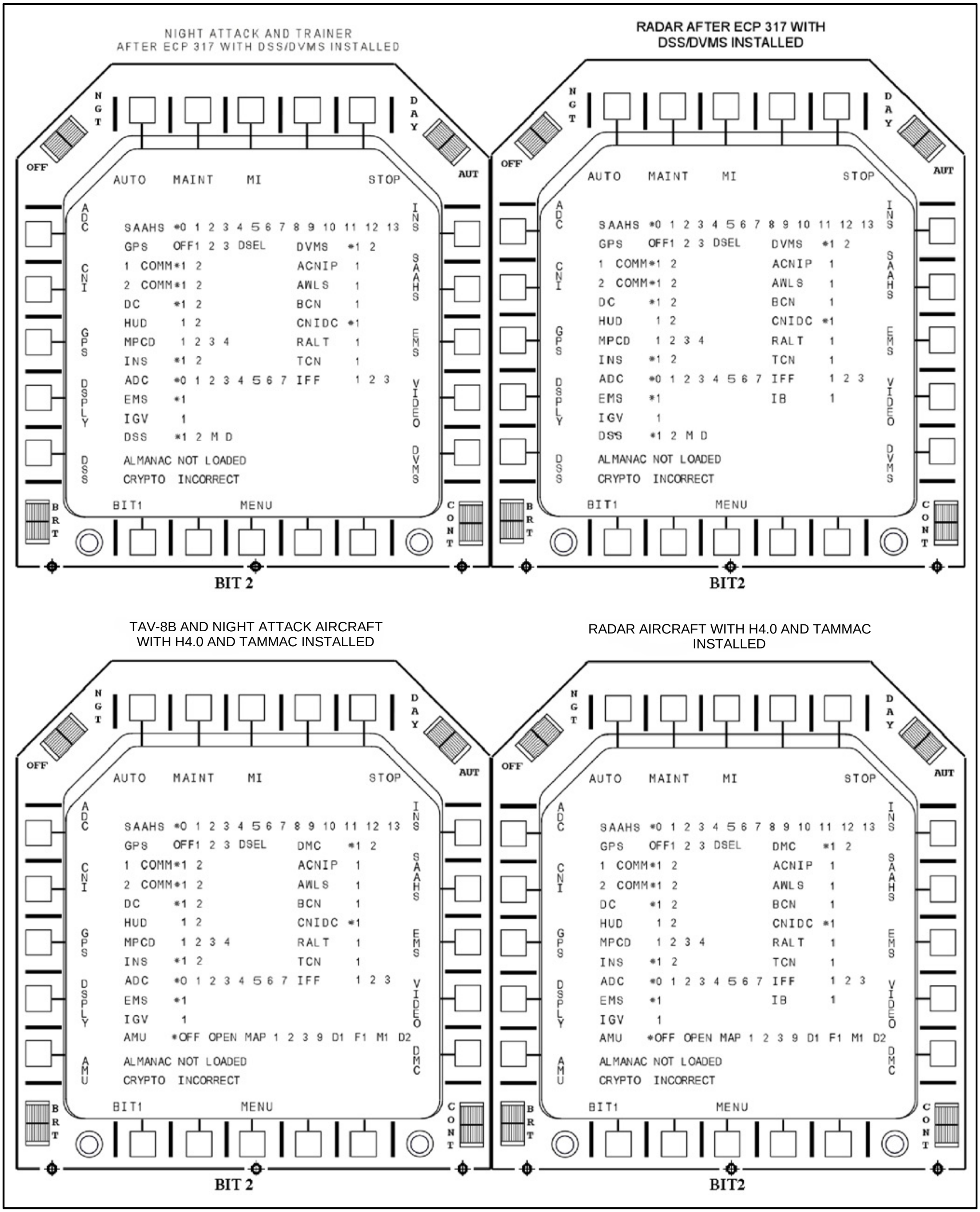


Figure 2-35. BIT Displays (Sheet 4)

Figure 2-36 contains a listing of WRA failure numerals with the associated equipment display nomenclature. In addition, a brief description of system/aircraft degradation is given for each failed WRA.

All WRA failures which are present when the BIT display is selected or were present for 2 minutes before selection of the BIT display and all MUX bus failures are displayed on the DDI. Limited duration, non-repeatable WRA failures which were not present for 2 minutes are not stored in the mission computer.

WRA and mux bus failures are reset (removed from mission computer storage) by performing an AUTO BIT (ground only) or an initiated BIT (IBIT) on the affected equipment. An exception to this is the SAAHS. The flight control computer stores SAAHS failures and the mission computer displays their status when the BIT display is selected. These failures can be reset only by performing IBIT or by placing the AFC switch to RESET. All SMS failures are cleared from the mission computer by an AUTO or initiated BIT. With H4.0, SMS will no longer be a part of the AUTO BIT. Failures which are detected by periodic BIT will be displayed again as they are detected; however, failed systems which are tested only on start-up will have all failure indications cleared and will not be re-tested by periodic, initiated, or AUTO BIT. MSC IBIT can be commanded in aircraft with H4.0. Once an MSC BIT is commanded, the MSC goes offline. Since the MSC is offline, an MSC IBIT cannot be stopped unless power to the MSC is secured. Backup displays produced by the display computer are displayed if the display computer is functioning correctly.

2.33.3 BIT Reporting

During postflight it is the pilot's responsibility to record (before engine shutdown) and report to ground maintenance BIT and AUTO BIT equipment fail indications. This reporting can avoid loss of inflight failure indications and the need for ground maintenance to apply electrical power to obtain BIT and AUTO BIT fail indications. The velocity reasonableness BIT failures (ADC 7, INS 2, and GPS 3) are never displayed on the deck even if the failures lasted more than 2 minutes. They are designed to provide the pilot with additional situational awareness while inflight.

2.33.4 BIT Initiation

In addition to displaying equipment BIT status, the DDI is used to command initiated BIT. Those avionics sets identified by the legends on the BIT display periphery have an initiated BIT capability. The pilot commands initiated BIT by pressing the adjacent button. The status messages are displayed as required as each equipment set enters, performs, and completes its BIT routine.

During the AMU BIT, the AMU pauses the Fatigue Tracking User Program. After the AMU completes BIT, the MSC will wait 15 seconds to verify that the Fatigue Tracking User Program has restarted. If the user program is not running, the MSC will automatically command another BIT (up to 6 times total). Therefore, the AMU BIT process may vary in length (anywhere from 18 to 108 seconds). If the user program fails to start 15 seconds after the last AMU BIT, U will be displayed next to the AMU legend on BIT page 2.

To perform a simultaneous initiated BIT on all systems except INS, RWR, SAAHS, SMS, and MSC (H4.0 only), the AUTO button is pressed. When the AUTO button is pressed, all failure codes are cleared for all systems. The INS, RWR and SAAHS failure codes may appear as each system performs its periodic BIT. SMS will display TEST for approximately 45 seconds, allowing the SMS time to report the results of its periodic BIT. With H4.0, SMS will no longer be a part of the AUTO BIT.

Note

- The SAAHS has 17 WRA failure codes. However, only 10 can be displayed at any given time on TAV-8B (with OMNI 7.1) and Day Attack aircraft or 14 on Trainer (with H4.0), Radar, and Night Attack aircraft (* and 0-13 or any combination totaling not more than 33 spaces). If more than 14 WRAs are reported, only the first 14 (or 33 spaces total) will be displayed.
- When TAMMAC is installed, the AMU has 19 different WRA failure codes. There is a maximum of 33 spaces available for display of failures on the AMU line. If more than 33 spaces worth of failures are being reported, only the first 33 spaces will be displayed.

EQUIPMENT	FAILURE NUMERAL (WRA)	INDICATION TO PILOT
ACNIP	1	ACNIP WRA failure
ADC	0	Software compatibility problem
	1	Invalid air data parameter(s) removed from HUD
	2	AOA removed from HUD
	3	TAS not available for display on HUD when A/G selected
	4	Altitude removed from HUD
	5	Magnetic heading invalid
	6	Magnetic heading invalid
	7	Velocity Reasonableness Test Failure
9 AMU	OPEN	The AMU door is open
	MAP	A MAP formatted card is installed
	1	AMU WRA failure
	2	High Speed Interface Bus (HSIB) failure
	3	Mission Card failure
	4	Mission Card format improper
	5	Mission Card type improper
	6	Maintenance Card failure
	7	Maintenance Card format improper
	8	Maintenance Card type improper
	9	AMU and PC Card Ambiguity
	D1	Mission Card Failed Checksum
	F1	Required mission files are missing
	M1	Mission Card memory is full
	D2	Maintenance Card failed checksum
	F2	Required maintenance files are missing
	M2	Maintenance Card memory is full
	U	Fatigue Tracking User program is not running but present
1 ASPJ	1	Low band receiver failure
	2	High band receiver failure
	3	Processor failure
	4	Low band transmitter failure
	5	High band transmitter failure
7 ATHS	1	A1, Interface Assembly
	2	A2, Switch Assembly
	3	A3, Modem, A Assembly
	4	Reserved for Modem B Assembly
	5	A5, Modem C Assembly
	6	Reserved for Modem D Assembly
	10	A10, 1553 and Processor Assembly
	12	A12, 1553 I/O Assembly
	13	A13, Power Supply and Discrete Assembly
AWLS	1	AWLS receiver failure
BCN	1	Radar beacon R/T failure
CMDS	1	CMDS WRA failure
CNIDC	1	CNI data converter failure
COMM 1	1	Radio 1 failure
	2	Radio 1 antenna system failure
COMM 2	1	Radio 2 failure
	2	Radio 2 antenna system failure

Figure 2-36. BIT Failure Indications (Sheet 1 of 3)

EQUIPMENT	FAILURE NUMERAL (WRA)	INDICATION TO PILOT
DC	1 2	DC 1 failure DC 2 failure
[2] DDI	1 2	DDI failure (fwd cockpit) DDI failure (aft cockpit)
[1] [8] [9] DMC	1 2	Digital map computer failure High speed interface bus (HSIB) failure
[3] DMT	1	DMT inoperable
[10] DSS	1 2 M D	Data storage set failed Incorrect DSU load DSS memory is full DSU failed checksum
[1] [10] DVMS	1 2	Digital map computer failure Digital memory unit failure
EMS	1	Engine monitoring unit failure
[1] FLIR	1 2 [4] 3	FLIR electronics unit failure FLIR sensor failure FLIR power supply failure
[5] GPS	1 2 3 [8] 4	GPS receiver fail GPS battery fail Velocity reasonableness test failure GPS antenna fail
HUD	1 2	Cockpit HUD failure Aft cockpit HUD failure
[4] IB	1	Interference blanker failure
[6] IGV	1	Inlet Guide Failure
IFF	1 2 3	IFF R/T failure KIT-1A failure IFF antenna system failure
INS	1 2	Automatic reversion to AHRS mode Velocity reasonableness test failure
[1] MPCD	1 3	Left MPCD failure (fwd cockpit) Right MPCD failure (fwd cockpit)
RALT	1	Radar altimeter R/T failure
[4] RDR	1 2 3 4 5 6 7 8 9 [8] 10 [8] 11 [8] 12	Radar target data processor Transmitter Receiver/Exciter Computer power supply Antenna Antenna electronics Transmitter flow low (indicates low liquid coolant) Waveguide pressure low Weight-on-wheels/inflight disagree Radar hardware or aircraft launch discrete to Radar not AMRAAM compatible AMRAAM data link RF power test fail System failure detected, run I-BIT to isolate fault

Figure 2-36. BIT Failure Indications (Sheet 2)

EQUIPMENT	FAILURE NUMERAL (WRA)	INDICATION TO PILOT
RWR	1 3 4 9 10 11 12	RWR computer inoperable Special receiver inoperable Integrated antenna array inoperable Quadrant receiver at 315° inoperable Quadrant receiver at 225° inoperable Quadrant receiver at 135° inoperable Quadrant receiver at 45° inoperable
SAAHS	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	Software compatibility problem Invalid mode or function inoperable Loss of pitch or roll or yaw function Loss of coordinated turn function Loss of control stick steering or emergency disengage Loss of forward pitch stab aug in approach Loss of pitch stab aug Loss of forward pitch stab aug in approach Loss of roll stab aug Loss of roll stab aug Loss of rudder trim and yaw stab aug Loss of roll/yaw interconnect Loss of particular switch function, or SAAHS switches off during BIT Loss of auto pitch trim or manual trim input Loss or auto roll trim or manual trim input Forward lateral accelerometer or roll rate gyro failed Static inverter or contactor failed
SMS	1 2 3 4 5 6 7 8 9 1 10	SMS computer failure Armament control panel failure Station 1 controller failure Station 2 controller failure Station 3 controller failure Station 4 controller failure Station 5 controller failure Station 6 controller failure Station 7 controller failure Aircraft wiring
1 TACTS	1	AISI failure
TCN	1	Tacan R/T failure

NOTES:

1. AV–8B 163853 and up.
2. TAV–8B, AV–8B Day Attack.
3. TAV–8B, AV–8B 161573 through 164547.
4. AV–8B 164549 and up.
5. AV–8B 165384 and up; also AV–8B 161573 through 165383, TAV–8B 162963 through 164542 after AFC–354 Rev A/Part 2/Part 3.
6. AV–8B 165354 and up.
7. AV–8B 165305 and up; also AV–8B 163853 through 165006 after AFC–326/Part 3.
8. H4.0 only.
9. H4.0 with TAMMAC installed.
10. TAMMAC not installed.

Figure 2-36. BIT Failure Indications (Sheet 3)

During AUTO BIT a mixture of tones is heard in the headset. These tones result from simultaneous BIT checks of the ACNIP and the two VHF/UHF receiver-transmitters. The ACNIP tone consists of three 2.5 KHz to 3.5 KHz beeps for approximately 6 seconds, followed for approximately 2 seconds by two cycles of the LAW tone and one cycle of the hooter tone. Each receiver-transmitter BIT produces a series of 960 Hz on/off tones while BIT is in progress and a steady 960 Hz tone after BIT completion. The total BIT time for the transmitter-receivers is typically from 3 to 6 seconds. The total time for the mixture of tones heard during the AUTO BIT varies from approximately 3 to 10 seconds. The sound heard will vary in accordance with the volume control settings of the above three pieces of equipment. AUTO BIT causes the INS and CIP/AUT caution lights to come on for a short period of time. At times this period will be long enough to trigger the MASTER CAUTION light. This is normal operation.

For subsystems which require operator participation for initiated BIT thoroughness, a maintenance BIT is provided. The AUTO, ARBS, MSC (H4.0 only) and MAINT BITs are usable only on the ground and must be performed with the aircraft stationary.

Note

Performing an AUTO BIT during taxi can cause false failure codes.

The STOP button allows the pilot to stop initiated BIT or AUTO BIT at any time. The same effect is also achieved by pressing MENU. With either method, any test in progress stops and the equipment returns to normal operation. The COMM 1 and COMM 2 BIT cannot be stopped once initiated, the TEST legend may be removed from the DDI but tones will be heard as BIT is performed. The GPS test cannot be stopped once initiated. With H4.0, BITs stop if they complete, or either MAINT or STOP is pressed. BITs continue even if the BIT page is left. With H4.0, if a system is unable to complete its BIT test, a ? is displayed next to the system’s label. The following legends are not displayed on the BIT display during flight: MAINT, AUTO, ADC, INS, SAAHS and MSC (H4.0 only).

Systems have to be turned on and warmed up for initiated BIT. Warm up times are: RALT, 3 minutes; AWLS, 15 seconds; IFF, TCN, and beacon (BCN), 30 seconds; and SAAHS has a 2-minute rate gyro run up time. If BIT is commanded before the system is warmed up the display will indicate TEST until warmup is completed.

Note

If a CNIDC BIT failure occurs, the status of critical IFR flight equipment (TACAN, RADALT, BCN, IB, IFF, AWLS, and ACNIP) will not be known.

On AV-8B 164549 and up, an Operational Readiness Test (ORT) is performed on the radar whenever the aircraft is powered up. The ORT is nearly the same as an initiated BIT, however, it cannot be stopped once started. The ORT is automatically initiated whenever the radar has been turned off for more than 7 seconds and is powered up. This interval defines a cold start. When the radar is turned on, it takes 3.5 to 4.0 minutes for warmup and ORT. The ORT is performed concurrent with the warmup process and begins after 30 seconds.

During ORT and initiated BIT with weight-on-wheels, the radar transmitter is tested with the radiation path into a dummy load to protect the ground crew from radiation hazard. Transmitter tests take about 30 to 45 seconds to complete, however the tests are inhibited if STBY or EMCON are selected during warmup. The radar will not function until the transmitter tests are complete. If the aircraft takes off in EMCON the tests will not be completed until EMCON is deselected. The pilot has no indication that the radar is not ready.

On AV-8B 161573 through 162973, auxiliary communication, navigation, identification panel (ACNIP) initiated BIT is also initiated each time the ACNIP mode switch is positioned to MAN. On TAV-8B, AV-8B 163176 and up, the battery switch must be in the alert mode to enable the ACNIP initiated BIT. A one second warning tone (hooter) indicates the ACNIP passed BIT. On TAV-8B 163856 and up, AV-8B 163519 and up, ACNIP BIT pass is indicated by an ACNIP GO, ACNIP GO voice warning and ACNIP BIT fail is indicated by an ACNIP FAIL, ACNIP FAIL voice warning.

Note

If emission control (EMCON) is selected, initiated BIT for the radar altimeter and IFF are inhibited, also the radar transmit function on AV-8B 164549 and up.

Initiated BIT procedures are described in the systems coverage throughout this manual where applicable. With a combined knowledge of reversion operation (Figure 2-34) and WRA failure numerals (Figure 2-36), it is sometimes possible for the pilot to determine the extent of system/aircraft operational degradation due to avionics equipment failure/anomaly.

On aircraft after AFC-392, the Enhanced Variable Inlet Guide Vane Control System (EVICS) conducts an automatic BIT check after engine start. The BIT check verifies proper operation of the EVICS, Hydro-Mechanical Unit (HMU) and T1 temperature sensor. Component failure is indicated by IGV 1 on the BIT 2 Page.

2.34 DDI MISSION COMPUTER OFP DISPLAY (OMNI 7.1 AND C1+)

The ID number of the current operational flight program (OFP) load for the mission computer can be determined by selecting the maintenance display on the DDI. The maintenance display is selected by the following procedure:

1. Select BIT display from MENU.
2. Select MAINT from BIT display.

With the maintenance display selected, the current mission computer OFP is displayed above the MENU button legend at the bottom center of the display.

2.35 SOFTWARE CONFIGURATION PAGE (H4.0 ONLY)

The software configurations of certain systems can be viewed by accessing the configuration displays (CONF1 or CONF2) from the main menu display by pressing CONF. See Figures 2-37 and 2-38. The MSC automatically performs a configuration check with the peripherals shown on the configuration pages. If a fault such as an incorrect software load is detected for one of the peripherals during the MSC power up cycle, the appropriate configuration page with the faulty item shall be displayed on the left MPCD with the offending software load flashing and ACK in window 1 of the ODU. When ACK is selected the software identifier of the offending item is lined out, as depicted in Figure 2-37. Items listed on the software configuration pages that are not powered up or are not applicable to that type of aircraft, are left blank. If TAMMAC is installed in the aircraft, NOT COMPATIBLE may appear flashing next to the digital map computer (DMC) legend. This indicates a map theater load or symbol set that is not compatible with the AV-8B. This can be corrected by loading an AV-8B theater from an AMU MAP card.

Note

Flight with a software configuration fault is prohibited.

2.36 POSTFLIGHT DATA RETRIEVAL

The mission computer stores WRA failures for postflight retrieval. To report these failures, the BIT display is selected before engine shutdown and the failures are recorded for use by maintenance personnel.

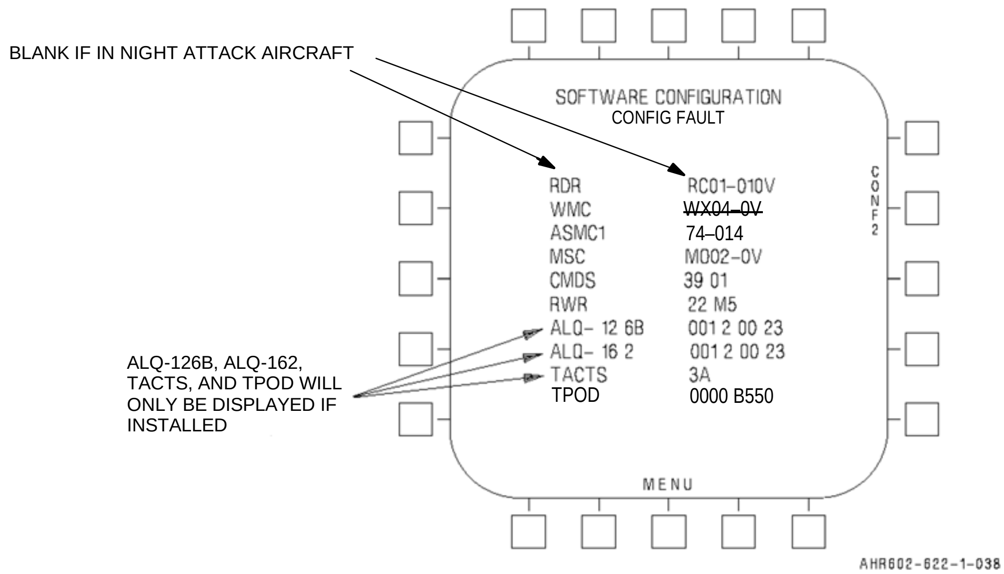


Figure 2-37. Configuration Page 1 (Configuration fault detected)

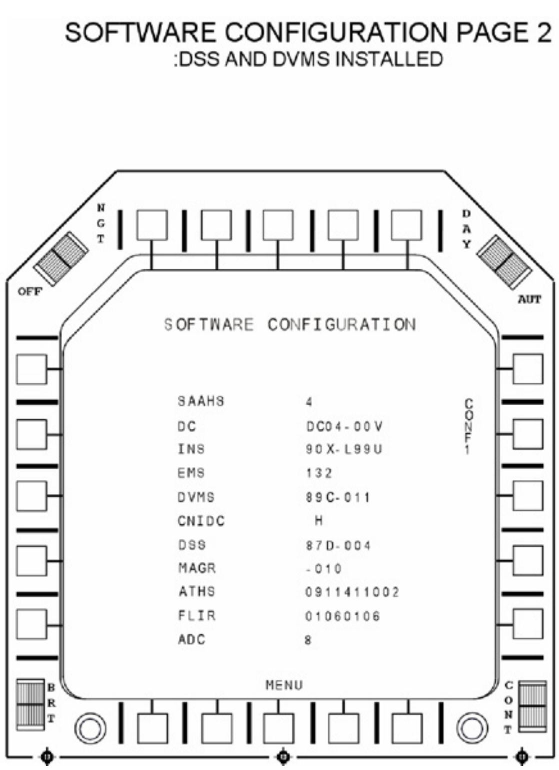


Figure 2-38. Configuration Page 2 (DSS and DVMS Installed) (Sheet 1 of 2)

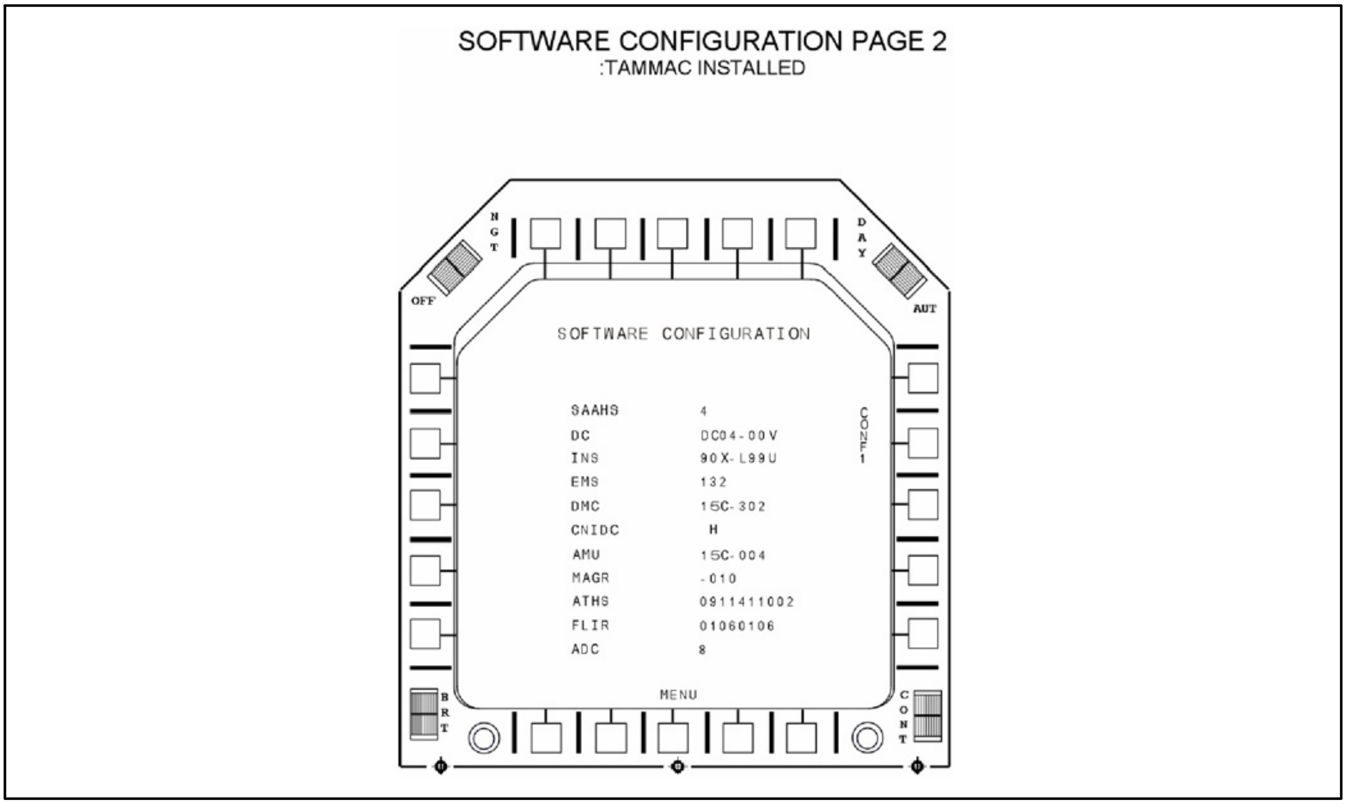


Figure 2-38. Configuration Page 2 (DSS and DVMS Installed) (Sheet 2)

CHAPTER 3

Servicing and Handling

3.1 SERVICING

Refer to A1-AV8BB-NFM-600.

CHAPTER 4

Operating Limitations

4.1 GENERAL

All aircraft/systems limitations that must be observed during normal operation, are covered or referenced herein. Some limitations that are characteristic only of a specialized phase of operation (emergency procedures, flight through turbulent air, starting procedures, etc.) are not covered here; however, they are contained along with the discussion of the operation in question.

4.2 ENGINE LIMITATIONS

Refer to Figure 4-2 for engine operating limitations, and Figure 4-3 for engine life count rate versus JPT.

4.2.1 Fuel

The engine is cleared for use with the following fuel grades and their corresponding NATO code.

Primary Fuels are JP-5 (NATO F44), JP-8 (NATO F34), Jet A, Jet A-1.

Alternate Fuels are JP-4 (NATO F40), NATO F35, and Jet B.

CAUTION

Flight above 20,000 feet using JP-4, both boost pumps off, and fuel proportioner off may result in engine flame out.

The +100 fuel additive and aerosol introduced PRIST (FSII) are not allowed in naval aircraft. Premixed PRIST (FSII) is allowable.

DECS will automatically compensate for the change in fuel specific gravity, and the aircraft is cleared for all normal operations (Figure 4-1).

4.2.2 RPM Limits

The maximum indicated rpm for the F402-RR-406 engine is limited to 107.0 percent due to structural limits and to 106.5 percent corrected rpm due to maximum flow limits.

The maximum indicated rpm for the F402-RR-408 engine is limited to 120.0 percent due to structural limits and to 116.8 percent corrected rpm due to maximum flow limits.

RPM corrected to a standard day is referred to as corrected or non-dimensional rpm. The corrected rpm is automatically limited by DECS.

4.2.3 Oil System

Engine turbine oil MIL-PRF-23699 (NATO Code 0-156) must be used. Maximum oil consumption is 3.75 pints per hour. Flight in less than 1g conditions must not exceed 15 seconds continuous duration to avoid oil starvation of the engine bearings.

AV-8B FUEL REFERENCE CHART

	US MIL CODE	NATO CODE	US MILITARY SPECIFICATION	COMMERCIAL DESIGNATION (SPECIFICATION)	BRITISH DESIGNATION (SPECIFICATION)	WT (LBS/ GAL)	COMMENTS
PRIMARY FUELS	JP-5	F-44	MIL-DTL-5624	NONE	DEF STAN 91-86 (AVCAT/FSII)	6.8	1A, 2
	JP-8	F-34	MIL-DTL-83133	NONE	DEF STAN 91-87 (AVTUR/FSII)	6.7	1A, 2, 3
	JP-4	F-40	MIL-DTL-5624	NONE	DEF STAN 91-88 (AVTAG/FSII)	6.5	1A, 2, 3, 4
RESTRICTED FUELS	NONE	F-35	MIL-DTL-83133	JET A-1 (ASTM D-1655)	DEF STAN 91-91 (AVTUR)	6.7	1B, 3, 5, 6
	NONE	NONE	NONE	JET A (ASTM D-1655)	NONE	6.7	1B, 3, 5, 6
	NONE	NONE	NONE	JET B (ASTM D-6615)	NONE	6.5	1B, 3, 4, 5, 6
	NONE	NONE	NONE	GOST 10227 GRADE TS-1	NONE	6.7	1B, 3, 5, 6, 7
EMERGENCY FUELS	JP-8 +100	F-37	MIL-DTL-83133	NONE	DEF STAN 91-87 (AVTUR/FSII + S-1749)	6.7	1C, 2, 8

CAUTION

- TO ENSURE THAT THEY CAN BE SAFELY HANGARED ABOARD SHIP, AIRCRAFT SHOULD BE FUELED WITH JP-5 (F-44) PRIOR TO SEA BASING. WHEN FUELING WITH JP-5 IS NOT POSSIBLE, AIRCRAFT SHALL NOT BE HANGARED UNTIL THE FLASHPOINT OF THE FUEL IN THE AIRCRAFT FUEL TANKS IS ABOVE 120 °F. NAVAIR 00-80T-109, SECTION 6.2.10 CONTAINS THOSE PROCEDURES THAT MUST BE FOLLOWED WHEN HANGARING AIRCRAFT CONTAINING FUEL OTHER THAN JP-5 (F-44).
- SHIP'S FUEL PERSONNEL HAVE TEST EQUIPMENT FOR MEASURING FUEL FLASHPOINT. FIGURE 4 OF MIL-HDBK-844A(AS) (AIRCRAFT REFUELING HANDBOOK FOR NAVY/MARINE CORPS AIRCRAFT) CAN BE USED WITH THE MEASURED FLASHPOINT TO DETERMINE MORE ACCURATELY THE PERCENTAGE OF JP-5 (F-44) REQUIRED TO RAISE THE FLASHPOINT OF JP-8 (F-34) OR JET A-1 (F-35) ABOVE 120 °F.
- OPERATION OF THE AV-8B AIRCRAFT IS RESTRICTED TO AMBIENT TEMPERATURES ABOVE 0 °C (+32 °F) WHEN USING FUEL WHICH DOES NOT CONTAIN FUEL SYSTEM ICING INHIBITOR (FSII). OPERATION BELOW 0 °C WITH FUEL THAT DOES NOT CONTAIN FSII MAY RESULT IN THE ICING OF THE ENGINE FUEL FILTER AND LOSS OF FUEL FLOW TO THE ENGINE. WHEN USING FUELS WHICH DO NOT CONTAIN FSII IT IS ESPECIALLY IMPORTANT TO REMOVE WATER FROM THE AIRCRAFT'S LOW POINT DRAINS TO MINIMIZE THE POSSIBILITY OF ICING AND MICROBIOLOGICAL GROWTH.
- PILOTS/AIRCREW SHALL ENSURE THAT AIRCRAFT MAINTENANCE DEPARTMENTS ARE INFORMED WHEN AIRCRAFT ARE FUELED WITH THE EMERGENCY FUEL JP-8+100 (F-37).
- NAVAIR 00-80T-109 (AIRCRAFT REFUELING NATOPS MANUAL) CONTAINS SPECIAL PROCEDURES THAT MUST BE FOLLOWED WHEN IT BECOMES NECESSARY TO DEFUEL AIRCRAFT THAT HAVE BEEN FUELED WITH THE EMERGENCY FUEL JP-8+100 (F-37). SINCE THERE IS NO VIABLE FIELD TEST THAT CAN DETECT THE PRESENCE OF JP-8+100 (F-37), PILOTS/AIRCREW AND AIRCRAFT MAINTENANCE PERSONNEL SHALL ENSURE THAT FUELS PERSONNEL ARE INFORMED OF AIRCRAFT THAT HAVE BEEN FUELED WITH THE EMERGENCY FUEL JP-8+100 (F-37).

Figure 4-1. AV-8B Fuel Reference Chart (Sheet 1 of 2)

COMMENTS

1. FUEL DEFINITIONS:
   a. PRIMARY FUEL - A FUEL THAT THE AIRCRAFT IS AUTHORIZED TO USE FOR CONTINUOUS UNRESTRICTED OPERATIONS.
   b. RESTRICTED FUEL - A FUEL WHICH IMPOSES OPERATIONAL RESTRICTIONS ON THE AIRCRAFT. THESE FUELS MAY BE USED ONLY IF NO PRIMARY MILITARY OR COMMERCIAL FUELS ARE AVAILABLE.
   c. EMERGENCY FUEL - A FUEL WHICH MAY BE USED FOR A MINIMUM TIME WHEN A PRIMARY OR RESTRICTED FUEL IS NOT AVAILABLE AND AN URGENT NEED EXISTS (SUCH AS HURRICANE EVACUATION OR URGENT MILITARY NECESSITY). PILOT APPROVAL SHALL BE OBTAINED BEFORE SERVICING AND THE AIRCRAFT SHALL BE CONSPICUOUSLY PLACARDED WITH THE EMERGENCY FUEL GRADE WHEN SERVICED.
2. ALL US MILITARY AND NATO FUELS, EXCEPT F-35, CONTAIN AN ADDITIVE PACKAGE WHICH INCLUDES FUEL SYSTEM ICING INHIBITOR (FSII).
3. JP-4, JP-8, TS-1, JP-8+100 AND ALL COMMERCIAL JET FUELS SHALL NOT BE DEFUELED INTO SHIPBOARD JP-5 FUEL STORAGE TANKS BECAUSE THE FLASH POINT OF THESE FUELS IS LESS THAN 140 °F.
4. JP-4 (F-40) HAS BEEN REPLACED BY JP-8 (F-34) IN US AND NATO SERVICE. JP-4 (F-40) AND JET B ARE NO LONGER WIDELY AVAILABLE WORLDWIDE BUT MAY STILL BE ENCOUNTERED IN SOME AREAS.
5. COMMERCIAL FUELS ARE AVAILABLE BOTH WITH AND WITHOUT FSII. SEE THE CAUTION ABOVE WHEN OPERATING THE AV-8B AIRCRAFT ON FUELS THAT DO NOT CONTAIN FSII.
6. PRIST. A COMMERCIAL FSII ADDITIVE, PRIST, MAY BE USED WITH COMMERCIAL JET FUEL (JET A/JET A-1/JET B). PRIST IS EQUIVALENT TO THE MILITARY FSII ADDITIVE. IT IS AVAILABLE IN TWO FORMS: (1) AEROSOL CANS WHICH ARE DISCHARGED INTO THE FUEL AS IT IS PUMPED INTO THE AIRCRAFT AND (2) PRE-MIXED INTO THE FUEL. WHEN PRIST IS PREMIXED WITH THE FUEL IT PROVIDES ANTI-ICING PROTECTION EQUIVALENT TO THAT PROVIDED BY MILITARY JET FUEL AND IS AUTHORIZED FOR USE. PRIST IN AEROSOL CANS IS NOT AUTHORIZED FOR USE SINCE IT DOES NOT MIX WELL WITH FUEL, HAS A TENDENCY TO SETTLE TO THE BOTTOM OF FUEL TANKS, AND MAY DAMAGE FUEL SYSTEM SEALS AND FUEL TANK MATERIALS.
7. TS-1 IS A COMMERCIAL AVIATION KEROSENE MADE TO THE RUSSIAN FUEL SPECIFICATION GOST 10227. IT IS VERY SIMILAR TO ASTM JET A-1 WITH THE EXCEPTION THAT THE FLASH POINT IS APPROXIMATELY 20 °C LOWER THAN JET A-1. THIS FUEL IS COMMONLY AVAILABLE IN RUSSIA, PARTS OF CENTRAL EUROPE, THE CENTRAL ASIAN REPUBLICS AND AFGHANISTAN.

CAUTION

TS-1 CONTAINING THE RUSSIAN FSII ADDITIVE IS NOT AUTHORIZED FOR USE. ITS IMPACT ON NAVY AND MARINE CORPS AIRCRAFT HAS NOT BEEN DETERMINED.

8. JP-8+100 (F-37) CONTAINS A THERMAL STABILITY ADDITIVE THAT AFFECTS THE ABILITY OF THE COALESCING FILTER-SEPARATORS AND CENTRIFUGAL PURIFIERS (FILTRATION EQUIPMENT USED IN SHORE STATION AND SHIPBOARD FUEL STORAGE/HANDLING SYSTEMS) TO REMOVE FREE WATER AND FINE PARTICULATE MATTER FROM FUEL. NAVAIR 00-80T-109 (AIRCRAFT REFUELING NATOPS MANUAL) CONTAINS ADDITIONAL INFORMATION ON JP-8+100 (F-37). NO USN/USMC AIRCRAFT ENGINES REQUIRE THE USE OF JP-8+100 (F-37). USN/USMC AIRCRAFT ARE NOT AUTHORIZED TO USE JP-8+100 (F-37) EXCEPT IN EMERGENCY SITUATIONS.

FOR ADDITIONAL INFORMATION ON AVIATION FUELS, CONSULT THE FOLLOWING:

1. NAVAIR 00-80T-109, AIRCRAFT REFUELING NATOPS MANUAL.
2. MIL-HDBK-844A (AS), REFUELING HANDBOOK FOR NAVY/MARINE CORPS AIRCRAFT.

Figure 4-1. AV-8B Fuel Reference Chart (Sheet 2)

F402-RR-406

RATING	LIMITATIONS		
	MAXIMUM % RPM [6]	MAXIMUM JPT °C [5]	COMBINED TIME LIMITS
SHORT LIFT WET [1]	107.0	727	15 SEC / 1.5 MIN / 2.5 MIN [3] / 10 MIN [3] / 15 MIN
SHORT LIFT DRY	103.0	703	
NORMAL LIFT WET [1] [2]	104.5	702	
NORMAL LIFT DRY [2]	100.5	684	
COMBAT	99.0	665	
MAXIMUM THRUST	99.0	625	
MAXIMUM CONTINUOUS [2]	91.0	570	UNLIMITED
IDLE	[7] 25.8 – 26.2	535	UNLIMITED
STARTING [2]	———	[4] 475	MOMENTARILY

NOTES

[1] DO NOT USE WATER INJECTION BELOW AMBIENT TEMPERATURES OF −5 °C OR AT ALTITUDES ABOVE 10,000 FEET.

[2] REQUIRES PILOT ACTION TO MAINTAIN LIMIT.

[3] EACH 2.5 OR 10-MINUTE PERIOD OF OPERATION AT THE LIFT OR COMBAT RATINGS RESPECTIVELY MUST BE SEPARATED BY A MINIMUM OF 1 MINUTE AT MAXIMUM THRUST OR BELOW.

[4] SLOW OR ABORTIVE STARTING ATTEMPTS SHOULD BE DISCONTINUED WITHOUT WAITING FOR JPT TO REACH 475 °C.

[5] COCKPIT INDICATED JPT MAY VARY ±5 °C.

[6] COCKPIT INDICATED N_F MAY VARY ±0.25%.

[7] THE MINIMUM ALLOWABLE SUB-IDLE RPM IS 20%.

- CORRECTED FAN SPEED IS LIMITED TO 106.5% (±0.5%) BELOW 10,000 FEET MSL AND 102.5% (±0.5) ABOVE 30,000 FEET.
- WHEN MANUAL FUEL IS SELECTED, PILOT ACTION IS REQUIRED TO MAINTAIN ALL ENGINE LIMITS. MAXIMUM THROTTLE POSITION IN MFS WILL PROVIDE APPROXIMATELY 111.0% CORRECTED FAN SPEED VERSUS THE 116.8% CORRECTED FAN SPEED LIMITATION PROVIDED UNDER DECS CONTROL. ACTUAL MECHANICAL SPEED AND THRUST ACHIEVED IN MFS WILL VARY WITH AMBIENT CONDITIONS. ANTICIPATE MAXIMUM ACHIEVABLE MFS PERFORMANCE EQUAL TO OR SLIGHTLY LESS THAN SHORT LIFT DRY PERFORMANCE UNDER DECS CONTROL WHEN OPERATING NEAR SEA LEVEL STATIC CONDITIONS.
- AT HIGH AMBIENT TEMPERATURE, WITH A HOT ENGINE USING JP-4 FUEL AND RPM BELOW 50%, AN INTERMITTENT BEAT MAY BE EMITTED BY ENGINE. THIS CONDITION SHOULD BE AVOIDED BY INCREASING RPM UNTIL BEAT CEASES.
- USE OF FULL 10-MINUTE COMBAT RATING MUST BE MONITORED CAREFULLY TO PRECLUDE PREMATURE ENGINE REMOVAL FOR COUNT DISSIPATION.
- MAXIMUM OVERSPEED IS 109% FOR 15 SECONDS OR 110%.
- TO COMPUTE MINIMUM IDLE, A STANDARD LAPSE RATE OF 1% RPM INCREASE PER 1,000 FEET PRESSURE ALTITUDE, STARTING AT 1,500 FEET PRESSURE ALTITUDE, IS USED.
- EXCLUDING P3 LIMITING, NORMAL RPM FLUCTUATIONS OF UP TO ±0.5 N_F CAN BE EXPERIENCED DURING OPERATION UNDER DECS CONTROL. FLUCTUATIONS GREATER THAN ±0.5% N_F MAY BE INDICATIVE OF A HARD OR IMPENDING COMPONENT FAILURE.

AHR602-425-1-035

Figure 4-2. Engine Operating Limitations (Sheet 1 of 2)

F402-RR-408

RATING	LIMITATIONS		
	MAXIMUM %RPM [6]	MAXIMUM JPT °C [5]	COMBINED TIME LIMITS
SHORT LIFT WET [1]	120.0	800	15 SEC; 1.5 MIN; 2.5 MIN [3]; 10 MIN [3]; 15 MIN
SHORT LIFT DRY	113.5	780	
NORMAL LIFT WET [1] [2]	116.0	780	
NORMAL LIFT DRY [2]	111.0	765	
COMBAT	111.0	750	
MAXIMUM THRUST	109.0	710	
MAXIMUM CONTINUOUS [2]	102.0	645	UNLIMITED
IDLE	[7] 28.4 – 29.0	545	UNLIMITED
STARTING [2]	————	[4] 475	MOMENTARILY

NOTES

[1] DO NOT USE WATER INJECTION BELOW AMBIENT TEMPERATURES OF –5 °C OR AT ALTITUDES ABOVE 10,000 FEET.

[2] REQUIRES PILOT ACTION TO MAINTAIN LIMIT.

[3] EACH 2.5 OR 10-MINUTE PERIOD OF OPERATION AT THE LIFT OR COMBAT RATINGS RESPECTIVELY MUST BE SEPARATED BY A MINIMUM OF 1 MINUTE AT MAXIMUM THRUST OR BELOW.

[4] SLOW OR ABORTIVE STARTING ATTEMPTS SHOULD BE DISCONTINUED WITHOUT WAITING FOR JPT TO REACH 475 °C.

[5] COCKPIT INDICATED JPT MAY VARY ±5 °C.

[6] COCKPIT INDICATED N_F MAY VARY ±0.25%.

[7] THE MINIMUM ALLOWABLE SUB-IDLE RPM IS 22%.

- CORRECTED FAN SPEED IS LIMITED TO 116.8% (±0.5%) BELOW 10,000 FEET MSL AND 110.5% (±0.5%) ABOVE 30,000 FEET.
- WHEN MANUAL FUEL IS SELECTED, PILOT ACTION IS REQUIRED TO MAINTAIN ALL ENGINE LIMITS.
- AT HIGH AMBIENT TEMPERATURE, WITH A HOT ENGINE USING JP-4 FUEL AND RPM BELOW 50%, AN INTERMITTENT BEAT MAY BE EMITTED BY ENGINE. THIS CONDITION SHOULD BE AVOIDED BY INCREASING RPM UNTIL BEAT CEASES.
- USE OF FULL 10-MINUTE COMBAT RATING MUST BE MONITORED CAREFULLY TO PRECLUDE PREMATURE ENGINE REMOVAL FOR COUNT DISSIPATION.
- MAXIMUM OVERSPEED IS 122% FOR 15 SECONDS OR 124.0%.
- TO COMPUTE MINIMUM IDLE, A STANDARD LAPSE RATE OF 1% RPM INCREASE PER 1000 FEET PRESSURE ALTITUDE, STARTING AT 1500 FEET PRESSURE ALTITUDE, IS USED.
- EXCLUDING P3 LIMITING, NORMAL RPM FLUCTUATIONS OF UP TO ±0.5% N_F CAN BE EXPERIENCED DURING OPERTION UNDER DECS CONTROL. FLUCTUATIONS GREATER THAN ±0.5% N_F MAY BE INDICATIVE OF A HARD OR IMPENDING COMPONENT FAILURE.

AHR602-425-2-035

Figure 4-2. Engine Operating Limitations (Sheet 2)

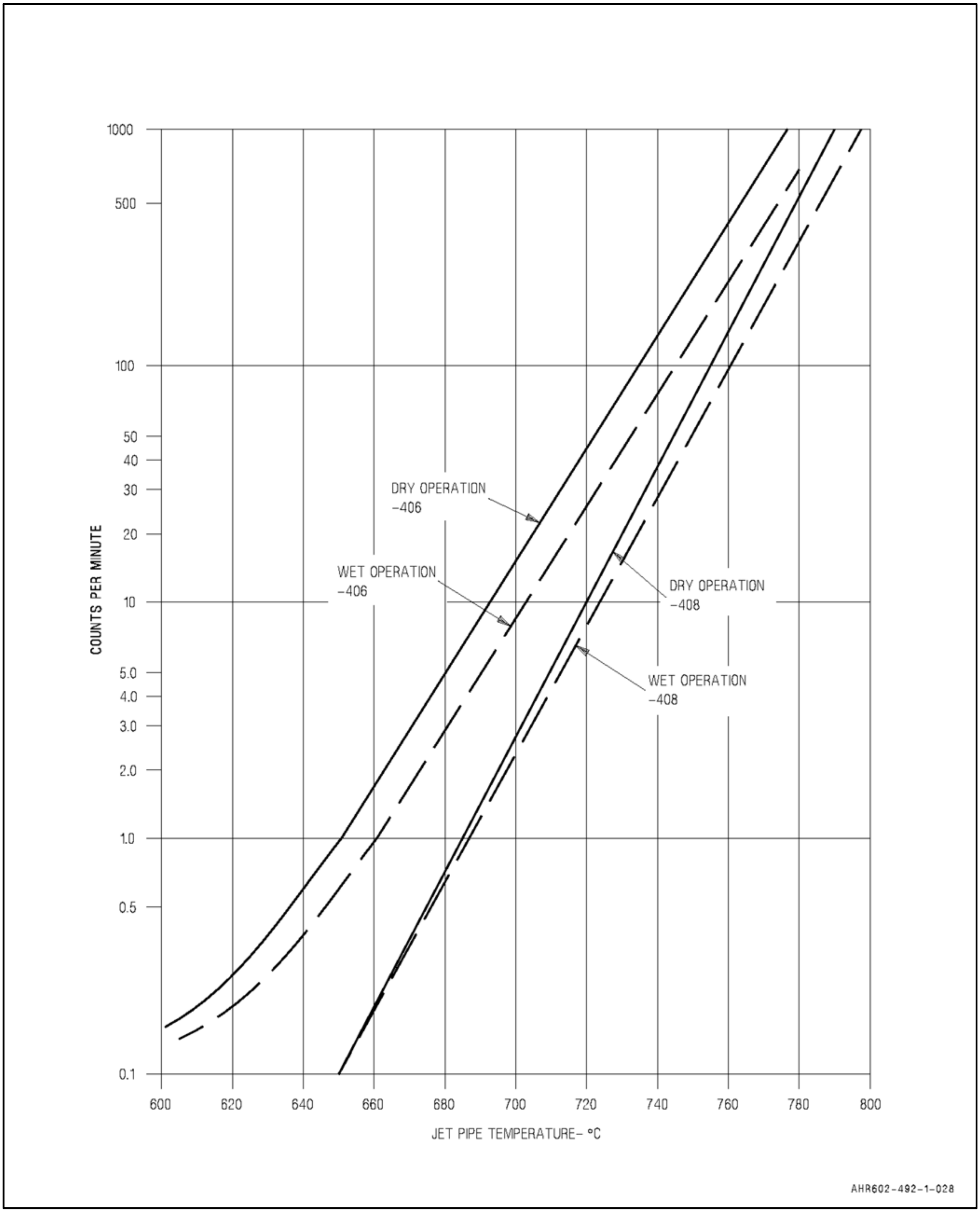


Figure 4-3. Engine Life Count Rates Versus JPT

4.2.4 Engine Starting Limitations

A starting attempt should be abandoned immediately if:

1. RPM stagnates below idle rpm.
2. JPT reaches 475 °C. If JPT rises rapidly between 350 °C and 400 °C, throttle OFF before 475 °C.
3. Light up has not occurred within 10 seconds of selecting idle.
4. Engine should not be started with flaps greater than 25°.

Do not select idle after start on a hot engine until JPT is below 150 °C.

Note

Engine start should not be attempted if OAT is less than −35 °C or greater than 52 °C.

If the engine fails to light, a fuel drainage period of 1 minute must be allowed before a further starting attempt is made.

4.2.5 Engine Airstart Envelope

See Figure 4-4.

4.2.6 Inlet Guide Vane Angles

For the F402−RR−406 engine the IGV setting band at 55 percent rpm is presented in Figure 4-5.

For the F402−RR−408 engine the IGV setting band at 60 percent rpm is presented in Figure 4-5.

The IGV schedule presented in Figure 4-6 is applicable to both −406 and −408 engines.

4.2.7 Water Injection Limitations

Distilled or demineralized water (per NAVAIR Instruction 13780.1) must be used whenever possible. Repeated use of other than distilled or demineralized water results in deterioration of engine performance. Water injection is not to be used if OAT is below −5 °C.

4.2.8 Engine Bleed Limitations

More than 5 minutes of continuous engine bleed in hover flight is prohibited. Continuous hover flight must be followed by a cooling period (forward flight or ground operations) of the same duration.

4.3 APU STARTING AND OPERATING ENVELOPE

Unless an external air supply is used to cool the electric starter motor, no more than three GTS/APU start cycles (within a 20 minute period) may be made, with at least 1 minute between attempts. To prevent damage/failure to the GTS main gearbox, engine start cycle may not be repeated following a failed or aborted engine start attempt until engine HP compressor rotation completely stops and the minimum 1 minute interval between start attempts is met. Refer to Figure 4-7 for inflight APU starting and operating envelope.

4.4 AIRSPEED LIMITATIONS

The maximum permissible airspeeds for flight in smooth or moderately turbulent air with landing gear and flaps retracted, the speed brake retracted, and Q−feel engaged is shown in Figure 4-8. The maximum permissible airspeed/Mach number, whichever is less:

AV−8B – 585 KCAS/1.0 indicated mach number (IMN).
TAV−8B – 550 KCAS/0.9 IMN.

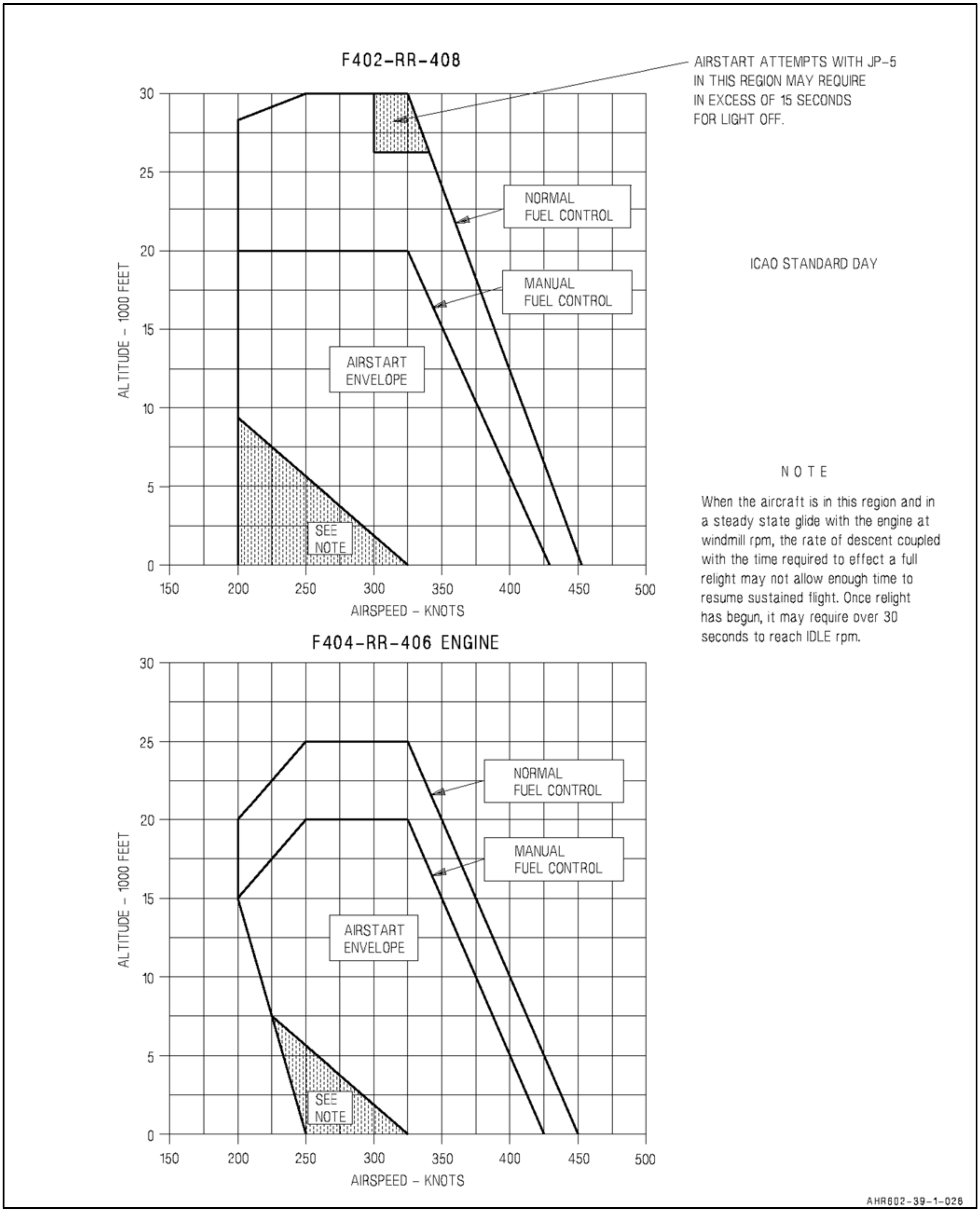


Figure 4-4. Engine Airstart Envelope

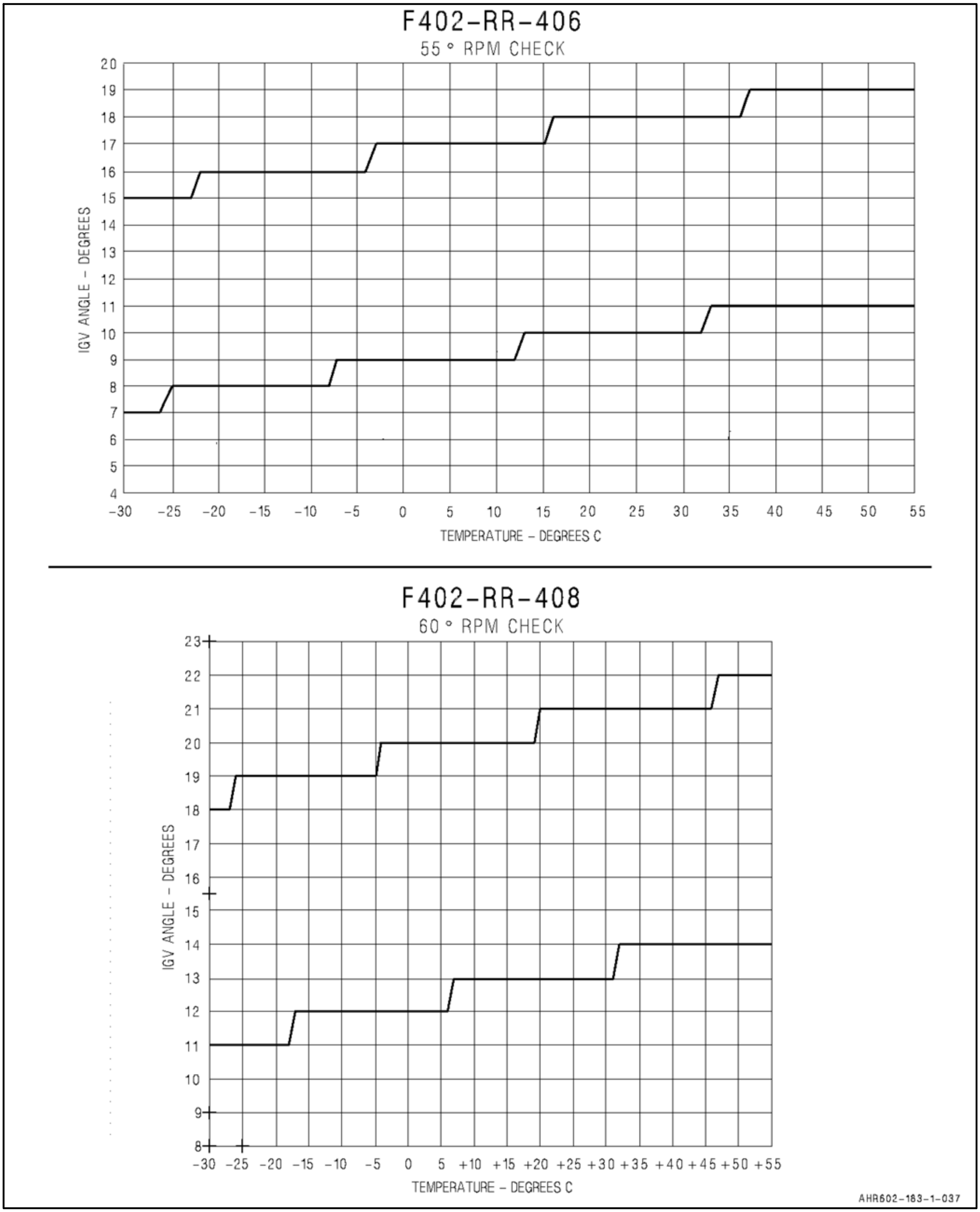


Figure 4-5. Effect of OAT on Variable Inlet Guide Vanes Engine

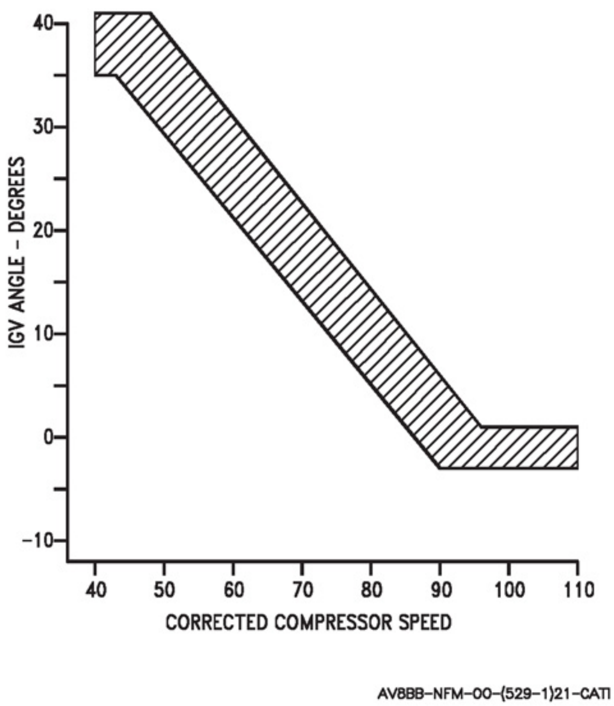


Figure 4-6. IGV Schedule

Airspeed limitations for various systems are as follows:

1. Flaps: STOL — 300 knots CRUISE — 0.87 Mach.
2. Landing gear operation — 250 knots.
3. Landing gear locked down — 250 knots.
4. Landing gear emergency extension — 210 knots.
5. Q-feel disengaged — 500 knots.
6. One hydraulic system inoperative — 500 knots.
7. Canopy open — 40 knots.
8. Wheels in contact with ground — 180 knots ground speed.
9. LIDS fence extended — 200 knots.
10. Air refueling probe extended — 300 knots.
11. Max airspeed for STOL flap landings — 130 knots.
12. With F402-RR-406 engine before PPC 170 and sea level ambient temperature below -1 °F and pressure altitude below 2,500 feet — 510 KCAS. With F402-RR-406 engine after PPC-170 — Normal limits.

4.5 PROHIBITED MANEUVERS (ALL AIRCRAFT)

1. Vertical takeoff with asymmetric load/stores greater than 45,000 inch-pounds.
2. STO with asymmetric load/stores greater than 85,000 inch-pounds or conventional takeoff (CTO) with asymmetric load/stores greater than 100,000 inch-pounds.

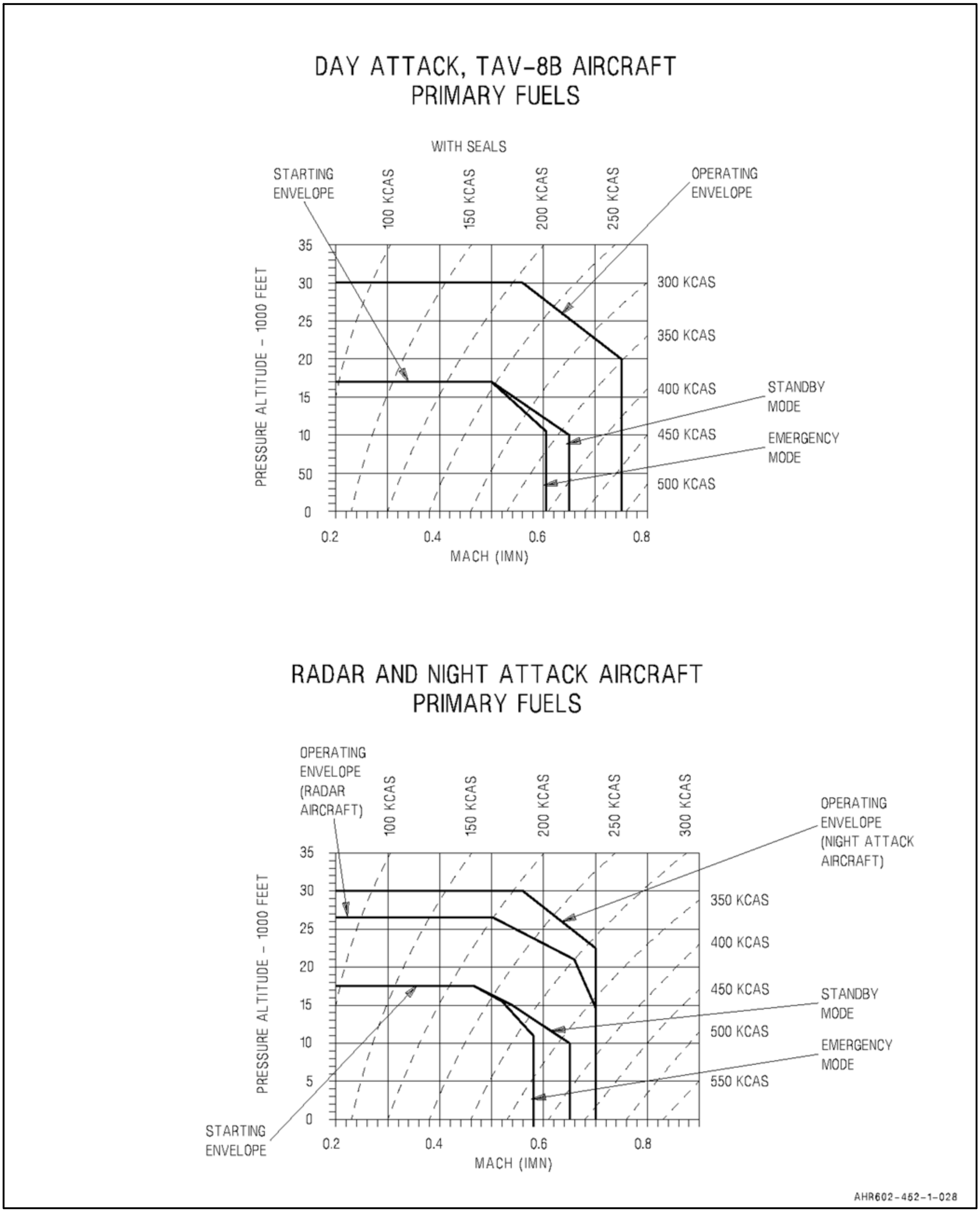


Figure 4-7. APU Starting and Operating Envelope (Sheet 1 of 2)

CAUTION

- If the GTS/APU inflight operating limits are exceeded, overheat damage may occur. Excessive heat damage can lead to GTS turbine failure with blade pieces exiting the GTS exhaust duct at high velocity.
- Continuous operation is affected by altitude, airspeed, AOA, and ambient air temperature. Limit maneuvers to 2 G and minimize to that required to safely recover the aircraft. If hard maneuvering is attempted near the edge of the envelope, the APU will probably over-temp with no warning or cockpit indication.
- When using alternate fuels, subtract 2,500 ft MSL (Day attack, Night attack, and TAV-8B aircraft) or 5,000 ft MSL (Radar aircraft) from GTS/APU standby start and emergency start envelopes or GTS/APU over temperature will result.

NOTES

- Emergency mode is a GTS start with main generator off line. Standby mode is a GTS start with main generator on and functioning normally.
- A successful start is controlled by many variables. The most important pilot controlled variables are altitude and airspeed. The chance of a successful start is improved by attempting a start as near the center of the envelope as possible. Repeated start attempts with the generator inoperative will reduce the battery voltage and decrease the likelihood of a successful start. A failed starting attempt is characterized by the APU failing to accept the electrical load.
- The APU requires 28 VDC bus power for starts in the standby mode or aircraft battery power for starts in the emergency mode.

Figure 4-7. APU Starting and Operating Envelope (Sheet 2)

3. Shipboard STO with asymmetric load/stores greater than 57,270 inch-pounds.
4. AUTO flaps — Slow landing (SL) with more than 148,000 inch-pounds asymmetry, or STOL flaps — SL with more than 85,000 inch-pounds asymmetry.
5. Vertical landing (VL) with more than 80,000 inch-pounds asymmetry.
6. Takeoff with less than 10° nozzles until wingborne.
7. Spin.
8. Under 1 g for more than 15 seconds.
9. Overriding aileron high speed stop.
10. Roll over 360°.
11. In accelerating or decelerating transition:
    a. Over 15° AOA above 50 knots with landing gear down.
    b. Between 30 to 100 knots, sideslip requiring more than 1/2 lateral stick or with RPS on.
12. Rearward or sideward translation above 30 knots.
13. TVC above 20,000 feet Mean Sea Level (MSL) with the -406 engine or 30,000 feet MSL with the -408 engine at AOA above onset of stall warning/maneuvering tone or at less than 0 g.
14. Over 80 percent rpm above 25,000 feet MSL at less than 0 g (-406 engine only).
15. Flight above onset of stall warning/maneuvering tone with more than 60,000 inch-pounds asymmetry.
16. Abrupt simultaneous stabilator, rudder, or aileron inputs with more than 90,000 inch-pounds asymmetry.
17. Wingborne flight at any speed with more than 148,000 inch-pounds asymmetry, or flight above 0.88 Mach with more than 90,000 inch-pounds asymmetry. For asymmetries above 90,000 inch-pounds, maneuvering limit is 5 g, 10° AOA or stall warning, whichever occurs first.

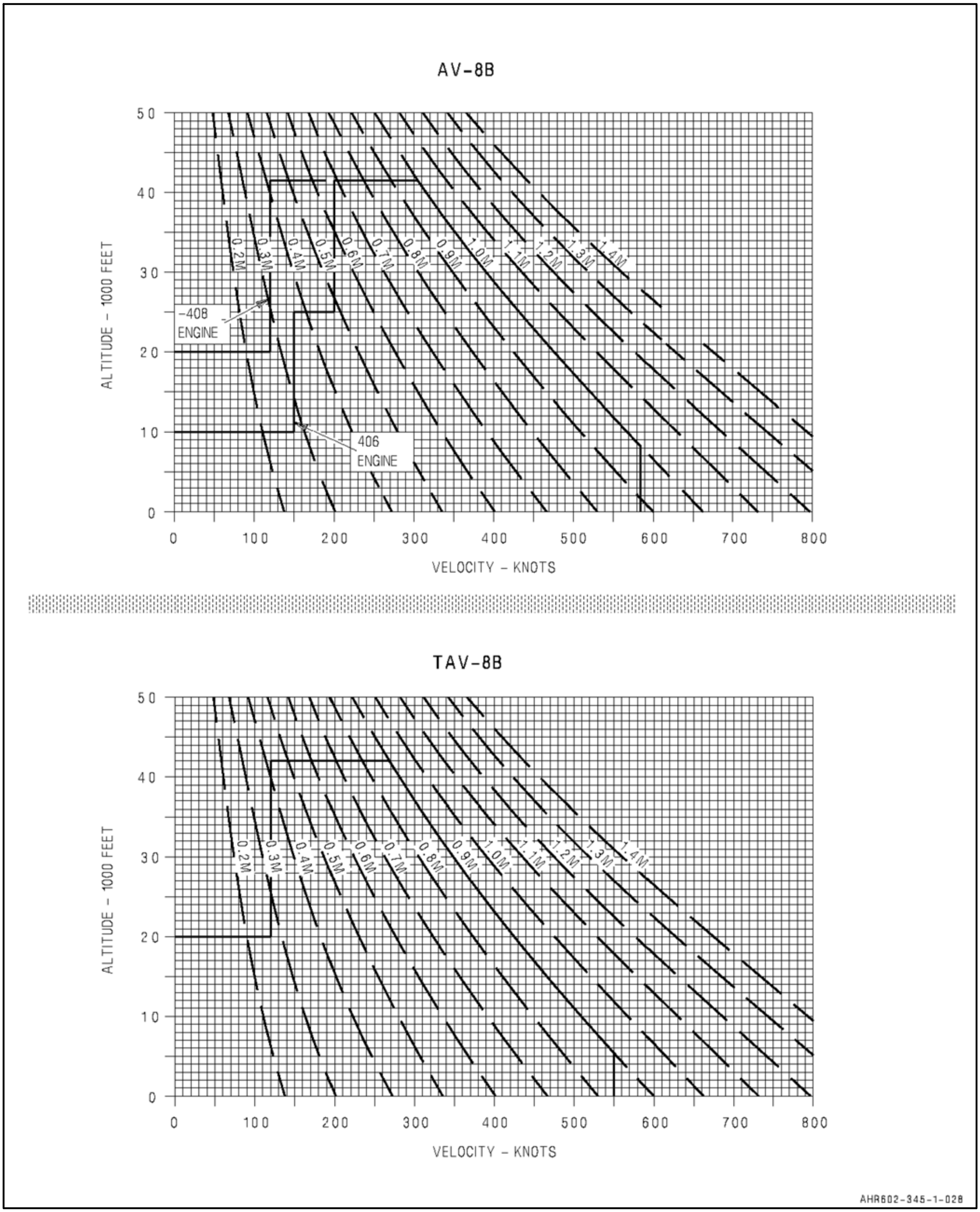


Figure 4-8. Airspeed Limitations

18. Departure above 250 knots.

19. Rudder deflection above 0.80 Mach.

4.5.1 Prohibited Maneuvers (SAAHS OFF)

1. Departure or stall.

2. Roll over 180° above 8° AOA.

3. Abrupt input of more than 1/2 rudder.

4. More than 1/2 lateral stick beyond onset of stall warning or with flap switch in CRUISE.

4.5.2 Prohibited Maneuvers (TAV-8B)

All those for the AV-8B as presented in this manual including:

1. Intentional stalls, tail slides, departures, spins, or flops.

2. Airspeed less than 120 KCAS in nose high conditions.

3. Rolling maneuvers in excess of 180° at more than 1 g.

4. Wingborne or TVC maneuvering flight above maneuvering tone.

4.5.3 Prohibited Maneuvers (Radar Aircraft)

All those for the AV-8B as presented in this manual including:

1. Abrupt (less than 1/2 second) lateral stick inputs to high speed stops with SAAHS — ON, above 3 g for speeds greater than 475 KCAS at altitudes less than 10,000 feet MSL.

2. Abrupt (less than 1/2 second) lateral stick inputs to high speed stops with SAAHS — OFF.

4.6 AOA LIMITATIONS (SAAHS OFF)

AOA limit versus Mach number with flaps AUTO, SAS OFF and nozzles 0° is shown in Figure 4-9. The limits are coincident with the maneuvering tone. AOA is also limited to that where onset of buffet, wing rock or sideslip buildup occurs. During abrupt maneuvers, HUD AOA lags the actual AOA.

4.7 CG LIMITATIONS

Refer to the Weight and Balance Data handbook, NAVAIR 01-1B-40.

4.8 WEIGHT LIMITATIONS

Maximum gross weight for taxi and takeoff is 32,000 pounds. Avoid abrupt maneuvering and hard braking at taxi gross weights above 29,750 pounds. Maximum gross weight for landing is 26,000 pounds.

4.9 SINK RATE LIMITATIONS

See Figure 4-10. For sink rate limitations at gross weights above 25,000 pounds, use RADAR/TAV-8B limits.

4.10 ACCELERATION LIMITATIONS

1. The maximum permissible acceleration in the takeoff and landing configuration is 0.0 g to +2.0 g's.

2. The maximum permissible acceleration in smooth air with flaps AUTO or CRUISE for aircraft with empty pylons or air-to-air loads is shown in Figure 4-11. An air-to-air load is two AIM-9 on outboard pylons and a gun.

3. For any other configuration, refer to Tactical Manual, A1-AV8BB-TAC-050, for external stores limitations.

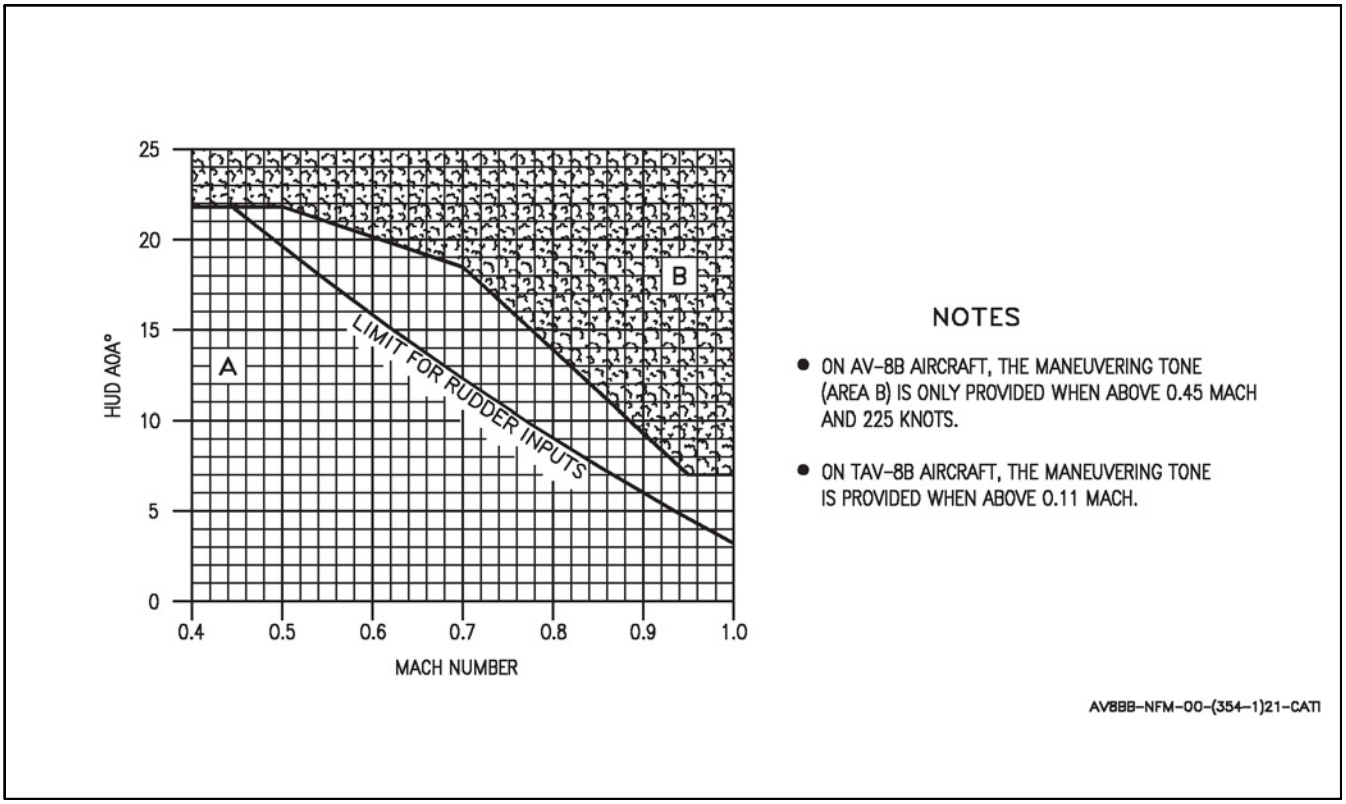


Figure 4-9. AOA Limits – Flaps – AUTO – SAS OFF – Nozzles 0°

4. Following a departure, the pilot should use the Maximum Possible Normal Load Factor chart (Figure 4-12) to estimate the maximum load factor (NZ) attained by the aircraft. An over–g inspection of the aircraft per the A1–AV8BB–GAI–400 maintenance manual is required if the estimated NZ exceeds the allowable structural load factor limit.
5. On TAV–8B, refer to Figure 4-11 for acceleration limitations.

4.11 CROSSWIND LIMITATIONS

Paved runway (minimum width 100 feet).

For wet runway operation, reduce crosswind limits by 5 knots.

4.11.1 Takeoffs

1. CTO (day or night) — 20 knots.
2. STO > 120 knots (day or night) — 15 knots.
3. STO ≦ 120 knots (day or night) — 10 knots.
4. RVTO Day — 10 knots, Night — 5 knots.
5. VTO (day or night) — 10 knots.

4.11.2 Landings

1. Approach speeds ≧ 140 knots Day — 20 knots, Night — 15 knots.
2. Approach speeds < 140 knots Day — 15 knots, Night — 10 knots.
3. Gross weights > 19,550 pounds, all approach speeds (day or night) — 10 knots.
(Due to outrigger stress limitations.)
4. Refer to Figure 4-13 for crosswind landing capability.

4.12 ARRESTING GEAR LIMITATIONS

The aircraft is cleared to taxi over a supported arresting gear wire up to a maximum speed of 5 knots. Stop immediately if wing gear is trapped by the wire. The aircraft may cross an unsupported tensioned arresting gear wire at any speed, engine rpm or nozzle angle if the wire lies flat on the runway or deck.

4.13 SYSTEMS LIMITATIONS

4.13.1 Global Positioning System

GPS is for tactical use only and does not meet Federal Aviation Administration (FAA) standards for en route or terminal phase of flight.

4.13.2 All Weather Landing System

Use of AWLS is limited to weather minimum of 400-foot ceiling and 1 nm visibility.

4.13.3 Automatic Flight Controls

1. Use of basic attitude hold mode above 0.85 Mach is prohibited.
2. Use of altitude hold (ALT) below 500 feet AGL is prohibited.
3. Use of control stick steering in pitch with ALT engaged is prohibited.

4.13.4 Canopy (AV-8B)

1. Canopy open with wind over 40 knots is prohibited.
2. Canopy open with rpm over 70 percent is prohibited.

4.13.5 Canopy (TAV-8B)

1. Both canopies shall remain closed and locked during taxi. This restriction does not apply if the vent strap is used to hold the canopy open.

4.13.6 Nozzle/Flap Limitations

1. During normal in-flight operations, with the exception of air refueling, use of STOL flaps is limited to nozzle positions greater than 25°.

4.13.7 APG-65 Operations (Radar Aircraft)

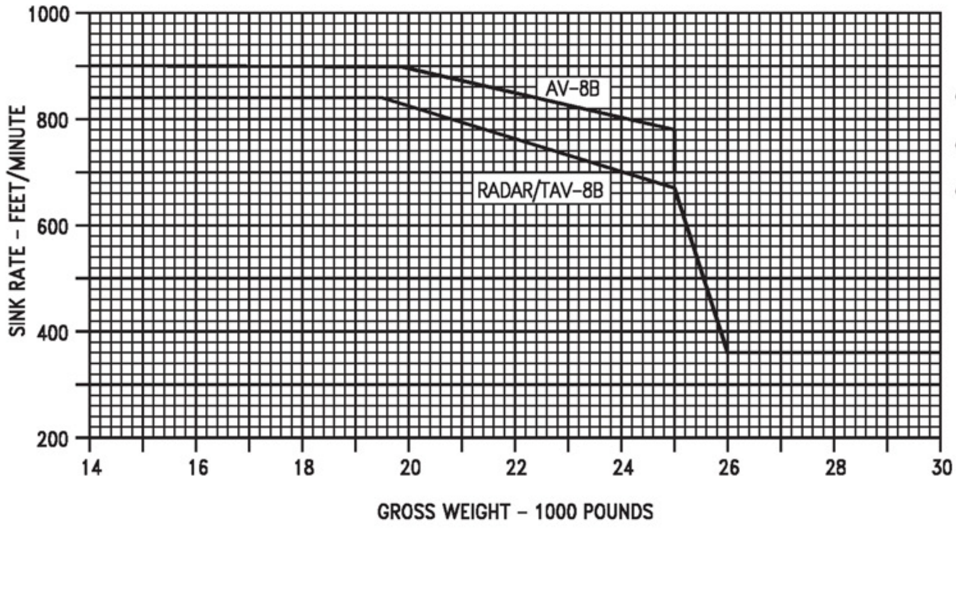
1. Use of terrain avoidance mode of radar in instrument meteorology conditions is prohibited.

4.13.8 Software (H4.0 only)

1. Flight with a software configuration fault is prohibited.

4.14 EXTERNAL STORES LIMITATIONS

Refer to NATIP, NTRP 3-22.4-AV8B.



NOTES

- PITCH ATTITUDE RANGE 5° TO 12°
- ROLL ATTITUDE ± 3.5°
- LATERAL DRIFT AND YAW ATTITUDE MINIMIZED PRIOR TO TOUCHDOWN.

Figure 4-10. Sink Rate Limitations

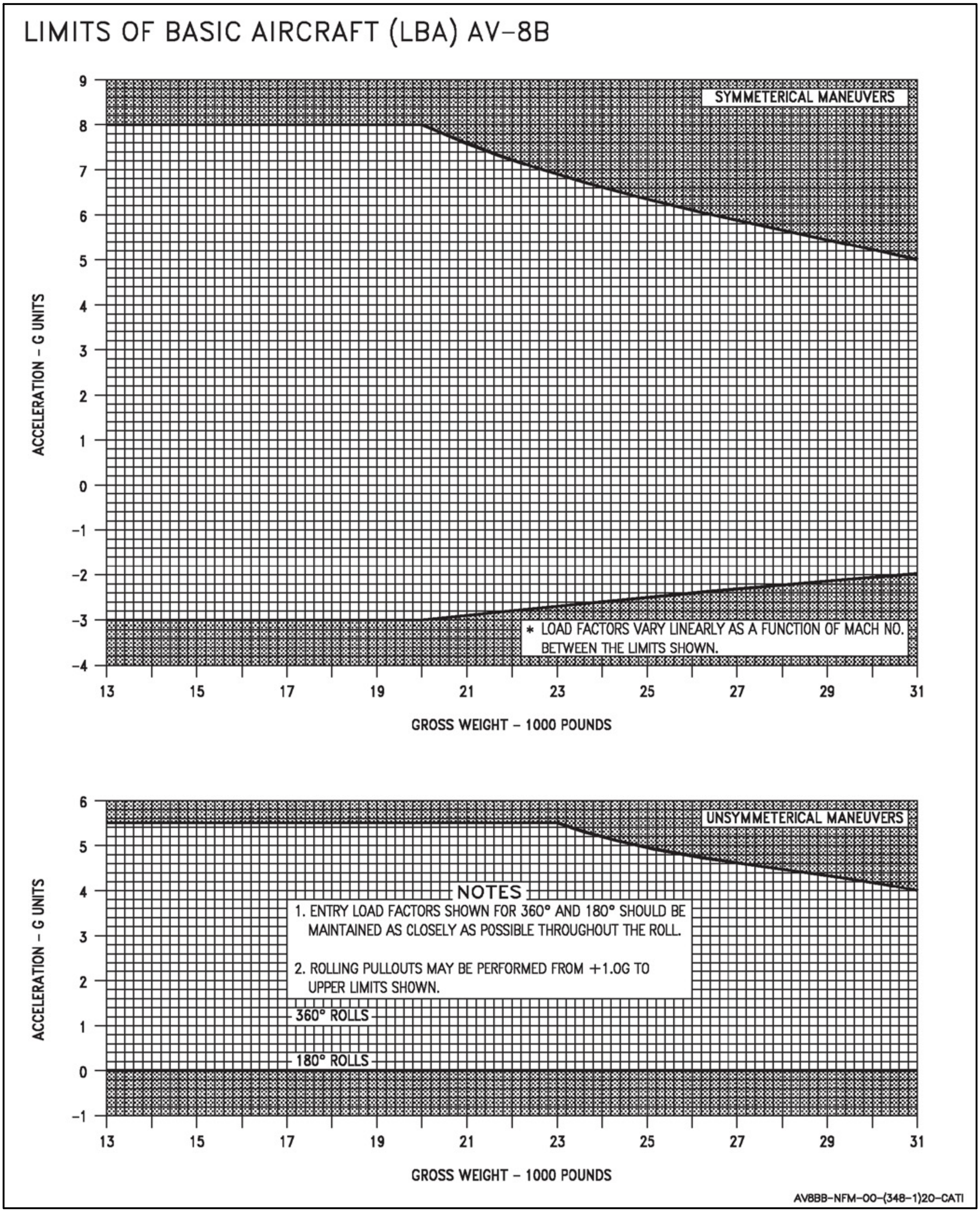


Figure 4-11. Acceleration Limitations (Sheet 1 of 2)

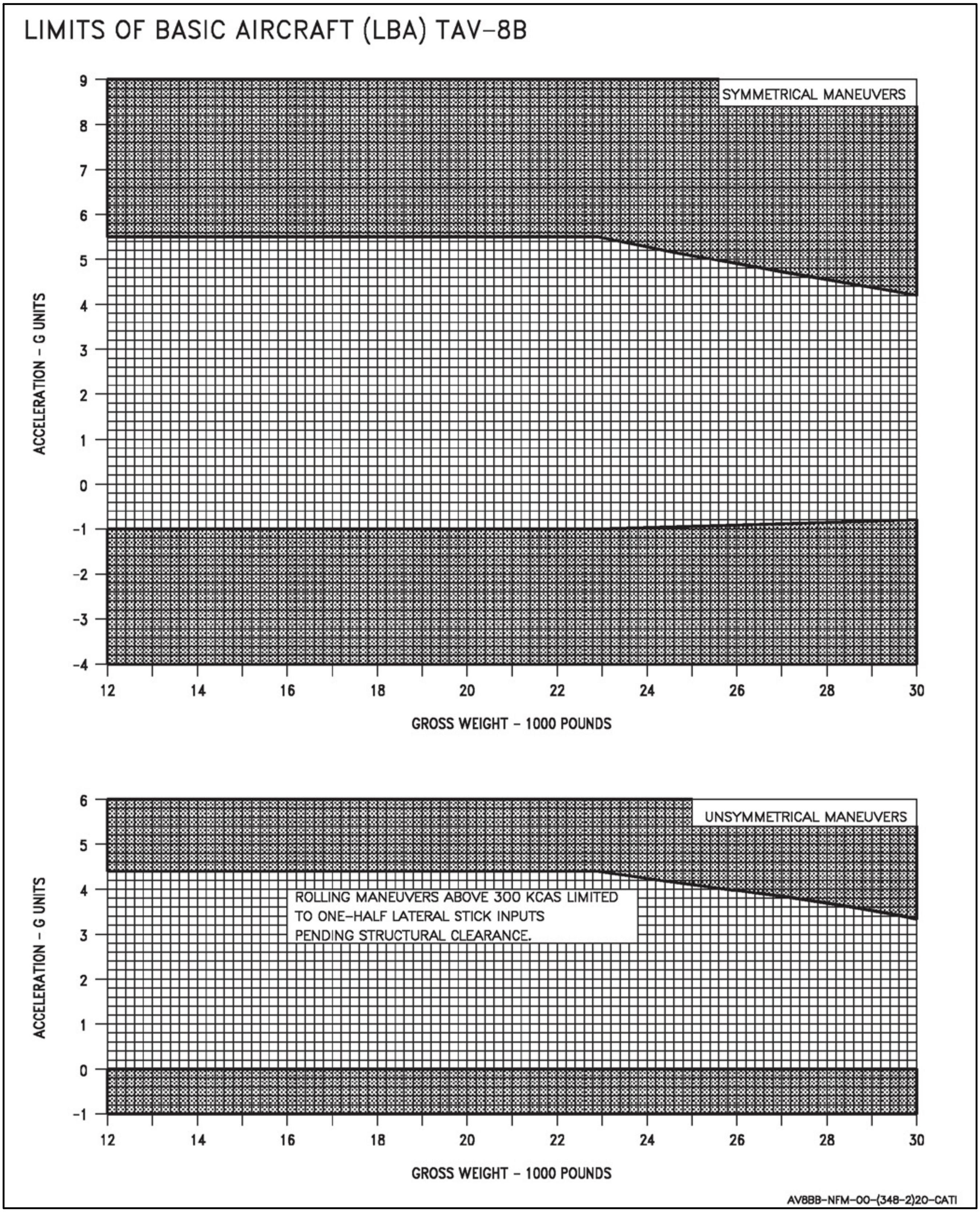


Figure 4-11. Acceleration Limitations (Sheet 2)

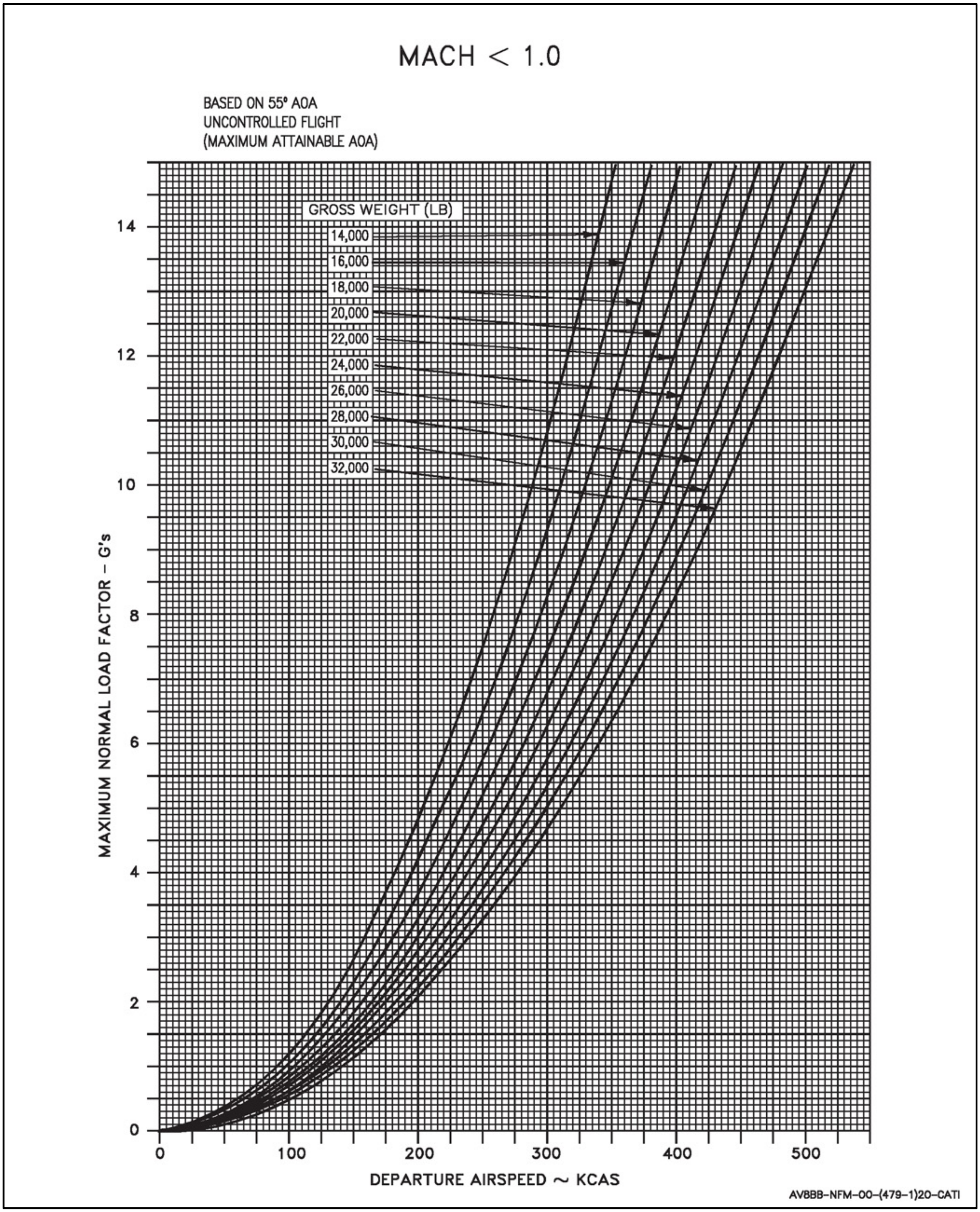
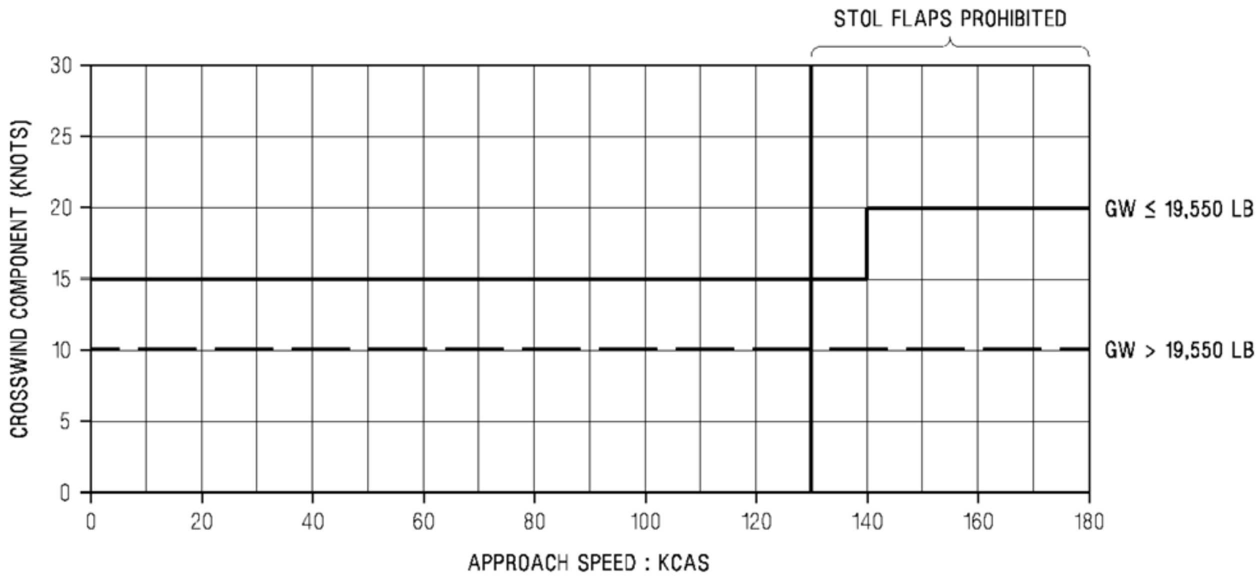


Figure 4-12. Maximum Possible Normal Load Factor

AIRCRAFT CONFIGURATION
ALL DRAG INDEXES

DATE: 17 AUGUST 1995
DATA BASIS: FLIGHT TEST



NOTE

1. LIMITS SPECIFIED ARE FOR SMOOTH, PREPARED HARD SURFACES.
2. VALID FOR AIRCRAFT GROSS WEIGHTS LESS THAN 19,550 POUNDS, FOR AIRCRAFT GROSS WEIGHTS IN EXCESS OF 19,550 POUNDS, THE CROSSWIND COMPONENT AT ALL TOUCHDOWN SPEEDS SHALL NOT EXCEED 10 KNOTS.
3. MAXIMUM CRAB ANGLE AT TOUCHDOWN SHALL BE LESS THAN 10 °.
4. MAXIMUM ROLL ANGLE AT TOUCHDOWN SHALL BE LESS THAN 3.5 °.
5. FOR WET RUNWAY CONDITIONS/NIGHT OPERATIONS, MAXIMUM CROSSWIND COMPONENT SHALL BE REDUCED BY 5 KNOTS.
6. MAXIMUM AIRSPEED FOR STOL FLAP LANDING IS 130 KCAS. APPROACH AIRSPEED IN EXCESS OF 130 KNOTS SHALL USE AUTO FLAP SETTINGS.

CAUTION

LANDING WITH CRAB ANGLES IN EXCESS OF 10 ° MAY RESULT IN STRUCTURAL DAMAGE TO OUTRIGGER LANDING GEAR.

AV8BB-NFM-00_590-1-23

Figure 4-13. Crosswind Landing Capability

PART II

Indoctrination

CHAPTER 5

Indoctrination

5.1 GROUND TRAINING SYLLABUS

5.2 MINIMUM GROUND TRAINING SYLLABUS

The overall ground training syllabus for each activity will vary according to local conditions, field facilities, requirements from higher authority, and the immediate Unit Commander's estimate of squadron readiness.

5.2.1 Familiarization

Engine.

Electrical System and Lighting.

Fuel System.

Hydraulic Power and Landing System.

Flight Controls.

Environmental Control System.

Standby Flight Instruments.

Mission Computer.

Up-Front Control Set.

Communication and Identification Equipment.

Head-Up Display.

Digital Display Indicator.

INS Theory.

Navigation Systems.

Basic Mission Planning.

Normal Procedures.

Operating Limits.

Start/Ground Emergencies.

In-flight Emergencies.

Landing Emergencies.

Aerodynamics.

5.2.2 Safety and Survival Training

Emergency Equipment.

Ejection Seat.

Pilot Survival Equipment.

5.2.3 Instruments

5.2.4 Formation

5.2.5 Night Procedures

5.2.6 Navigation

5.2.7 Basic Fighter Maneuvering

5.2.8 Basic Conventional Weapons Delivery

5.2.9 Air Combat Maneuvering

5.2.10 Low Altitude Tactics

5.2.11 Offensive Air Support

5.2.12 Anti-Air Warfare

5.2.13 Shipboard

Field Carrier Landing Practice (FCLP).

Forward Site Operations.

Road Operations.

Grass Operations.

Carrier Qualifications.

5.2.14 Electronic Warfare

5.3 WAIVING OF MINIMUM GROUND TRAINING REQUIREMENTS

Where recent pilot experience in similar aircraft models warrant, Unit Commanding Officers may waive the minimum ground training requirements provided the pilot meets the following mandatory qualifications:

Has obtained a current medical clearance.

He is currently qualified in flight physiology.

Has satisfactorily completed the NATOPS Flight Manual open and closed book examinations.

Has received adequate briefing on normal and emergency operating procedures.

Has received adequate instructions on the use/operation of the ejection seat and survival kit.

5.4 FLIGHT TRAINING SYLLABUS

5.4.1 Aircrew Flight Training Syllabus

Prior to flight, all pilots will have completed the appropriate Ground Training Lectures. The Flight Training Syllabus is described in detail in MCO P3500.15 series, Aviation Training and Readiness Manual Vol 2. The geographic location, local command requirements, squadron mission, and other factors will influence the actual flight training syllabus and the sequence in which it is completed.

5.5 OPERATING CRITERIA

5.5.1 Minimum Flight Qualifications

Where recent pilot experience in similar aircraft models warrant, Unit Commanding Officers may waive the minimum flight training requirements for basic qualifications. Minimum flight hour requirements to maintain pilot qualifications after initial qualification in each specific phase will be established by the Unit Commanding Officer. Pilots who have more than 50 hours in model are considered current subject to the following criteria:

Must have a NATOPS evaluation check with the grade of Conditionally Qualified, or better, within the past 12 months and must have flown 10 hours in model and made five takeoffs and landings within the last 60 days.

Must have satisfactorily completed the ground phase of the NATOPS evaluation check, and be considered qualified by the Commanding Officer of the unit having custody of the aircraft.

5.5.2 Ceiling/Visibility Requirements

Prior to the pilot becoming instrument qualified in the airplane, field ceiling/visibility and operating area weather must be adequate for the entire flight to be conducted in a clear air mass according to Visual Flight Rules. After the pilot becomes instrument qualified, the following weather criteria (Figure 5-1) apply:

TIME-IN-MODEL (HR)	CEILING/VISIBILITY (FT)/(MI)
0 to 50	500/1
50 and above	Field minimums or 200/1/2 whichever is higher

Figure 5-1. Ceiling/Visibility Requirements

Where adherence to these minimums unduly hampers pilot training, Commanding Officers may waive time-in-model requirements for actual instrument flight, provided pilots meet the following criteria:

Have a minimum of 10 hours in model.

Completed two simulated instrument sorties.

Completed two satisfactory tacan penetrations.

5.5.3 Requirements for Various Flight Phases

5.5.3.1 Night

Not less than 10 hours in model.

5.5.3.2 Cross Country

Have a minimum of 50 hours in model and a NATOPS check for lead or single aircraft.

Have a minimum of 20 hours in model for wingman.

Have a valid instrument card.

Have satisfactorily completed an instrument check in model.

Have completed the night familiarization syllabus prior to night cross country flight.

5.5.3.3 Forward Based Operations

In accordance with MCO P3500.15 series, Aviation Training and Readiness Manual Vol 2, and the discretion of the Commanding Officer.

5.5.4 Ship Qualification

Each pilot will have a minimum of 50 hours in model for day qualification and 100 hours in model for night qualification and meet the requirements set forth in the Landing Signal Officer (LSO) NATOPS manual.

5.6 PILOT FLIGHT EQUIPMENT

5.6.1 Minimum Requirements

In accordance with OPNAVINST 3710.7, the flying equipment listed below will be worn by pilots on every flight. All survival equipment will be secured in such a manner that it will be easily accessible and will not be lost during ejection or landing. This equipment shall be the latest available as authorized by Aircrew Personal Protective Equipment Manual (NAVAIR 13-1-6).

Anti-buffet helmet modified in accordance with current aviation clothing and survival equipment bulletins.

Oxygen mask.

Anti-g suit (required on all flights where high g forces may be encountered).

Fire retardant flight suit.

Steel-toed flight safety boots.

Life preserver.

Harness assembly.

Shroud cutter.

Sheath knife.

Flashlight (for all night flights).

Strobe light.

Pistol with tracer ammunition, or approved flare gun.

Fire retardant flight gloves.

Identification tags.

Anti-exposure suit in accordance with OPNAVINST 3710.7.

Personal survival kit.

Other survival equipment appropriate to the climate of the area.

PART III

Normal Procedures

CHAPTER 6

Flight Preparation

6.1 MISSION PLANNING

6.1.1 General Requirements

Mission planning shall be conducted in accordance with Air NTTP 3-22.1-AV8B (AV-8B Employment) utilizing the MAWTS-1 AV-8B Mission Planning, Briefing, and Debriefing Guide. The pilot is responsible for accurate preparation of a joint mission planning station (JMPS) mission plan and data storage unit (DSU) or AMU load including fuel planning, V/STOL performance, load plans, and weaponeering.

6.1.2 Flight Codes

OPNAVINST 3710.7 and NAVMC DIR 3500.14 AV-8B Training and Readiness Manual promulgate the proper Total Mission Requirement classification and Training and Readiness code assigned to individual flights.

6.2 BRIEFING AND DEBRIEFING

6.2.1 Briefing

The flight leader is responsible for briefing all pilots on all aspects of the flight. Flight briefs shall be conducted in accordance with Air NTTP 3-22.1-AV8B (AV8B Employment) utilizing a briefing guide or syllabus card. At a minimum, a review of the “Flight Administration Briefing Guide” is required for every flight. Review additional briefing guides or syllabus card as required based on mission requirements.

6.2.2 Debriefing

The flight leader is responsible for debriefing all pilots on all aspects of the flight. Flight debriefs shall be conducted in accordance with Air NTTP 3-22.1-AV8B (AV8B Employment) utilizing a debriefing guide. At a minimum, a review of the “General Debriefing Guide” is required for every flight. Review additional debriefing guides as required based on mission requirements.

CHAPTER 7

Shore-Based Procedures

7.1 PREFLIGHT CHECK

7.1.1 General Procedures

The aircraft discrepancy book of the assigned aircraft must be checked for flight status, configuration, armament, and servicing prior to manning the aircraft. Previous discrepancies for the last 10 flights should be checked for the corrective action taken. Weight and Balance clearance is the responsibility of the maintenance department.

7.1.2 Exterior Inspection

The exterior inspection is divided into 19 areas. The first step is to inspect the surrounding area to ensure it is free of FOD. The inspection begins at the nose gear T-handle and continues around the aircraft in a clockwise direction. Throughout the inspection check doors and panels secure and be alert for loose fasteners, cracks, dents, leaks, corrosion, and other discrepancies.

1. Nose Section (Left Side).

   a. Nose gear selector valve T-handle — SEATED AND FLUSH.

   b. Canopy and windshield — CLEAN, CRACKS/CRAZING.

   c. Pitot static probe — DAMAGE/OBSTRUCTION.

Radar Aircraft:

   d. AOA probe — DAMAGE/OBSTRUCTIONS, GENTLY ROTATE TO CHECK FREEDOM OF MOVEMENT.

Note

Due to the close proximity of the intakes, careful inspection of panels and fasteners around the nose section is warranted.

2. Nose Section (Front).

All Aircraft:

   a. Nose cone/radome — SECURE.

   b. IFF antenna (top) — DAMAGE/SECURITY.

   c. Yaw vane — FREE TO ROTATE.

   d. Reaction control valve — BINDING/SCORING, BURNT PAINT, EXCESSIVE MOVEMENT. RCS BOLTS SECURE.

Radar and Night Attack Aircraft:

   e. FLIR lens — CLEAN.

   f. FLIR fairing (top) — DAMAGE/SECURITY.

Day and Night Attack Aircraft:

g. DMT lens — CLEAN.

h. Ground cooling fan air inlet — OBSTRUCTIONS.

3. Nose Section (Right Side).

All Aircraft:

a. Pitot static probe — DAMAGE/OBSTRUCTION.

b. Tacan antenna — DAMAGE/SECURITY.

c. RWR (bottom) antenna — DAMAGE/SECURITY.

d. Boarding steps — FLUSH WITH SKIN.

e. Normal canopy release handle — FLUSH WITH SKIN.

Failure to fully restow the external normal canopy release handle may result in canopy separation during flight.

f. Canopy and windshield — CLEAN, CRACKS/CRAZING.

TAV-8B, Day and Night Attack Aircraft:

g. AOA probe — DAMAGE/OBSTRUCTIONS, GENTLY ROTATE TO CHECK FREEDOM OF MOVEMENT.

4. Right Intake.

All aircraft:

a. Boundary layer doors — BINDING.

b. Intake suction doors — BINDING, FOD.

c. LP blades — NICKS/DAMAGE/ENGINE RUB.

d. Intake skin — LOOSE RIVETS.

e. DECS T1 probe — BLOCKAGE AND INTEGRITY.

5. Nose Wheel Well.

a. Doors (L/R and aft) — DAMAGE/SECURITY.

b. Wheel well — LEAKS, ACCESS DOOR AND WEBBING SECURE.

c. Flight control cables — TIGHT, NOT FRAYED.

d. RCS Tubing — DAMAGE/DISCOLORATION.

6. Nose Landing Gear.

a. NLG strut — LEAKS.

b. Nose downlock and depress pin — REMOVED.

c. Nosewheel steering system — LEAKS.

d. Approach/aux lights — DAMAGE.

e. Nose landing gear tie down ring — MOVEMENT/SPRING LOADED.

f. Tire — CHOCKED, TREAD/INFLATION (AT LEAST 2 OF 5 TIRE WEAR INDICATOR BANDS REMAINING).

g. Wheel — DAMAGE.

h. LIDS fence — DAMAGE/SECURITY; ENSURE LIDS EXTENDER REMOVED WITH GUN INSTALLED.

7. Right Center Fuselage.

a. Forward engine bay ram air intake — CLEAR.

b. Oil vent mast — LEAKAGE.

c. Fuel vent mast — LEAKAGE.

d. OBOGS vent — OBSTRUCTIONS.

e. Cold nozzle — CRACKS, SECURITY, CHECK LP COMPRESSOR BLADES AND STATORS FOR EVIDENCE OF FOD. CHECK HP HOUSING FOR CRACKS AND BOLTS SECURE.

f. Hot nozzle — CRACKS, SECURITY.

g. Panel 108R — BINDING/DAMAGE.

h. LP turbine — DAMAGE.

i. Spider — DAMAGE/SECURITY.

j. Exhaust duct — POOLED OIL, FUEL, AND TURBINE SPLATTER.

k. Jet blast deflector — SECURITY.

l. Ammunition pak/strake — DAMAGE/SECURITY.

8. Right Wing.

a. Leading edge — DAMAGE, BUBBLED/BURNT PAINT (EVIDENCE OF RCS LEAK).

b. LERX — SECURITY.

c. Wing root air intake — CHECK.

d. Wing drain holes — LEAKAGE/OBSTRUCTION.

e. Pylons — SAFE, DAMAGE.

f. External stores — PREFLIGHT.

g. TPOD VRS — LOADED, STBY, RECORD SERIAL NUMBER.

h. Vortex generators — DAMAGE.

i. RWR quadrant antenna — DAMAGE/SECURITY.

j. Position and formation lights — CRACKS.

k. Reaction control valve — CRACKS, BURNT PAINT, SCORE MARKS, EXCESSIVE MOVEMENT, CASTELLATED NUTS COTTERPINNED.

l. Fuel jettison drain — LEAKAGE/OBSTRUCTION.

m. Flap/aileron — DAMAGE, MOVEMENT (NO SIDE TO SIDE, 1/2 INCH MAX UP AND DOWN), LESS THAN 25° FLAP DEFLECTION.

CAUTION

Starting the engine with flaps greater than 25° may result in damage to the flaps.

9. Right WLG.

a. L/R doors — DAMAGE/SECURITY.

b. WLG strut — PROPER EXTENSION.

c. Strut — LEAKS.

d. Downlock — REMOVED.

e. Tie-Down Ring — CHAINS REMOVED, SPRING LOADED.

f. Scissor bolt nut — ROTATION AND COTTERPINNED.

g. Tire — TREAD/INFLATION.

10. Main Gear.

a. Doors (L/R) — DAMAGE/SECURITY.

b. MLG downlock pin — REMOVED.

c. Strut — LEAKS/CHROME SHOWING.

d. Brakes — LEAKS.

e. Tires — TREAD/INFLATION.

f. Chocks — REMOVED.

g. Emergency landing gear bottle discharge indicator — FLUSH, NO RED SHOWING.

h. Flight control cables — TIGHT, NOT FRAYED.

i. Main wheel weapon panel access door — SECURE (FASTENERS PARALLEL TO DECK).

j. Flight control accumulator hydraulic gauges — LEAKS, 1,000 TO 1,350 PSI.

k. Doors — CLOSE AFTER INSPECTION.

l. Chocks — REMOVED.

11. Right Aft Fuselage.

a. Anti-collision light (lower) — DAMAGE.

b. Speedbrake — TRAIL POSITION, LEAKS, DAMAGE.

c. Ventral fin — DAMAGE.

d. Tailplane — DAMAGE, RUBBING.

e. Tailplane jack — FOD, LEAKS, COTTERPINNED, POTENTIOMETER COTTERPINNED.

f. Rear ECS exhaust vent — CLEAR.

g. Vertical stabilizer — DAMAGE.

h. Radar altimeter (forward/aft) — DAMAGE.

i. ALE-39 Chaff/Flare dispensers/covers — DAMAGE/SECURITY, T-HANDLE STOWED, IF LOADED — ARMING PINS INSTALLED.

12. Tail.

a. Rudder — DAMAGE/SECURITY.

b. Yaw and pitch reaction control valves — BINDING/SCORE MARKS, BURNT PAINT, ROD EYE END CONNECTIONS, AND RUDDER MOVEMENT.

c. RWR antennas — DAMAGE/SECURITY.

d. Position light — DAMAGE.

13. Left Aft Fuselage.

a. Tailplane — DAMAGE, RUBBING.

b. Tailplane jack — FOD, LEAKS.

c. Ventral fin — DAMAGE.

d. Vertical stabilizer — DAMAGE.

e. Rear ECS exhaust vent — CLEAR.

f. Speedbrake — DAMAGE, LEAKS.

g. ALE-39 chaff/flare dispensers/covers — DAMAGE/SECURITY.

14. Left Center Fuselage.

a. Gun pak/strake — DAMAGE/SECURITY.

b. Hot nozzle — POSITIONED AFT, CRACKS, SECURITY.

c. Panel 108L — BINDING/DAMAGE.

d. LP turbine — DAMAGE.

e. Spider — DAMAGE/SECURITY.

f. Exhaust duct — POOLED OIL, FUEL, AND TURBINE SPLATTER.

g. Cold nozzle — CRACKS, SECURITY, CHECK LP COMPRESSOR BLADES AND STATORS FOR EVIDENCE OF FOD. CHECK HP HOUSING FOR CRACKS AND BOLTS SECURE.

h. Forward engine bay ram air intake — CLEAR.

i. Aircraft refueling panel (door 22L) — CHECK OIL LIGHTS AND EFC, EMU, AND IGVC DOLLS EYE (AFC 392) NOT POPPED, SECURE DOOR 22L.

j. Aircraft refueling cap — SECURE.

15. Left WLG.

    a. L/R doors — DAMAGE/SECURITY.

    b. WLG Strut — PROPER EXTENSION.

    c. Strut — LEAKS.

    d. Downlock — REMOVED.

    e. Tie-Down Ring — CHAINS REMOVED, SPRING LOADED.

    f. Scissor bolt nut — ROTATION AND COTTERPINNED.

    g. Tire — TREAD/INFLATION.

16. Left Wing.

    a. Flap/aileron — DAMAGE, MOVEMENT (NO SIDE TO SIDE, 1/2 INCH MAX UP AND DOWN), LESS THAN 25° FLAP DEFLECTION.

CAUTION

Starting the engine with flaps greater than 25° may result in damage to the flaps.

    b. Fuel jettison drain — LEAKAGE/OBSTRUCTION.

    c. Reaction control valve — CRACKS, BURNT PAINT, SCORE MARKS, EXCESSIVE MOVEMENT, CASTELLATED NUTS COTTERPINNED.

    d. Position/formation lights — CRACKS.

    e. RWR quadrant antenna — DAMAGE/SECURITY.

    f. Vortex generators — DAMAGE.

    g. Pylons — SAFE, DAMAGE.

    h. External stores — PREFLIGHT.

    i. Leading edge — DAMAGE.

    j. Wing drain holes — LEAKAGE/OBSTRUCTION.

    k. LERX — SECURITY.

    l. Air Refueling probe — DAMAGE, SECURITY, LEAKS.

17. Fuselage Underside.

    a. Check for fluid leaks.

    b. Engine bleed air dual wall hose failure indicator — FLUSH.

    c. Centerline pylon — SAFE, DAMAGE.

    d. Centerline store — PREFLIGHT.

Radar and Night Attack Aircraft:

e. TACTS antenna/plate — DAMAGE/SECURITY.

All Aircraft:

18. Left Intake.

    a. Intake suction doors — BINDING, FOD.

    b. Boundary layer doors — BINDING.

    c. LP blades — NICKS/DAMAGE/ENGINE RUB.

    d. Intake skin — LOOSE RIVETS.

    e. DECS T1 probe — BLOCKAGE AND INTEGRITY.

19. Top of Aircraft.

    a. LERX panels — SECURE.

    b. GTS intake/exhaust — OBSTRUCTIONS.

    c. MDC cord — DAMAGE.

    d. Anti-collision light — DAMAGE.

    e. Rear ECS ram air intake — CLEAR.

    f. Water filler cap — SECURE.

    g. GPS antenna — DAMAGE/SECURITY (if applicable).

7.1.3 Before Entering Cockpit

1. Canopy — OPEN.

CAUTION

- The TAV-8B canopy should be moved slowly to the open position until the damper lock engages. The canopy should not be allowed to freefall to the full open position. Additionally, the canopy should not be left open during windy conditions. Both of these conditions may cause undue stress that may lead to canopy acrylic failure.

- When boarding the aircraft, clear area under the boarding step before opening the canopy. Ensure boarding step is completely down before use to prevent canopy system damage. Use the designated handholds and steps and do not use the air inlet duct. Exercise care not to disturb MDC pattern on the top of the canopy by contact with the flight helmet.

2. Ground safety control handle — UP.

3. Ground safety pins except internal emergency canopy shattering handle safety pin — REMOVED AND STOWED.

4. Landing gear handle — DOWN AND LOCKED, WHEEL UPRIGHT.

5. Master armament switch — SAFE.

6. Ejection seat and canopy — CHECK:

   a. Condition of canopy and MDC patterns.

   b. Four bolts on top of seat headrest for rotation.

   c. Lap belt and riser webbing harness secure.

   d. SEWARS housing integrity.

   e. Elasticity of seat-man separation lanyards.

   f. Emergency restraint release handle.

   g. Emergency oxygen gauge in the green.

   h. Manual emergency oxygen release ring secured.

   i. Emergency oxygen and emergency locator beacon activation lanyard connected.

   j. Leg restraint strap snubber release — LOCKED.

7. IGN ISO switch — OFF.

8. Load DSU in receptacle and rotate to up and locked position or load mission and maintenance cards into the appropriate slots in AMU, close AMU door, and rotate AMU to up and locked position.

WARNING

- The DSU or AMU must be locked in the AFT position prior to canopy closure. Failure to lock the DSU or AMU in the AFT position may cause right shoulder injury in the event of an ejection. The DSU and AMU cannot be rotated aft with the canopy closed.
- The ejection control handle is easily unseated from its detent during cockpit entry/egress unless care is taken to avoid stepping on the handle. When the handle is out of the detent a force of 15 pounds is sufficient to initiate ejection of the seat, if armed. Stepping anywhere on the ejection seat should be avoided.

9. Load 8mm VTR tape. Lock door. Set switches to STBY and REMOTE.

7.1.4 After Entering Cockpit

1. Boarding steps and external canopy release handle — STOWED.

2. Strap-in.

   a. Helmet, oxygen, and communication lines — CONNECT.

   b. Anti-G hose — CONNECT.

   c. Leg restraint garters — CONNECT.

   d. Lap belt fittings — CONNECT.

e. Lap belt straps — TIGHTEN.

f. Lap belt adjusters — CHECK (no slippage).

g. Parachute riser fittings — CONNECT.

h. Shoulder harness locking lever — CHECK OPERATION.

WARNING

Ensure items stored in the cockpit will not interfere with the canopy pressurization system, airspeed/altitude sensor striker, or ejection seat lanyards.

CAUTION

Do not place any materials on the glareshield. Damage to the windshield and engine FOD may occur.

3. DECS enable switch — OFF.

4. Fuel shutoff handle — OFF.

Note

Boost pumps deliver small amounts of fuel to the engine during igniter check if fuel handle is ON.

5. Engine RPM switch — LO.

6. Engine fuel control switch — POS 2.

7. LIDS switch — NORM.

8. Oxygen switch — OFF.

9. H2O dump — OFF.

10. Exterior lights — AS REQUIRED.

11. Exterior lights master switch — ON.

12. A/R switch — IN.

13. Left and right wing dump switches — NORM.

14. Left and right boost pump switches — NORM.

AV-8B Aircraft:

15. FUEL PROP — ON.

TAV-8B Aircraft:

16. FUEL PROP — AUTO.

All Aircraft:

17. Throttle — OFF.
18. JPTL switch — ON.
19. Manual fuel switch — OFF.

AV-8B 164151 and up; also TAV-8B, AV-8B 161573 through 164150 after AFC-328:

20. MFS EMER BATT — CHECK (white not visible).

All Aircraft:

21. Parking brake — ON.
22. SAS — SET.
    a. Pitch — ON.
    b. Roll — ON.
    c. Yaw — ON.
23. Q-feel switch — ON.
24. Rudder pedal shaker switch — ON.
25. Landing light switch — OFF.
26. ANTISKID switch — ON.
27. Landing gear handle — DOWN.

AV-8B 164151 and up; also TAV-8B, AV-8B 161573 through 164150 after AFC-328:

28. LDG GEAR EMER BATT — CHECK (white not visible).

All Aircraft:

29. Flap switches — AUTO AND OFF.
30. Water switch — OFF.
31. MASTER ARM — OFF.
32. Armament control panel — SAFE/NORM.
33. IR cool switch — OFF.
34. DDI, HUD and COMM — AS DESIRED.
35. Clock — SET.

Night Attack Aircraft:

36. FLIR switch — AS DESIRED.

Radar Aircraft:

37. LST/FLIR switch — AS DESIRED.
38. Radar — OFF.

All Aircraft:

39. VRS display select switch — AS DESIRED.

Day and Night Attack Aircraft:

40. DMT switch — AS DESIRED.

All Aircraft:

41. INS mode selector knob — OFF.

42. DP switch AUTO.

43. MC switch — AUTO.

44. Circuit breakers (7) — IN.

45. ECM control panel.

    a. RWR — AS DESIRED.

    b. Expendables — OFF.

    c. ECM — OFF.

46. Battery switch — OFF.

47. Generator switch — GEN.

CAUTION

Failure to select generator switch to GEN may result in dual DECS failure during engine start.

48. V/UHF radio remote control — T/R or T/R + G.

49. ACNIP panel — AS DESIRED.

50. IFF — NORM.

51. Internal lights panel — AS DESIRED.

52. ECS panel.

    a. Temperature controller — AUTO.

    b. Aft bay equip switch — ON.

    c. DEFOG switch — NORM.

    d. Cabin pressure switch — NORM.

53. Video recorder — LOAD TAPE, STBY/REMOTE.

7.1.5 Pre-Start

1. Battery switch — BATT (24.5 volts minimum).

After AFC 449:

a. EAAS/MS — BATTERY and FAULT LEDs on then off after 8 seconds.

(1) If BATTERY and/or FAULT LED remain on, refer to A1-AV8BB-NFM-600.

For TAV-8B Aircraft:

(2) Rear cockpit EAAS/MS — BATTERY and FAULT LEDs on then off after 8 seconds.

(3) If BATTERY and/or FAULT LED remain on, refer to A1-AV8BB-NFM-600.

2. ICS — CHECK/SET.
3. Warning and caution lights — TEST; MASTER CAUTION RESET.
4. Brakes — CHECK.

a. Accumulator — 1,000 PSI MINIMUM.

b. Brake pressure — 1,500 PSI MINIMUM IF AIRCRAFT NOT SECURED.

CAUTION

Do not start aircraft if brake pressure is less than 1,500 psi unless the aircraft is secured by at least two tiedown chains or chocked.

5. Landing gear indicator — 4 GREEN.
6. Throttle quadrant check.

a. Parking brake — OFF.

b. Throttle — FULL, JPT LIMITER OFF.

c. Idle stop — CHECK.

d. Throttle — OFF.

e. JPT limiter — ON.

f. Parking brake — ON.

7. Igniters — CHECK (boost pump lights out).

a. Depress airstart button.

The igniters fire in and out of phase with each other and produce an irregular cracking sound. If this cracking sound is regular, one of the igniters has failed.

b. Manual fuel switch — ON.

c. Check igniters — SWITCH OFF.

CAUTION

The MFS switch is spring loaded to the center position, OFF must be selected to prevent starting the engine in manual fuel.

8. EDP — BIT (OBSERVE THE FOLLOWING).
   a. NOZZLE — 60° THEN FLUCTUATE.
   b. OT warning light — ON.
   c. 15 SEC light — ON.
   d. Water flow light — ON.
   e. Lights OUT after BIT complete.
9. Fuel panel — CHECK QUANTITY/BIT (OBSERVE THE FOLLOWING).
   a. Left window — 1,400 ±100.
   b. Right window — 2,400 ±100.
   c. TOT window — 3,800 ±200.
   d. L and R fuel low level lights — FLASHING.
   e. LOAD caution light — ON.
   f. BINGO caution light — ON (if bingo fuel set above 4,000 pounds).
   g. LEFT and RIGHT full advisory lights — FLASHING.
   h. All lights OUT after BIT complete.

AV-8B Aircraft:

10. Canopy caution light switches — CHECK.
    a. Canopy open — CHECK CONTROL HANDLE FULL FORWARD AND CANOPY CAUTION LIGHT ON.
    b. Pull canopy control handle full aft with canopy open — CHECK CAUTION LIGHT OUT.
    c. Canopy close — CHECK CANOPY HANDLE FULL FORWARD AND CANOPY CAUTION LIGHT OUT.

TAV-8B Aircraft:

11. Canopy caution light switches — CHECK.
    a. Rear canopy closed — CANOPY CAUTION LIGHT ON.
    b. Front canopy closed — CANOPY CAUTION LIGHT OUT.
    c. Rear canopy open momentarily — CANOPY CAUTION LIGHT ON.
    d. Rear canopy closed — CANOPY CAUTION LIGHT OUT.

CAUTION

Do not apply excessive fore while attempting to move the canopy from the full open position. If excessive force is required, the damper lock handle is not fully disengaged. The application of excessive force on the canopy with the damper lock engaged creates undue stress on the canopy acrylic and can lead to acrylic cracking and failure. A creaking sound as the canopy is closed should be immediately investigated by maintenance personnel.

All Aircraft:

If external power is to be used:

12. Battery switch — OFF.

13. External electrical power — CONNECT.

14. Battery switch — BATT.

To energize aircraft electrical buses - TAV-8B, Day and Night Attack Aircraft:

15. Ground power panel switches: AFT EQP — ALL; COCKPIT — ON; FWD EQP — ON; STORES — ACP or SMS.

Radar Aircraft:

16. Ground power panel switches: CNI — ALL (hold for 5 seconds); DISP/FLT — ON; MISC — ON; STORES — ACP or SMS.

All Aircraft:

If APU power is to be used:

17. Fire bottle — MANNED.

18. Canopy — CLOSED (Only rear canopy required to be closed in TAV-8B).

19. APU generator switch — ON.

20. APU Advisory Light — ON.

21. APU GEN light — OUT.

22. Canopy — AS DESIRED.

7.1.6 Starting Engine

1. Fire bottle — MANNED.

2. Intake and exhaust areas — CLEAR.

WARNING

- Suction at the intakes is sufficient to kill or severely injure personnel drawn into or pulled suddenly against the duct.
- Danger areas to each side and aft of the aircraft are created by high exhaust temperatures and velocities. Nozzle rotation and high power settings increase this danger.

3. Canopy — CLOSED.

4. DECS power — CHECK.

Failure to enable DECS prior to engine start could result in a rapid uncommanded rpm increase.

a. DECS enable switch — OFF.

b. EFC warning, EFC caution, and JPTL warning lights — ON.

c. DECS enable switch — ON.

d. EFC warning, EFC caution, and JPTL warning lights — OFF.

e. Fuel shutoff handle — ON.

f. EFC switch — CYCLE (EFC CAUTION LT FLICKERS).

g. EFC switch — POS 2.

5. External power — DISCONNECT IF APPLICABLE.
6. Parking brake — ON.
7. Throttle — OFF.
8. Nozzles — AFT TO 10°. If nozzles are drooped and nozzle handle is not aft to 10°, have ground crewman lift nozzles to 0 to 10° and simultaneously push the nozzle handle to corresponding position before engine start. If the nozzles will not stay up on their own, hold the handle during the start until pressure is relieved from the handle.
9. Engine start switch — ENG ST.

On a direct engine start, the GTS normally lights off in about 5 seconds, after which the engine begins to rotate.

On a translation start (APU started first), there is a 10 second deceleration of the APU before the GTS engages to start the engine.

WARNING

Loss of emergency dc bus power during start cycle will result in simultaneous loss of power to the DECS JPTL system, EDP, and warning and caution lighting systems. Loss of power to the JPTL system will result in normal engine acceleration to wet idle speed. Loss of EDP power will cause RPM-JPT indications to freeze at approximately 22 percent, visually consistent with hung start.

CAUTION

- Do not manually override the engine start switch logic by holding it in the ENG ST position. Overspeed and catastrophic failure of the GTS may result.
- Under hot engine/fuel conditions, ground starts may exhibit slow acceleration to idle rpm/stagnation and rapid JPT rise towards the starting limit of 475 °C.
- During engine start if the fuel shutoff handle was inadvertently left in the OFF (up) position, do not drop the handle until the engine has completely stopped. Dropping this handle after engine start could cause FMU damage and engine fire.

10. Throttle — IDLE (after indication of rpm).
11. Engine start switch — CHECK OFF PRIOR TO 15 PERCENT.

If the engine start switch does not disengauge automatically by 15 percent rpm, manually place switch OFF to prevent damage to the GTS.

12. Idle rpm — CHECK.
    a. 25.8 to 26.2 percent (–406 engine).
    b. 28.4 to 29.0 percent (–408 engine).

    IDLE rpm will increase 1 percent rpm per 1,000 feet of pressure altitude, starting at 1,500 feet pressure altitude.
13. JPT — CHECK.
    a. 535 °C MAXIMUM (–406 engine).
    b. 545 °C MAXIMUM (–408 engine).
14. HYD 1 and HYD 2 pressure — 3,000 ±200 psi.
15. Brake accumulator pressure — 3,000 ±200 psi.
16. Brake pressure — CHECK.

    With the brake pedals fully pressed, check that brake pressure is 2,700 psi minimum.
17. Nozzles — 10°. Unless in FOD environment or prohibitive to ground crew operations.

Note

Setting the nozzles to 10° will prevent excessive wear on the tail plane and flaps due to the heat and jet efflux acting on those control surfaces.

18. Warning and Cautions lights — TEST (hold until LIDS light illuminates).
19. Landing gear indicators — 4 GREEN.
20. DDI, HUD, COMM — ON/AS DESIRED.
21. DDI — SELECT ENG PAGE.
    a. Check engine I.D.
    b. IGV angle — 31° to 39° at IDLE.
    c. Reset sortie JPT.
22. Canopy — AS DESIRED.

7.1.7 Before Taxiing

All Aircraft:

1. INS — ALIGNMENT.
    a. Parking brake — SET.

With C1+ or OMNI 7.1:

b. DDI — DTX, UNBOX TRUE.

With H4.0:

c. MPCD — SDAT-DTX/OLX/GPSX.

All Aircraft:

d. DDI — CHECK A/C LAT/LONG (input correct position if required).

Plus:

Magnetic variation (MVAR) for Gyro Align SHIP DATA for MANSEA align.
OMNIBUS 7.1 - Box MVAR if MAD input may be invalid.

e. INS Switch — GND ALIGN.

f. Waypoints — CHECK/ENTER.

Day and Night Attack Aircraft:

2. DMT — ON.

All Aircraft:

3. AVIONICS — VERIFY.

a. RADALT/IFF/TCN/LASER PER ADMN 1.

b. COMM 1/2 PER ADMN 3.

c. ALQ-164 — POWER ON/BIT IAW MISC CARD.

d. ALR-67 — ON.

Night Attack:

4. FLIR switch — ON.

Radar Aircraft:

5. LST/FLIR switch — LST/FLIR.

6. RADAR switch — OPR.

All Aircraft:

7. Transformer-rectifier/boost pumps — CHECK.

a. Left and right pump switches — OFF.

(1) Pump lights ON.

b. Left and right pump switches — DC.

(1) Pump lights — OFF.

(2) Voltmeter stable at approximately 27 volts.

c. DC test switch — SET TO MAIN.

(1) STBY TR caution illuminates at approximately 24.75 volts.

(2) Voltmeter returns to above 25.5 volts.

d. DC test switch — SET TO STBY.

(1) Voltmeter drops to approximately 25.5 volts.

(2) Left and right pump switches — NORM.

(a) Increase of 1 volt for each pump.

e. DC test switch — SET TO CENTER POSITION.

WARNING

Loss of emergency DC bus power during standby TRUcheck will result in simultaneous loss of power to the DECS JPTL system, EDP, warning and caution lighting system, and loss of voltage indication on voltmeter. Loss of power to the JPTL system will result in normal engine acceleration to wet idle speed. Loss of EDP power will cause RPM-JPT indications to freeze.

8. JPT limiters switch — CHECK.

a. JPT limiters switch — OFF.

(1) RPM rise of 3.3 to 4.3 percent for the -406 engine, and 6.0 to 7.0 percent for the -408 engine.

(2) JPTL warning light — ON.

b. EFC switch — POS 1, THEN BACK TO POS 2.

(EFC caution light comes on momentarily and then goes off).

Note

RPM should remain constant.

c. JPT limiters switch — ON.

(1) RPM drop of 3.3 to 4.3 percent for the -406 engine and 6.0 to 7.0 percent for the -408 engine.

(2) JPTL warning light — OFF.

9. Manual fuel switch — CHECK.

Place the manual fuel switch ON and check MFS caution light on. Maintain idle limits. Place water switch to TO and note steady rpm. Place water switch to OFF, then place manual fuel switch OFF. Check MFS light off. RPM should not be allowed to drop below 20 percent for the -406 engine and 22 percent for the -408 engine.

10. Water switch — CHECK, THEN OFF.

Place water switch to TO and note rpm rise of 3.3 to 4.3 percent for the -406 engine and 6.0 to 7.0 percent for the -408 engine. Place water switch OFF and check rpm returns to IDLE. Repeat in LAND.

11. EVICS — CHECK.

a. Throttle — ADJUST TO 55 PERCENT CORRECTED HP COMPRESSOR SPEED (ENGINE PAGE ON THE DDI/MCPD) AND RETURN TO IDLE.

Note

- 55 percent corrected HP compressor speed is required for EVICS to complete its diagnostic preflight checkout.
- For TAV-8B aircraft with F402-RR-408B engine installed and OMNI 7.1 OFP, after completion of pilot checks and EVICS diagnostic checkout (above), aircrew shall have a qualified T/AV-8B Plane Captain check EVICS Dolls Eye on the external fuel panel for failure indications. If a failure is indicated by the Dolls Eye being tripped, flight is prohibited. If a qualified T/AV-8B Plane Captain is not available during a cross country flight, the pilot shall check the EVICS Dolls Eye in the ground refuel panel prior to each engine start. If a failure is indicated by the Dolls Eye being tripped, flight is prohibited.
- For AV-8B aircraft with F402-RR-408B engine installed, after completion of pilot checks and EVICS diagnostic checkout (above), aircrew shall check the readings on the IGV bit on BIT 1 page. An IGV 1 code indicates a failure of the EVICS. If IGV 1 is displayed flight is prohibited.

AV-8B Aircraft:

12. FUEL PROP — CHECK, THEN ON.

    a. Turn fuel proportioner switch OFF; note PROP caution light ON. Turn proportioner switch ON; note PROP caution light OFF.

TAV-8B Aircraft:

13. FUEL PROP — CHECK, THEN AUTO.

    a. Fuel prop switch — OFF.

       PROP caution light on.

    b. Fuel prop switch — DUAL.

       R FEED warning, PROP caution, and R FEED advisory lights off.

    c. Fuel prop switch — RIGHT.

       R FEED advisory light on, R FEED warning light on after short delay.

    d. Fuel prop switch — AUTO.

       R FEED warning, PROP caution, and R FEED advisory lights off.

All Aircraft:

14. Trim — CHECK, THEN SET.

    a. Trim rudder left and right. Check rudder indicator for proper travel. Trim to neutral.

    b. Trim aileron left and right. Check aileron indicator for proper travel. Trim to neutral.

    c. Trim stabilator up and down. Check stabilator indicator for travel.

    d. Set 4° ND.

15. Standby instruments — CHECK, ATTITUDE INDICATOR - UNCAGED/ERECT.

16. Altimeter — SET BAROMETRIC PRESSURE.

17. Oxygen switch — ON.
18. OBOGS System — CHECK.
    a. Verify mask(s) ON, OXY caution — OFF.
    b. OBOGS monitor — Check.

       Press and hold OBOGS monitor test plunger or press and release OBOGS monitor test button.
    c. Master caution light — ON.
    d. OXY caution — ON.
    e. Master caution tone — ON.

Note

Inadvertent rotation of the OBOGS monitor test plunger while pressed can result in the locking of the plunger in a maintenance position and intermittent OXY Cautions. Rotation of the test plunger disengages the locking slot allowing the plunger to extend and move freely when pushed.

19. Flaps BIT — INITIATE (Flaps — ON/AUTO) (1 FINGER SIGNAL).
    a. FLAPS 1, FLAPS 2, AUT FLAP cautions, FLAPS warning lights — ON.

       The flap BIT will not initiate unless the above lights are on. If lights are not on, cycle the flap power switch to OFF then ON.

       For aircraft with ECP-255 R1 nozzles must be 10° or greater to run BIT.
    b. BIT button (on landing gear control panel) — PRESS.

For aircraft before ECP-255 R1:

(1) Nozzle indicator — 50° THEN FLUCTUATES.

For aircraft with ECP-255 R1:

(2) Nozzle indicator — continues to indicate the current nozzle setting position.

All Aircraft:

(3) Flap indicator — FLUCTUATES.

(4) Flaps move up and down approximately halfway through BIT.

(5) DROOP advisory lights may cycle during BIT.

c. All lights go out after successful completion of BIT and flaps go to selected position.

d. Flap switch — STOL.

   Verify STOL flaps are selected by STO light, and aileron droop by DROOP light and by moving stick full left and right and checking aileron position. (DROOP light goes out at full aileron deflection) Repeating flaps BIT more than three times may mask a potential flap failure.

Note

To successfully complete the flaps BIT, the flaps switch must be placed ON without going to RESET. If the flaps BIT does not run successfully, place flaps switch OFF, then ON and reinitiate BIT.

20. Flaps — CRUISE.

Ground operation in AUTO/STOL flaps above idle rpm causes heating of the fuselage skins and fairings resulting in skin/fairing cracks.

21. Flight controls — CHECK (2 FINGER SIGNAL).

a. Rudder — FULL LEFT, THEN RIGHT (check proper rudder direction).

b. Longitudinal stick — FULL FORWARD AND AFT (check proper stabilator direction and 11° DOWN and 10° UP on the engine display panel).

c. Lateral stick — FULL LEFT AND RIGHT (check proper aileron direction).

22. SAAHS BIT — INITIATE (3 FINGER SIGNAL).

a. On BIT display — SAAHS BUTTON PRESS.

(1) TEST is displayed next to SAAHS display.

(2) AFC, PITCH, ROLL and YAW caution lights flash until MASTER CAUTION is pressed.

(3) 40 seconds after BIT initiated, stick shakes in pitch axis.

b. Record all failures.

c. All lights go out after successful completion of BIT.

23. Paddle switch — PRESS, CHECK ALL THREE SAAHS AXES DISENGAGE — (LIGHTS ON).

24. DDI STORES/BIT CHECK.

If carrying external stores:

Note

- With ONMI 7.1 and C1+ do not attempt to clear BIT indications by initiating AUTO BIT. Initiating AUTO BIT prior to checking the BIT or stores pages will clear all indications on the BIT, STORES, and SMSFF pages of a possible armament system failure. See Note below.
- With H4.0, attempt to clear BIT indications by initiating SMS IBIT. If the failed functions return, see Note below.

a. SMSFF — CHECK FOR TYPE SMS FUNCTION FAILURE.

Note

Exiting the SMSFF page will clear the flashing WPN fail cue on the stores page, but the failed function will continue to be listed on the SMSFF page. Flight with external stores and the following SMSFF cues should not be attempted.

(1) SELECT JETT ON.

(2) SELECT JETT INOP.

(3) EMER JETT FAILED ON.

(4) EMER JETT INOP.

(5) MASTER ARM BUS ON.

(6) MASTER ARM BUS FAIL.

(7) FUS GUN SELECT ON.

(8) FUS GUN FIRE ON.

All Configurations:

b. BIT page — CHECK.

If IGV 1 is present, abort mission.

c. Plane Captain — CHECK THE DOLLS EYES IN THE AIRCRAFT REFUELING PANEL (DOOR 22L). If Dolls Eyes are popped, abort mission.

d. BIT display — AUTO.

(1) Voice and/or tones sound.

(2) TEST is displayed next to equipment that is on.

(3) Failure codes (if any) are displayed next to failed equipment.

Note

On Radar and Night Attack aircraft, the FLIR will continue to cool down during AUTO BIT and will begin initiated BIT when it has completed the cool down sequence. On Night Attack aircraft, the display computer will cause the HUD to flicker and may display an incomplete HUD display head down on the right MPCD. On Radar aircraft, the HUD display will be blanked.

e. Record all failures.

f. BIT is complete when TEST is no longer displayed next to equipment.

With H4.0:

25. STORES — PROGRAM.

a. STORES — LOP-PGRM.

b. Input per Admin 2.

All Aircraft:

26. TPOD — POWER ON (Signal PC with pinky pull).

a. Verify TPOD power on MPCD.

27. ATIS — RECORD INFORMATION.

28. Display Computer — CHECK.

a. Set DP switch to PRIM then ALTER, record any failures.

b. Set DP switch to AUTO.

29. A/R probe — CYCLE (if use is intended) (4 FINGER SIGNAL).

30. DDI — CHECK PERFORMANCE.

a. MENU, VRST — CHECK BAW, H2O, BDI.

b. VL — CHECK OAT, FELV, GWT.

c. ODU, ENG — CHECK RJPT, JPTL, RHOV.

d. Note VL performance.

Radar and Night Attack Aircraft:

31. Displays/NVGs — ADJUST FOR SENSOR CLARITY (gray scale), ADJUST NVGs (if applicable).

a. Initialize.

(1) Cockpit lighting — ADJUST (to lowest comfortable viewing level).

(2) Get dark adapted.

(3) Select EHSD MAP Video on Left MPCD, Radar Display (Radar Aircraft) or FLIR Video (Night Attack Aircraft) on Right MPCD.

(4) HUD control panel — NIGHT MODE.

(5) HUD control panel — SYM BRT, VIDEO BRT, VIDEO CONT — MINIMUM (counterclockwise).

(6) Set Design Eye — While sitting erect in seat, adjust the seat up or down until the upper combiner just cuts the heading numerals in the center.

b. MPCD Controls — ADJUST BRT/CONT (to give minimum comfortable viewing levels).

(1) Left MPCD EHSD MAP Video Mode — AJUST.

(2) Right MPCD Radar Mode/FLIR — ADJUST.

(3) DAT displays and readjust EHSD MAP Video in right MPCD and Radar/FLIR display in Left MPCD.

(4) DAT displays to put EHSD MAP Video in left MPCD and Radar/FLIR display in right MPCD.

c. FLIR Video — SELECT, CONFIRM SETTINGS AND ADJUST (gray scales), both White and Black Hot.

(1) FLIR Video — SELECT (right MPCD).

(2) FLIR Video — CONFIRM SETUP AND BORESIGHT SETTINGS.

(3) FLIR Video White Hot — ADJUST CONTRAST (to give minimum comfortable FLIR Video viewing level).

(4) Gray Scales — Insure all nine are visible.

(5) Repeat — For Black Hot.

(6) DAT displays and repeat for left MPCD.

(7) DAT displays and return FLIR Video to right MPCD.

d. HUD Controls — ADJUST CONTRAST, BRIGHTNESS AND HUD FLIR VIDEO.

(1) HUD contrast and brightness — ADJUST.

(2) HUD contrast and brightness — ADJUST with NVGs energized (if applicable).

(3) FLIR Video in HUD — SELECT (by pressing down on the castle switch).

(4) HUD contrast and brightness — ADJUST (to give minimum comfortable HUD FLIR Video viewing level).

(5) Insure all nine gray scales are visible.

32. MDC pin — STOWED.

33. INS — CHECK STATUS PRIOR TO TAXI.

Note

Recommend not releasing parking brake until OK INS status.

7.1.8 Before Entering Rear Cockpit

1. Canopy — OPEN.

CAUTION

The TAV-8B canopy should be moved slowly to the open position until the damper lock engages. The canopy should not be allowed to freefall to the full open position. Additionally the canopy should not be left open during windy conditions. Both of these conditions may cause undue stress that may lead to canopy acrylic failure.

Exercise care not to disturb MDC pattern on the top of the canopy by contact with the flight helmet.

2. Ground safety control handle — UP.

3. Ground safety pins except internal emergency canopy shattering handle safety pin — REMOVED AND STOWED.

4. Ejection seat and canopy — CHECK.

a. Condition of canopy and MDC patterns.

b. Four bolts on top of Seat headrest for rotation.

c. Lap belt and riser webbing harness secure.

d. SEWARS housing integrity.

e. Elasticity of seat-man separation lanyards.

f. Emergency Restraint Release Handle — CHECK.

g. Emergency oxygen gauge in the green.

h. Manual emergency oxygen release ring secured.

i. Emergency oxygen and emergency locator beacon activation lanyard connected.

j. Leg Restraint Strap Snubber release — LOCKED.

WARNING

The ejection control handle is easily unseated from its detent during cockpit entry/egress unless care is taken to avoid stepping on the handle. When the handle is out of the detent a force of 15 pounds is sufficient to initiate ejection of the seat, if armed. Stepping anywhere on the ejection seat should be avoided.

7.1.9 After Entering Rear Cockpit

1. External Canopy Release Handle — STOWED.
2. Load DSU or insert AMU mission and maintenance cards.
3. Strap-in.
   a. Helmet, oxygen and communication lines — CONNECT.
   b. Anti-G hose — CONNECT.
   c. Leg restraint garters — CONNECT.
   d. Lap belt fittings — CONNECT.
   e. Lap belt straps — TIGHTEN.
   f. Lap belt adjusters — CHECK (no slippage).
   g. Parachute riser fittings — CONNECT.
   h. Shoulder harness locking lever — CHECK OPERATION.

WARNING

Ensure items stored in the cockpit will not interfere with the canopy pressurization system, airspeed/altitude sensor striker, or ejection seat lanyards.

CAUTION

Do not place any materials on the glareshield. Damage to the windshield and engine FOD may occur.

4. Oxygen switch — OFF.
5. ICS MIC switch — AS DESIRED.
6. Landing light switch — FWD.
7. Front cockpit lights switch — FWD.

8. FUEL PROP — FWD.

9. Manual fuel switch — OFF.

After AFC-328:

10. MFS EMER BATT — CHECK (white not visible).

All Aircraft:

11. Throttle — OFF.

12. Nozzles — AFT.

13. H2O switch — FWD.

14. Flap power switch — FWD.

15. Ejection sequence selector handle — AS BRIEFED.

16. Emergency landing gear handle — UP.

After AFC-328:

17. LDG GEAR EMER BATT — CHECK (white not visible).

All Aircraft:

18. DDI, HUD, and COMM — AS DESIRED.

19. Clock — SET.

20. Interior lights — AS DESIRED.

21. Warning and caution lights — OBSERVE TEST.

    All caution/advisory lights are not illuminated until AC power is available.

22. Landing gear indicator — 4 GREEN.

23. Engine Display Panel — BIT.

    a. Nozzle — 60°.

    b. OT warning light — ON.

    c. 15 SEC light — ON.

    d. Water flow light — ON.

    e. Lights out after BIT.

24. Canopy caution light switches — CHECK.

    a. Rear cockpit canopy closed — CAUTION LIGHTS ON.

    b. Front cockpit canopy closed — CAUTION LIGHTS OUT.

    c. Rear cockpit canopy open — CAUTION LIGHTS ON.

    d. Rear cockpit canopy closed — CAUTION LIGHTS OUT.

7.1.10 Before Taxiing (Rear Cockpit)

1. Canopy — AS DESIRED.
2. Oxygen switch — ON.
3. DDI, HUD, COMM — ON AND SET.
4. Standby instruments — CHECK, ATTITUDE INDICATOR - UNCAGED/ERECT.
5. Altimeter — SET BAROMETRIC PRESSURE.
6. Rear cockpit checks.
   a. Trim — CHECK.
   b. SAAHS — DISENGAGE.
   c. Manual fuel switch — CHECK.
   d. Water switch — CHECK.
   e. Prop switch — CHECK.
7. MDC pin — STOWED.

7.2 TAXIING

Aircraft directional control during taxi should be via nosewheel steering since no differential braking is available. Figure 7-1 shows the turning radius using the maximum nosewheel steering angle (45°). On AV-8B 165354 and up, the maximum nosewheel steering angle is only obtained in hi gain steering. Lo gain steering provides a turn radius of approximately 90 feet measured at the aircraft center of gravity. Hi gain steering should be used for confined area maneuvering only. The turn radius provided by lo gain steering should be sufficient for maneuvering on most taxiways. FBOs and other situations requiring deliberate movement may require the use of hi gain steering. In these situations, the pilot shall select ANTISKID to ON prior to takeoff. If the ANTISKID switch is not reset to ON, the ensuing takeoff will not have antiskid protection. Depressing the NWS/undesignate switch will result in hi gain steering, which is undesirable above 20 knots.

Proper steering selection technique is critical to eliminating a transient nosewheel steering output during landing rollout. Rudder pedals should be neutralized prior to steering selection as the nosewheel steering system will immediately move to the commanded rudder pedal position when steering is selected. Selecting steering at other than neutral pedals may result in a rapid heading change that may not be desirable. Also, crab angle, while on the runway, must be eliminated or reduced as much as possible when selecting steering. Selecting nosewheel steering while crabbed will result in an initial steering output away from the desired direction of travel.

WARNING

Engagement of hi gain steering above 30 KGS may result in pilot induced oscillation which may result in loss of directional control during landing roll out or high speed taxi.

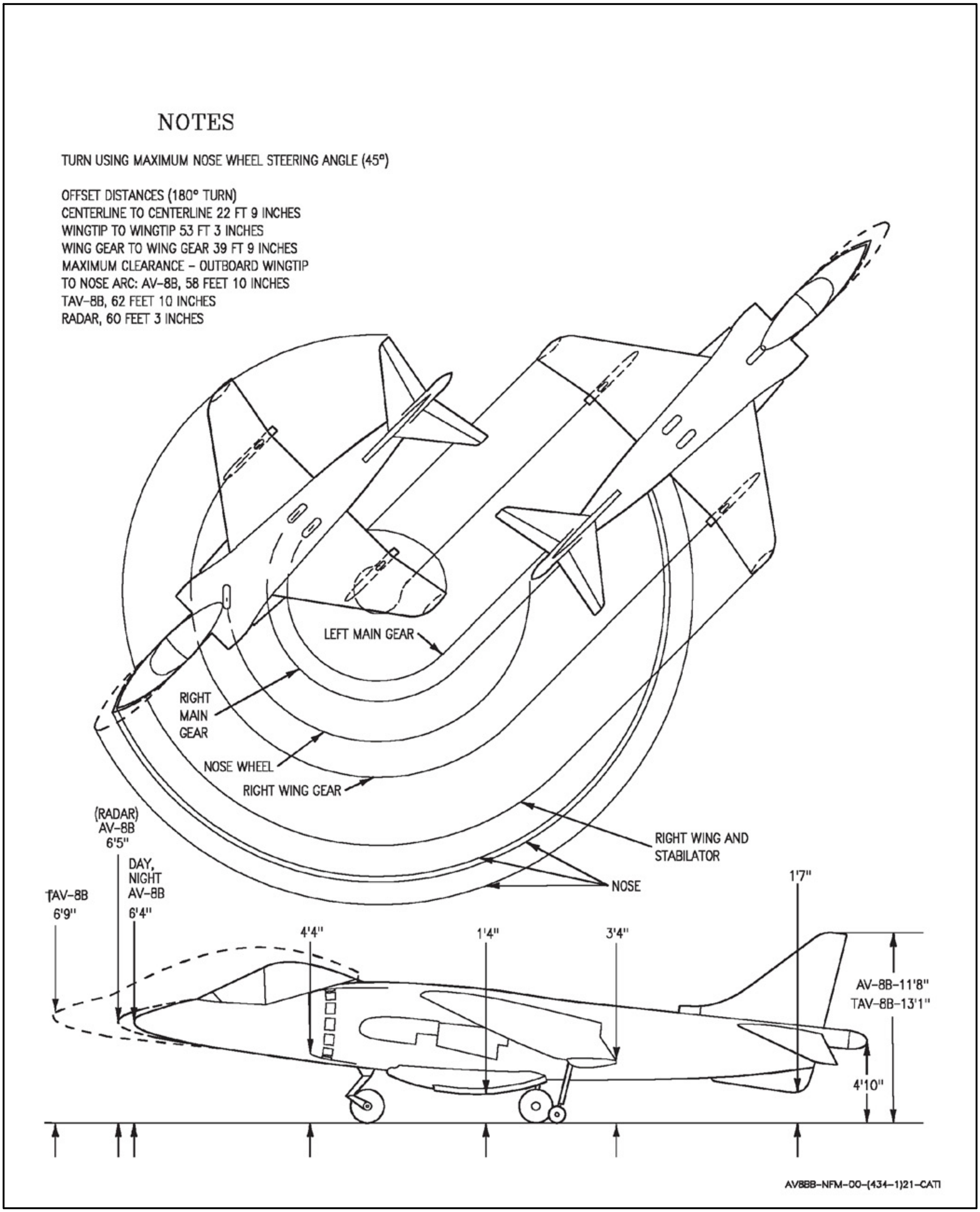


Figure 7-1. Minimum Turn Radius and Ground Clearance

If the ANTISKID/NWS switch is selected to NWS, ANTISKID is selected OFF and braking should be done carefully to avoid tire flat spotting. If taxi speed exceeds 16 knots, ANTISKID should be selected ON and nosewheel steering engaged by pressing and holding the NWS switch on the stick grip. Idle thrust is high and will result in excessive taxi speed unless the brakes are used or nozzles deflected. The brakes are designed for the limited requirements of V/STOL operations and will overheat easier than on most conventional aircraft. Brake energy usage can be calculated using Brake Energy chart. Refer to Chapter 9, A1-AV8BB-NFM-400. If brake energy exceeds 10×10^6 foot-pounds hot brakes may occur.

Note

- The use of nozzle deflection between 45° and 60° for control of taxi speed is recommended.
- If tires deflate for unknown reasons, suspect hot brakes.

When taxiing with nozzles deflected, it is essential that the stick be held forward of 2° nose down or that the stabilator be appropriately trimmed so that the nose RCS valve will remain closed. (Since the stick will move fore and aft slightly during taxi, the stabilator should be trimmed to 4° ND if the stick is not going to be held during taxi.) This action will prevent the high velocity jet from the nose puffer from blowing debris into the engine intake ducts. Should the taxi speed become too slow, the nozzles should be placed to 10° before increasing rpm above idle. If the nozzles are stiff or fail to follow properly at idle rpm, check the nozzle operation at 36 to 40 percent rpm. If the nozzles operate properly at 36 to 40 percent rpm, allow a short cooling period and again check nozzle operation at no more than 29 percent rpm. If the nozzles fail to operate properly at 36 to 40 percent rpm or during the second idle rpm check, abort. Place nozzles to 10° after stopping to avoid overheating of main landing gear tires and possible damage to the taxiway surface.

CAUTION

- If the nozzle angle exceeds 60°, the danger of ingestion of debris blown by the nozzles is high and the nozzle exhaust may overheat the tires.
- ANTISKID should be selected to NWS (skid light on) in confined areas to prevent releasing brake pressure when stopping.

Below 8 knots the antiskid is inoperative and care must be used to avoid locking the wheels, particularly at low gross weights. There is no sensation of brake locking which will result in tire skid.

Above 8 knots the antiskid is operative and the characteristic tugging deceleration will be felt during heavy braking as the brake pressure oscillates.

A minimum radius turn can be made only at taxi speeds below 2 to 3 knots ground speed. The radius of turn will increase with speed and a full nose gear steering angle at relatively high speeds will heavily load the outboard wing gear, cause a bank angle of 5° to 7° and may cause a skid as the main wheel tires lose adhesion.

The aircraft is cleared to taxi over a supported arresting gear wire up to a maximum speed of 5 knots. Stop immediately if a wing gear is trapped by the wire. The aircraft may cross an unsupported, tensioned arresting gear wire at any speed, engine rpm or nozzle angle if the wire lies flat on the runway or deck.

When ready to taxi:

1. Master mode — V/STOL.
2. Nozzles — 10°.
3. Flaps — CRUISE.

4. Trim — 0, 0, 4° ND.
5. Antiskid — CHECK.
   a. Parking brake — OFF.
   b. Stationary position with brake pedals — MAINTAIN.
   c. ANTISKID switch — TEST.
      (1) Brake relieves momentarily and aircraft moves forward. Brake returns and aircraft stops.
      (2) Brake pressure drops below 110 psi as brake relieves and increases as aircraft stops.

Note

Antiskid check should be performed while chocked or when clear of other aircraft or obstacles.

6. Brakes/NWS — CHECK.

Before AFC-391:

7. Nosewheel caster — CHECK.

   Release nosewheel steering while in a turn and ensure that the nosewheel does not snap back to center.

Note

This check is the only means available to determine proper operation of the nosewheel steering system.

TAV-8B Aircraft After AFC-391:

8. Aft Seat High Gain Override — CHECK.
   a. ANTISKID Switch — NWS.
   b. Front C/P NWS/Undesignate Switch — PRESS AND HOLD (NWS HI in HUD).
   c. Rear C/P NWS/Undesignate Switch — PRESS.
      (1) NWS HI in HUD changes to NWS.
      (2) Both C/Ps NWS/Undesignate Switch — RELEASE.
   d. ANTISKID Switch — ON.

7.2.1 Taxiing on Unprepared Surfaces

On loose surfaces or snow, rpm and nozzle deflection should be kept at a minimum to reduce the danger of FOD and flaps should be in CRUISE position to prevent damage by debris.

The aircraft can be taxied on surfaces too soft to support its parked weight. Directional control is good even when the nosewheel digs a rut. The main wheels will sink deeper than the nosewheel. Nozzle angles up to 45° may be used to reduce sinking into soft surfaces with due regard for surface damage and FOD. RPM in excess of 70 percent with nozzles aft or 80 percent with nozzles at 45° will cause excessive loads on bogged landing gear.

7.2.2 Sub-Idle Taxiing on Slippery Surfaces

In order to reduce engine thrust while taxiing on slippery surfaces, the throttle may be moved aft of the idle gate to the sub-idle dwell position.

CAUTION

Because of the increased possibility of engine surge occurring, this procedure should only be used when absolutely necessary.

Note

- Minimum rpm is 20 percent (-406) or 22 percent (-408). If rpm descends below 20 percent (-406) or 22 percent (-408) the engine must be shut down.
- Monitor JPT (535 °C max for -406 engine or 545 °C max for -408 engine).
- Shall not be attempted in MFS.
- Following this procedure, the throttle shall be advanced to idle and rpm stabilized at normal idle rpm prior to moving the throttle above the idle gate.

7.2.3 Pre-Positioning Checks

Pre-positioning checks may be completed in the chocks, while taxiing, or while marshalling.

1. CWAIVER checks

   a. With H4.0:

   CLOCK/CMBT

   W - WEAPONS PROGRAM

   MENU-STORES: BOX STORE

   FUZE/ARM/SOLENOID/AUTO-CCIP/Q:M:I
   TONE — BOXED
   SITE — SET/BOXED
   IR COOL — AS REQUIRED

   PROGRAM TPE: T0 - T4

   MENU-EHSD-DATA-T0
   UFC: TGTS-TERM
   ANG: _______
   HDG: _______
   REPEAT FOR T1-T4

   A - AVIONICS

   TPOD

   MENU-TPOD-STBY
   DATA-DPFL: Note
   HOLD DPFL: Note
   VCR — REC
   YARDSTICK: M
   DESIGNATOR: D+M/LSR/TRNL/MRK
   CHECK CCD/FLIR

CINT/HINT
FOV: NAR, ZOOM 2
TPOD(V) FREQ: SET

APG-65

PROGRAM SETS PER MISC 1
CHANNEL SELECTED
ECCM SELECTED

GPS

MENU-BIT
ALMANAC LOADED
CRYPTO OK
H/V ERRORS CHECKED

ARC-210

MENU-COMM: LOAD TIME
CHECK AJ AS REQUIRED TO VERIFY MWOD

NAVFLIR/ARBS

BORESIGHT
FLTR/GRAY SCALES/NITE

TACAN

CARD DEFAULTS

SET L MPCD: ADMIN 4/5, BRF 1
SET R MPCD: ADMIN 1/3, BRF 2

ATHS

VERIFY NETS
MYAC SET
OSR CHECK

I - IFF

MODE 1/2/4A: PER COMM PLN
MODE 3 AS ASSIGNED/REQUIRED

V - VRS

RUN/AUTO
MPCD/HUD

E - ECM

ALQ-164

BIT PROGRESS

ALE-39

CASTLE LEFT TO EW PAGE
CMDS: BOX
VERIFY LOAD/PROGRAM PER ADMIN 2 CARD

ALR-67 BIT

CASTLE LEFT TO EW PAGE
RWR-RBIT: PERFORM

R - RADALT

PUC/LAW: PER BRF 1
BOMB: PER BRF 1

b. With C1+ or OMNI 7.1:

CLOCK/CMBT

W - WEAPONS PROGRAM

MENU-STORES: BOX STORE

FUZE/ARM/SOLENOID/AUTO-CCIP/Q:M:I
TONE: BOXED
SITE: SET/BOXED
IR COOL: AS REQUIRED

A - AVIONICS

TPOD

MENU-TPOD-STBY
DATA-DPFL: Note
HOLD DPFL: Note
VCR-REC
YARDSTICK: M
DESIGNATOR: D+M/LSR/TRNL/MRK
CHECK CCD/FLIR
CINT/HINT
FOV: NAR, ZOOM 2
TPOD(V) FREQ — SET

APG-65

PROGRAM SETS PER MISC 1
CHANNEL SELECTED
ECCM SELECTED

GPS

MENU-EHSD-DATA-GPS
ALMANAC LOADED
CRYPTO OK
H/V ERRORS CHECKED
GPSE-BOXED

ARC-210

LOAD TIME ON RCU
CHECK AJ AS REQUIRED TO VERIFY MWOD

NAVFLIR/ARBS

BORESIGHT
FLTR/GRAY SCALES/NITE
CUERS/DELTA T/TSIZE AS BRIEFED

TACAN

CARD DEFAULTS

SET L MPCD: ADMIN 4/5, BRF 1
SET R MPCD: ADMIN 1/3, BRF 2

ATHS

VERIFY NETS
MYAC SET
OSR CHECK

I – IFF

MODE 1/2/4A: PER COMM PLN
MODE 3 AS ASSIGNED/REQUIRED

V – VTR

RUN/AUTO
MPCD/HUD

E – ECM

ALQ–164

BIT PROGRESS
RECV WHEN COMPLETE

ALE–39

VERIFY LOAD/PROGRAM PER ADMIN 2 CARD

ALR–67 BIT

RWR BIT — PERFORM

R – RADALT

PUC/LAW: PER BRF 1
BOMB: PER BRF 1

2. Canopy — CLOSED/CHECK.

   a. Light out.

   b. AV–8B — check viewports, physically pull back on both canopy bow handles.

WARNING

If the latches are not completely down and seated (canopy properly closed), orange alignment lines will not be aligned and canopy failure in flight may occur.

Note

> Physically pulling back on both canopy bow handles only ensures the canopy is latched on one side due to the rigidity of the canopy frame.

c. TAV-8B — push up on canopies without disturbing MDC and check canopy misalignment marker.

3. Seat — ARMED.
4. Flight and standby instruments — CHECK.
5. APU — AS DESIRED.
6. ANTISKID — ON (LIGHT OUT).
7. VTR — RUN.
8. Abort #'s — CHECK.
9. Altitude Switch — AS DESIRED.
10. INS Knob — IFA/NAV.
11. Approach Light — ON.
12. Rudder pedal shaker — CHECK.

While taxiing place RPS switch to TEST and make left and right turns with nosewheel steering. The rudder pedal shaker activates when the sideslip ball reaches its limits. During left turns the ball moves right and activates the right rudder pedal shaker. During right turns the ball moves left and activates the left rudder pedal shaker.

7.3 TAKEOFF

Four methods of takeoff are possible. These are Vertical Takeoff (VTO), Rolling Vertical Takeoff (RVTO), Short Takeoff (STO) and Conventional Takeoff (CTO). The method of takeoff is dependent upon tactical and other conditions and must be predetermined in order to perform the necessary calculations and properly configure the aircraft. Refer to Performance Data, A1-AV8BB-NFM-400, Mission Planning System (MPS), or the Mission Computer VREST calculator in order to determine required takeoff parameters. For crosswind takeoff techniques and considerations, refer to Chapter 11, Crosswind Takeoff Operations.

7.3.1 Takeoff Checklist

The following takeoff checklist is used to configure the aircraft for all four takeoff methods. Although it is suitable for use in a wide variety of operating conditions, no single checklist can be written to encompass all types of austere operating conditions. Certain environmental conditions (i.e. ice, snow, FOD, etc.) may require modification of the established take off checklist as it may not be safe to accomplish items such as acceleration or nozzle checks while the aircraft is stationary. Prudence dictates that a modified checklist be practiced, preferably in a simulator, before deployment to a site requiring its use. If conditions prohibit certain checks from being completed, operational necessity of the flight must be considered before continuing.

Note

> Each aircraft cockpit contains a takeoff checklist placard. The content of these placards varies substantially from the takeoff checklist described in this manual.

The Takeoff Checklist consists of two parts. During the first part the aircraft is placed in the proper configuration. This configuration check is referred to as a One Finger check because it is initiated and confirmed by signaling with the index finger extended. During the second part of the takeoff checks, the pilot evaluates engine performance, flap programming and nozzle movement, as well as arming the water system, if required. This check is referred to as a Two Finger or Five Finger check depending on whether or not water is being used. Once the check is complete, the pilot indicates preparation for a dry takeoff by signaling with two extended fingers. If the takeoff will be wet, then five fingers are extended.

Pitch carets (PC) are set at 14 for all takeoffs. This places the pitch carets at 6° of elevation with respect to the horizon bars in the V/STOL Master Mode. This position indicates the desired post-takeoff placement of the Depressed Attitude Symbol (or Witches Hat). This takeoff attitude is the level-flight equivalent of 14° AOA. Trim for takeoff shall be 0° for both aileron and rudder. Shore-based pitch trim shall be 2° ND except when conducting a VTO in the TAV-8B, in which case 1° ND will be used. These trim settings are based upon rotation of the aircraft/nozzles at the calculated rotation airspeed while the stick remains guarded at the trimmed position. Use of additional airspeed in order to provide a performance pad will produce nose down pitching moments after rotation that will have to be arrested with aft stick deflections. Configuration of the NRAS, STO STOP, flaps and water, as well as movement of the nozzles during the flight control check, will vary depending on the type of takeoff being performed. Refer to specific takeoff procedures for additional detail.

Configuration Checks (One Finger Checks):

1. Nozzle Rotation Airspeed (NRAS) — AS REQUIRED.

Press V/STOL master mode button. Select NRAS option on ODU. Insert NRAS on the UFC.

2. Pitch Carets (PC) — SET.

   Select PC on ODU. Insert 14 on UFC.

3. STO Stop — AS REQUIRED.
4. Trim — SET.
5. Flaps — AS REQUIRED.
6. Warning/caution lights — OUT.

WARNING

On aircraft after AFC-391 (NWS Mod), it is imperative that the ANTISKID switch be reset to ON prior to completion of takeoff checks. Failure to do so will result in the loss of antiskid protection on the ensuing takeoff and will additionally result in the unintended selection of hi gain steering if the NWS button on the stick is depressed and held with throttle below about 75 percent fan speed.

Engine, Water System and Flight Control Checks (Two/Five Finger Checks):

7. Engine — CHECK.
   a. DDI — Select Eng/Box Accel.
   b. Accelerate engine from idle to 55 percent (-406) or 60 percent (-408).
   c. Check acceleration time within limits: -406 engine 27 to 55 percent in 3.7 to 4.3 seconds. -408 engine 35 to 60 percent in 2.4 to 3.1 seconds.
   d. IGVs — check scheduling and verify in the band of 8° to 19° at 55 percent (-406) or 10° to 21° at 60 percent (-408).

e. (−408A or −406 engine only) Record IGV angle from Engine page and plot on card (Figure 7-2) in relation to ambient temperature to ensure IGV angle is within the boundaries depicted on card. If the IGV angle is outside the boundary lines abort the flight and report the anomaly to maintenance personnel.

CAUTION

Abnormal engine accelerations under DECS control, regardless of fuel type, OAT or density altitude are indicative of either a degraded engine or engine control system.

8. Water — AS REQUIRED.

   a. Place water switch to TO and note RPM rise.

   b. Reset RPM to top end of acceleration band.

9. Nozzle/flaps/duct pressure — CHECK.

   a. Set nozzles momentarily to STO stop (or 50° if STO stop is not required).

   b. Check flaps for proper angle based on flap mode.

   c. Check duct pressure approximately 45 psi.

   d. Place nozzles at the takeoff position.

7.3.2 Jetborne/Semi-Jetborne Takeoffs

All jetborne and semi-jetborne takeoffs begin with a takeoff procedure and end with an accelerating transition to wingborne flight. Conceptually, the transition point between the takeoff procedure and the accelerating transition procedure begins once the aircraft is off the ground, the wings are level and the vane is centered. At this point, attitude (and AOA) can be safely increased and the Accelerating Transition (7.3.2.4) can begin.

7.3.2.1 Vertical Takeoff

If possible, VTO into the wind. Lateral control during the first few feet of a VTO is critical. Do not hesitate to make immediate, large and rapid control movements to counteract bank angles.

Configuration Checks (One Finger Checks):

1. Nozzle Rotation Airspeed (NRAS) — NOT REQUIRED.

2. Pitch Carets (PC) — SET.

3. STO Stop — CLEAR.

4. Trim — SET.

5. Flaps — STOL.

6. Warning/Caution Lts — OUT.

Engine, Water System and Flight Control Checks (Two/Five Finger Checks):

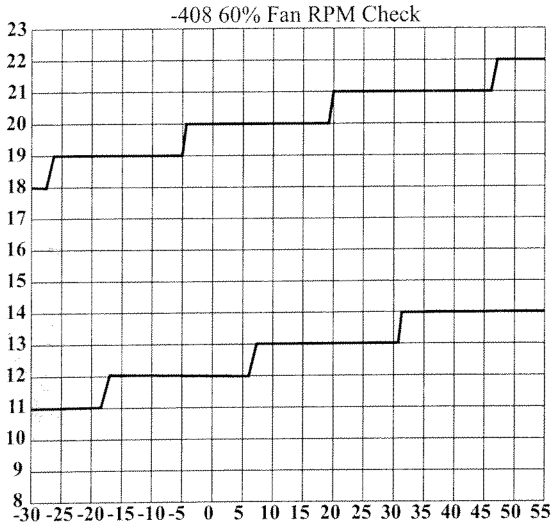
7. Engine — CHECK.

8. Water — AS REQUIRED.

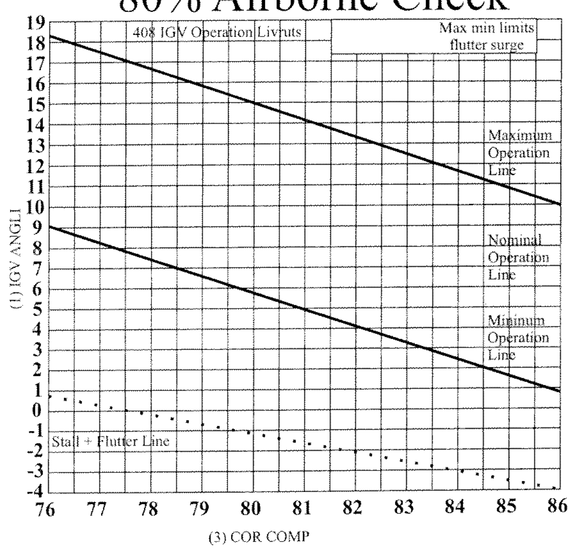
IGV CHECK CARD

Pilot:____________ Date:_________ Side #:______

60% Ground Check



80% Airborne Check



MODEX____________

60% RUN UP CHECK

TEMP ____________

IGV ANGLE ____________

SET FAN RPM TO 80% AND RECORD

____________ #(1) IGV

____________ #(2) COMP RPM

____________ #(3) COR COMP

Figure 7-2. 60/80% Check Card for −408A

9. Nozzle/Flaps/Duct Pressure — CHECK.

   a. Set nozzles momentarily to approximately 50°.

   b. Check flaps at approximately 62°.

   c. Check duct pressure approximately 45 psi.

   d. Place nozzles at the Hover Stop and check angle.

Initiate Takeoff:

10. Throttle — FULL.

11. Brakes — HOLD until airborne.

12. CHECK TOP END RPM and Water Flow (if armed).

13. During liftoff — ensure wings remain level. Hold heading and adjust attitude to prevent fore/aft drift.

14. When clear of ground effect (20 to 25 feet), gradually reduce power to establish a hover, or when passing 50 feet and clear of obstacles, begin transition to wingborne flight (see paragraph 7.3.2.4 Accelerating Transition).

7.3.2.2 Rolling Vertical Takeoff

An RVTO may be performed in those instances when a VTO is desired but the takeoff surface is deemed unsuitable. The RVTO requires approximately 100 feet of ground roll and should be made as nearly into the wind as possible. RVTO can be performed up to hover weight as calculated in Performance Data, A1-AV8BB-NFM-400. The Mission Computer VREST function does not provide hover weight calculation, so VTO weight should be used as a conservative estimate.

Configuration Checks (One Finger Checks):

1. Nozzle Rotation Airspeed (NRAS) — NOT REQUIRED.

2. Pitch Carets (PC) — SET.

3. STO Set — 70°.

4. Trim — SET.

5. Flaps — STOL.

6. Warning/caution lights — OUT.

Engine, Water System and Flight Control Checks (Two/Five Finger Checks):

7. Engine — CHECK.

8. Water — AS REQUIRED.

9. Nozzle/Flaps/Duct Pressure — CHECK.

   a. Set nozzles momentarily to STO Stop and check angle.

   b. Check flaps at approximately 62°.

   c. Check duct pressure approximately 45 psi.

   d. Place nozzles to 30°.

Initiate Takeoff:

10. NWS — ENGAGE.
11. Throttle — FULL.
12. Brakes — RELEASE (no later than at initial tire skid).
13. Nozzles — STO STOP AS RPM PASSES - 100 percent (-406 engine) - 110 percent (-408 engine).
14. During liftoff ensure wings remain level and center the sideslip vane.
15. Begin transition to wingborne flight (see paragraph 7.3.2.4 Accelerating Transition).

7.3.2.3 Short Takeoff

The STO can be used for the widest variety of aircraft configurations, weights and runway conditions provided that crosswinds remain within specified limits. Nozzle rotation airspeed (NRAS) and nozzle angle calculation can be performed using Performance Data, A1-AV8BB-NFM-400, Mission Planning System (MPS), or the Mission Computer VREST function.

CAUTION

When the takeoff surface is littered with hard foreign objects such as rocks or stones and takeoff conditions permit, the use of AUTO flaps is recommended to reduce the potential for flap damage due to debris impact. VREST data is invalid for AUTO flap STOs.

Configuration Checks (One Finger Checks):

1. Nozzle Rotation Airspeed (NRAS) — SET AS CALCULATED.
2. Pitch Carets (PC) — SET.
3. STO Stop — SET AS CALCULATED.
4. Trim — SET.
5. Flaps — AS DESIRED (STOL or AUTO).
6. Warning/Caution Lts — OUT.

Engine, Water System and Flight Control Checks (Two/Five Finger Checks):

7. Engine — CHECK.
8. Water — AS REQUIRED.
9. Nozzle/Flaps/Duct Pressure — CHECK.
    a. Set nozzles momentarily to STO Stop and check angle.
    b. Check flaps for proper angle based on flap mode.
    c. Check duct pressure approximately 45 psi.
    d. Place nozzles at 10°.

Initiate Takeoff:

10. NWS — Engage.

11. Throttle — FULL.

12. Brakes — Release (no later than at initial tire skid).

13. CHECK TOP END RPM and Water Flow (if armed).

14. Nozzles — STO Stop at calculated NRAS.

15. During liftoff — ensure wings remain level and center the sideslip vane.

16. Begin transition to wingborne flight (see paragraph 7.3.2.4 Accelerating Transition).

7.3.2.4 Accelerating Transition

Accelerating transition is the term used to describe transition from jetborne/semi–jetborne flight to wingborne flight. The accelerating transition begins once the aircraft is clear of ground effect and at an altitude sufficient to avoid obstacles and introduction of FOD onto the landing surface. A slight climb should be maintained throughout the transition manuever. Accelerating transitions are performed using a capture attitude technique – meaning the aircraft is rotated in pitch until the depressed attitude symbol, or Witches Hat, coincides with the pitch carets. The capture attitude technique decreases pilot workload, as well as reducing the probability of having AOA excursions early in the takeoff maneuver due to pilot induced pitch oscillations.

WARNING

During accelerating transitions, angle of attack must not exceed 15°. Overrotation or high rotational rates may result in the AOA rising uncontrollably even with the stick full forward. Uncontrollable pitch ups are most likely to occur at extreme aft CG loadings and/or with the wing flaps deflected more than 25°.

1. Throttle — FULL.

2. Set attitude — Witches hat at the pitch carets (Continue to maintain wings level and vane centered).

3. Nozzles — gradually rotate the nozzles aft. Nozzle rotation rate should enable the aircraft to maintain a slight climb. (Maintain a nozzle angle of 25° or greater while in STOL flaps).

Note

Steps 2 and 3 are performed simultaneously, so that the effective nozzle angle with respect to the ground does not increase when the attitude is being set.

Once wingborne flight is achieved:

4. Reduce power in order to achieve the normal lift dry rating or less (extinguish the 15 sec light) and stop water flow (if required).

5. Perform After Takeoff check or enter the landing pattern.

CAUTION

Uncommanded nosewheel steering angle excursions may occur if after lift-off an immediate turn is made. With lift-off above 100 KGS, the nosewheel may cant to such a degree that undesirable ground handling characteristics may occur on touch down. Extending upwind for approximately 10 to 15 seconds while rotational speed slows down can minimize this gyroscopic effect.

7.3.3 Conventional Takeoff

The CTO can be used when configuration or environmental conditions preclude use of any other takeoff type (i.e., crosswinds or asymmetric loadings). The CTO is restricted to gross weights that will not cause the wheel/tire limitation speed of 180 KGS to be exceeded on the takeoff roll. Refer to Performance Data, A1-AV8BB-NFM-400. The Mission Computer VREST function does not provide CTO performance calculations.

Configuration Checks (One Finger Checks):

1. Nozzle Rotation Airspeed (NRAS) — SET NOSEWHEEL LIFTOFF SPEED.
2. Pitch Carets (PC) — SET.
3. STO Stop — CLEAR.
4. Trim — SET.
5. Flaps — AUTO.
6. Warning/Caution Lts — OUT.

Engine, Water System and Flight Control Checks (Two/Five Finger Checks):

7. Engine — CHECK.
8. Water — AS REQUIRED.
9. Nozzle/Flaps/Duct Pressure — CHECK.
    a. Set nozzles momentarily to approximately 50°.
    b. Check flaps at approximately 25°.
    c. Check duct pressure approximately 45 psi.
    d. Place nozzles to 10°.

Initiate Takeoff:

10. NWS — Engage.
11. Throttle — FULL.
12. Brakes — Release (no later than at initial tire skid).
13. CHECK TOP END RPM and Water Flow (if armed).
14. At nose wheel liftoff speed — Gradually rotate with aft stick. Guard against over-rotation.

15. During liftoff — ensure wings remain level and center the sideslip vane.

16. Set attitude — Witches hat at the pitch carets.

CAUTION

Uncommanded nosewheel steering angle excursions may occur if after lift-off an immediate turn is made. With lift-off above 100 KGS, the nosewheel may cant to such a degree that undesirable ground handling characteristics may occur on touch down. Extending upwind for approximately 10 to 15 seconds while rotational speed slows down can minimize this gyroscopic effect.

7.3.4 Formation Takeoff

7.3.4.1 Formation Vertical Takeoff

Formation Vertical Takeoff is not recommended.

7.3.4.2 Formation Rolling Vertical Takeoff

Formation Rolling Vertical Takeoff is not recommended.

7.3.4.3 Section STO

The Section STO provides the capability to launch a section of aircraft using the STO technique when conditions make the time required to execute a formation rendezvous unacceptable or undesirable (i.e., low ceilings or poor visibility). Aircraft conducting Section STOs should be like configured (engine type and gross weight). Line up with a minimum lateral separation of one wingspan. The wingman shall be upwind with intakes forward of the leader's cold nozzles. The flight shall use the highest calculated NRAS and its corresponding nozzle rotation angle.

1. Takeoff checks — TWO/FIVE FINGER CHECKS COMPLETE.

2. Signal two or five fingers to flight lead.

Leader nods head:

3. Brakes — RELEASE.

4. Throttle — ADVANCE SMOOTHLY TO MAX RPM.

At NRAS leader nods head:

5. Nozzles — STO STOP.

6. Begin transition to wingborne flight while maintaining formation position (see paragraph 7.3.2.4).

When wingborne flight is achieved:

7. Flight lead nod head to initiate After Takeoff checks (see paragraph 7.3.5).

WARNING

Section STOs should not be conducted a night.

7.3.4.4 Section CTO

The Section CTO provides the capability to launch a section of aircraft using the CTO technique when conditions make the time required to execute a formation rendezvous unacceptable or undesirable (i.e., low ceilings or poor visibility). Aircraft conducting Section CTOs should be like configured (engine type and gross weight). Line up with a minimum lateral separation of one wingspan. The wingman shall be upwind with intakes forward of the leaders cold nozzles. The flight leader should use the rotation speed of the heaviest aircraft.

1. Takeoff checks — TWO/FIVE FINGER CHECKS COMPLETE.
2. Signal two or five fingers to flight lead.

Leader nods head:

3. Brakes — RELEASE.
4. Throttle — ADVANCE SMOOTHLY TO MAX RPM THEN LEAD SETS.
   a. 93 percent rpm (–406 engine).
   b. 100 percent rpm (–408 engine).

Just prior to rotation airspeed, flight leader gives go fly signal:

5. Wingman matches lead’s rotation rate and maintains lateral separation.

After safely airborne, flight leader nods head:

6. Initiate After Takeoff checks (see paragraph 7.3.5).
7. Wingman closes to standard parade position.

7.3.4.5 Section Stream STO or Division Stream STO

When multiple aircraft need to be launched together, but ceilings and visibility are great enough to permit a rendezvous underneath, then a Section or Division Stream STO can be used. Aircraft conducting Stream STO need not be identically configured. Line up on the runway with the flight lead on the downwind side with a minimum distance between aircraft of 1,000 feet. Each succeeding aircraft should be staggered diagonally. On signal, all the aircraft roll simultaneously and perform individually computed STO. (The flight lead transmits calculated NRAS/STO STOP values only as a cross check for the flight.) When safely airborne, the flight leader reduces power slightly to expedite the rendezvous.

CAUTION

Do not enter the jetwash of preceding aircraft during climbout.

Flight Leader transmits “LEAD (Left/Right side), STREAM STO, (calculated NRAS value), (calculated STO STOP value), (Wet/Dry)”:

1. Once in position with one finger checks complete — REPORT “(number in flight) ONE FINGER”.

Flight Leader directs “RUN’EM UP”:

2. Two/Five Finger Checks — REPORT “(number in flight) TWO/FIVE FINGER”.

Leader transmits “ROLLING, ROLLING, GO”:

3. Perform a normal STO on individually calculated numbers.

4. Transition to wingborne flight (see paragraph 7.3.2.4 Accelerating Transition).

5. Initiate After Takeoff checks (see paragraph 7.3.5).

6. Execute formation rendezvous or deploy to assigned position.

7.3.4.6 Radar Trail Departure

Radar Trail Departures. Radar trail departure is normally used to get a flight of two or more airborne (4 is the maximum allowed by OPNAV 3710) under IMC conditions. Local training flights requiring a DD-175 will need to request non-standard formation in the remarks section. Circling minimums will be required. Airspeed is the primary means for separation, using the radar to fine tune formation keeping. Aircrew will not begin radar switchology until their aircraft is cleaned up.

Prior to Takeoff:

Set radar parameters to range while scan (RWS)/4bar/90°/10nm/MPRF/4 sec. aging, (use 6 bar for division takeoffs), verify antenna coverage. Ensure the radar is not in the BIT cycle and all parameters are set prior to taking the runway.

Departure:

The primary mode of radar trail departures from a visual start (under the overcast) will be via BACQ or GACQ, and then follow in STT. TWS should be avoided because it takes too long to extrapolate targets. Radar trail departures will be conducted from an individual takeoff profile. A 30 second interval should give a 2 nm separation between aircraft.

If trail is to be accomplished under a cloud layer with intent for an IMC climb, dash-2, once safely airborne, can select either BACQ or GACQ and visually place the leader in the scan volume which will command STT. Once radar lock is verified visually and with range/altitude, the wingman calls “tied”. The wingman further repositions himself to a 1-2 nm trail.

If desired, a trail departure may be done as separate elements. From a 30 second interval as before, dash 2/3/4, once safely airborne, will monitor the flight via the RWS parameters stated earlier. The wingmen maintain 2 nm separation with AA TACAN, radar, and airspeed. As lead makes a turn, the wingmen lag all turns following the same flight profile as lead rather than decreasing nose to tail. This is done by allowing the preceding aircraft to drift 5° laterally for each mile if separated prior to starting the turn. For example, for 1 nm trail, let the lead/interval drift 5°, for 2 nm trail, let the lead/interval drift 10°, and so on. Monitor Vc in the HUD or RADAR display and the airspeed of your interval to ensure that you are not closing or opening. Lead and lag turns appropriately to maintain the correct 2 nm spacing. Appropriate lag pursuit curves may be used to adjust distance (lead pursuit should be avoided due to excessive closures without a visual). This profile will continue until a visual join-up on top can be accomplished. Echelon formation will have the lead 30° left/right on the scope with approximately 170° target aspect, and range will auto scale to better display 1-2 nm range to lead. Pure trail formation will show the leader on the nose with 180° aspect.

If radar contact is lost, call “clean” if using RWS, or call “broke lock” if using STT. Select GACQ (visual) or RWS (IMC) for reacquiring the lead. If a flight member is clean or breaks lock, the flight lead will call all turns and headings, as well as passing each 5,000 feet of altitude change.

In division it is recommended that BACQ be used to more discriminately lock the next element (i.e., dash-3 locks dash-2) if visibility/ceiling permits. If the weather causes you to be unable to visually confirm the lock, then the RWS format described above will enable the pilot to see all elements of the flight. Once the flight has been detected, the pilot must sort the formation and command a manual acquisition of his interval.

WARNING

- Positive deconfliction must be made within a division to ensure “simo” joins on an element do not occur. This maybe done by verifying range with AA TACAN and comm. Using RWR (buddy spikes) at these ranges will not give adequate confirmation.
- Once radar contact is established, the pilot may fly the profile in either RWS or STT. Using the RWS mode will be more difficult and lost detections may occur. STT will be the simplest method of precisely keeping position during the climbout but will keep the wingman blind to all other traffic. In all cases the wingman will be required to maintain the same ground track as the lead, hence the requirement for lag pursuit.

7.3.5 After Takeoff

1. Landing Gear — UP.
2. Flaps — AUTO.

Selection of AUTO flaps shall be made when comfortably airborne at no less than 25° nozzle angle.

3. Nozzles — AFT.
4. Water switch — OFF.
5. STO Stop — CLEAR.

CAUTION

After takeoff, do not apply wheel brakes prior to, or as part of raising the landing gear. Applying wheel brakes immediately after takeoff while the wheels are spinning places undue stress on the main landing gear system and may cause the main landing gear door to be pulled into the main wheel well. If the main landing gear doors are jammed, the main landing gear will not extend when the landing gear handle is lowered resulting in a main landing gear up landing.

Note

With the landing gear up, the JPT limiters will throttle the engine back to the maximum thrust rating when nozzle angle is reduced below 7° to 12°. If operating near lift ratings (particularly on a wet takeoff), this sudden and large thrust reduction must be anticipated or the last 20° of nozzle rotation delayed until after power has been reduced with the throttle.

6. VTR — AUTO OR RUN AS REQUIRED.

7.3.6 CLIMB Performance Data

A1-AV8BB-NFM-400 specifies a simplified climb technique consisting of a constant airspeed climb until interception of the specified Mach number, at which point a constant Mach climb is initiated. The initial phase of the climb is normally conducted at 300 KCAS, unless there is intent to level off and cruise below 10,000 feet MSL, in which case the climb can be conducted at 250 KCAS.

7.4 INFLIGHT

Periodic checks of engine displays, fuel quantity, and instruments must be made to detect system anomalies early on. Fuel asymmetry must be monitored to prevent development of asymmetric loads.

Note

Refer to Flight Characteristics, Chapter 11; All Weather Operation, Chapter 20; and Performance Data, A1-AV8BB-NFM-400.

7.4.1 10,000 Foot Check

1. Fuel transfer/quantity.
2. Cabin pressure.

7.4.2 18,000 Foot Check

1. Altimeter — 29.92 SET.
2. Cabin pressure.
3. APU secure if conditions permit.

7.4.3 IGV Check (-408A or -406 engine only)

This check should be performed at 5,000 feet MSL.

1. Set engine fan speed to 80 percent RPM.
2. Data — Record required data on card (Figure 7-2).
3. IGV Angle — Within bands indicated (Figure 7-3).
4. If IGV angle above indicated boundary execute IGV failure procedure for IGVs stuck at high angle.
5. If IGV angle below indicated boundary execute IGV failure procedure for IGVs stuck at low angle.

WARNING

If the in-flight check results in an IGV angle for a given Cor Comp RPM value that falls on or outside of the minimum/maximum operating lines, treat as an IGV failure.

7.5 DESCENT

Perform the following checks before commencing descent:

1. STO Stop — CLEAR.
2. Weather — CHECK (ATIS information).
   a. Verify wind speed and direction.
   b. Verify ceiling and visibility.
   c. Determine approach and landing suitable for weather and aircraft configuration.

3. Instruments — Set-up.

   a. STP — Set to intended point of landing.

   b. TCN — Set to airfield/ship or A/A TCN per brief.

   c. Courseline — Set to runway heading or approach Final Approach Course.

   d. NAVFLIR, HUD, RADALT — Set to desired configuration for cueing to landing environment.

4. Fuel — CHECK.

   a. Reset BINGO bug to briefed setting.

   b. Balance asymmetry if greater than 300 pounds.

5. Temperature — PREHEAT/DEFOG (as required).

6. APU — AS REQUIRED (see Chapter 4, Figure 4-7).

7.6 LANDING

The break speed is 350 KCAS. The standard break interval is 2 seconds. VFR Straight-in-recoveries should be accomplished using an en route formation to the initial point. The flight may be separated either in a clean or dirty configuration. To separate the flight in the clean configuration, once established on extended final and with the field in sight, wingmen should be detached by the flight leader at 2 nm intervals. 4 ship formations should detach dash 4 at 8 nm, dash 3 at 6 nm, and dash 2 at 4 nm to allow lead the ability to transition to the landing configuration 2 nm prior to the landing threshold. Once detached, each flight member should ensure airspeed is below 250 KCAS, transition to the landing configuration, select 25° nozzles, flaps as required, and slow to 8 to 10 degrees AOA. At 2 nm flight members should select 60 degrees nozzles (or as required for type landing) and slow to 10 to 12 degrees AOA. To separate the flight in a dirty configuration, once established on extended final and with the field in sight, the flight leader should lower landing gear as a flight. 4 ship formations should detach dash 4 at 7 nm, dash 3 at 5 nm, dash 2 at 3 nm. Once detached each flight member should select hover stop until approaching 8 to 10 degrees AOA then reset nozzle angle to 60 degrees (or as required for type landing). The flight leader may provide the signal to detach from the formation either via radio or visually. Flight members should strive to maintain interval between aircraft once separated from the formation and fly a 3 degree glide slope, but at no time fly below the flight path of the aircraft in front of them. Landings are normally made to centerline, and beyond the landing touch down point of the preceding aircraft. Once comfortable, flight members should move to the side of the runway of expected exit in order to provide an avenue for aircraft landing behind experiencing brake failure. FOD awareness and proper FOD prevention intervals should always be maintained.

The break speed is 350 KCAS. The standard break interval is 2 seconds. At the break, apply bank angle, retard the throttle and extend speed brake. Once below 250 KCAS, complete the Landing Checklist (7.6.1). Four methods of landing are possible. These are Vertical Landing (VL), Rolling Vertical Landing (RVL), Slow Landing (SL) and Conventional Landing (CL). The method of landing is dependent upon tactical and other conditions and must be predetermined in order to properly configure the aircraft. In the case of VLs and RVLs, it is also necessary to calculate landing performance using Performance Data, A1-AV8BB-NFM-400 or the Mission Computer VREST calculator.

A decelerating transition from wingborne flight is used to place the aircraft in position for a VL or an RVL. All other landing types use a standard pattern approach to landing. On all rolling landings (CL, SL, RVL) the recommended landing attitude is to place the depressed attitude symbol (Witches Hat) on to 2° above the horizon bar. Pilots should expect turbulence and random trim changes when the aircraft enters ground effect (below 20 to 25 feet) as jet efflux strikes various airframe surfaces, the aircraft must be actively flown all the way to the ground. Prior to engaging NWS ensure the aircraft is tracking straight and the rudder pedals are centered. Power Nozzle Braking (PNB) is normally used for most roll-on landings; however, the aircraft can be stopped using wheel brakes alone. If wheel brakes alone are used after landing at speeds greater than 140 KGS and above 20,000 LBS GW, the pilot should expect main tire fuse plug release approximately one minute after the aircraft comes to a stop. To achieve minimum braking distance, the anti-skid system operates most efficiently when the brakes are applied 2 seconds after touchdown using a quick, full pedal input held steady until taxi speed is reached. Do not cycle, pump or lightly ride the brakes. For crosswind landing techniques and considerations, refer to Chapter 11, Crosswind Landing Operations.

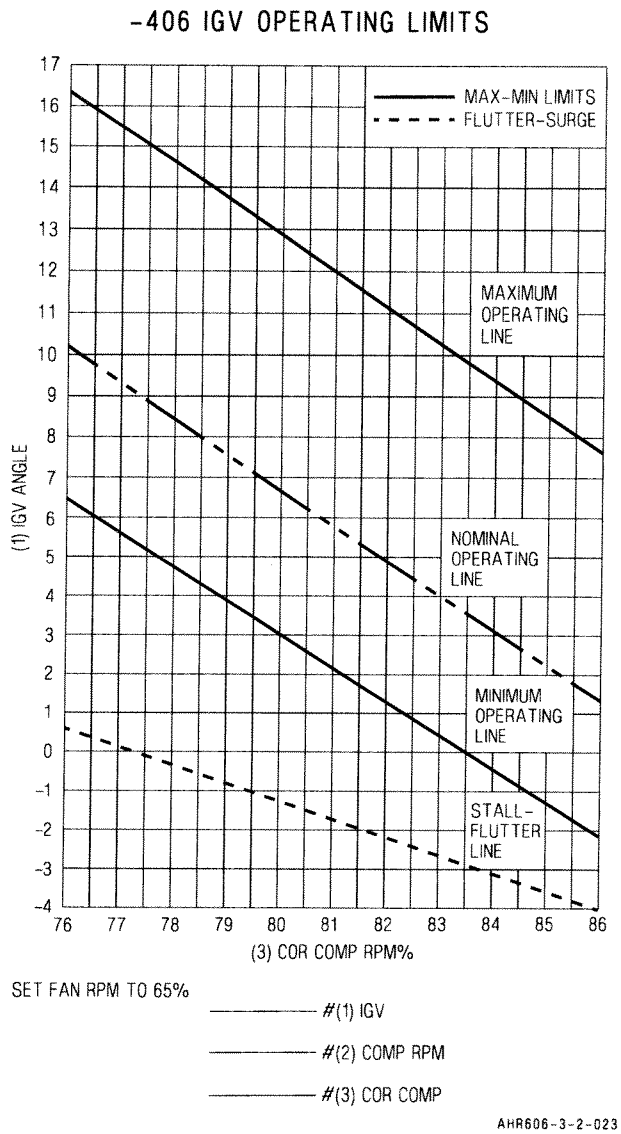


Figure 7-3. 65% Check Card for -406A

7.6.1 Landing Checklist

The following landing checklist is used to configure the aircraft for all four of the landing methods.

Note

Each aircraft cockpit contains a landing checklist placard. The content of these placards varies substantially from the current version described in this manual.

1. Gear — DOWN.
2. Flaps — AS REQUIRED (nozzles 25° or greater prior to selecting STOL flap).
3. STO Stop — CLEAR.
4. Duct pressure — CHECK.
5. Brake pressure — CHECK.
6. Water — AS REQUIRED.

If water is to be used:

a. Nozzles — AS REQUIRED.

b. Water switch — T/O (check for RPM rise).

c. Throttle — 105 PERCENT MINIMUM.

d. Check for green water flow light or W in the HUD, and water quantity countdown.

e. Water switch — AS REQUIRED.

WARNING

- Proper performance of the water check is not a guarantee that the system will activate and provide water flow later in the landing evolution. It is essential that RPM, JPT and flow status be monitored if wet performance is required.
- Failure of the water non-return valve may cause cavitation of the water pump resulting in loss of thrust without associated warning indications (i.e. water flow light on but no flow). Monitoring JPT is considered crucial for awareness of proper water system operation.

7. VTR — RUN.
8. Warning and caution lights — CHECK.
9. Lights — AS REQUIRED.

WARNING

On aircraft after AFC-391 (NWS Mod), it is imperative that the ANTISKID switch be reset to ON. Landing with the ANTISKID switch in NWS will result in the loss of antiskid protection during the landing and will additionally result in the unintended selection of hi gain steering if the NWS button on the stick is depressed and held with throttle below about 75 percent fan speed.

7.6.2 Decelerating Transition to a Hover

Decelerating transitions for VLs are started from a key position approximately 1/2 NM from the touchdown point (preferably downwind) at an altitude of approximately 310 feet AGL. This places the aircraft on a slightly descending flight path toward a point abeam the intended point of landing at approximately 150 feet AGL. From, or just prior to arrival at, this abeam position, the aircraft then crosses to hover directly over the intended point of landing. (See Figure 7-4.)

Approaching 180:

1. Nozzles — 60°.
2. Flaps — CHECK PROGRAMING AND DROOP.
3. AOA — 10° TO 12°.

Off the 180:

4. Adjust flight path with stick.
5. Control AOA with throttle or nozzles.

At the Key:

6. Set attitude — WITCHES HAT ON THE HORIZON.
7. Nozzles — HOVER STOP.
8. Minimize sideslip, ensure no more than 15° AOA and strive for 0° AOB until less than 30 knots. Increase power as required to maintain a shallow glideslope (approximately 3°) to arrive abeam the landing site at 150 feet AGL.

At 60 KCAS:

9. Check for adequate performance margin — if more than two legs of the power hexagon then execute a waveoff.

Note

Due to numerous dynamic factors associated with every approach, a valid 60 knot check does not guarantee acceptable performance will remain for the hover and vertical landing. 60 knot check validity is improved by having the velocity vector on the horizon, a proper attitude and a steady state power condition when approaching the check airspeed.

10. Approaching landing site — Select ground references and monitor rate of closure. When closure is under control and below 30 knots, cross over the landing site while remaining at 150 feet AGL minimum until over a prepared surface. Flare slightly to stop, or use braking stop as required, and establish hover over the desired landing point.

7.6.3 The Hover

The hover may be entered from a decelerating transition or a VTO. It is an interim period during which the aircraft is held relatively stationary at an altitude of 50 to 60 feet AGL.

1. Control height with small throttle changes.
2. Maintain position with ground references.
3. RPM/JPT — WITHIN LIMITS.

7.6.4 Vertical Landing

The vertical landing, Figure 7-4, is commenced from a 50 to 60 foot AGL hover. Landing should be made pointing into the wind to minimize exhaust reingestion.

1. Start a slow descent with the throttle.
2. Monitor ground references.
3. Maintain heading and adjust attitude and roll as necessary to correct for drift.
4. Maintain positive rate of descent. Avoid stopping in ground effect. Some throttle reduction may be required if descent rate is slow since the aircraft will tend to stop in the area of maximum LIDS capability (5 to 10 feet). Additionally, surface winds in excess of 10 knots may degrade LIDS performance and may require a corresponding coarse power correction just prior to touchdown.

Note

If strakes or gun pods are not installed some suck-down effect is present. A power increase may be required near touchdown to prevent excessive sink rate.

When positively down:

5. Throttle — IDLE.
6. Brakes — APPLY.
7. Nozzles — AFT.
8. Trim — 4° ND.
9. Water — OFF (if selected).

Note

Do not hover in ground effect. Avoid large pitch changes near ground to prevent hot gas reingestion and hitting the tail bumper.

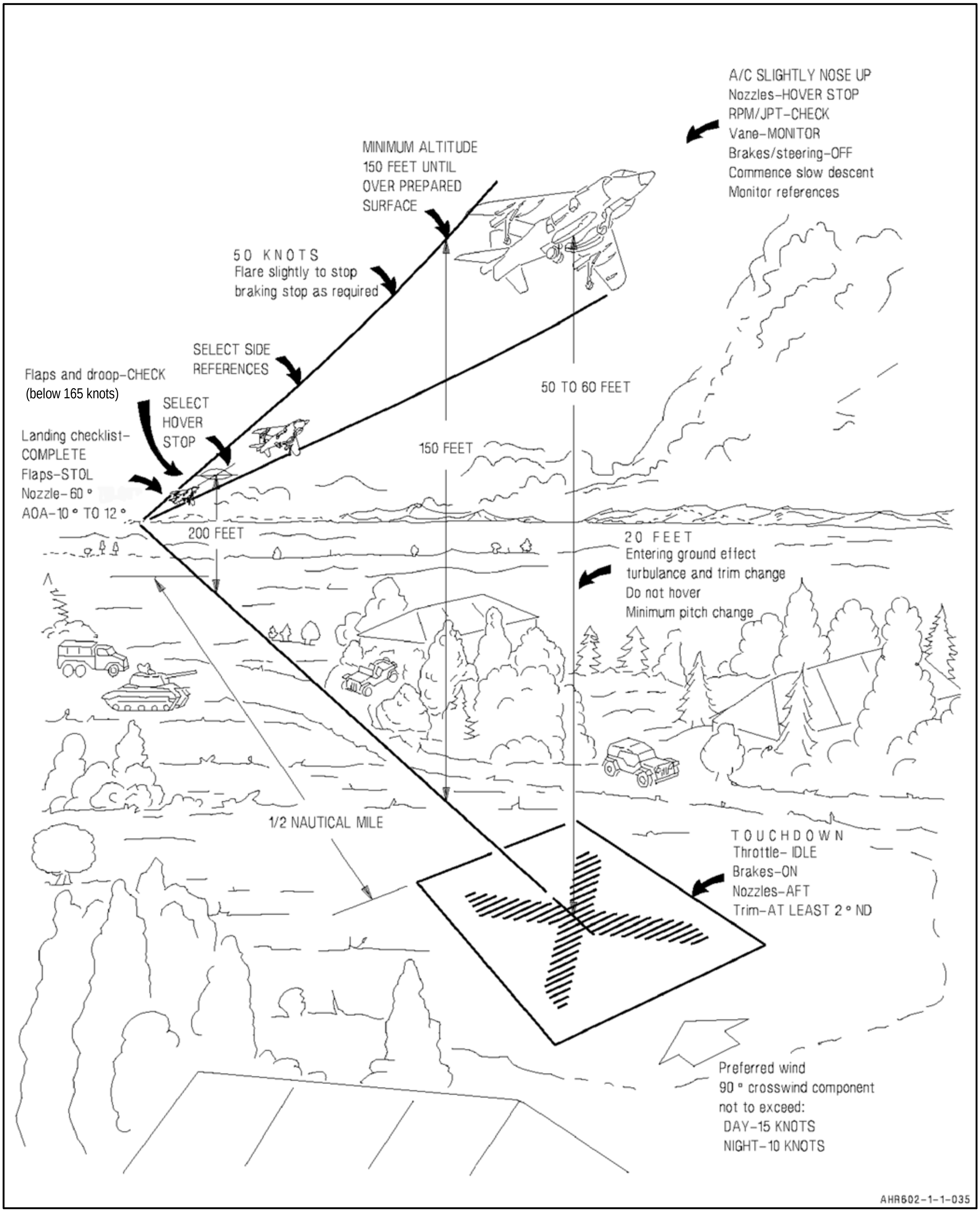


Figure 7-4. Vertical Landing

7.6.5 Decelerating Transition to a Rolling Vertical Landing

The RVL should be used when the landing surface isn't long enough to support a SL, but the landing area cannot support a VL because it is subject to damage from heating or is a source of FOD. A ground speed of five to ten knots is sufficient to avoid overheating and damaging asphalt in good condition. However, a ground speed of 60 knots or higher will be required if FOD is a major concern. (At this speed objects blown up at touchdown will remain behind the intake suction doors.) Decelerating transitions for RVLs are started from a key position approximately 3/4 nm from the touchdown point at an altitude of approximately 310 feet AGL. At the key the aircraft attitude and estimated nozzle angle are set while a crabbed approach is used to maintain runway centerline. The aircraft is flown on a slightly descending flight path (approximately 3°) until the touchdown point reaches the desired level of depression in the HUD. At this point, flight path can be adjusted to ensure precise landing on centerline and at the desired point. Workload is increased slightly over the SL, particularly when making an approach into short runways or confined areas. Such approaches require both precise centerline control and accurate control of the touchdown point by variation of the glide slope. Care must be taken to avoid making a play for the intended point of touchdown or checking back on the stick in close as these actions inevitably increase sink rate and cause the aircraft to bounce or rock forward onto the nosewheel. Normally a glideslope of three degrees will satisfy the need to control touchdown point and rollout distance. However, a steeper glideslope, up to 6 degrees, may be necessary when approaching over significant obstacles into fields short enough to dictate touchdown as close to the threshold as possible. If runway distance is critical and FOD potential is low, ground speeds slower than 60 knots should be considered. Performance Data, A1-AV8BB-NFM-400, will permit the pilot to calculate max gross landing weight and nozzle angle for a desired RVL approach speed. However, since RVL capability is directly related to VL capability, the following relationships can be used (number based on STOL flaps, 10° AOA and nozzle angle as required to maintain KCAS).

TOUCHDOWN SPEED (KCAS)	MAXIMUM RVL WEIGHT (ALL ENGINES, WET/DRY)
≤ 45 knots	VL weight
50 knots	VL + 2,300 pounds
55 knots	VL + 2,700 pounds
60 knots	VL + 3,100 pounds
65 knots	VL + 3,500 pounds
70 knots	VL + 4,000 pounds

Note

When targeting ground speed during an RVL, pilots must consider wind speed and direction to endure that KCAS does not fall below that required to maintain performance margin. Tail winds, steep descent angles and higher ground speeds will increase descent AOA and may necessitate a reduction in attitude or a change in other parameters in order to maintain the 15° AOA limit.

Approaching 180:

1. Nozzles — 60°.
2. Flaps — Check programming and droop.
3. AOA — 10° TO 12°.

Off the 180:

Adjust flight path with stick Control AOA with throttle or nozzles.

At the Key:

4. Set attitude — Witches hat on the horizon.
5. Nozzles — AS REQUIRED, adjust to maintain desired ground speed.
6. Minimize sideslip, ensure no more than 15° AOA.
7. Adjust power to intercept desired glideslope to touchdown point.

At touchdown:

8. Throttle — IDLE.
9. Nosewheel steering — ENGAGE WHEN ROLLING STRAIGHT AND PEDALS ARE NEUTRALIZED.
10. Nozzles — AS SET.
11. Brakes — APPLY.
12. Trim — MINIMUM 2° ND.
13. Water — OFF.
14. Nozzles — LESS THAN 60° WHEN SLOW.

7.6.5.1 Slow Landing

The SL may be used when aircraft gross weight is too high for a VL or RVL or to reduce engine stress. Performance calculations are required for heavy gross weights or short strips. There are four basic types of Slow Landings, the specific type being defined by a combination of flap position (STOL or AUTO) and whether the nozzles remain fixed during the approach or are varied as the primary means of airspeed control. These slow landing types are referred to as the Auto Flap Fixed Nozzle Slow Landing (AFNSL), STOL Flap Fixed Nozzle Slow Landing (SFNSL), Auto Flap Variable Nozzle Slow Landing (AVNSL), and STOL Flap Variable Nozzle Slow Landing (SVNSL). Any of these four SL types can be modified at the in close position by application of Hover Stop or Braking Stop. (See paragraph 7.6.5.2.1 Hover Stop Slow Landing/Braking Stop Slow Landing.)

7.6.5.1.1 Fixed Nozzle Slow Landing

The STOL Flap — FNSL, Figure 7-5, is the recommended slow landing technique and is the procedure on which the Short Landing Distance Chart in A1-AV8BB-NFM-400 is based. It is significantly easier to accomplish than a VNSL, requires less fuel for an approach and very nearly approximates the landing speeds of the variable nozzle approach. With high temperature and pressure altitude and at heavy gross weight, care must be exercised as waveoff capability may be degraded. The AFNSL is also simple to fly but will produce a substantially higher approach speed and landing rollout. This approach is normally used when crosswind conditions preclude a landing below 140 KCAS or when dealing with high asymmetric store loadings. The same landing approach path is used for either technique. (See Figure 7-5.)

Approaching 180:

1. Nozzles — 60°.
2. Flaps — Check programming and droop.
3. AOA — 10° TO 12°.

Note

If power exceeds 92 percent rpm for the –406 engine or 100 percent rpm for the –408 engine a lower nozzle angle should be used.

Off the 180:

4. Adjust flight path with stick.

5. Control AOA with throttle.

At 30 to 50 feet AGL:

6. Set Attitude — Witches Hat on to 2° above the horizon.

7. Control ROD with throttle (200 to 400 fpm).

At touchdown:

8. Throttle — IDLE.

9. Nosewheel Steering — ENGAGE WHEN ROLLING STRAIGHT AND PEDALS ARE NEUTRALIZED.

10. Nozzles — AS REQUIRED (up to full braking stop).

11. Trim — MINIMUM 2° ND.

12. Throttle — AS REQUIRED (for PNB a maximum of 60 percent (–406) to 70 percent (–408)).

At 60 kts:

13. Throttle — IDLE.

14. Nozzles — HOVER STOP.

15. Brakes — APPLY.

16. Water — OFF.

17. Nozzles — LESS THAN 60° WHEN SLOW.

7.6.5.2 Variable Nozzle Slow Landing

The variable nozzle slow landing (VNSL) is used whenever the throttle needs to remain at a relatively constant setting throughout the approach. There are numerous reasons why the pilot might elect to set a constant power setting. A SVNSL with a high end throttle setting may be flown when attempting to perform a slow landing at the minimum practical airspeed. In other cases, the pilot may elect to set power when engine reliability is suspect. The same landing approach path is used for either technique. (See Figure 7-6.)

Note

Using STOL flaps requires a power setting high enough to prevent the selection of nozzle angles less than 50°, but low enough to allow excess rpm for waveoff capability. If less than 50 nozzles are used when in STOL flaps, the flaps will raise and wing lift will be lost. Accordingly, AUTO flaps shall be used for VNSL if rpm is set less than 80 percent (–406 engine) or 90 percent (–408 engine).

Approaching 180:

1. Nozzles — 40° TO 60°.
2. Throttle:
   a. 70 to 90 percent (-406 engine).
   b. 80 to 100 percent (-408 engine).
   c. Nozzles — AS REQUIRED TO ACHIEVE 8° TO 10° AOA.
   d. Flaps — CHECK PROGRAMING AND DROOP.

Off the 180:

3. Adjust flight path with stick.
4. Control AOA with nozzles.

At 30-50 feet AGL:

5. Set Attitude — Witches Hat on to 2° above the horizon.
6. Control ROD with throttle (200 to 400 fpm).

At touchdown:

7. Throttle — IDLE.
8. Nosewheel Steering — ENGAGE WHEN ROLLING STRAIGHT AND PEDALS ARE NEUTRALIZED.
9. Nozzles — AS REQUIRED (up to full braking stop).
10. Trim — MINIMUM 2° ND.
11. Throttle — AS REQUIRED (for PNB a maximum of 60 percent (-406) to 70 percent (-408)).

At 60 kts:

12. Throttle — IDLE.
13. Nozzles — HOVER STOP.
14. Brakes — APPLY.
15. Water — OFF.
16. Nozzles — LESS THAN 60° WHEN SLOW.

7.6.5.2.1 Hover Stop/Braking Stop Slow Landing

The Hover Stop or Braking Stop Slow Landing (HSSL/BSSL) is used to minimize landing rollout distance. The HSSL is easily controllable with the rate of descent being most critical as airspeed bleeds off quite quickly (especially at high gross weights); therefore, the throttle must be adjusted to control the rate of descent. The BSSL method requires careful judgement and should be attempted only after considerable V/STOL experience. Should the aircraft bounce, a nose up pitch may occur which will require full forward stick and nozzle and/or power reduction to correct.

CAUTION

During landings above 20,000 pounds gross weight, when the nozzles are positioned beyond 70° to 75°, the aircraft sink rate can become difficult to control and may result in the pilot exceeding the throttle JPT limiter switch or landing at an excessive rate of descent. Nozzles positioned beyond 70° to 75° severely limits the aircraft waveoff capabilities in the event of a fouled landing area or unsatisfactory approach and may result in damage to the aircraft.

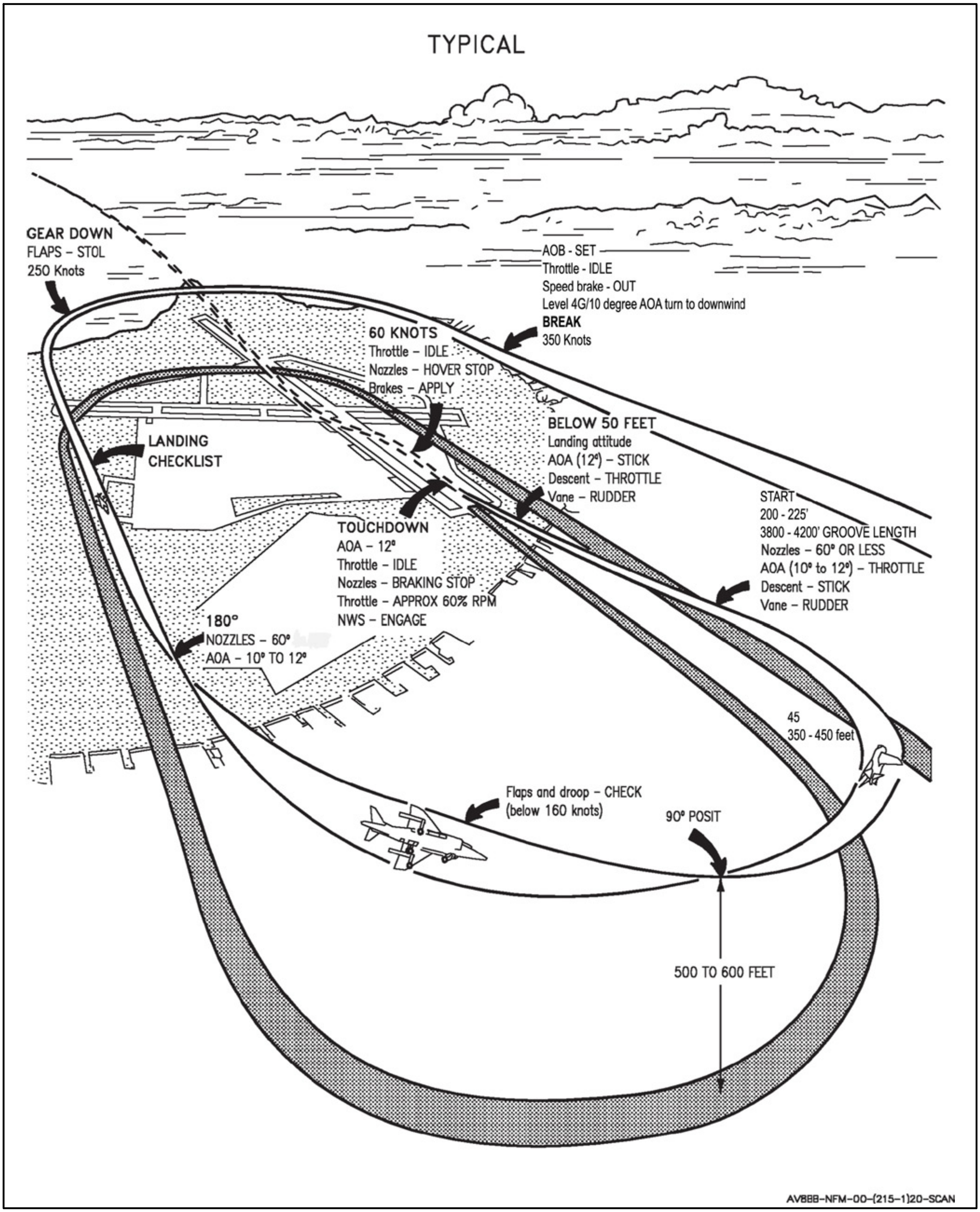


Figure 7-5. Slow Landing (Fixed Nozzle)

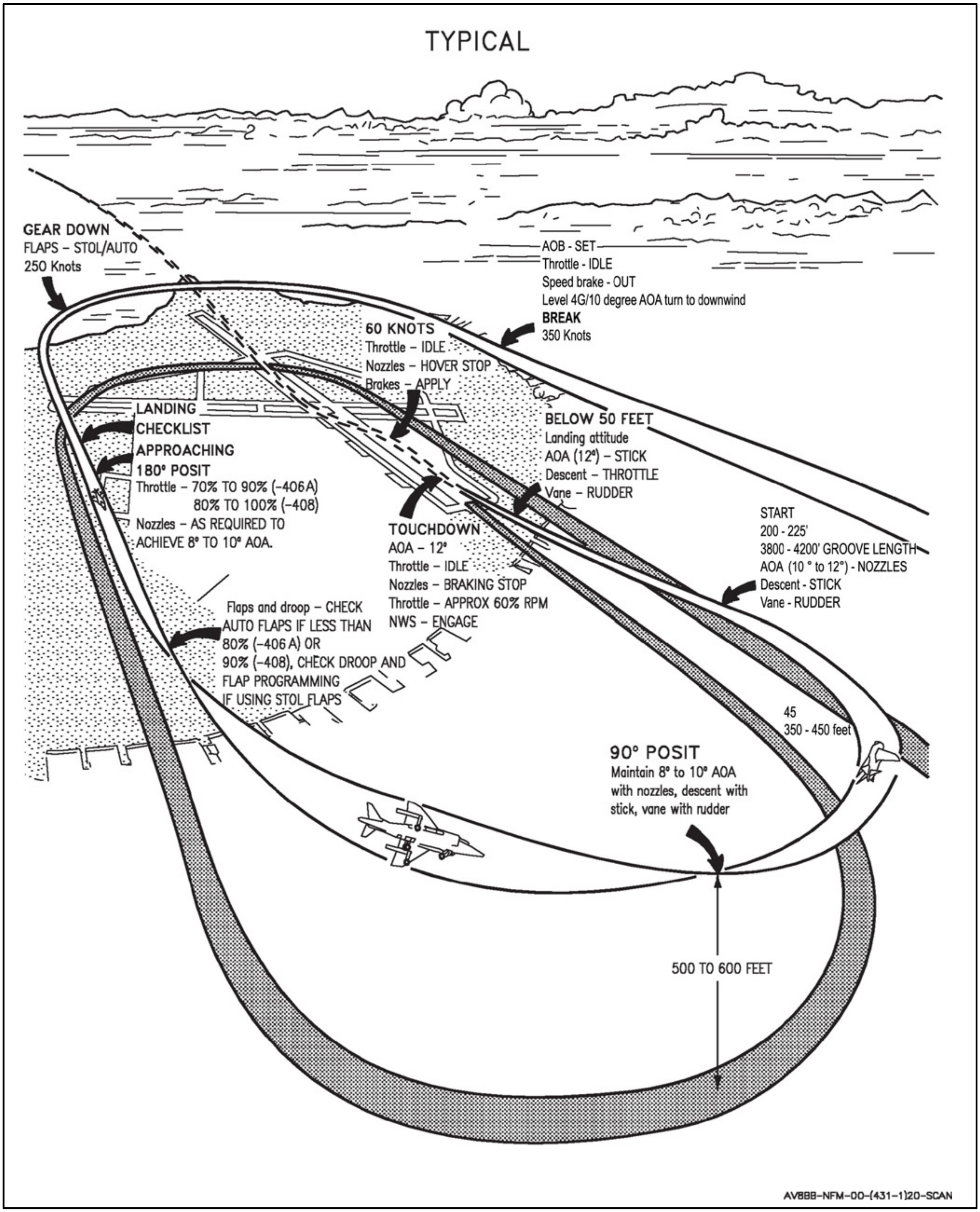


Figure 7-6. Slow Landing (Variable Nozzle)

Utilize slow landing procedure until entering ground effect (10 to 20 feet):

1. Set Attitude — Witches Hat on to 2° above the horizon.
2. Nozzles — HOVER STOP.

Just prior to touchdown (2 to 3 feet):

3. Nozzles — BRAKING STOP (if desired).

After touchdown (if Hover Stop selected):

4. Throttle — IDLE.
5. Nozzles — BRAKING STOP.
6. Trim — MINIMUM 2° ND.
7. Throttle — AS REQUIRED (for PNB a maximum of 60 percent (-406) to 70 percent (-408)).
8. Nosewheel Steering — ENGAGE WHEN ROLLING STRAIGHT AND PEDALS ARE NEUTRALIZED.

After touchdown (if Braking Stop selected):

9. Throttle — AS REQUIRED (for PNB a maximum of 60 percent (-406) to 70 percent (-408)).
10. Trim — MINIMUM 2° ND.
11. Nosewheel Steering — ENGAGE WHEN ROLLING STRAIGHT AND PEDALS ARE NEUTRALIZED.

At 60 kts:

12. Throttle — IDLE.
13. Nozzles — HOVER STOP.
14. Brakes — APPLY.
15. Water — OFF.
16. Nozzles — LESS THAN 60° WHEN SLOW.

7.6.6 Waveoff From Vertical/Slow Landing

A waveoff may be required due to a fouled landing area, an unsatisfactory approach or insufficient power.

1. Throttle — FULL.

If nozzles at the braking stop:

2. Nozzles — HOVER STOP.
3. Maintain 8° to 12° AOA or Hover Attitude.

With wings level and vane centered:

4. Begin transition to wingborne flight (See paragraph 7.3.2.4 Accelerating Transition).

Note

Acceleration time to achieve full rpm during a waveoff may take up to 8 seconds based on initial throttle setting.

7.6.7 Conventional Landing

A standard CL, Figure 7-7, requires substantially greater distance to stop than a SL or RVL. Landing distance available is a critical consideration when performing a CL. The brakes are designed primarily for V/STOL and are marginal for a CL without PNB; therefore, No PNB CLs should be used only as an emergency procedure. Refer to Performance Data, A1-AV8BB-NFM-400, for stopping distance with and without PNB.

Approaching 180:

1. Nozzles — AFT.
2. Flaps — Recheck in AUTO.
3. AOA — 10° to 12°.

Off the 180:

4. Adjust flight path with stick.
5. Control AOA with throttle.

At 30 to 50 feet AGL:

6. Set Attitude — Witches Hat on to 2° above the horizon.
7. Control ROD with throttle.

At touchdown:

8. Throttle — IDLE.
9. Nosewheel Steering — ENGAGE WHEN ROLLING STRAIGHT AND PEDALS ARE NEUTRALIZED.
10. Nozzles — AS REQUIRED (up to full braking stop).

Note

Porpoising on touchdown will normally be damped out by selection of the braking stop. Do not use wheel brakes while conducting PNB.

11. Trim — MINIMUM 2° ND.
12. Throttle — AS REQUIRED (for PNB maximum of 60 percent (-406) to 70 percent (-408)).

At 60 kts:

13. Throttle — IDLE.
14. Nozzles — HOVER STOP.
15. Brakes — APPLY.
16. Water — OFF.
17. Nozzles — LESS THAN 60° WHEN SLOW.

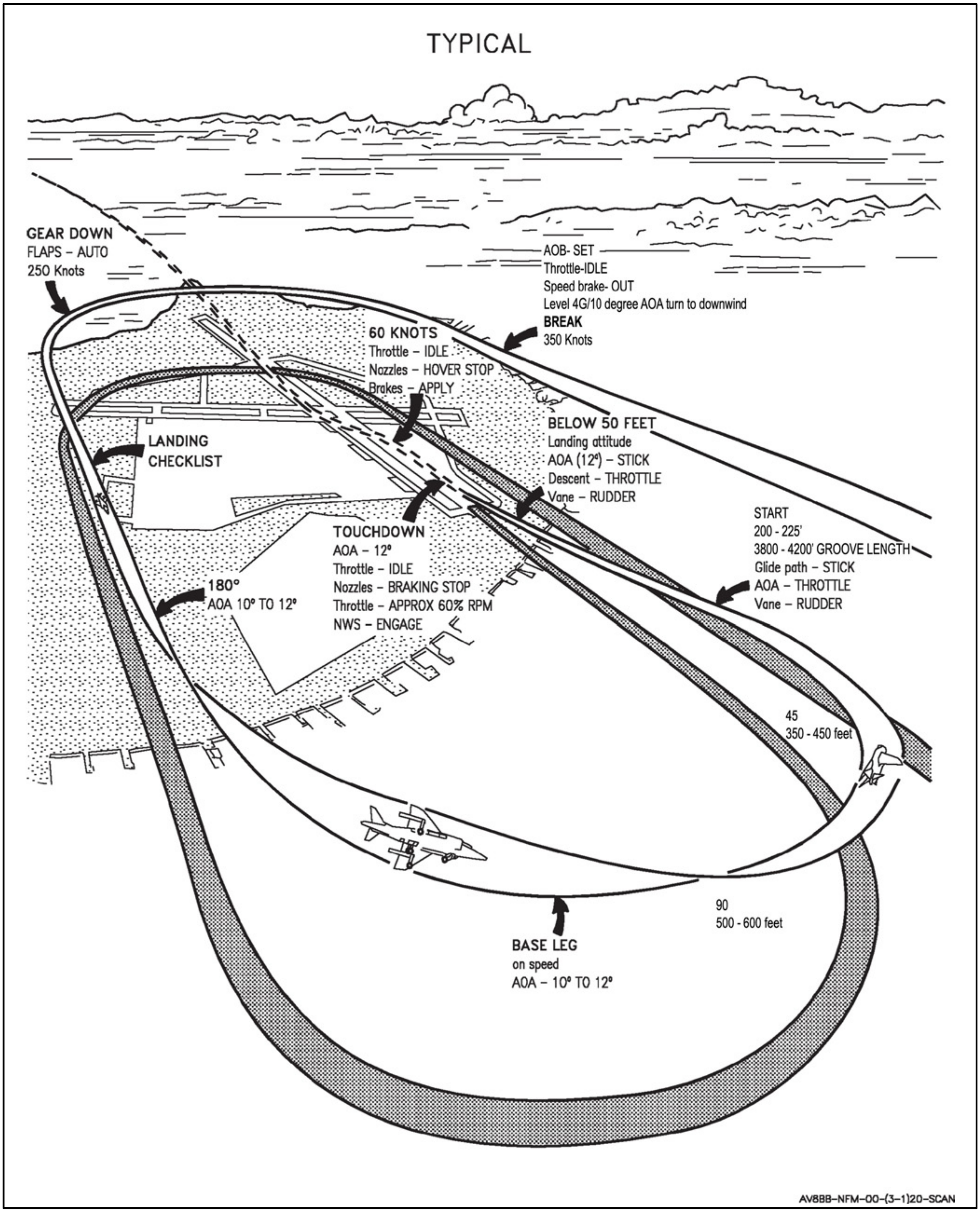


Figure 7-7. Conventional Landing

7.7 POSTFLIGHT

7.7.1 After Landing

When clear of the active runway:

1. Trim — 4° ND.
2. Flaps — CRUISE FOR TAXI.
3. Water — OFF.
4. IFF — HOLD, WAIT 10 SECONDS, THEN AS DESIRED.
5. Master arm switch — OFF.
6. Emergency canopy shattering handle safety pin — INSTALLED (TAV-8B both cockpits).
7. Ground safety control handle — UP (TAV-8B both cockpits).
8. Oxygen switch — OFF.
9. APU — OFF.
10. Landing light — OFF.

When parked:

11. Nozzles — 0° to 10°.
12. Parking brake — SET.
13. ANTISKID switch — ON.
14. Flap switches — OFF.
15. Engine life and max JPT — RECORD.
16. Fatigue life count — RECORD.
17. MENU, BIT — RECORD FAILURES.

    a. If a SAAHS failure code or asterisks is displayed, do a SAAHS BIT before doing the auto BIT. If an SMS failure code is displayed, select MAINT, SMS, then DISP. Record all failures by scrolling with DISP button.

    b. AUTO BIT — PERFORM.

    If RDR failure is displayed, select MAINT, RDR then B, O, and A respectively and record all failure codes (FULL displayed during any of these operations means there are additional failures. Reselecting the function will scroll through any additional failures).

    c. Record other failures to include:

    (1) GPS (Loads/errors).

    (2) TPOD (DPFL).

    (3) ARC-210.

    (4) NAVFLIR/ARBS.

(5) IFF.

(6) ASE.

(a) ALQ-164.

(b) ALE-39.

(c) ALR-67.

18. MENU-TPOD-DATA-DPFL — RECORD FAILURES.

a. Hold DPFL until PFL list clears.

b. If PFL list returns, IBIT — PERFORM.

c. Record IBIT failures.

19. Display Computer — CHECK.

a. Set DP switch to PRIM then ALTER, record any failures.

b. Set DP switch to AUTO.

20. INS update — PERFORM/ACCEPT IF APPLICABLE.

Night Attack Aircraft:

21. LST/FLIR switch — AS DESIRED.

Radar Aircraft:

22. FLIR switch — AS DESIRED.

23. RADAR switch — OFF.

All Aircraft:

24. MENU, BIT, MAINT, INS, POST — RECORD INS DATA.

25. TPOD VRS — UNTHREAD. (IF TPOD loaded).

26. TPOD PWR — OFF. (IF TPOD loaded).

27. INS switch — OFF (minimum of 10 seconds before throttle OFF).

28. DDI, HUD, and COMM — AS DESIRED.

29. VRS — LOCAL/UNTHREAD.

30. SDAT — ERASE.

31. ODU — ACPT.

32. Aircraft — SECURE (chock and chain as necessary).

33. Throttle — OFF.

Before engine shutdown, the engine should be idled for a minimum of one minute, if possible, to allow temperatures to stabilize.

34. Fuel boost pump switches — NORM.

35. DECS enable switch — OFF.

36. Fuel shutoff handle — OFF.

37. Battery switch — OFF.

38. Personal equipment — DISCONNECT.

    Release the two upper Koch connectors from the parachute risers and the two lower Koch connectors from the lower harness. Disconnect the oxygen/communication leads. Unfasten leg garters. Disconnect anti-g suit.

39. Conduct exterior inspection (Refer to paragraph 7.1.2).

7.7.2 Hot Refueling

The L and R TRANS lights are designed to indicate when the fuel pressure at the inlet to the respective feed tank has dropped to a point where fuel transfer into the center tank may be insufficient. It provides the pilot with an indication of fuel pressure, not an indication of fuel level in the fuel tanks. When the fuel tanks are full, it signals the refueling valve to close, resulting in a drop in fuel pressure and illumination of the corresponding TRANS caution light. There are situations, though, when the illumination of a TRANS caution light does not correspond with the fuel tanks being full. A more accurate indication of fuel levels in the tanks is the LEFT and RIGHT full advisory lights located on the left side windshield arch. The fuel high thermistor that is used to determine when to close the refueling valve is same one that illuminates the RIGHT or LEFT full advisory lights. These lights are designed specifically to indicate full levels in their respective feed group. If a refueling valve fails to close during hot refueling, the fuel pressure will not drop, and the TRANS caution light will not illuminate to indicate to the pilot that the tanks are full. This could result in the tanks become overfilled and fuel to stream from the fuel vent mast. With the A/R probe switch in the OUT position, and the RIGHT and LEFT full advisory lights are activated.

1. Aircraft — CHECKED FOR HOT BRAKES AND UNEXPENDED ORDNANCE.

2. All emitters — SECURED (TCN, RAD ALT, BCN, IFF, AWLS) OR EMCON SELECTED.

3. Nozzles — 10°.

4. Form Lts — OFF.

5. OBOGS — OFF.

6. RAM AIR — SELECTED.

If equipped with an air refueling probe:

7. A/R switch — OUT.

If not equipped with an air refueling probe:

8. A/R switch — IN OR OUT (NOT IN PRESS).

9. Cockpit configuration:

Note

On TAV-8B the seat status, safe or armed, must be the same for both cockpits.

If Seat armed:

a. Canopy — CLOSED.

10. Pilot strapped-in.

If Seat safe:

   a. Canopy — AS DESIRED.
   b. Straps — AS DESIRED.

11. Fuel Load — AS DESIRED (ensure balanced).

    LEFT full advisory light (IFR probe) or L TRANS light (no IFR probe) — signal for shutoff (1 FINGER SIGNAL).
    RIGHT full advisory light (IFR probe) or R TRANS light (no IFR probe) — signal for shutoff (2 FINGER SIGNAL).

12. After Hot Refueling adjust items in steps 2 to 8 as required.

7.8 RAPID REARM

Note

- Only like stores are authorized for re-loading.
- If hung weapons are present or any weapon failure exists, stop rapid rearm and use standard rearming procedures. Complete the following checklist to prepare the aircraft and aircraft systems for hot rearming.

1. IFF — HOLD, WAIT 10 SECONDS, THEN OFF.
2. ALQ-164 — OFF.
3. ALR-67 — OFF.
4. RADAR — OFF.
5. FLIR — OFF.
6. RADALT — OFF.
7. DMT — OFF.
8. APU — OFF.
9. TPOD — OFF.
10. Master Arm — OFF.
11. MENU — STRS. Verify no WPN FAIL.
12. MENU — BIT. Verify no SMS BIT codes.
13. MENU-BIT-SMSFF — Verify no WPN FAIL or HUNG indications.
14. INS — GND ALGN.

Note

Do not turn INS off. The alignment will hold through the rapid rearm procedure. Ordnance crews will ground the aircraft and establish communications with the pilot with hand-and-arm signals or via ground communication input directly to the aircraft. Once the above checklist is complete communicate via “thumbs-up” hand-and-arm signal or voice communications that the aircraft is ready for rapid rearm.

When the ordnance crew signals:

15. GEN — OFF (approximately 20 to 30 seconds).

On aircraft without AFC 392, Digital Engine Control Unit power is now provided by the battery. Monitor battery voltage ensuring it remains greater than 16-volts. If any engine anomaly occurs, execute Emergency Engine Shutdown procedures.

Note

The generator must be off line for 15 to 20 seconds in order for stores station controllers to clear all electrical charge. The ordnance crew will install cartridges in the BRU-36.

When the ordnance crew signals:

16. GEN — ON.

17. MENU-STRS — Verify weapon loadout is correct.

If weapon loadout is correct:

18. Signal to ordnance crew via “thumbs-up” hand-and-arm signal or voice communication indicating weapon loadout is correct.

If weapon loadout is incorrect:

19. Signal to ordnance crew via “thumbs-down” hand-and-arm signal or voice communication indicating weapon loadout is incorrect.

20. Troubleshoot.

Reset aircraft systems.

21. IFF — ON.

22. ALQ-164 — ON.

23. ALR-67 — ON.

24. RADAR — ON.

Note

RADAR sets will have to be reprogrammed.

25. FLIR — ON.

26. RADALT — ON.

27. DMT — ON.

28. APU — ON (if desired).

29. TPOD — ON.

30. INS — IFA or NAV.

31. LASER CODE — PROGRAM AS DESIRED.

7.9 SCRAMBLE OPERATION

The aircraft is designed to operate from forward sites in close proximity to the FEBA (forward edge of the battle area) with minimum support. Normally such sites are dispersed, camouflaged and operated in such manner that each aircraft is an independent entity except for control through communications. With the short reaction time available due to the proximity to the FEBA and the STO capability, many formerly airborne evolutions, such as on-call close air support or CAP, are conducted with the aircraft on the ground at a forward site. Before assuming the directed Ready Condition, the pilot should perform normal preflight, start, post start and pre-takeoff checks. Shut down the engine and set the parking brake. Dependent upon the prescribed ready condition the pilot may then be required to remain strapped in the cockpit or may un-strap and remain in close proximity to the aircraft. If un-strapped, pull ground safety control handle up. The battery switch position is dependent upon the radio monitoring requirement.

7.9.1 Scramble Interior Check

1. Harness — FASTEN (if unfastened).
2. Canopy — CLOSE AND LOCK.
3. Ground safety control handle — DOWN.

7.9.2 Scramble Engine Start

1. Battery switch — BATT.
2. Fuel shutoff handle — ON.
3. DECS enable switch — ON.
4. Engine start switch — ENG ST.
5. Throttle — IDLE.
6. Warning and caution lights — TEST.
7. Inertial navigation system — ALIGN.

Radar Aircraft:

8. RADAR switch — OPR.

All Aircraft:

9. Inertial navigation system — NAV/IFA AS REQUIRED.
10. FLAPS — ON/RESET.
11. Parking brake — RELEASE.

CHAPTER 8

Shipboard Procedures

8.1 GENERAL SHIPBOARD PROCEDURES

Refer to NAVAIR 00-80T-111.

CHAPTER 9

Special Procedures

9.1 FORMATION FLIGHT

The following sections describe the parameters for each standard formation, procedures for maintaining position, and the execution of formation flight. Figure 9-1 is a summary of all standard formations characterizing each formation's attributes with respect to environment, maneuverability, mutual support, and application. Refer to NTTP 3-22.1-AV-8B for more specifics on the tactical employment of each formation.

FORMATION	ENVIRONMENT	MANEUVERABILITY	VISUAL MUTUAL SUPPORT	STANDARD APPLICATION
Section Formations				
Parade	IMC or VMC Day or Night	Limited	None	Instrument Departures and Approaches Break En route IMC
Cruise	VMC Day or Night	Average	Limited	En route VMC Formation rendezvous Administrative holding
Defensive Combat Spread	Day VMC	Fair	Excellent	En route VMC Medium to High Threat (A/S) Battle Break
Offensive Combat Spread	Day VMC	Good	Good	En route VMC Medium to High Threat (A/A)
Fighter Wing	Day VMC	Excellent	Limited	En route VMC Tactical Holding
Deployed Echelon	Day or Night VMC	Excellent	Limited	En route VMC (night) Administrative execution (night) Tactical execution (night)
Division Formations				
Division Parade	Day VMC	Limited	None	Administrative execution Break
Balanced Parade	Day VMC	Limited	None	Administrative execution
Fingertip	Day IMC	Limited	None	IMC penetration
Cruise	Day VMC	Fair	Limited	En route VMC Administrative holding
Deployed Echelon	Night	Good	Limited	Night execution
Wedge	Day VMC	Good	Fair	Low altitude tactical execution
Box/Offset Box	Day VMC	Excellent	Excellent	Low altitude tactical execution
Fluid Four	Day VMC	Excellent	Good	Medium altitude tactical execution
Wall	Day VMC	Limited	Excellent	Medium altitude tactical execution

Figure 9-1. Standard Formations Summary

9.1.1 Section Administrative Formations

9.1.1.1 Parade

The parameters for section parade are: a bearing line extended from lead's aileron and flap hinge lines, maintaining lateral distance by superimposing the outrigger landing gear wheel on the center of the fuselage avionics panel (door 60L or R), and stepped down by aligning the wingtip and bottom of the fuselage. See Figure 9-2.

9.1.1.1.1 Turns

Parade turns are either VFR parade turns or instrument flight rules (IFR) parade turns.

9.1.1.1.2 VFR Parade Turns

For VFR parade turns, if the lead rolls away from the wingman, the wingman maintains parade step down position and rolls about his axis and matches leads roll rate and ultimate AOB. When using this technique, the lead aircraft's intake obscures the leader's head making it difficult to exchange hand-and-arm signals. If the lead rolls into the wingman, the wingman maintains parade bearing line, lateral distance, and relative step down position cues and rolls about the lead's axis. This requires a slight power reduction to maintain position during turn execution to facilitate slight altitude and radius-of-turn reductions.

9.1.1.1.3 IFR Parade Turns

For IFR parade turns, the wingman maintains parade bearing line, lateral distance, and relative step down position cues rolling about lead's axis either with a slight increase in altitude on turns away or slight decrease in altitude on turns into the wingman. Roll-rate should be slower to account for IMC limited visibility and so as not to induce vertigo. At night, execute IFR parade turns.

9.1.1.1.4 Cross-under

Perform cross-unders by reducing power slightly to go sucked on the bearing line, while simultaneously descending to achieve adequate vertical clearance from lead's aircraft and jet wash. Ensuring a minimum nose-to-tail separation of one-half aircraft length, cross under lead's aircraft in a "U" shaped maneuver to a low and sucked position on the other side. Halfway through the maneuver the aircraft fuselages should be aligned nose to tail. Once on the other side, add power to climb and move forward to parade position. When flying in division fingertip, it is necessary for the aircraft on the opposite side to make room for the crossing aircraft in division parade position.

9.1.1.1.5 Lead Change

The flight leader passes the lead to his wingman via voice communication or hand and arm signals. After acknowledging receipt of the lead, the new dash 2 (the former lead aircraft) increases lateral separation slightly then reduces power to move back to the parade bearing line. Power is then added to stop the aft movement and close back to parade position.

9.1.1.2 Cruise

The parameters for section cruise are: a 120 degree cone aft of lead's 3/9 line, a minimum nose-to-tail separation of one aircraft length, and a slightly stepped-up position to enable the flight leader to keep sight of the wingman. See Figure 9-3. To establish cruise formation, the flight lead uses a hand signal of a clenched fist with the thumb out and the right arm alternating across each shoulder or stating, "CLEARED TO CRUISE." When maneuvering, the wingman maintains position in the cone inside or outside the lead's turn radius to manage proper nose-to-tail separation. Maintaining position in the cone is critical to ensuring collision avoidance if the lead maneuvers abruptly.

9.1.2 Section Tactical Formations

9.1.2.1 Combat Spread

There are two types of combat spread: defensive combat spread and offensive combat spread.

9.1.2.1.1 Defensive Combat Spread

The parameters for defensive combat spread are: abeam, 0.7 to 1.0 NM, and an altitude split of 1,000 to 3,000 feet (above or below lead's aircraft). If flying below 1,000 feet AGL, maintain co-altitude with the lead aircraft. See Figure 9-4.

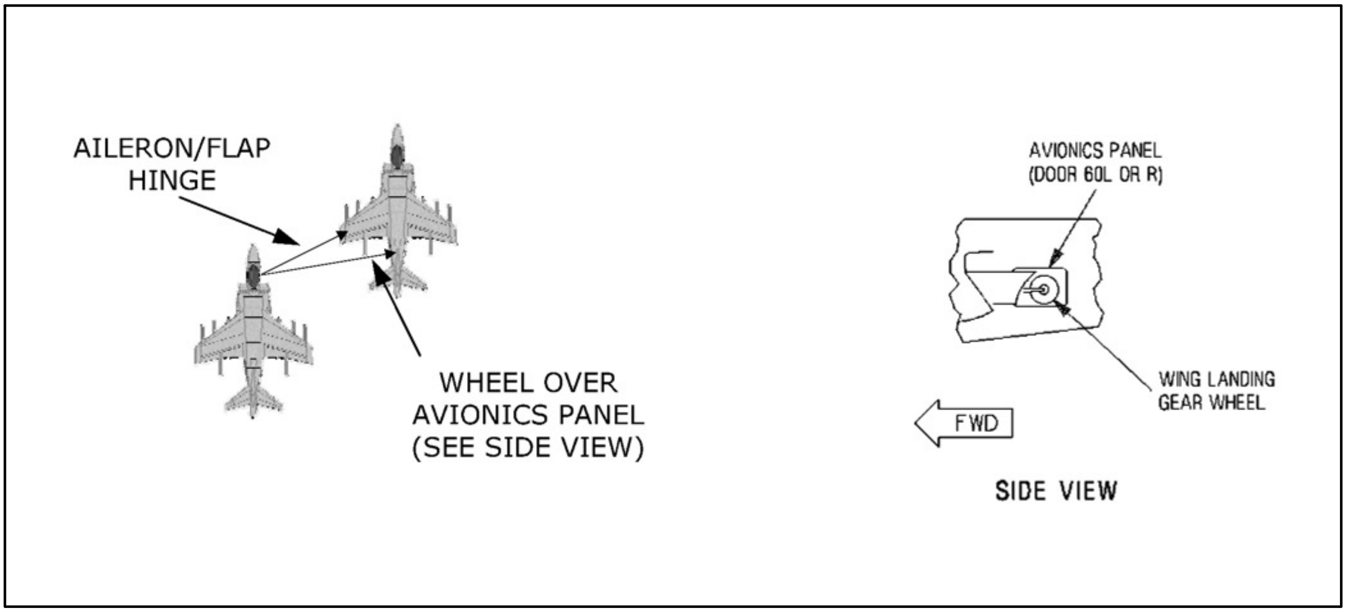


Figure 9-2. Section Parade

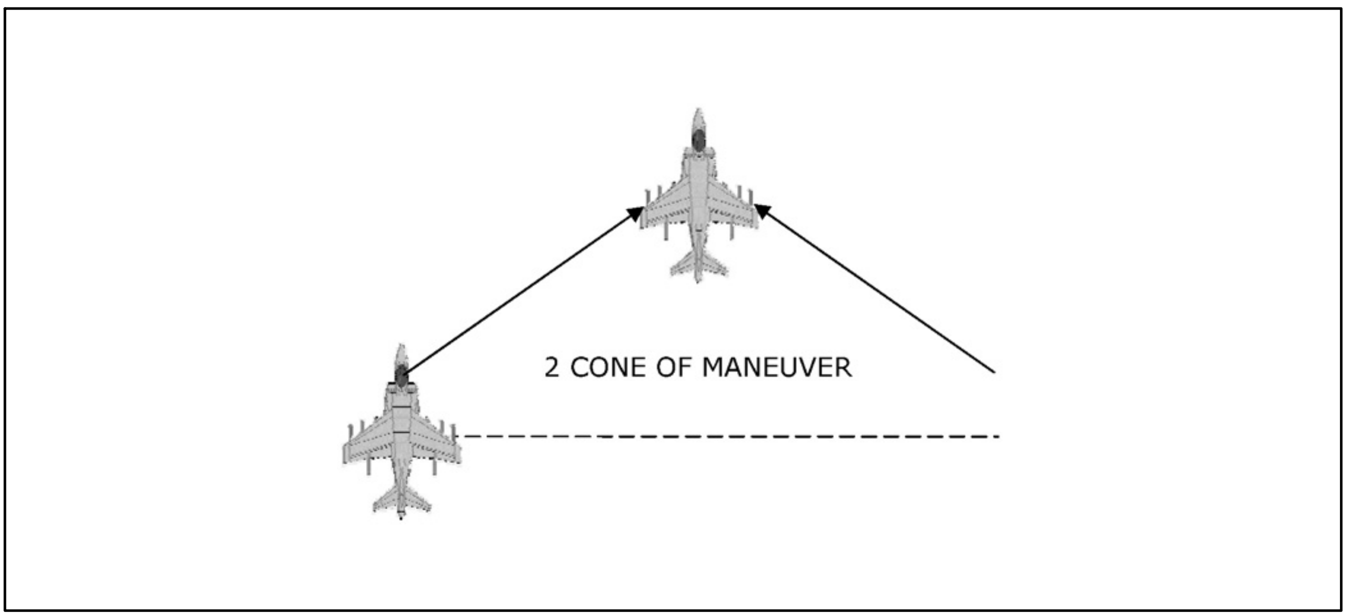


Figure 9-3. Section Cruise

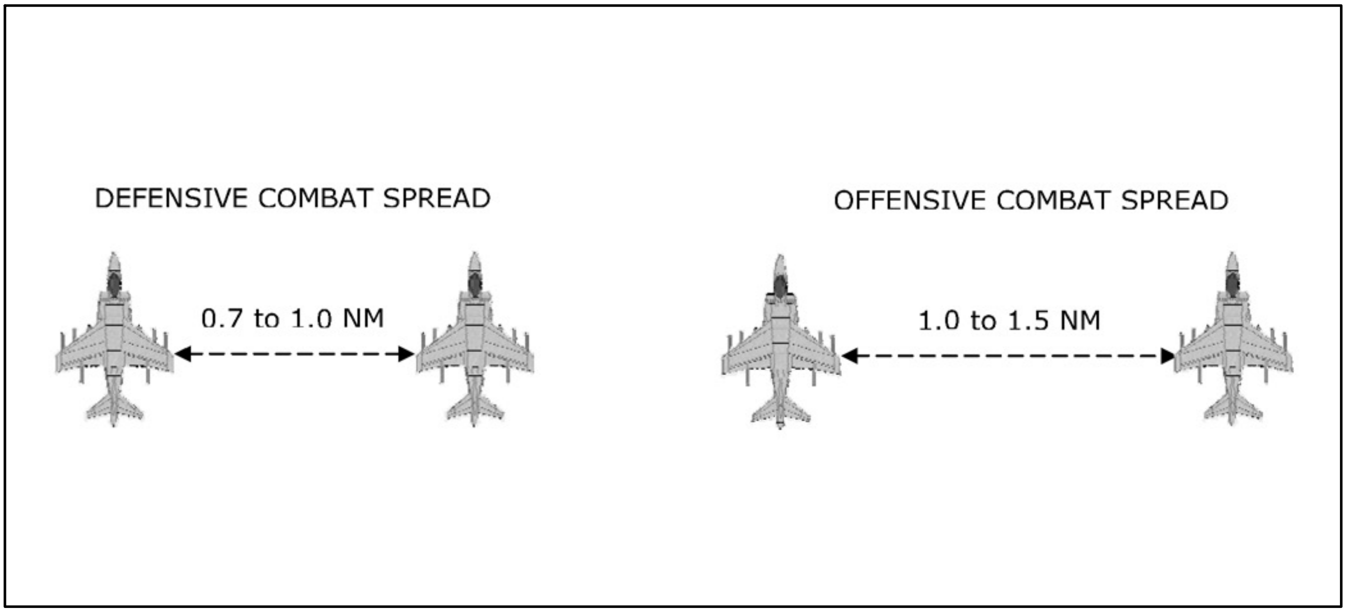


Figure 9-4. Combat Spread

9.1.2.1.2 Offensive Combat Spread

The parameters for offensive combat spread are: abeam, 1.0 to 1.5 NM, and an altitude split of 3,000 to 5,000 feet (above or below lead's aircraft). If flying below 1,000 feet AGL, maintain co-altitude with the lead aircraft. See Figure 9-4.

9.1.2.1.3 Combat Spread Execution

The flight lead initiates combat spread with a hand signal of an outward pushing motion with the hand and arm, with the palm outboard or transmitting "TAKE DEFENSIVE (OFFENSIVE) COMBAT SPREAD ON THE RIGHT (LEFT)." The wingman will take a cut away from lead, add full power, and fly to the briefed position (high or low).

To close the formation to cruise or parade, lead porpoises the aircraft or transmits, "CLEARED TO PARADE (OR CRUISE)." The wingman will take a slight turn into lead and place him on or slightly above the horizon (on the horizon if the flight is below 1,000 feet) and rejoin. A slight power addition may be necessary. Perform a CV(Circling)/Running rendezvous and watch for lateral closure since aspect will be minimal. Continuously reference the A/A TACAN distance measuring equipment (DME) throughout the maneuver.

9.1.2.1.4 Maintaining Combat Spread Position

If sucked, use a combination of geometry (e.g., a shackle turn) and power to regain position. If acute, take a cut away to decrease downrange travel and reduce power as required. Reset the proper abeam distance after achieving the proper abeam bearing line.

9.1.2.2 Fighter Wing

The parameters for fighter wing are: a bearing line 30 to 60 degrees aft of lead's 3/9 line, 2,000 to 3,000 feet nose-to-tail separation (0.3 to 0.5 NM slant range), and an altitude differential of 1,000 to 3,000 feet (above or below lead's aircraft). If flying below 1,000 feet AGL, maintain co-altitude. See Figure 9-5. While maneuvering, wing will maintain position off lead by using turn circle geometry. As lead turns, wing will maneuver to get on lead's turn circle, maintain position until the turn is just about complete, then float to the opposite side, resetting fighter wing. Turns into the wingman will cause him to delay the turn until lead is about to cross wing's nose. Wing will then roll in the direction of turn, start the pull, place lead on the canopy rail, and fly on lead's turn circle. Approaching the desired heading, wing will float the turn to the outside and reset the fighter wing position. Turns away from wing require wing to turn when lead turns. Wing will pull to lead's turn circle and maintain position until approaching the desired heading. As lead rolls out on the new heading, wing will continue to pull, temporarily go belly up, and reset the fighter wing position on the inside of the turn.

9.1.2.3 Deployed Echelon

This formation is similar to fighter wing but has increased nose–to–tail separation to facilitate increased mission crosscheck time for the wingman by slightly reducing position keeping tasking. However, it is critical to maintain the proper bearing line to prevent sliding to a trail position. It is extremely difficult to perceive closure, especially at night, from a trail position. The parameters for deployed echelon are: a bearing line 60 to 70 degrees aft of lead’s 3/9 line, 0.7 to 1.2 NM slant range, and an altitude split of 1,000 feet above or below lead’s altitude. If flying below 1,000 feet AGL, maintain co–altitude. See Figure 9-5.

9.1.3 Section Tactical Maneuvering

This section details the procedures for maneuvering a formation other than parade or cruise. All turns are hard turns (full–power, energy–sustaining turns) unless otherwise briefed. When maneuvering at altitudes above approximately 20,000 feet, at high gross weights, or high drag indices, turns are at full power and constant airspeed due to the reduction of lift and g available.

9.1.3.1 Formation Altitude Splits

The altitude differential between aircraft in a formation is a balance between environmental considerations, threat lookout/avoidance, and the airspace available. The primary de–confliction method for a visual formation is visual. If at any time a visual formation is not maintained (e.g., times when both aircraft are working cockpit systems (TPOD, RADAR, etc.)) a briefed altitude contract will be maintained for de–confliction. Traditionally, AV–8B formations have been flown with 1,000 foot altitude intervals with the wingmen in a stepped up position. This is not required if visual de–confliction is maintained. In some formations, (e.g., fighter wing), 1,000 feet of altitude split makes it difficult for the wingman to maintain sight of lead in a stepped up position (500 feet of separation, level, or stepped down may be preferred). Additionally, in combat, rarely is 3,000 to 4,000 feet of airspace available for unimpeded use by a division. Flight leads will likely have to modify the altitude de–confliction to account for this. Wingman will have to adjust by flying extremely disciplined formations to maintain visual separation and/or reduced lateral and vertical separation. Use of the Automatic Flight Control (AFC) and altitude hold is encouraged to ease cockpit workload.

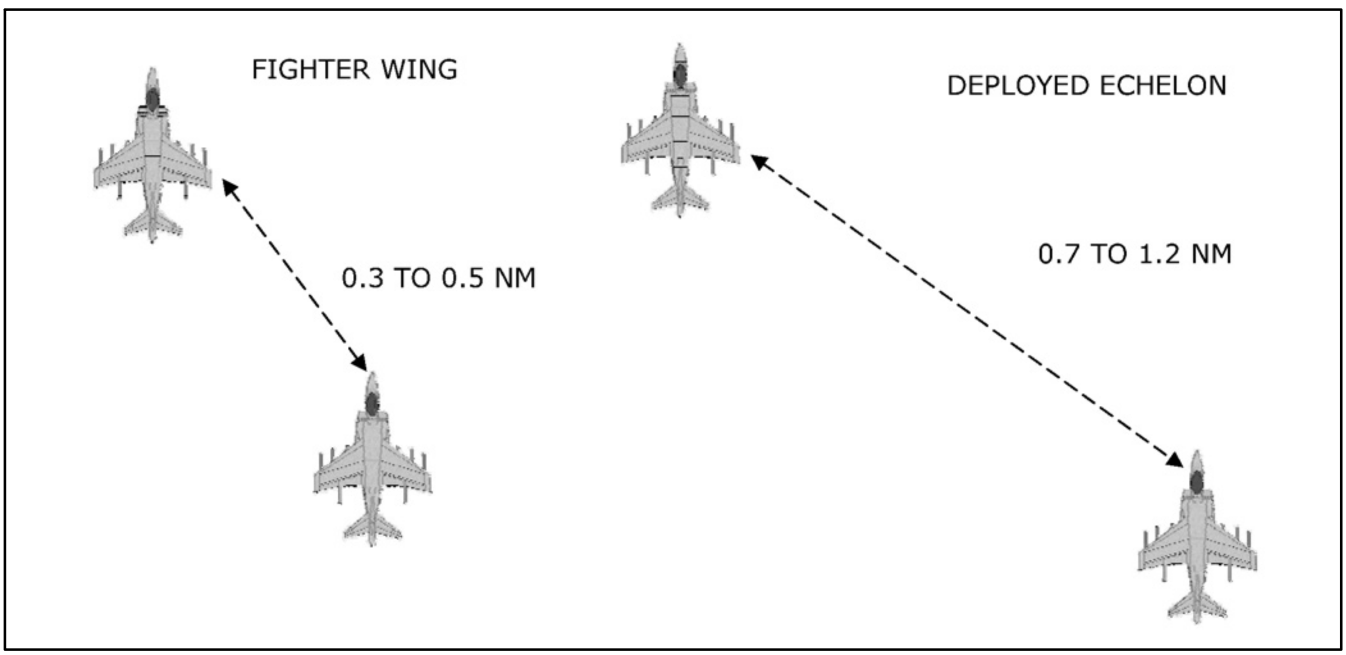


Figure 9-5. Fighter Wing and Deployed Echelon

9.1.3.2 COMM-OUT Maneuvering

COMM-OUT turns are the standard with a known (briefed) route or holding pattern. Called turns are the standard when off the briefed route. COMM-OUT maneuvering procedures are:

1. The flight lead may use a double microphone click to get the wingman's attention.
2. When observing a wing flash, wing turns into lead.
3. Always assume the turn is a 90 degree tac-turn unless:
   a. Lead immediately turns into wing (cross turn or shackle turn).
      (1) If cross turn, lead will continue the turn.
      (2) If shackle turn, lead will roll out after approximately 45 degrees.
   b. Lead immediately turns away (hook turn).
   c. Lead turns after wing has turned 30 to 60 degrees (nav turn).
4. Lead turns into Wing without a wing-flash (assume tac-turn).
   a. Lead rolls out after only 30 to 60 degrees of heading change (nav turn).
5. The only COMM-OUT turn not performed is a Hook Turn into the wingman as there is no effective COMM-OUT method to signal this.

9.1.3.3 De-confliction

Wingmen are always responsible for de-confliction from the lead's aircraft. For maneuvering at medium altitudes, maintain the established trend (e.g., if stacked low, de-conflict low). For maneuvering below 1,000 feet AGL, the wingman will always de-conflict above the lead aircraft.

9.1.3.4 Check Turn

A check turn is used to change course up to 30 degrees. Check turns are unique in that they are the only turns which do not provide a built-in formation geometry fix. That is, check turns will put the formation out of position. Lead initiates check turns by transmitting, "RAZOR 11, CHECK-LEFT/RIGHT." Lead may also include the number of degrees to turn or the new reference heading such as "RAZOR 11, CHECK LEFT REFERENCE 270." COMM-OUT check turns are not signaled, lead will simply turn to the new heading. Independent of how the turn is signaled, the wingman must be proactive to minimize formation geometry misalignment by making immediate corrections to reduce the time out of position.

9.1.3.4.1 Check Turns into Wingman

Due to a smaller turn radius, the wingman has a shorter distance to travel thus driving the geometry acute. Counter this with an aggressive S-Turn. Perform the S-Turn in the horizontal or the oblique plane to slow downrange travel and/or convert airspeed to altitude. As lead rolls out and the aircraft drops back to bearing, lower the nose to regain airspeed then adjust the abeam distance if required. Avoid the tendency to simply reduce power to adjust geometry. This causes the wingman to become slow and typically fall to sucked position unless the acceleration is properly timed.

9.1.3.4.2 Check Turns Away from Wingman

Due to a larger turn radius, the wingman has a longer distance to travel thus driving the geometry sucked. Maneuver to decrease turn radius and/or lower the nose to increase airspeed. Once on bearing, smoothly raise the nose and bleed off excess airspeed to regain altitude. Avoid anticipating bearing line or pulling up too aggressively, thereby stagnating or falling backed sucked. Avoid gaining excessive airspeed causing acute geometry or forcing a rapid pull-up.

9.1.3.5 Nav-Turn

Use a nav-turn to change course 30 to 60 degrees. The lead initiates the nav-turn by transmitting, “RAZOR 11, NAV-LEFT/RIGHT.” COMM-OUT nav-turns are initiated into the wingman when lead initiates a turn into the wingman. COMM-OUT nav-turns are initiated away from the wingman with a wing flash.

9.1.3.5.1 Nav Turns Into Wingman

For turns into the wingman, lead turns 30 to 60 degrees and rolls out. The wingman then executes a small turn to fly 70 to 80 degrees to lead’s flight path and pass ahead of lead. It is more important to pass in front of lead than to achieve the 70 to 80 degrees track crossing angle. As the wingman crosses lead’s flight path, reverse course to arrive in combat spread on the opposite side.

9.1.3.5.2 Nav Turns Away From Wingman

For turns away from the wingman, the maneuvering roles are exactly the opposite of a nav-turn into the wingman. That is, after lead communicates to initiate a nav-turn, the wingman turns into lead 30 to 60 degrees. The wingman stops turning when reaching the assigned heading or when lead initiates a turn into the wingman. As the lead crosses the wingman’s flight path, lead reverses course to arrive in combat spread on the opposite side. The wingman is then responsible for adjusting formation geometry to combat spread.

9.1.3.6 Tac-Turn

Use a tac-turn to change course 60 to 120 degrees. The lead initiates a tac-turn by transmitting, “RAZOR 11, TAC-LEFT/RIGHT.” COMM-OUT tac-turns are initiated when lead turns or executes a wing-flash.

9.1.3.6.1 Tac-Turn Into Wingman

For tac-turns into the wingman, lead turns first. If executing a COMM-OUT tac-turn, lead simply starts turning towards the wingman. If lead turns more than 60 degrees, this indicates to the wingman that a tac-turn is likely desired, not a nav-turn (refer to rules above). The wingman delays turning until lead’s intakes are visible (i.e., lead is in pure pursuit). The wingman then executes a hard turn to match lead’s heading, observes lead roll out after greater than 60 degrees but less than 120 degrees of turn, and arrives on the opposite side of the formation.

9.1.3.6.2 Tac-Turn Away From Wingman

For tac-turns away from the wingman, the wingman executes a hard turn as soon as lead signals for a turn (voice communication or wing flash). Unless indicating a specific heading, the wingman will turn for 90-degrees. After lead rolls out on the new heading, the wingman is then responsible to adjust formation geometry.

9.1.3.7 Hook Turn

Use a hook turn to change course by 120 to 240 degrees. The hook turn is initiated when lead transmits, “RAZOR 11 HOOK-LEFT/RIGHT.” COMM-OUT hook-turns are only executed away from the wingman, never into the wingman and are signaled only with a wing-flash. Lead turns away from the wingman as soon as the wingman starts turning. To execute a hook turn, both aircraft perform a hard turn in the direction specified. It is critical to fly a predictable hard turn to ensure proper formation geometry on roll-out. If lead and the wingman have differing turn performance, the wingman will arrive acute or sucked and/or with too much or too little lateral separation.

9.1.3.7.1 Hook Turn Into Wingman

Always signal hook turns into the wingman via voice communication. As the turn begins, the wingman will lose sight of lead. As the turn ends, the lead will lose sight of the wingman. It is critical that as the turn ends, the wingman either quickly regains sight and establishes de-confliction or immediately reports “BLIND” and begins to scan altitude and A/A TACAN DME while searching for lead. If the wingman reports “BLIND”, the lead must immediately report status as well and positively establish de-confliction via altitude and headings.

9.1.3.7.2 Hook Turns Away From Wingman

Hook turns away from the wingman are the mirror image of hook turns into the wingman. For this turn, as the section is through 90 degrees of turn, the wingman is ideally at the lead's 6 o'clock position. If the top of lead's aircraft is visible, lead is through more of the turn than the wingman. This will drive the wingman sucked and too close on roll-out. Momentarily increase g and then re-establish a hard turn. Take caution to avoid pulling into buffet and/or bleeding off maneuvering speed thus resulting in sucked geometry. Conversely, if the bottom of lead's aircraft is visible, lead is through less turn than the wingman. This drives the wingman acute and too far away on roll-out. Momentarily reduce g to ease the turn and then re-establish a hard turn. Take caution to not float the turn into lead's airspace while simultaneously going belly up.

9.1.3.8 Cross Turn

Use cross turns to reverse course 180 degrees and provide excellent visual mutual support throughout the maneuver. Lead initiates the cross turn by transmitting, "RAZOR 11, CROSS TURN." The COMM-OUT Cross Turn is initiated by a wing flash and is initially similar to a shackle. Once the wingman begins turning into lead, lead immediately turns into the wingman. Instead of rolling out as in a shackle, the lead continues to turn thus signaling the wingman to continue until course reversal. The wingman de-conflicts above and slightly outside of lead. Since the turn is predicated on both aircraft making identical turns, any basic air work deviations affect the resultant formation geometry.

As lateral separation decreases at cross turn initiation, the resultant lateral separation increases at turn completion. This is exacerbated by higher altitudes, drag indices, and gross weights. If initiating a cross turn from defensive combat spread, the wingman continues to turn past the final reference heading for 10 to 30 degrees to drive back to the proper abeam distance.

9.1.3.9 Shackle

Use a shackle to readjust formation geometry, establish desired target area geometry, and/or delay momentarily to correct route timing. The lead initiates a shackle by transmitting, "RAZOR 11, SHACKLE." Lead initiates COMM-OUT shackles by using a wing-flash to get the wingman to turn. Lead then turns as soon as the wingman begins turning. Both aircraft roll-out after 45 degree of turn, cross paths, and then reverse to arrive in combat spread on the original heading.

If using a shackle to adjust formation geometry, the amount of turn each aircraft executes varies to ensure proper resultant formation geometry. If the formation is wide, then the procedures remain the same except that both aircraft will not extend past the merge for the same length of time it took to get there. Generally, three seconds is a good starting time for the delay. This time will vary somewhat depending on offensive or defensive combat spread and the speed of the aircraft. If the wingman is acute or sucked, the geometry becomes more dynamic. The acute aircraft turns more than 45 degrees, slowing downrange travel. He must not turn too far to avoid going sucked in the process. In general, the acute jet should not cross the sucked jet's flight path at an angle of greater than 90 degrees. On the other hand, the sucked jet needs to increase its downrange travel to catch up with the acute jet. In extreme cases, the sucked jet may just check turn to ensure he crosses the other aircraft's flight path and drive into position. Remember, the wingman has an altitude contract and is responsible for de-confliction.

9.1.4 Division Administrative Formations

9.1.4.1 Division Parade

The parameters for division parade are essentially the same as section parade except three or four aircraft are now in parade formation. It is incumbent on the flight lead to minimize aggressive maneuvering (no greater than 30 deg AOB) in this formation as the "whip" action makes it difficult for dash 3 and 4 to maintain a proper bearing line. Gradual changes in airspeed are also recommended to ensure formation integrity. Pilots should delay transitioning to division parade formation for as long as possible (e.g., after the final turn to the runway initial is complete). Division parade should not be used for extended IMC penetration due to the "whip" effect and reduced visibility. See Figure 9-6.

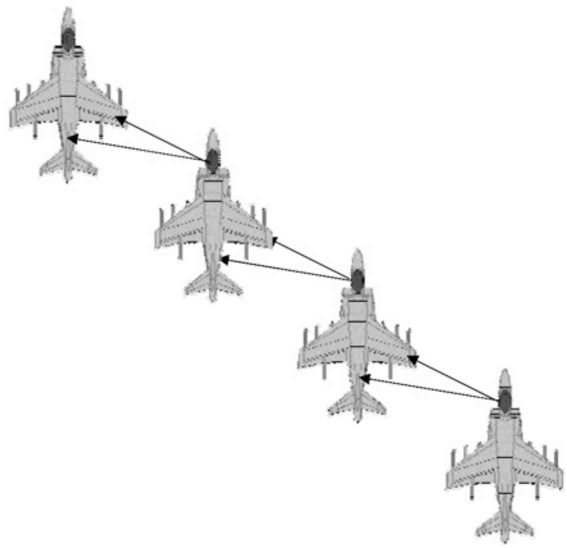


Figure 9-6. Division Parade

9.1.4.2 Balanced Parade

The parameters for balanced parade are dash 2 and 4 maintain section parade on their respective leads. Then, dash 3 increases lateral separation on the lead aircraft until the outrigger landing gear wheel is in the center of the fuselage avionics panel (door 60L or R) of dash 2; and stepped down by aligning the wingtip and bottom of the fuselage. This leaves enough space between lead and dash 3 for dash 2 to cross under to form division parade. See Figure 9-6. Dash 2 positions on the opposite side of the lead aircraft from dash 3. Section cross–unders are performed by dash 3 in the same manner as described in paragraph 9.1.1.2 with dash 4 executing a simultaneous cross–under on dash 3.

9.1.4.3 Fingertip

When entering IMC conditions with a three or four plane formation, the preferred option is to divide the flight into a section and a single (3–ship) or into two sections (4–ship) in RADAR trail. If this is not feasible, the lead directs the flight to assume fingertip formation. To execute this formation, start in balanced parade and have dash 3 move up into parade on the lead. See Figure 9-7.

9.1.4.4 Division Cruise

The parameters for division cruise are dash 3 maintains fighter wing off the lead, dash 2 balances opposite dash 3 in section cruise on lead. Dash 4 maintains section cruise on dash 3. See Figure 9-8.

9.1.4.5 Administrative 3-Ship Division Formations

For administrative purposes, 3–ship formations simply drop the dash 4 aircraft from each one of the formations listed above.

9.1.5 Division Tactical Formations

9.1.5.1 Deployed Echelon

The parameters for division deployed echelon are: all aircraft on a bearing line 45 degrees aft of lead’s 3/9 line. Dash 2 is 0.7 to 1.2 NM from lead. Dash 3 is from 1.2 to 2.5 NM from lead. Dash 4 is 0.7 to 1.2 NM from Dash 3. Dash 3 maintains an altitude split of level to 1,000 feet above or below lead. See Figure 9-9.

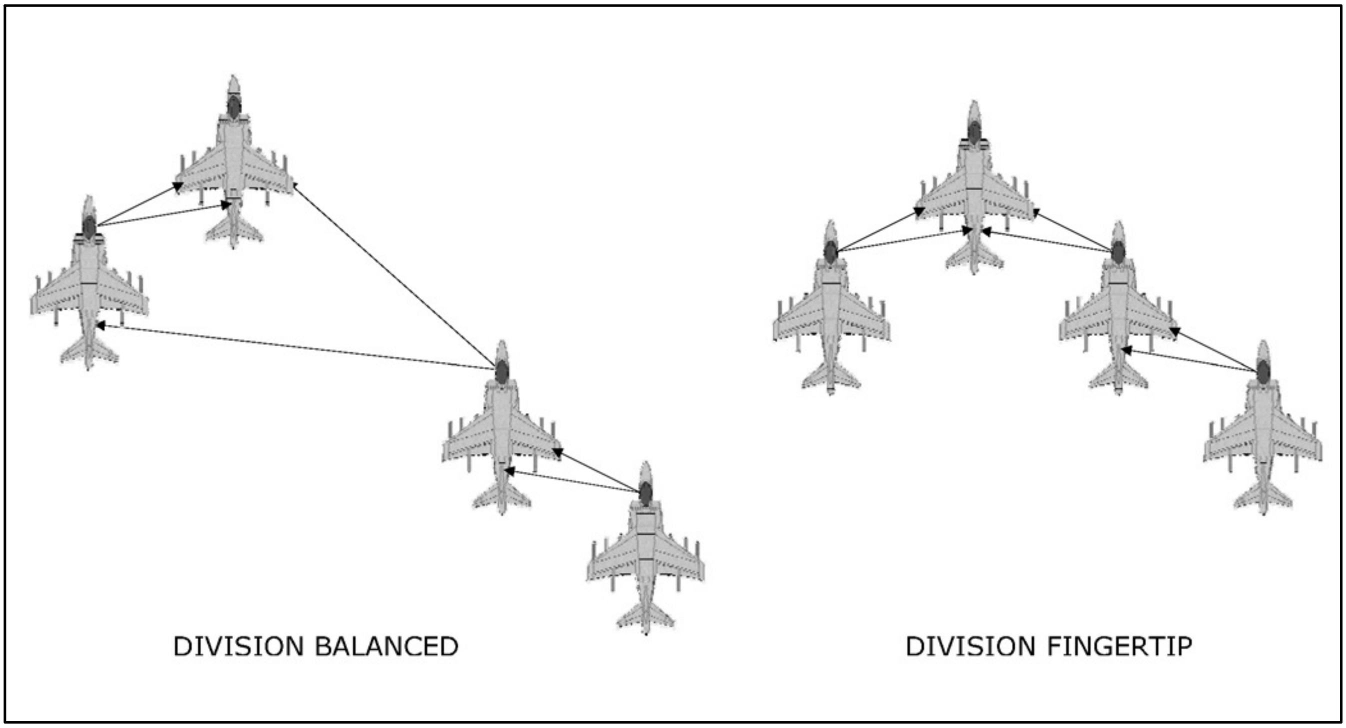


Figure 9-7. Division Fingertip and Balanced Parade

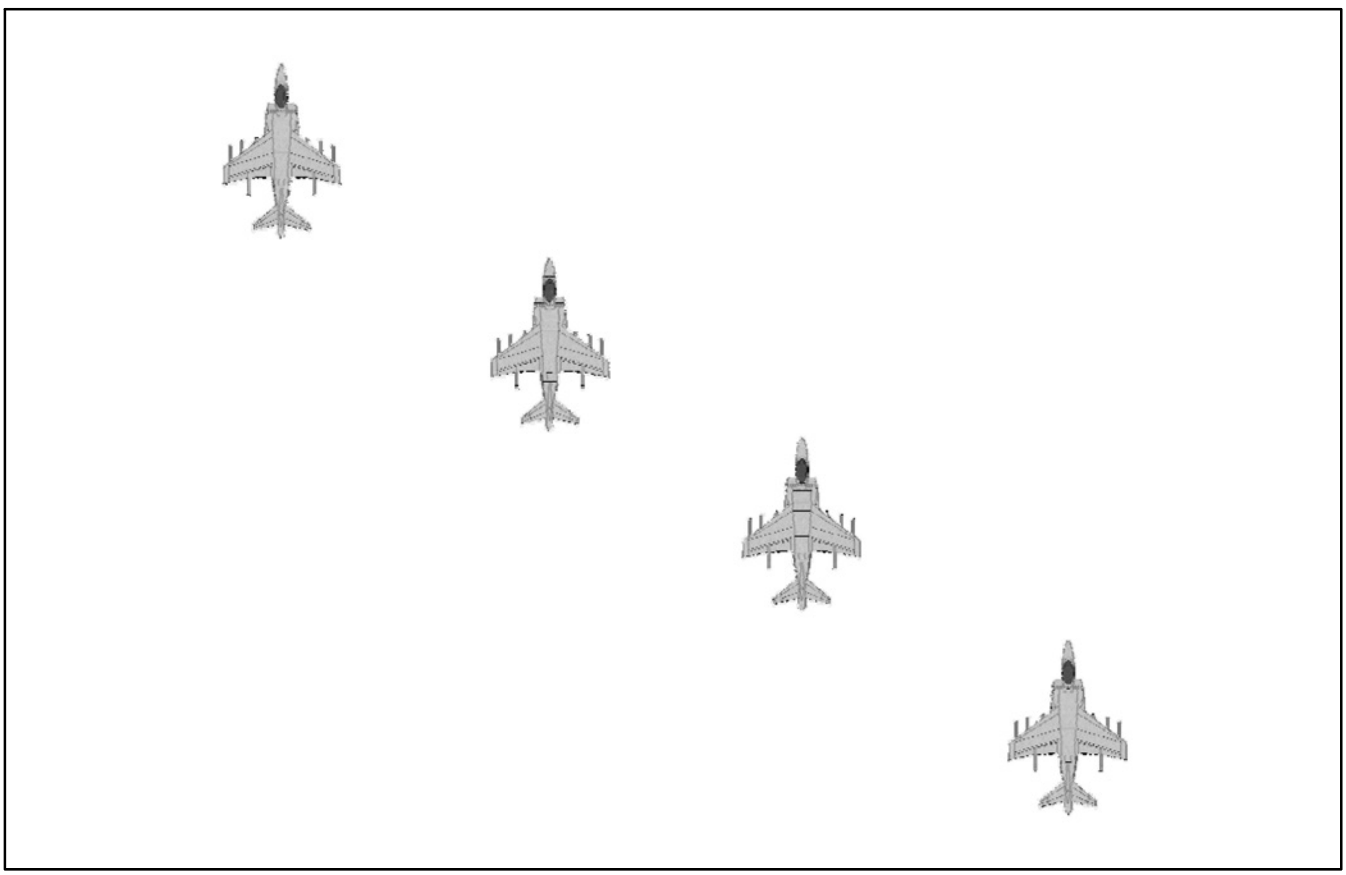


Figure 9-8. Division Cruise

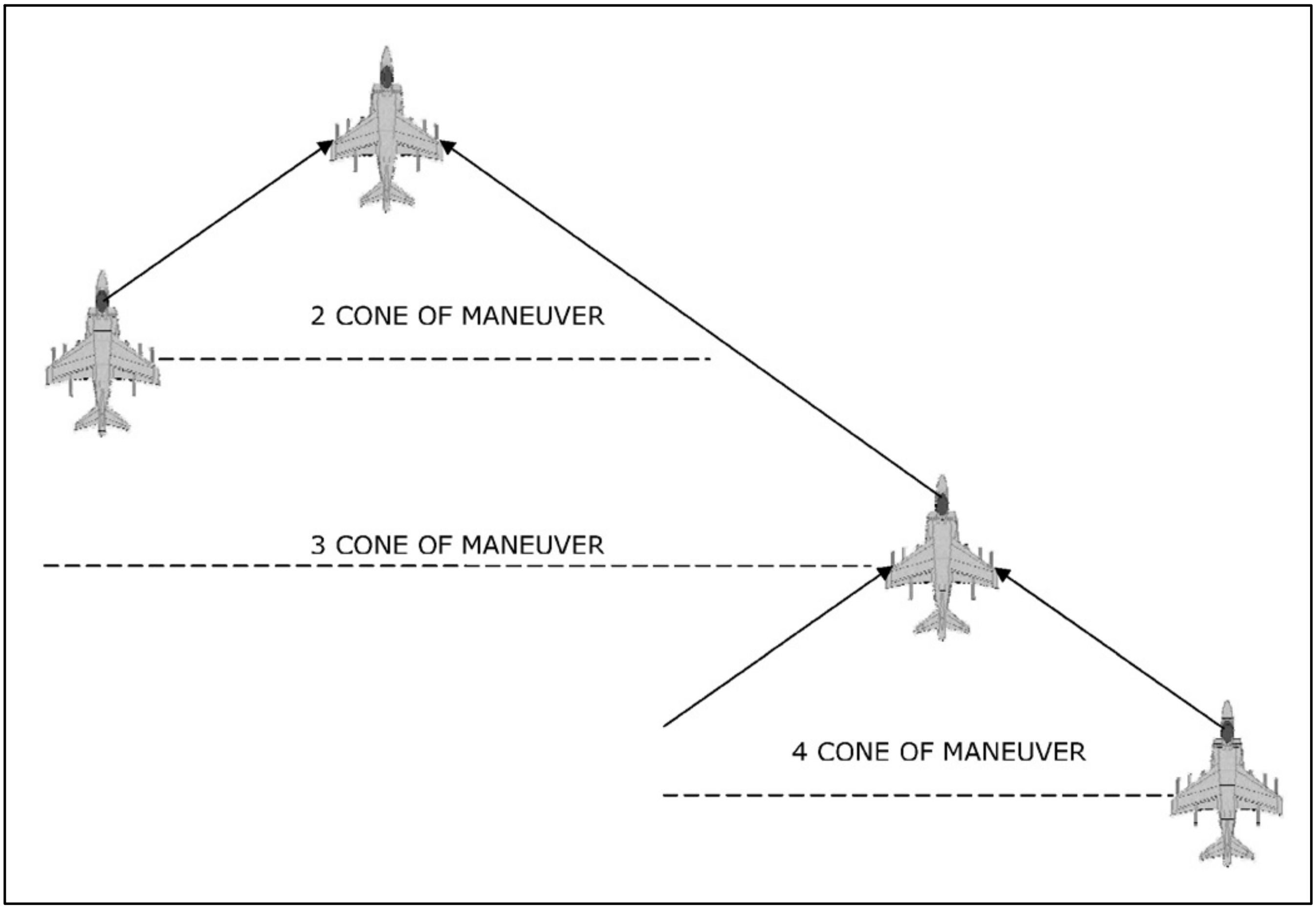


Figure 9-9. Deployed Echelon

9.1.5.2 Fluid Four

The parameters for fluid four are dash 3 flies defensive combat spread on lead, dash 2 and dash 4 fly fighter wing on their respective leads, and maintain an altitude split of 1,000 to 3,000 feet. If flying below 1,000 feet AGL, the formation is co-altitude. The division leader will establish the de-confliction plan based on mission requirements. For example, for air-to-surface missions, the second section may be stacked high or for air-to-air missions, the second section may be stacked low. While maneuvering, lead and dash 3 execute combat spread maneuvering procedures while dash 2 and dash 4 maintain fighter wing positions on their respective lead. The second section must provide positive de-confliction from lead's section or broadcast its intentions. All turns should be level unless de-confliction dictates otherwise. The wingmen need only to maneuver their aircraft with respect to their lead's aircraft as though they are in section. All section combat spread turns can be performed from fluid four. See Figure 9-10.

9.1.5.3 Division Box

The parameters for division box are: lead and dash 2 fly defensive combat spread, dash 3 and dash 4 fly defensive combat spread between 1.0 and 2.5 NM behind the lead section, maintaining an altitude split of 1,000 to 3,000 feet. If flying below 1,000 feet AGL, maintain co-altitude with the lead section. For an “offset box” the trail section offsets 3,000 feet left or right from the lead section. See Figures 9-11 and 9-12.

9.1.5.4 Wedge

The parameters for division wedge are: dash 2 maintains fighter wing while dash 3 and dash 4 fly defensive combat spread between 1.0 and 2.5 NM aft of the lead section maintaining an altitude split of 1,000 to 3,000 feet. If flying below 1,000 feet AGL, maintain co-altitude with the lead section. See Figure 9-13.

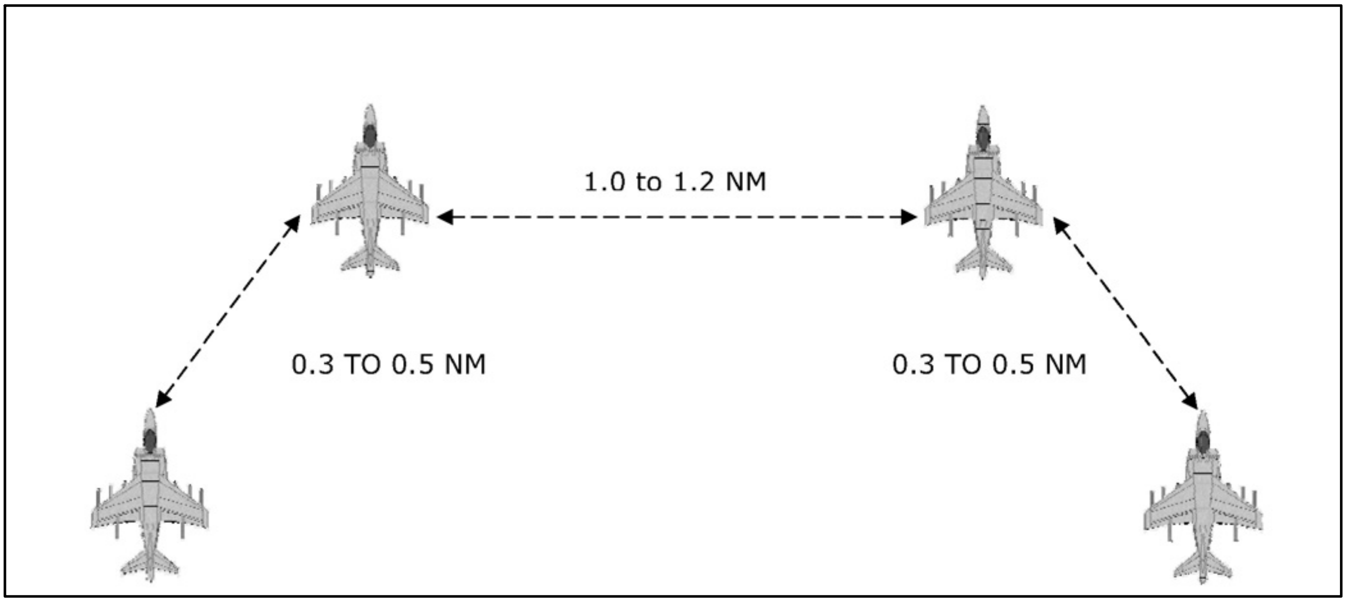


Figure 9-10. Fluid Four

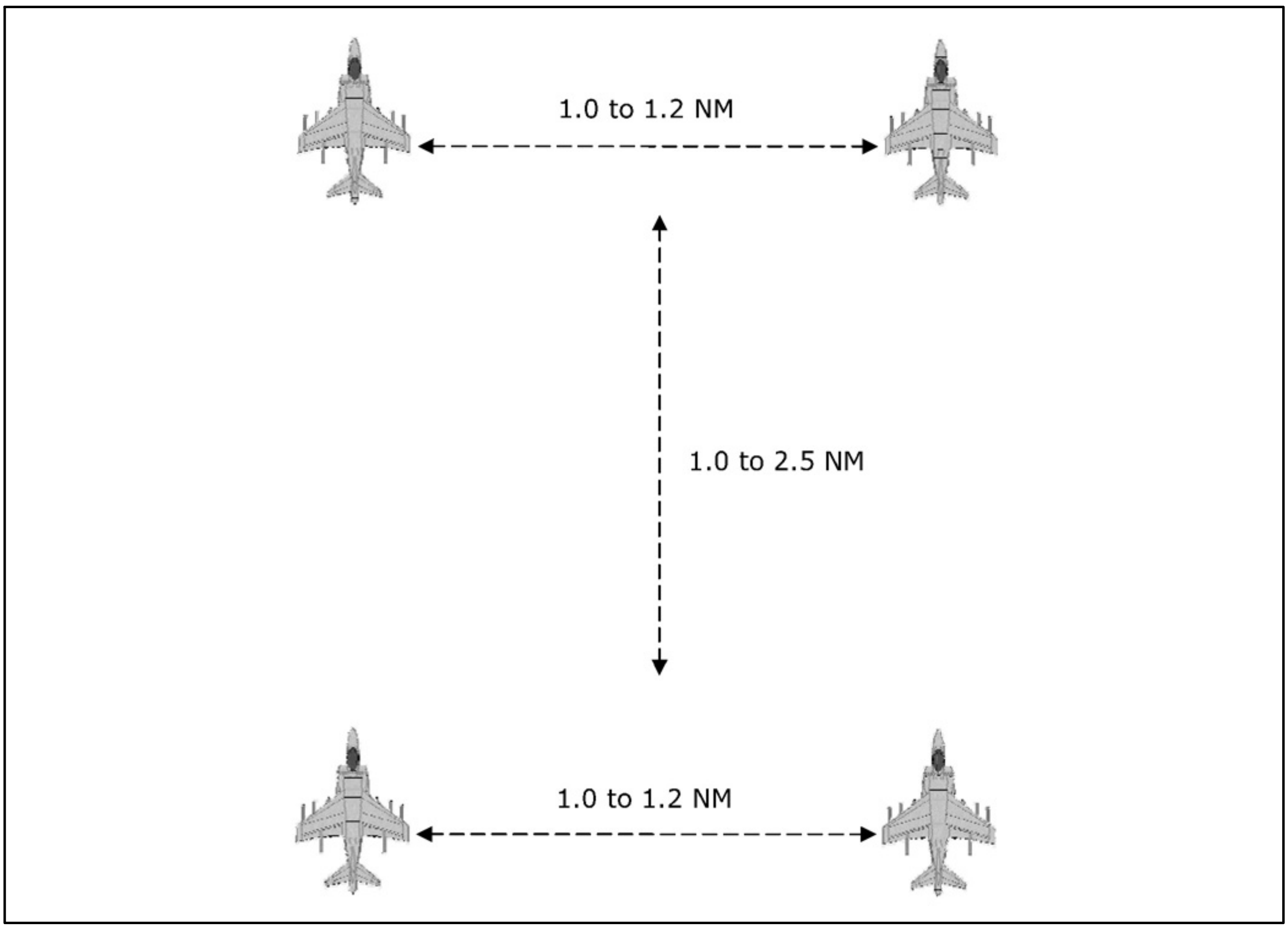


Figure 9-11. Division Box

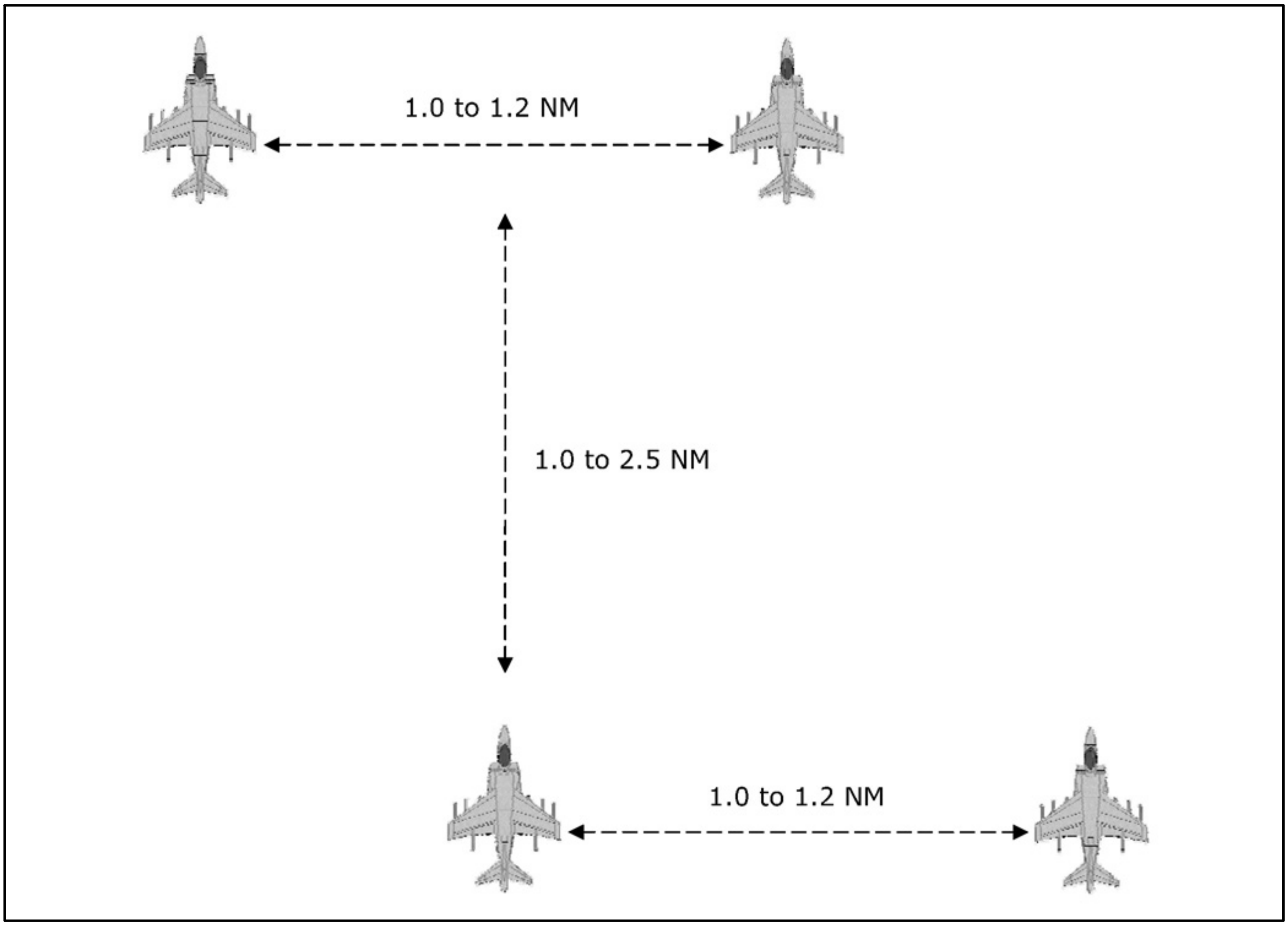


Figure 9-12. Division Offset Box

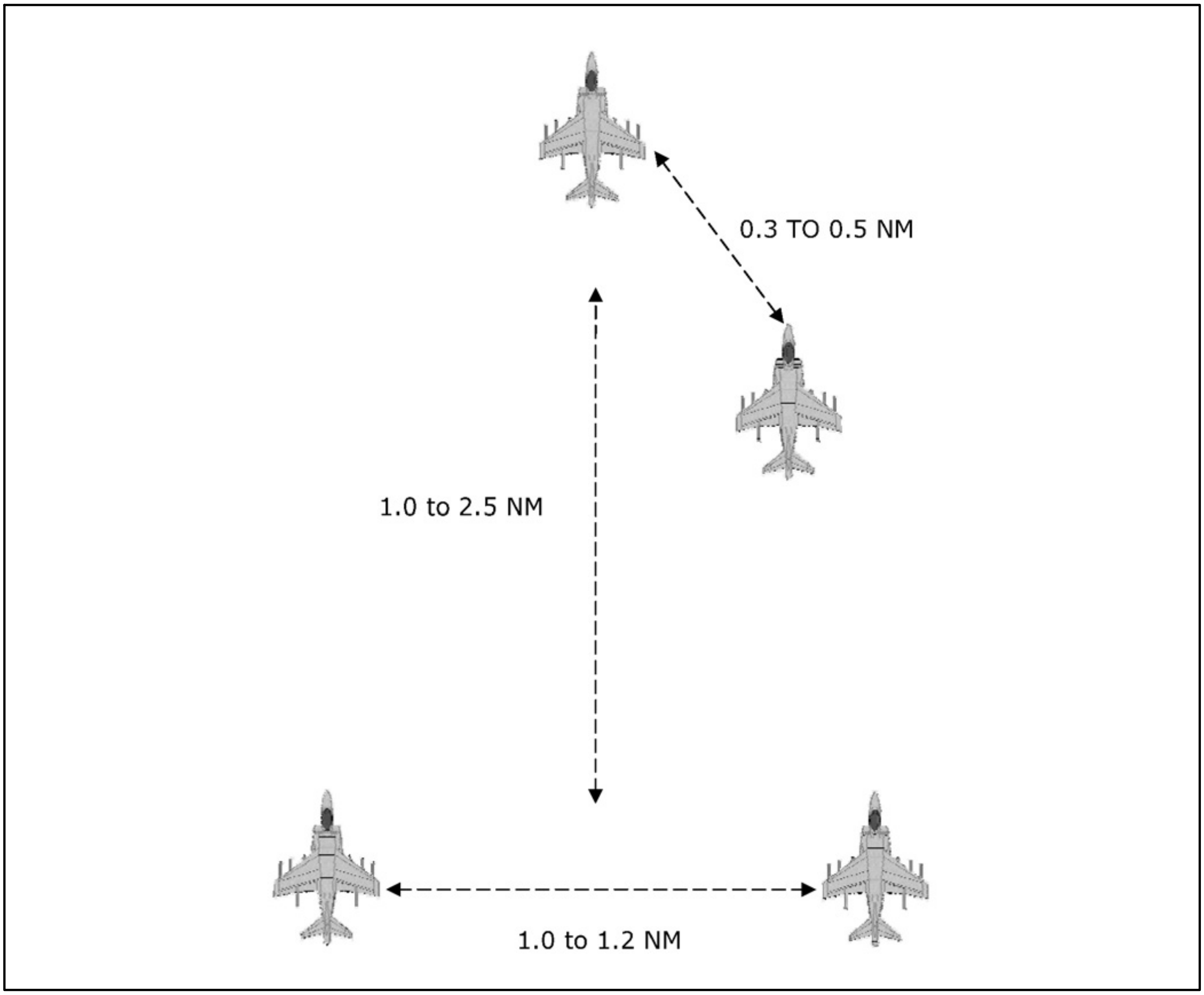


Figure 9-13. Division Wedge

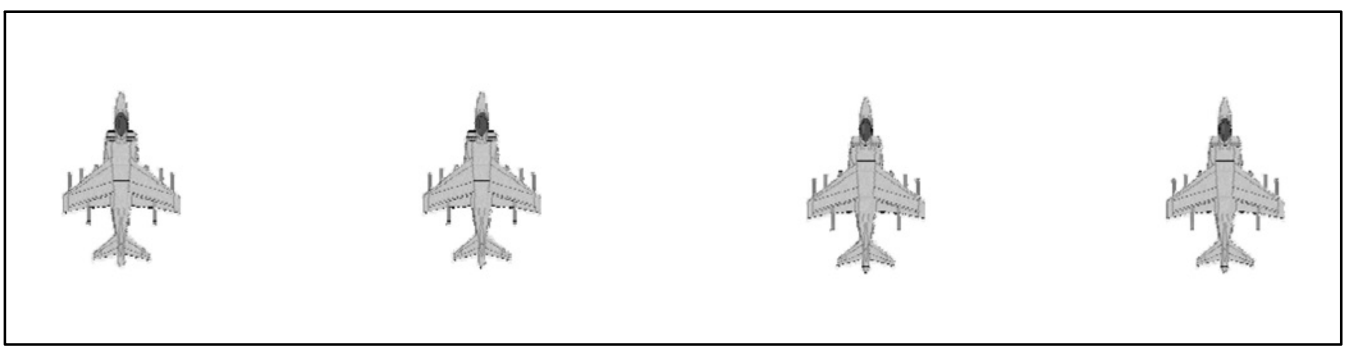


Figure 9-14. Division Wall

9.1.5.5 Wall

The parameters for division wall are dash 3 maintains defensive (or offensive) combat spread on lead, dash 2 and dash 4 maintain defensive (or offensive) combat spread on their respective flight leads. See Figure 9-14.

9.1.5.6 Tactical 3-Ship Division Formations

Figure 9-15 shows three ship tactical formation options.

FORMATION	OPTION
Deployed Echelon	“Ghost” Dash 2
Fluid Four	“Ghost” Dash 4
Box/Offset Box	Fly Offset Box with “Ghost” Dash 2
Wedge	“Ghost” Dash 2
Wall	“Ghost” Dash 4

Figure 9-15. Recommended Division 3 Ship Formation Options

9.1.6 Division Maneuvering

9.1.6.1 Fluid Four Maneuvering

Maneuvering in fluid four consists of combat spread section maneuvering between lead and dash 3. The wingmen maintain a fighter wing position on their respective leads throughout the maneuvering. For continued mutual support, after maneuvering has ceased, the wingmen resume fluid four ensuring they look through their respective leads into the rest of the division. All calls are initiated by the division lead to dash 3. For example: “RAZOR 21 FLIGHT, TAC LEFT”. The division then executes a tac turn. Dash 2 and 4 remain silent throughout all maneuvers in this formation.

Transitions from fluid four to wedge/box may be accomplished however the flight lead dictates. Lead initiates the transition by stating, “RAZOR 21 FLIGHT, ASSUME WEDGE/BOX”. Transitions are either executed by the division lead with a 90° turn away from dash 3 or by dash 3 with a 90° turn into the division lead. If lead pumps away from the division, dash 3 then follows after the appropriate time delay to flow in trail. Dash 4 then assumes combat spread position on dash 3. If dash 3 pumps into the division lead, after the appropriate time delay, he resumes the original heading. Out of the turn, dash 4 assumes combat spread position. To transition from wedge/box back into fluid four, the division lead initiates a 90° turn left/right followed by a reversal back to original heading in order to expedite the transition. Both dash 2 and dash 4 then assume fighter wing on their respective leads to resume the fluid four formation.

9.1.6.2 Box Maneuvering

All calls are initiated by lead to the wingman. For example: “RAZOR 21, TAC-RIGHT,” and they execute the tac-turn. Dash 3 follows lead’s cues, restates the same intentions to his section, and initiates at the same point as the lead section. This will typically occur anywhere from 4 to 12 seconds after lead’s call (“RAZOR 23, TAC-RIGHT”) based on nose-to-tail distance between the first and second section. All turns can be performed from division box/offset box.

9.1.6.3 Wedge Maneuvering

Assume any turns in division wedge to be 90 degrees unless called. Lead may give a reference heading or degrees of turn for all other turns. In that case, lead may say, “RAZOR 21, HOOK RIGHT, REFERENCE 210.” Dash 2 will remain silent since he is flying fighter wing. Dash 3 initiates the required turn after the appropriate delay with, “RAZOR 23, HOOK-RIGHT (or CROSS TURN).”

9.1.6.4 Wall Maneuvering

Turns in division wall are limited to pumps, tac-turns, and hook turns.

9.1.7 Formation Rendezvous

9.1.7.1 Running Rendezvous

A running rendezvous is a method of joining on a non–maneuvering aircraft from the rear quarter. The wingman should know the leader's airspeed to avoid an overshoot. The wingman should maneuver to achieve a parallel course with a moderate amount of lateral separation (< 500 feet). The visual cue for this is placing the lead aircraft between the edge of the HUD glass and the canopy bow. The wingman simultaneously establishes a moderate rate of closure on the lead (no more than 50 knots). Since closure is difficult to detect when approaching from the rear, avoid placing the velocity vector on lead's aircraft and closely monitor the A/A TACAN DME. As the wingman approaches the parade bearing line, reduce speed so as to arrive on bearing with no more than 25 knots of closure. The aircraft is then flown up the bearing line to an appropriate formation position. If attempting to join a flight prior to entering IMC, the flight lead should carefully consider the ceiling and flight clearance requirements. Adjust the rendezvous airspeed if necessary to expedite the join–up. If unable to safely join a flight underneath the weather, transition to a RADAR trail departure. If conducting a running rendezvous in division, the flight lead should thoroughly brief the desired side for each aircraft's join–up if joining in any formation other than division parade.

In the event that closure is not under control during the final phase of a running rendezvous, execute an overrun with the following procedures:

1. Lower the nose to create vertical separation.
2. Turn away from lead to increase lateral separation.
3. Throttle — IDLE.
4. Speedbrake — OUT.
5. Transmit "RAZOR 12, OVERRUN".
6. Once slowed, allow the lead to pass by, intercept the bearing line, and complete the rendezvous.

9.1.7.2 CV (Circling) Rendezvous

A CV (circling) rendezvous is a method of joining up on a turning aircraft from the rear quarter. Again, the wingman should know the leader's airspeed. Although it is possible to rendezvous co–airspeed the circling rendezvous can be expedited by using approximately 25 knots of closure when on the bearing line. The wingman maneuvers to pure pursuit and holds this flight path until he enters lead's turn circle. At this point, determine position relative to the leader's bearing line. If forward of the bearing line, go to lag pursuit by leveling wings or making a slight turn away from lead. This maneuver should place the aircraft on or aft of the bearing line. If on the bearing line, turn to align fuselages then readjust to the bearing. If aft of the bearing line, increase the rate of turn to fly toward the bearing line while simultaneously aligning fuselages. Once achieving the bearing line, adjust fuselage alignment by placing the lead aircraft just forward of the junction of the canopy bow and the lower edge of the windscreen. The wingman will normally join to parade on the outside of the turn. This requires taking step down at one aircraft length of separation, then executing a normal cross–under to IFR parade. If conducting this rendezvous as a division, wingmen must maintain situational awareness of not only the lead aircraft but other aircraft conducting the join–up. If one aircraft is slow to join, it may require the other aircraft to stagnate on bearing line until the slow aircraft completes the join–up.

In the event that closure is not under control during the final phase of a circling rendezvous, execute an underrun with the following procedures:

1. Lower the nose to create vertical separation.
2. Level wings to pass behind the lead aircraft.
3. Throttle — IDLE.
4. Speedbrake — OUT.

5. Transmit “RAZOR 12, UNDERRUN”.

6. Once stabilized on the outside and cleared by lead, turn inside to reestablish the final portion of the rendezvous.

9.1.7.3 Tacan Rendezvous

A tacan rendezvous is a method of using a tacan navigation aid to join aircraft that are not in visual contact. The wingman must know the leader’s altitude. The leader flies to the briefed tacan fix, either inbound or outbound, and establishes a constant angle of bank turn to the left at the pre-briefed altitude and airspeed. The joining aircraft establishes altitude separation and then flies to the pre-briefed fix while visually searching for lead. To enhance the probability of visual acquisition, each pilot should communicate his current position on the circle. The fix is point one, 90° of turn is point two, 180° of turn is point three and 270° of turn is point four. Once the wingman is visual, perform the appropriate rendezvous.

9.1.7.4 Rendezvous Technique

The use of nozzles to slow closure during a rendezvous is an acceptable technique but can lead to additional pilot workload and the possibility of inadvertently leaving the nozzles out of the full aft position.

WARNING

Inadvertently leaving the nozzles near the hover or braking stop position can be mistaken for engine failure and result in aircraft damage and/or loss of aircraft control. The following are indications of this condition:
—Lack of forward thrust despite full power.
—Inability to maintain level flight despite full power.
—15 Second light.
—Extreme sensitivity in the pitch axis.
—Duct pressure above 3 PSI.
—Nozzle indicator on EPI not AFT.
—RPM above 109% (combat disabled), or above 111% (combat enabled).

9.1.7.5 Night Unaided Considerations

Unaided rendezvous at night pose significantly more risk of midair collision due to the lack of closure cues and lack of visual acuity. Strict adherence to closure rates is required, no more than 25 knots in trail and 15 knots on the bearing line. Because the aircraft will not be visible to the naked eye until in close when the closing aircraft’s own anti-collision light begins to illuminate the lead aircraft, the light triangle should be used to approximate an acceptable bearing line for re-join. The light triangle is defined as the upper anti-collision light positioned 1/3 of the distance aft of the port/starboard position light and 2/3 of the distance forward of the aft position light. When on bearing line, continuous monitoring of airspeed (closure) and the light triangle (bearing) as well as a disciplined scan of proper altitude in the HUD is required to complete a safe join.

9.1.7.6 Night Aided Considerations

While night vision goggles improve the visual acuity at night, closure is difficult to assess without angular rates due to the lack of depth perception. The night-time light triangle is still a valuable tool to use during a CV rendezvous; however, the pilot will begin to see the aircraft sooner than an in close position. Once the lead aircraft is seen visually, a visual scan of the appropriate bearing and altitude should be commenced. Night-time closure rates should still be controlled, no more than 25 knots in trail and 15 knots on bearing, in order to complete a safe join.

SEE IC # 38

9.2 AIR REFUELING

Note

Before air refueling operations, each pilot shall be familiar with the NATOPS Air Refueling Manual and the flight characteristics of the air refueling probe. See Flight Characteristics, Chapter 11. Air refueling is authorized for the single seat model only.

Aerial refueling operations are authorized with the tankers listed in Figure 9-16. All tanker limits apply. Use of all other tankers is prohibited. Aerial refueling operations are authorized in all cleared loading configurations. Ferry loading CG must be maintained forward of 14.5 percent mean aerodynamic cord (MAC) by keeping the maximum water quantity below 250 pounds.

9.2.1 Before Plug-in

The air refueling checklist should be completed prior to plug-in.

1. Master arm switch — OFF.
2. A/R switch — OUT (READY light ON).
3. Probe light — AS DESIRED.

Note

The L and R TRANS lights may illuminate after tank depressurization but internal fuel will still be available to the center tanks by siphoning action.

CONTINUED

PLATFORM	MINIMUM AIRSPEED	MAXIMUM AIRSPEED	MINIMUM ALTITUDE	MAXIMUM ALTITUDE
USAF KC-135R[1,2,3,4] French AF KC-135R[1,2,3,4]	220 KIAS (USAF) 240 KIAS (FAF)	300 KIAS/0.86 IMN (most restrictive)	Greater of 5,000' MSL or 1,500' AGL	35,000' MSL
Spanish B707 Italian B707 Australian B707	230 KIAS (Spanish[5]/Italian) 250 KIAS (Australian)	300 KIAS	1,500' AGL[6]	35,000' MSL
Omega B707	230 KIAS	300 KIAS	Greater of 5,000' MSL or 1,500' AGL	35,000' MSL[7]
Omega KDC-10[11]	200 KIAS	290 KIAS	15,000 MSL	30,000 MSL
US/Spanish KC-130	210 KIAS	250 KIAS	1,500' AGL	20,000' MSL
US KC-130J	190 KIAS	250 KIAS	1,000' AGL	30,000' MSL
Canadian CC-130T	210 KIAS	250 KIAS	1,500' AGL	15,000' MSL
UK TriStar (K Mk 1, KC Mk 1)[8]	230 KIAS	300 KIAS	1,500' AGL	35,000' MSL
UK VC 10 (K Mk 2, K Mk 3, K Mk 4)[9]	260 KIAS	300 KIAS	1,500' AGL	30,000' MSL
US S-3B	200 KIAS	275 KIAS	1,500' AGL	25,000' MSL
US KC-10	200 KIAS	290 KIAS	15,000' MSL	30,000' MSL
US F/A-18 E/F	230 KIAS[6]	250 KIAS[10]	12,500' MSL[6]	17,500' MSL[6]

Notes:

1. AR from boom drogue adapter not authorized. Refer to ATP-56.
2. Tanking position high and inboard relative to the MPRS tankers outboard engine may result in the receiver engine rolling back or flaming out.
3. Lateral stick and trim inputs are required to counter the receiver aircraft tendency to roll toward the tanker.
4. While flying at the approach position (20 feet aft of drogue), small lateral trim inputs may be required to counter a tendency to roll toward the tanker. Deviations inboard and outboard may require additional lateral stick inputs. Deviations of more than 10 feet high can result in a strong sideslip (on right tanker wing, full left ball). Flight buffet is a good indication to reposition down with respect to the tanker.
5. Optimum airspeed for tanker is 275 KIAS or 0.78 IMN, whichever is less.
6. Refueling below 10,000 feet requires special authorization from the RAAF.
7. Airspeeds between 250 and 300 KIAS are recommended above 30,000 feet MSL.
8. Use of tanker high pressure pumps not authorized.
9. Use of tanker high pressure pumps not authorized on centerline system.
10. AV-8B flying qualities may degrade rapidly outside of the F/A-18E/F refueling airspeed and altitude limits.
11. Maximum closure 3 KTS due to probe limit loads.

Figure 9-16. Authorized AR Platforms

4. Airspeed — 190 to 300 KNOTS.
5. Angle-of-attack — 13° MAXIMUM.
6. Flaps — CRUISE.

   STOL flaps may be used to maintain AOA below 13°. Use of AUTO flaps is prohibited prior to contact with drogue basket.

WARNING

> Uncommanded programming of the flaps greater than 25° with nozzles less than 20° will cause a severe nose down pitch rate. The extreme attitudes coupled with the negative g's of up to −2.5, as experienced by the pilot, will be extremely disorienting and make cockpit functions difficult to perform. A combination of full aft stick and rotation of the nozzles to an angle greater than 40° are required to arrest this condition.

7. AFC — ENGAGE (if desired), Reduces workload.
8. Visor — DOWN.
9. Radar — SILENT.

9.2.2 Refueling Technique

Note

> The following procedures, as applied to tanker operation, refer only to single drogue refuelers.

Refueling altitudes and airspeeds are dictated by receiver and/or tanker characteristics and operational needs, consistent with the tanker's performance and refueling capabilities. This, generally, covers a practical spectrum from the deck to 35,000 feet and 190 to 300 knots.

9.2.3 Approach

Once cleared to commence an approach, refueling checklists completed, assume a position 10 to 15 feet in trail of the drogue with the refueling probe in line in both the horizontal and vertical reference planes. Trim the aircraft in this stabilized approach position and ensure that the tanker's (amber) ready light is illuminated before attempting an approach. Select the drogue as the primary reference point on the tanker. Increase power to establish an optimum 3 to 5 knots closure rate on the drogue. It must be emphasized that an excessive closure rate will cause a violent hose whip following contact and/or increase the danger of structural damage to the aircraft in the event of misalignment or drogue take-up reel malfunction; whereas, too slow a closure rate results in the pilot fencing with the drogue as it oscillates in close proximity to the aircraft's nose. Small corrections in the approach phase are acceptable; however, if alignment is off in the final phase, it is best to immediately retire to the initial approach position and commence another approach, compensating for previous misalignment by adjusting the reference point selected on the tanker. Small lateral corrections with a shoulder probe are made with the rudder, and vertical corrections with the stabilator. Avoid any corrections about the longitudinal axis since they cause probe displacement in both the lateral and vertical reference planes.

9.2.4 Missed Approach

If the receiver probe passes forward of the drogue basket without making contact, a missed approach should be initiated immediately. Also, if the probe impinges on the canopy lined rim of the basket and tips it, a missed approach should be initiated. A missed approach is executed by reducing power and backing to the rear at an opening rate commensurate with the optimum 3 to 5 knot closure rate made on an approach. By continuing an approach past the basket, a pilot might hook his probe over the hose and/or permit the drogue to contact the receiver aircraft fuselage. Either of the two aforementioned hazards require more skill to calmly unravel the hose and drogue without causing further damage than to make another approach. If the initial approach position is well in line with the drogue, the chance of hooking the hose is diminished when last minute corrections are kept to a minimum. After executing a missed approach, analyze previous misalignment problems and apply positive corrections to preclude a hazardous tendency to blindly stab at the drogue.

9.2.5 Contact

When the receiver probe engages the basket, it will seat itself into the drogue coupling and a slight ripple will be evident in the refueling hose. The tanker's drogue and hose must be pushed forward 3 to 5 feet by the receiver probe before fuel transfer can be effected. This advanced position is evident by the tanker's (amber) ready light going out and the (green) fuel transfer light coming on. When the tanker's (green) fuel transfer light illuminates the ready light on the canopy bow goes out. While plugged-in, merely fly a close tail chase formation on the tanker. Although this tucked-in condition restricts the tanker's maneuverability, gradual changes involving heading, altitude and/or airspeed may be made. A sharp lookout doctrine must be maintained due to the precise flying imposed on both the tanker and receiver pilots. In this respect, the tanker can be assisted by other aircraft in the formation. When the tanks are full the refueling valves close to stop the flow and the LEFT and RIGHT full advisory lights come on as follows:

With no external tanks – Flashing when the internal wing fuel tanks are full.

With two external tanks – Flashing when the external tanks are full.

With four external tanks – Steady when the inboard external tanks are full and flashing when the outboard external tanks are full.

Switching from CRUISE flaps to AUTO flaps is authorized after probe engagement with the drogue. Selection of AUTO flaps should occur after the aircraft is stabilized in the refueling basket and before aircraft angle of attack increases above 5°. Waiting to initiate the transition from CRUISE to AUTO until the angle of attack has increased above 5° will cause an abrupt change in flap position, resulting in a more severe pitch attitude change, oscillations, and possible disconnect from the basket.

CAUTION

> Transition from CRUISE flaps to AUTO flaps while tanking may result in disengagement unless timely power corrections are made to correct positional trends. If the flap transition results in a sustained pilot-induced oscillation, execute emergency breakaway procedures. CRUISE or STOL flaps must be selected before attempting to reconnect to the basket.

9.2.6 Disengagement

Disengagement from a successful contact is accomplished by reducing power and backing out at a 3 to 5-knot separation rate. Care should be taken to maintain the same relative alignment on the tanker as upon engagement. The probe will separate from the drogue when the hose reaches full extension. When clear of the drogue, place the A/R switch to IN. The LEFT and RIGHT full advisory lights go out when the probe is fully retracted or if PRESS is selected.

9.3 FORWARD OPERATING BASE

A Forward Operating Base (FOB) offers the MAGTF Commander flexibility through quick emplacement and repositioning of forces, rapid response to battle requirements and enhanced survivability during counterattack. Doctrinally, a FOB is an airfield used to support tactical operations without establishing full support facilities and should not be confused with an Expeditionary Air Field (EAF) which is a construction method using AM–2 Aluminum Matting. The base may be used for an extended time period or abandoned as the battle moves and a new FOB is established. Support from a main operating base is required to provide backup support for a FOB. The basic requirements for a FOB are secure location, beyond indirect enemy fire but within a combat radius of 15 to 250 nautical miles, and accessible to logistical support lines.

An airfield can be considered a FOB even though the runway dimensions are comparable to a permanent airfield. It is the absence of full support facilities such as standard airfield lighting, robust air traffic control services, or on site or robust weather services that determine if Forward Base Operations (FBO) and considerations are appropriate. Additionally, a FOB may be operating with waivers to standard airfield procedures so that operations can proceed without extensive delays. Waivers can include lighting requirements, obstruction free zones, or concurrent operations restrictions (helicopter and fixed wing operations). During recent AV–8B employment in Operation Iraqi Freedom and Operations Enduring Freedom, VMA squadrons have operated at An Numaniyah, Al Asad Air Base, Kandahar International, and Bagram Air Base. Each airfield poses unique operating challenges due to variations in airfield environment and support facilities and capabilities.

9.3.1 Concept of Employment

There are four types of FOBs: main base, air facility, air site, and air point. Categorization is determine by logistic and maintenance support available, not by size or location. Each type of FOB has potentially unique challenges for safe execution. A detailed discussion of each is published in MCWP 3–21.1, Aviation Ground Support.

9.3.2 FOB Operations Preparation

Prior to operating from a FOB, a detailed site survey must be completed IAW MAG or Wing SOP by designated personnel from Operations, Logistics, Safety, and Maintenance Departments. Administration and Intelligence Departments personnel may be required depending on the objectives of the FOB. The objective of a site survey is to quantify the availability of support services, identify gaps in services and subsequent potential hazards and challenges to operations. The endstate of the site survey is to develop Standard Operating Procedures (SOP) for FOB execution.

9.3.2.1 FOB Site Survey

A FOB site survey shall include, but is not limited to, inspecting flight planning facilities, airfield condition, and ATC services. As part of the site survey, coordinate with the tenant command that is responsible for maintaining and operating the facility to obtain a copy of the FOB SOP for detailed review. The objective of a site survey is to determine what effects the condition of the FOB will have on maintaining tactically sound and safe operations.

9.3.2.1.1 Flight Planning Facilities

Adequate flight planning facilities are crucial for safe, detailed flight planning and execution. Research the availability of the following flight planning resources: operating area navigation publications, airfield diagram, local area of operations charts, weather services, and flight planning and preparation work spaces.

9.3.2.1.2 Airfield Inspection

A thorough inspection of all aspects of the FOB is critical. Inspect the runways and taxiways to determine dimensions; location and types of arresting gear; visual landing aids; distance marker availability and visibility day and night; condition of the surfaces; clearance from nearest obstacles; presence of FOD removal equipment and procedures; and condition and layout of parking apron. The focus of this airfield inspection is to determine what effect the airfield layout will have on Normal and Emergency procedures.

The airfield surface must be sufficiently hard to prevent the aircraft from sinking into the surface. A minimum CBR (California Bearing Ratio) hardness of 8 to 10 percent at 3 inches below the surface is required for STOs, RVTOs, RVLs, and SLs from a smooth strip. STOs, RVTOs, RVLs, and SLs from rough surfaces may damage the landing gear.

Finally, a detailed inspection of the expected landing point is required. In addition to determining suitability, surface conditions, and durability, determine a precise GPS coordinate and elevation for all intended points of landing to include airfield centerline at both approach ends and any vertical landing points. Accomplishing this will support FBO recovery and landing procedures.

9.3.2.1.3 ATC Services

Liaison with all aspects of air traffic control (ATC) services at the airfield to include ground controllers, tower controllers, Crash-Fire-Rescue, and radar services personnel. Obtain a copy of local course rules procedures. Determine the availability of instrument approach services. The focus of the ATC services inspection is to determine if modifications or waivers to FAA and/or OPNAVINST procedures are in place and what effect this will have on Normal and Emergency procedures.

9.3.2.1.4 Normal and Emergency Procedures Review

Upon completion of the site survey and once a complete understanding of the status of the airfield, ATC services, and flight planning facilities is achieved, conduct a thorough review of all Normal and Emergency Procedures delineated in Chapters 7, 13-18 of this manual. These procedures may be modified to support the location of the site, surrounding obstacles, threat, and terrain.

9.3.2.1.5 Landing Site Supervisor Kit

Compile and maintain a landing sight supervisor (LSS) kit with the following recommended equipment:

Lensatic compass.

Maps.

Colored panels.

Pyrotechnics (red flares and/or red smoke).

NATOPS manual and NATOPS emergency check list.

Flare pistol with red flares.

Goggles and sound suppressors or HST helmet.

Adequate VHF, FM, and UHF communications equipment.

Binoculars.

JMPS Computer.

GPS.

NVGs.

9.3.3 FBO Training

FBO are extremely challenging and pose potentially insidious hazards that are mitigated through a detailed SOP, thorough pilot training, and standardized execution. Before executing from a FOB, thorough pre-deployment training is essential. This training should include lectures, simulators and flights. Lectures should include aircraft and engine handling specifics and Normal, Emergency, and instrument flight procedures germane to the FOB. Simulator and flight training should replicate the flight conditions of the FOB as much as possible to include aircraft configuration, runway dimensions, weather conditions as well as day, night and instrument flight scenarios.

9.3.4 FBO Execution

Since each FOB is unique, a detailed SOP is required that provides specific procedures for preflight, taxiing, takeoff, recovery, and landing. These procedures should include instrument flight condition considerations and night procedures. Furthermore, care must be taken during all ground operations to decrease the risk of FOD especially when operating from an unprepared site. While at the FOB, due attention must be given to individual pilot proficiency and currency in regard to the specific characteristics of the site.

9.3.4.1 FBO Supervision

Due to the dynamic environment of FBO, having a Landing Site Supervisor (LSS) on station for takeoffs and landings will enhance situational awareness. The primary responsibility of the LSS is akin to a LSO–safe and timely recovery of aircraft. The LSS can ensure the intended point of landing is satisfactory and support pilots with threat lookout, Emergency Procedure execution, and airfield support services coordination. The LSS is another Risk Mitigation resource. Others include Operational Duty Officers (ODO) and Supervisors of Flight (SOF) that can be positioned in the airfield tower or squadron Operations Department to assist pilots during FOB operations. The LSS will supervise a mandatory FOD walk and inspection. Additionally, the LSS will ensure visual aids are properly positioned. The LSS shall check all equipment for serviceability including a communications check with all applicable agencies and assets. Two–way radio communication between the pilot and the LSS is required.

9.3.4.2 Preflight

A normal preflight should be accomplished with particular attention to the intakes and LPC blades for possible foreign object damage. Ensure clearance between obstacles and aircraft is adequate for performing post start control checks. Inspect the immediate area for evidence of FOD.

9.3.4.3 Taxiing

Due to the hazards at a FOB, pilots must follow the taxi director's signals precisely and taxi at a slow controlled rate. The antiskid system should be selected off for taxiing in confined areas. Complete all requisite pre–takeoff checklists IAW the FOB SOP. Five degrees of nozzles and full nose down trim should be utilized, unless in the vicinity of other turning aircraft. In that case, the nozzles should remain aft.

9.3.4.4 Takeoff

Aircraft performance and ordnance load, as well as FOB variables such as surface, slope, and obstacles, will all determine which takeoff procedure to use. Every takeoff is considered a maximum performance maneuver and pilots should enter the 14 degree pitch carats as well as program runway heading, relative wind and obstacles to determine NRAS and abort capability.

CAUTION

A combination of aircraft gross weight, engine performance, environmental factors (e.g. temperature) and runway length, may induce an NRAS that exceeds abort capability. If required, perform a wet STO to ensure either abort capability is available or, at a minimum, STO speed is only slightly greater than abort speed. If abort speed is less than wet STO NRAS, determine modifications to Emergency Procedures that are appropriate for that particular FOB.

Additionally, arming the ALE–39 to AUTO as part of the takeoff checklist may be necessary in certain tactical situations.

Note

The 28 Vdc Armament BUS receives power from the Armament Contactor Relay when the aircraft is weight off wheels and the landing gear handle is in the up position. Therefore, the ALE–39 will only be available when landing gear handle is selected up and the aircraft is weight off wheels, independent of whether the gear is still in transition.

Engine acceleration checks should be conducted on a FOD-free surface to the maximum extent practical. Avoid positioning the aircraft with the intakes in close proximity to an expansion joint or area of damaged runway to reduce the risk of FOD ingestion during acceleration checks. Flaps and duct pressure checks should also be conducted on a hard, FOD-free surface. Additionally, flap checks can be conducted at idle RPM.

9.3.4.5 CTO and STO Procedures

The following takeoff procedures have proven operationally effective during FBO execution in an effort to reduce FOD ingestion from damaged runways and/or simultaneous helicopter and jet aircraft use. They are adaptable to fit either a CTO or STO procedure. For a CTO, the aircraft rotation speed is defined by gross weight at takeoff and is independent of temperature and altimeter settings. During FBO execution with aircraft gross weight at 31,000 pounds and 12,000 feet of runway available, a CTO with a rotation of approximately 165 KCAS proved effective while maintaining an abort capability. However, a tailwind will increase KGS faster than KCAS and potentially cause KGS to exceed the limit for tire speed (180 KGS) before rotation airspeed is reached. Additionally, temperature and altimeter settings affect a CTO in two ways. First, as temperature increases or altimeter setting decreases, the amount of takeoff roll required to reach rotational speed will lengthen encroaching upon abort distance requirements. Second, extremely high outside air temperatures and/or low altimeter settings may cause a slight difference between KCAS and KGS inducing a rotation airspeed that exceeds the limit for tire speed. These conditions were particularly exacerbated during the summer months with high ambient air temperatures and low altimeter settings. In these cases a wet STO was executed with modifed procedures.

To determine the safest procedures, conduct detailed mission planning balancing the following factors:

1. Aircraft gross weight.
2. Forecasted maximum ambient air temperature and minimum altimeter setting.
3. Forecasted wind velocity.
4. Runway length available. Consider the worst case scenario, i.e. runway length remaining for the lead aircraft if positioning a flight on the runway.
5. Airfield elevation.
6. Maintaining an abort capability.

The following procedures comprise a modified STO affecting the ground roll portion of the takeoff:

1. Position the aircraft so that the aircraft intakes are not directly over an expansion joint, an area of damaged runway, or an area with FOD present.
2. All aircraft in the flight complete takeoff and acceleration checks as per paragraph 7.3.1 Takeoff Checklist and report Two/Five finger.

Lead begins to roll and initiates takeoff:

3. NWS Engage.
4. Brakes - release.
5. Allow aircraft to accelerate while maintaining throttle position at 60 percent RPM.
6. At 30 KGS smoothly advance the throttle to full power.
7. Complete CTO or STO procedure as per paragraph 7.3.2 or 7.3.3 as applicable.

When the next member of the flight recognizes that the preceding aircraft is at full power (exhaust plume and/or engine noise), initiate takeoff beginning with step 3 above.

9.3.4.6 Recovery/Approach

Although each FOB is unique, sensor and system optimization to assist in maintaining situational awareness throughout the recovery is essential. The FOB landing environment may be extremely dynamic due to weather, airfield conditions, obstructions, threat, or concurrent operations with other aircraft, including helicopters. Therefore, the following procedures will ensure that all available systems and sensors provide cueing to the desired landing point prior to commencing either a VMC or IMC recovery, day or night.

1. Select the waypoint of the intended point of landing determined during the site survey. Box DESG-STP.

2. Scroll a courseline to the runway heading for recovery.

3. TACAN — AS REQUIRED.

   Day/night VMC recovery: Air-to-Air TACAN-PROX set per flight brief.

   Day/night IMC recovery: TACAN set to airfield channel.

Depending on day/night and/or VMC or IMC recoveries.

4. Sensor Select Switch — right to select NAVFLIR.

or

5. Select HUD projection on right MPCD.

or

6. Select the NAVFLIR in the HUD. Adjust brightness and contrast, as desired.

7. Sensor Select Switch — right to select HUD projection on the NAVFLIR.

Intercept local course rules for VMC or IMC recoveries, such as the overhead, straight-in, whirlpool, TACAN, PAR, or AWLS, to become established in the landing pattern. Prior to recovery, a LSS can conduct a FOD inspection and then select a position to observe all portions of the landing pattern.

9.3.5 Landing

Landings at a FOB are performed using the normal procedures for SL, RVL, or VL. The landing checklist will be completed upon reaching the abeam position. In certain tactical situations, select AUTO on the ALE-39 as part of the landing checklist may be necessary.

Note

The 28 Vdc Armament BUS receives power from the Armament Contactor Relay when the aircraft is weight off wheels and the landing gear handle is in the up position. Therefore, the ALE-39 will only be available when landing gear handle is selected up and the aircraft is weight off wheels, independent of whether the gear is still in transition.

The FOB environment may not be as clearly defined as that of a main base exacerbated by inclement weather and/or night operations. Therefore, the intended point of landing may be lost from view during the approach. Fly a normal approach utilizing system and sensor cues to reacquire visual contact with the correct landing area. Utilize the courseline on the moving map, re-attack steering in the HUD, and NAVFLIR during the approach turn and while rolling out on the final approach course to maintain situational awareness to the intended point of landing. Once on final, the pilot's attention should be directed toward acquiring and maintaining visual contact with the landing area and any obstacles that should be taken into consideration. For a RVL a minimum ground speed of 60 knots is required for landings on unprepared surfaces. Glideslope and intended point of landing should be selected with reference to terrain in the approach corridor, landing surface condition and length, and aircraft performance. For a VL, depart the key using visual cues as necessary to arrive over the landing area at the appropriate altitude to prevent FOD and or surface damage. Pilot attention must not be allowed to focus on the landing area to the exclusion of sideslip, AOA, and airspeed. Cross the edge of the pad at 100 feet or above. This height should be increased to a minimum of 150 feet if the pad is on a loose surface, otherwise the ensuing dust cloud will impair the pilot's view and the jet exhaust could lift the pad. After a vertical landing, and where space permits, it is good practice to taxi clear of the point of landing to avoid the possibility of the tires becoming heated by the landing surface.

The following landing procedures have proven operationally effective during FBO execution in an effort to reduce FOD ingestion from damaged runways and/or simultaneous helicopter and jet aircraft use.

1. Execute an AUTO flaps, FNSL with nozzles at 50° for dry runway conditions. The resultant landing speed is approximately 140 to 150 KGS.

After touchdown:

2. Rudder pedals – center prior to engaging the nosewheel steering button.
3. Nozzles – maintain 50 degrees or increase to hover stop to decrease stopping distance.
4. Flaps – CRUISE as soon as practical.

Decelerating through 85 KGS:

5. Brakes – engage with slow steady pressure until pedals are fully depressed. See Figure 13-1 for additional information.

With braking action verified:

6. Trim – full nose down.
7. Nozzles – AFT as soon as practical. Ensure nozzles are aft prior to slowing to less than 60 KGS.
8. Brakes – maintain full application until safe taxi speed. Minimize the use of PNB but do not allow the aircraft to depart the prepared surface or run over the departure end gear because of a failure to apply PNB.

9.3.6 Night Operations

Night operations are permitted from a FOB only if adequate approach and landing environment lighting, either visible or IR lighting, or visual cues are available providing lateral and directional cues during all phases of approach to landing. Additionally, securing or dimming landing environment lighting may be effective to prevent NVG blooming and increase NVG acuity.

9.3.6.1 Takeoff

No changes in takeoff technique are needed for night operations. If a VTO is carried out with limited lighting cues, it is important that the attitude and heading needed for the transition are stabilized before the transition is started and the lighting cues are left behind.

9.3.6.2 Landing

When making a VL or RVL at night with restricted lighting cues, there is a tendency to establish the hover at lower heights than during daylight. This could lead to damage of the landing area and its surroundings. The use of the landing lights or specially designed ground light cues is mandatory. For vertical landings, do not descend below 150 feet AGL without approval from the LSS.

9.3.6.3 Visual Aides

There are no fixed rules for laying out visual aids. The LSS may use colored panels, barrels or lights to provide line–up and touchdown cues. At night aircraft will not descend below 150 feet AGL until cleared by the LSS. Sites for night operations shall have sufficient lighting to provide lateral and directional cues.

9.4 NIGHT VISION DEVICES

WARNING

- Maneuvering above 3g with the AN/AVS-9 in the up-locked (not in use but on helmet) position is prohibited.
- When g-loaded in the up-locked position, goggles have slammed down and departed from the helmet in both centrifuge testing and flight incidents.
- Increased risk of injury is probable when ejecting with NVDs on the helmet.

9.4.1 AV-8B

The use of AN/AVS-9 NVDs is authorized in the AV-8B.

9.4.2 TAV-8B

The use of AN/AVS-9 NVDs is authorized in TAV-8Bs with AFCs 416, 442, 451, and 455.

CHAPTER 10

Functional Checkflight Procedures

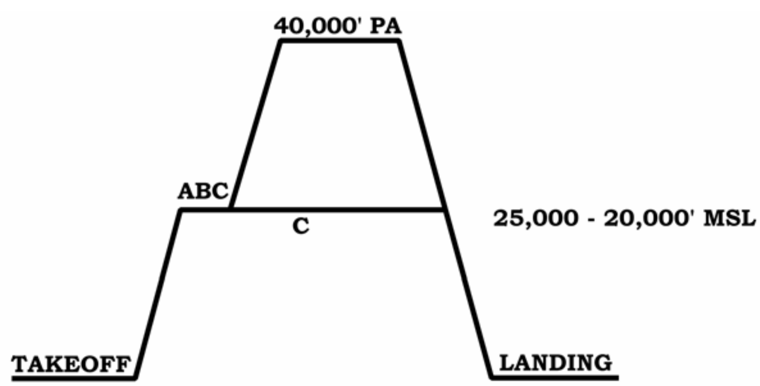
10.1 GENERAL PROCEDURES

Requirements for Functional Checkflight (FCF) are listed in COMNAVAIRFORINST 4790.2 Series and will be performed using the applicable Functional Checkflight Checklist. This section contains a detailed description of the checkflight requirements, sequenced in the order in which they will be performed. The checkflight personnel will familiarize themselves with these requirements prior to the flight. NATOPS procedures will apply during the entire checkflight. Only those pilots designated in writing by the Squadron Commanding Officer shall perform squadron checkflights. Checkflight procedures will be in accordance with the current edition of COMNAVAIRFORINST 4790.2. Minimum crew required for TAV-8B FCF will be one qualified FCF pilot.

Pilots who perform FCFs shall be qualified in accordance with OPNAVINST 3710.7 (NOTAL) and this manual. They shall be given a thorough briefing, coordinated by maintenance control, through the use of appropriate Quality Assurance (QA) work center personnel. This briefing shall describe the maintenance performed, the requirements for that particular flight, the expected results, and corrective emergency action to be taken if required.

At the discretion of the CO, FCFs may be flown in combination with operational flights, provided the operational portion is not conducted until the FCF requirements have been completed and entered on the FCF checklist.

Items contained in the FCF requirements are coded. This coding is intended to assist the FCF pilot in determining which items pertain to the various conditions requiring checkflights. Perform the flight profile and applicable checks in accordance with the following checkflight conditions:



F-0102

A. At the completion of aircraft rework and all calendar inspections.

B. After the installation of an engine, engine fuel control, or any FMU components (DECUs are excluded).

C. When fixed or movable flight surfaces, or flight control system components have been installed, reinstalled, adjusted or rerigged and improper adjustment or replacement of such components could cause an unsafe operating condition. This is a composite profile for a multitude of aircraft systems. Individual steps may be omitted based on the nature of the maintenance performed if that individual system is not affected (i.e., a nozzle trim check is not required for the replacement of the rudder and vice versa; a 450 knot trim check is not required for a nozzle trim adjustment).

Note

The presence of external stores may aggravate or invalidate some of the flight checks in the FCF profile.

A new Functional Checkflight Checklist, A1-AV8BB-NFM-700, need not be initiated in flights which are a continuation of the original FCF. Items not completed shall be noted on the card and a Maintenance Action Form shall be initiated by the pilot for each discrepancy. After appropriate maintenance is accomplished, another FCF can be flown using the open card, checking the remaining items. When the flight is satisfactorily completed the original card will be closed out.

At cooler ambient temperatures or when operating with the -408 engine, it may not be possible to operate the engine at JPTs high enough to conduct all the JPT limit checks defined in the FCF. If a JPT limit check cannot be completed because of low JPTs the check can be deleted. At warmer ambient temperatures it may not be possible to operate the engine at fan speeds high enough to conduct all the fan speed checks defined in the FCF (JPT limit had been reached). If a fan speed check cannot be completed because of JPT limiting, the check can be deleted.

PROFILE

10.2 PREFLIGHT

A B C

1. Exterior inspection — PERFORM.

   Perform an Exterior Inspection in accordance with paragraph 7.1.2 Particular attention shall be made to check for loose or improperly installed panels in those areas where maintenance has been performed.

A B C

2. Before entering cockpit checks — PERFORM.

   Perform the Before Entering Cockpit checks in accordance with paragraph 7.1.3.

A

3. Ensure ordnance SIM codes are loaded in stores management computer and BRU-36 bomb rack hooks are open. Ordnance SIM codes are loaded using the MPCD, ODU, and UFC with H4.0.

A B C

4. After entering cockpit checks — PERFORM.

   Perform the After Entering Cockpit checks in accordance with paragraph 7.1.4.

A B C

5. Auxiliary power unit — START (if translational start is planned).

   Place APU generator switch to ON. The APU advisory light comes on and the APU GEN light is out. If the APU GEN light comes on, place APU GEN switch to RESET then release. All aircraft electrical buses except the main ac, main dc, armament and master arm buses will be powered. On TAV-8B 163856 and up, AV-8B 163659 and up, the APU advisory light comes on only when the APU is ready to accept an electrical load.

A B C

6. DDI, HUD, COMM, and UFC — ON AND AS DESIRED.

A

7. UHF/VHF RSC — CHECKS.

   a. Perform functional check of COMM 1 and COMM 2.

   b. Select MAN on the ACNIP and select a preset channel. Perform a functional check on program 1 and program 2.

   c. KY 58 — CHECK.

A B C

8. Warning and caution lights — CHECK.

   Check warning and caution lights for proper operation.

10.3 STARTING ENGINE

A B C

1. DECS power — CHECK.

CAUTION

Failure to enable DECS prior to engine start could result in a rapid uncommanded rpm increase.

PROFILE

a. DECS enable switch — CHECK OFF.

b. EFC warning, EFC caution, and JPTL warning lights — CHECK ON.

c. DECS enable switch — ON.

d. EFC warning, EFC caution, and JPTL warning lights — CHECK OFF.

e. Fuel shutoff handle — ON.

f. EFC switch — CYCLE.

Check EFC caution light comes ON momentarily and then goes out.

g. EFC switch — POS 2.

A B C 2. Fuel shutoff handle — CHECK.

Grasp handle and attempt to pull up without pressing button. If handle moves out of the located position attempt to lock again. If handle fails to lock, do not start aircraft.

A B C 3. Parking brake — ON.

A B C 4. Throttle — OFF.

A B C 5. Nozzles — AFT TO 10°.

If nozzles are dropped and nozzle handle is not aft to 10°, have ground crewman lift nozzles to 0° to 10°, and simultaneously push the nozzle handle to corresponding position before engine start. If the nozzles will not stay up on their own, hold the handle during the start until pressure is relieved from the handle.

A B C 6. Engine start switch — ENG ST.

On a direct engine start, the GTS normally lights off in about five seconds, after which the engine begins to rotate.

On a translation start (APU started first), there is a ten second deceleration of the APU before the GTS engages to start the engine.

A B C 7. Throttle — IDLE (after indication of rpm).

a. Maximum JPT during engine start is 475 °C.

b. Acceleration time to 20 percent rpm — 35 seconds maximum after selecting IDLE.

CAUTION

Under hot engine/fuel conditions, ground starts may exhibit slow acceleration to idle rpm/ stagnation and rapid JPT rise toward the starting limit of 475 °C.

PROFILE

A B C

8. Engine start switch — OFF.

BY 15 percent RPM.

If the engine start switch does not disengage automatically by 15 percent rpm, manually place switch OFF to prevent damage to the GTS.

A B

9. At idle check the following:

a. RPM — CHECK.

(1) 25.8 to 26.2 percent (–406 engine).

(2) 28.4 to 29.0 percent (–408 engine).

(3) Idle rpm should increase 1 percent rpm per 1,000 feet of pressure altitude starting at 1,500 feet pressure altitude.

b. JPT — CHECK.

(1) 535 °C maximum (–406 engine).

(2) 545 °C maximum (–408 engine).

c. Inlet guide vane angle — 31° to 39°.

With engine at idle, check that the IGV display on the DDI is 31° to 39°.

d. Fuel flow — 18 TO 24 PPM.

e. Sortie JPT — RESET.

A B C

10. HYD 1 AND HYD 2 pressure — 3,000 ±200 psi.

A B C

11. Brake accumulator pressure — 3,000 ±200 psi.

A B C

12. Brake pressure — CHECK.

With the brake pedals fully pressed, check that brake pressure is 2,700 psi minimum.

A B C

13. DDI — MSC BIT.

a. On BIT display — PRESS MSC.

(1) Verify DC backup displays are present in the HUD and MPCDs.

(2) Verify normal displays are restored after approximately 30 seconds.

b. Record all failures.

A B

14. Boost pumps — CHECK.

a. Left and right pump switches — OFF.

Check pump lights on.

PROFILE

b. Left and right pump switches — DC.

(1) Check pump lights off.

(2) Check voltmeter stable at approximately 27 volts.

c. DC test switch — SET TO MAIN.

(1) Check STBY TR caution illuminates at approximately 24.75 volts.

(2) Check voltmeter returns above 25.5 volts.

d. DC test switch — SET TO STBY.

(1) Check voltmeter drops to approximately 25.5 volts.

(2) Left and right pump switches — NORM.

Check for a 1 volt increase.

e. DC test switch — SET TO CENTER POSITION.

A B C — 15. Warning and caution lights — TEST.

A — 16. Landing gear position indicators — GREEN.

10.4 BEFORE TAXIING

Night Attack Aircraft:

A B C — 1. FLIR switch — FLIR.

Radar Aircraft:

A B C — 2. LST/FLIR switch — LST/FLIR.

A — 3. Radar — CHECK.

Place radar control switch to OPR. TEST and test number will be displayed in upper left corner of DDI and (after approximately 1 minute) a time-out cross is displayed in the lower left corner of the DDI. A Maltese cross replaces the time-out cross (after approximately 3 minutes) indicating that warmup is completed.

All Aircraft:

A B — 4. JPT limiters switch — CHECK.

a. JPT limiters switch — OFF.

Note rpm rise of 3.3 to 4.3 percent for the -406 engine and 6.0 to 7.0 percent for the -408 engine.

b. JPTL warning light — CHECK ON.

(On AV-8B 163519 and up, TAV-8B 163856 and up, voice — LIMITER OFF, LIMITER OFF.)

PROFILE

c. EFC switch — SET TO POS 1.

Check EFC caution light comes on momentarily and then goes off. (On TAV-8B 163856 and up, AV-8B 163519 and up, voice — CAUTION, CAUTION.)

d. JPT limiters switch — ON.

Note rpm drop 3.3 to 4.3 percent for the -406 engine and 6.0 to 7.0 percent for the -408 engine.

e. JPTL warning light — CHECK OFF.

f. EFC switch — SET TO POS 2.

A B

5. Manual fuel — CHECK, THEN OFF.

Place manual fuel switch ON and check MFS caution light on. (On AV-8B 163519 and up, TAV-8B 163856 and up, voice - MANUAL FUEL, MANUAL FUEL.) Maintain idle limits. Place water switch to TO and note steady rpm. Place water switch OFF, then place manual fuel switch OFF. Check MFS light off.

A B C

6. Water switch — CHECK, THEN OFF.

Place water switch to TO and note rpm rise of 3.3 to 4.3 percent for the -406 engine, and 6.0 to 7.0 percent for -408 engine. Place switch OFF and check rpm returns to IDLE. Repeat in LAND.

A B

7. EVICS — CHECK.

a. Throttle — ADJUST TO 55 PERCENT CORRECTED HP COMPRESSOR SPEED (ENGINE PAGE ON THE DDI/MCPD) AND RETURN TO IDLE.

Note

- 55 percent corrected HP compressor speed is required for EVICS to complete its diagnostic preflight checkout.
- For TAV-8B aircraft with F402-RR-408B engine installed and OMNI 7.1 OFP, after completion of pilot checks and EVICS diagnostic checkout (above), aircrew shall have a qualified T/AV-8B Plane Captain check EVICS Dolls Eye on the external fuel panel for failure indications. If a failure is indicated by the Dolls Eye being tripped, flight is prohibited. If a qualified T/AV-8B Plane Captain is not available during a cross country flight, the pilot shall check the EVICS Dolls Eye in the ground refuel panel prior to each engine start. If a failure is indicated by the Dolls Eye being tripped, flight is prohibited.

PROFILE

Note

- For AV-8B aircraft with F402-RR-408B engine installed, after completion of pilot checks and EVICS diagnostic checkout (above), aircrew shall check the readings on the IGV bit on BIT 1 page. An IGV 1 code indicates a failure of the EVICS. If IGV 1 is displayed flight is prohibited.
- Immediately report indication of failure to AV8BFST.3, (252) 464-7335, DSN 451-7335 for evaluation and further instruction.

A B

8. Fuel proportioner — CHECK, THEN ON.

   a. Turn FUEL PROP switch OFF and note PROP caution light on.

   b. Turn FUEL PROP switch ON and note PROP caution light off.

TAV-8B Aircraft:

   c. FUEL PROP switch — DL.

   Check R FEED warning, PROP caution, and R FEED advisory lights off.

   d. FUEL PROP switch — RT.

   Check R FEED advisory light on, check R FEED warning light on after short delay.

   e. FUEL PROP switch — AUTO.

   Check R FEED warning, PROP caution, and R FEED advisory lights off.

All Aircraft:

A C

9. Trim — CHECK, THEN SET.

   a. Trim rudder full left and right. Check rudder and indicator. Have ground crew confirm travel. Trim to neutral.

   b. Trim aileron full left and right. Check aileron and indicator. Have ground crew confirm travel. Trim to neutral.

   c. Trim stabilator full up and down. Check stabilator indicator for travel (↓ 7-8° to ↑ 4°) on the engine display panel. Trim to minimum 2° ND.

TAV-8B Aircraft After AFC-391:

A B C

10. Aft Seat High Gain Override — CHECK.

   a. ANTISKID switch — NWS.

   b. Front C/P NWS/Undesignate switch — PRESS AND HOLD (NWS HI in HUD).

PROFILE

c. Rear C/P NWS/Undesignate switch — PRESS.

(1) NWS HI in HUD changes to NWS.

(2) Both C/P's NWS/Undesignate switch — RELEASE.

d. ANTISKID switch — ON.

All Aircraft:

A 11. Standby attitude indicator — ERECT.

A 12. Altimeter — CHECK.

Set current barometric pressure and compare to field elevation. HUD and standby altimeter should read within 75 feet of field elevation.

A 13. On-board oxygen system BIT — CHECK.

Press monitor plunger on monitor and check that OXY light comes on. Release plunger and check OXY light out within 1 minute.

A C 14. Flaps emergency retract — CHECK.

a. Flaps — ON, RESET (lights out).

b. Flaps — STOL.

c. Flaps — OFF, THEN ON.

d. Have ground crew confirm flaps retract evenly to 0°.

A C 15. Flaps IBIT — PERFORM IN AUTO.

a. STOL flaps — SELECT.

Verify STOL flaps are selected by STO light. Verify aileron droop by DROOP light and by moving stick full left and right, checking aileron position (DROOP light goes out at full aileron deflection).

b. Flaps — CRUISE.

A C 16. Flight controls — CHECK.

a. Rudder pedals — FULL LEFT AND RIGHT.

Check proper rudder direction.

b. Longitudinal stick — FULL FORWARD AND AFT.

Check proper stabilator direction and ↑ 10° and ↓ 11° on the engine display panel.

PROFILE

c. Hold RPS/YAW switch in TEST.

(1) Move lateral stick — FULL LEFT (check proper aileron direction and rudder moves left).

(2) Move lateral stick — FULL RIGHT (check proper aileron direction and rudder moves right).

A C 17. SAAHS BIT — INITIATE.

a. On BIT display — PRESS SAAHS.

(1) TEST is displayed next to SAAHS legend.

(2) AFC, PITCH, ROLL and YAW caution lights flash until MASTER CAUTION is pressed.

(3) 40 seconds after BIT initiate, stick shakes in pitch axis.

b. BIT page — CHECK.

If IGV 1 is present, abort mission.

c. Plane Captain — CHECK THE DOLLS EYES IN THE AIRCRAFT REFUELING PANEL (DOOR 22L).

If Dolls Eyes are popped, abort mission.

d. Record all failures.

e. All lights go out after successful completion of BIT.

A 18. DDI — AUTO BIT.

a. On BIT display — PRESS AUTO.

(1) Tones sound for 6 seconds.

(On TAV-8B 163856 and up, AV-8B 163519 and up, voice - ACNIP GO, ACNIP GO or ACNIP FAIL, ACNIP FAIL.)

(2) TEST is displayed next to equipment that is on.

(3) Failure codes (if any) are displayed next to failed equipment.

Note

On radar and night attack aircraft, the FLIR will continue to cool down during AUTO BIT and will begin initiated BIT when it has completed the cool down sequence.

PROFILE

Note

On night attack aircraft, the display computer will cause the HUD to flicker and may display an incomplete HUD display head-down on the right DDI. On radar aircraft, the HUD display will be blanked.

b. Record all failures.

A C — 19. Paddle switch — PRESS.

Check all three axes disengage, lights on.

A — 20. LIDS switch — CYCLE.

Ensure LIDS caution light on with switch in RET position. Ground crewman should verify LIDS fence fully retracts and extends.

A — 21. Air refueling probe — CYCLE (if installed).

A — 22. Exterior lights — CHECK.

A — 23. Display Computer — CHECK.

a. Set DP switch to PRIM then ALTER, record any failure.

b. Set DP switch to AUTO.

A — 24. Inertial navigation system — CHECK.

a. NAV selected.

b. OK displayed.

c. Select NAV waypoints — VERIFY.

A B C — 25. Nozzles — FUNCTIONAL CHECK, STOL flaps schedule — CHECK.

Operation of the nozzle system shall be checked at idle rpm in a FOD free area using a prebriefed ground crewman. Stiffness should be checked and if present, rpm will be increased to 36 to 40 percent , the nozzles cycled, and normal feel subsequently verified at a maximum of 29 percent rpm. Nozzle accuracy shall also be checked by selecting hover stop. Indicated and actual nozzle position (verified by ground crewman) should be within 81° to 83°. If actual nozzle position accuracy is not within this tolerance, nozzle position accuracy should be checked at 50 percent rpm. If actual nozzle position at 50 percent rpm is not 81° to 83°, the cause should be investigated before flight. Check friction knob secured with shear wire. Move nozzles aft. Ground crewmen should verify all nozzles are 0° nozzles angle (±1°).

PROFILE

CAUTION

As little as 2° negative nozzle angle on the cold nozzle can cause a severe nose down pitch during nozzle out. If any nozzle angle is not within limits, the cause should be investigated prior to flight.

A 26. VRS — CHECK.

Run in HUD and DDI/MPCD with HUD display on DDI. Check both DDIs on radar and night attack aircraft.

A 27. DMT/FLIR — BORESIGHT.

10.5 DURING TAXI

A C 1. Antiskid — CHECK.

While holding constant brake pressure, press and release the ANTISKID test switch, check that brake pressure immediately drops to below 110 psi then builds up to 2,800 psi (within 12 seconds).

A C 2. Nosewheel steering — CHECK.

Engage nosewheel steering and move rudder pedals left and right. (Afloat, ensure Launch Officer checks nosewheel centered prior to launch).

Before AFC-391:

A C 3. Nosewheel caster (ashore) — CHECK .

Release nosewheel steering while in a turn and ensure that it does not return to center at maximum rate.

All Aircraft:

A C 4. Rudder shaker — CHECK.

With nosewheel steering engaged, select RPS/YAW TEST and alternately deflect the rudder pedals. Rearward rudder pedal should begin oscillation when HUD sideforce symbol touches left or right limit line.

A 5. TACAN — FUNCTIONAL CHECK USING FIELD PLACARD.

a. The bearing pointer must center within ±1° of known course to station. Erratic bearing pointer movement is unacceptable.

b. Range counter accuracy is ±0.2 miles plus 0.1 percent of total distance from station; however, reading and flying accuracy will permit an accuracy check of no better than ±1 mile.

c. Check steering symbol on HUD.

PROFILE

10.6 BEFORE TAKEOFF

A B

1. Perform engine check with nozzles aft.

   a. Perform acceleration check.

      (1) For the –406 engine, accelerate from 27 to 55 percent rpm. The engine shall reach 55 percent rpm within 3.7 to 4.3 seconds (Figure 7-3).

      (2) For the –408 engines, accelerate from 35 to 60 percent rpm. The engine shall reach 60 percent rpm within 2.4 to 3.1 seconds (Figure 7-2).

   b. With the engine stabilized at 55 percent rpm (–406 engine) or 60 percent rpm (–408 engine), check inlet guide vane angle. Check duct pressure with nozzles aft (0 to 3 psi) and at 50°.

A B

2. APU — START.

   Start the APU before takeoff so the automatic shutdown feature can be checked in flight.

10.7 HOVER CHECKS AFLOAT

A B

1. Perform VTO and hover checks at 1,500 pounds (fuel low level lights on). See Hovers from a VTO, paragraph 10.16.

Note

Ensure minimum wind over the deck to lessen bleed usage.

10.8 TAKEOFF

A B

1. Perform a conventional takeoff (ashore) or STO (afloat). Ensure CMBT deselected. Check the following:

   a. RPM:

      (1) 103.0 percent maximum (–406 engine).

      (2) 113.5 percent maximum (–408 engine).

   b. 15 SEC light at:

      (1) 684 °C JPT (Night Attack aircraft with –406 engine and TAV–8B 164113 and up).

      (2) 687 °C JPT (Day Attack aircraft with –406 engine and TAV–8B 162747 to 163861).

      (3) 765 °C JPT (–408 engine).

   c. JPT:

      (1) 703 ±5 °C maximum (–406 engine).

      (2) 780 ±5 °C maximum (–408 engine).

PROFILE

d. JPT cutback:

Check may require less than full throttle.

(1) 625 ±5 °C (–406 engine).

(2) 710 ±5 °C (–408 engine).

e. RPM cutback:

(1) 98.4 to 99 percent (–406 engine).

(2) 108.8 to 109.2 percent (–408 engine).

f. APU automatic shutdown — 325 KNOTS (accelerate and check that the APU automatically shuts down as airspeed increases through 275 knots or 325 knots as applicable).

10.9 CLIMB

A B C

1. Aileron high speed stops — CHECK ENGAGED.

   Check stops engaged above 0.4 Mach.

A

2. Perform a functional check of the standby instruments. Compare with HUD indications and note discrepancies.

   a. Angle–of–attack indicator.

   b. Altimeter.

   c. Attitude indicator.

   d. Vertical velocity indicator.

   e. Airspeed indicator.

   f. Turn and slip indicator.

   g. HSI (TAV–8B, AV–8B 161573 to 163852).

   h. Clock and second hand.

A B

3. Full throttle climb — PERFORM.

   Perform a full throttle climb to 40,000 feet at 300 knots/0.80 IMN and record rpm and JPT when passing through 10,000, 30,000, and 40,000 feet. Monitor JPT and rpm for corrected rpm cutback.

10.10 40,000 FEET

A

1. Cabin pressure — CHECK.

   At 40,000 feet the nominal cabin pressure is 16,800 feet. The minimum pressure is 15,000 and maximum pressure is 17,200 feet.

PROFILE

A B

2. Max power pushover — PERFORM.

At 40,000 feet and 0.8 Mach perform a maximum power pushover to 0 g.

A B

3. Windup turn — PERFORM.

At 40,000 feet and 200 knots, perform a maximum power windup to:

a. 15° AOA (–406 engine).

b. 19° AOA (–408 engine).

Observe rpm cutback during windup turn.

A B

4. Throttle slam — PERFORM.

At 40,000 feet, 200 knots and 15° AOA perform a slow (5 seconds) throttle slam from IDLE to MAX.

A B

5. Hot throttle reslam — PERFORM.

At 40,000 feet and 200 knots, run engine at full throttle for at least 1 minute. At 15° AOA , reduce throttle to IDLE for 2 seconds, then smoothly advance throttle to MAX in less than 5 seconds.

10.11 25,000 TO 20,000 FEET

A C

1. SAAHS/Departure Resistance — CHECK.

a. Maneuvering tone — CHECK.

At 25,000 feet MSL and 240 knots indicated airspeed (KIAS) start a slightly nose low turn and go to full power. Pull to 21.5° AOA, ensuring above 225 KIAS and 0.45 Mach. Check the maneuvering tone present and the aircraft stable with no lateral stick required.

b. Roll coordination — CHECK.

With the condition established and the maneuvering tone still present, apply aileron to the high speed stop in the opposite direction of the turn. The aircraft should roll slowly in the proper direction with little adverse yaw and no reversal of the roll rate.

WARNING

Exceeding the high speed stop is likely to cause a departure from controlled flight.

10.12 17,000 TO 10,000 FEET

A

1. Fuel dump BINGO — CHECK.

Set BINGO fuel below existing fuel quantity, but above 2,800 pounds, and place fuel dump switches to DUMP. Check that fuel is dumped from each side and dump switches return to NORM when BINGO caution light comes on. (On TAV–8B 163856 and up, AV–8B 163519 and up, voice — BINGO, BINGO).

PROFILE

A

2. IFF — FUNCTIONAL CHECK.

Functional check of IFF to include mode C and emergency function.

Radar Aircraft:

A

3. Radar — FUNCTIONAL CHECK ALL MODES.

All Aircraft:

A

4. Windshield defog system — CHECK.

Functional check the windshield defog system in DEFOG and MAX DEFOG.

A B

5. APU — CHECK.

APU ON, check green light, APU OFF.

A C

6. AFC — CHECK.

a. AFC — Select AFC ON and check that AFC captures pitch attitude, roll attitude and heading hold.

b. ALT HOLD — With AFC ON, select ALT HOLD. Check that AFC and ALT HOLD disengage by clicking the paddle switch.

A C

7. AUTO flap — CHECK AND RECORD HEADS DOWN FLAP ANGLE. At 200 ±3 KCAS, <0.50 IMN, Set 10° AOA. Verify flap angle 15° ±1°.

After AFC-391:

A B

8. NWS steering mode — CHECK (200 knots dirty, nozzles as required).

a. ANTISKID Switch — NWS.

Slowly advance throttle from below 65 percent while pressing the NWS steering button. NWS HI changes to NWS between:

72 to 83 percent (-406 engine).
83 to 89 percent (-408 engine).

All Aircraft:

A C

9. SAS — CHECK (200 knots dirty, AUTO flaps).

a. Pitch SAS ON — Lower nozzles and note stabilator position indicator. The stabilator trim position indicator should drift downward (stabilator leading edge up). This is a positive check that the pitch SAS is countering the nose up pitch caused by nozzle deflection. SAS OFF, hand off stick, lower nozzles and note pitch trim indicator does not move.

b. Roll SAS ON — Rap the control stick and check for normal damping. SAS OFF, Rap the control stick and note no damping. Turn roll SAS ON.

c. Yaw SAS ON — Pulse the rudder and check for normal damping. Enter a rudder free turn, select yaw SAS OFF and note sideslip symbol in HUD deflects. Turn yaw SAS ON and note sideslip symbol returns to center. SAS OFF, Pulse rudder and note no damping. Turn yaw SAS ON.

PROFILE

A C

10. Rudder pedal shaker — CHECK (below 165 knots dirty, AUTO flaps).

Set 10° nozzle, induce side slips left and right and check for proper rudder pedal shaker operation.

A B C

11. Nozzle trim — CHECK SAS OFF (150 knots dirty, AUTO flaps).

Set engine at 90 percent rpm (–406 engine) or 100 percent rpm (–408 engine), and maintain 150 knots. Ensure aircraft is in trim. Select hover stop (note 81° to 83° nozzle angle) and check that directional trim change does not exceed one ball width. Maintain 90 percent rpm (–406) or 100 percent rpm (–408) as applicable and 150 knots and select braking stop (note 95° to 98° nozzle angle). Check that trim change is less than one ball width.

A C

12. HUD sideslip — CHECK (120 knots, dirty, AUTO flaps).

The HUD sideslip symbol shall be within 1/4 width when the exterior sideslip vane is centered.

A B C

13. Inverted flight — PERFORM (clean).

At 85 percent rpm, invert the aircraft for a maximum of 15 seconds (less than zero g). Check fuel pump caution lights do not illuminate and that oil light comes on. Check for FOD in the cockpit. Check that flight controls are not restricted during inverted flight.

10.13 5,000 FEET

A C

1. Trim — CHECK.

Establish 450 knots, SAS ON, check aileron and rudder trim. Trim for hands off flight must be 0 trim ±10 percent for aileron and 0 trim ±20 percent for rudder. If lateral and directional trim requirements exceed the values above, note trim position, turn SAS OFF and note trim position again for future maintenance corrective action. See Figure 10-1 for trim indication.

A C

2. Q–feel — CHECK.

Perform a 4 g turn. Select Q FEEL switch OFF and ON. Note fore and aft stick movement.

A B

3. G–suit — CHECK.

Check normal operation of the g–suit.

A B

4. Combat thrust — CHECK.

   a. Press CMBT switch/light — SEL LIGHT ON.

   b. Throttle — FULL.

   c. CMBT light — ON.

      (1) 630 ±5 °C maximum (–406 engine).

      (2) 715 ±5 °C maximum (–408 engine).

   d. RPM — CHECK.

      (1) 98.4 to 99 percent (–406 engine).

      (2) 110.8 to 111.2 percent (–408 engine).

PROFILE

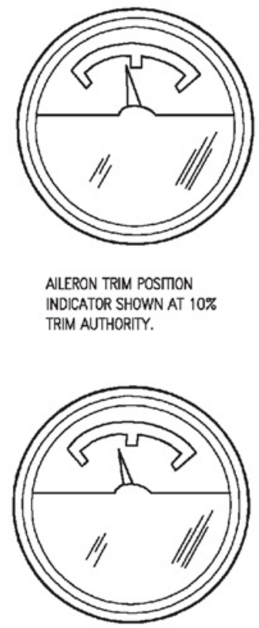


Figure 10-1. Trim Position Indicators

e. JPT — CHECK.

(1) 665 ±5 °C (-406 engine).

(2) 750 ±5 °C (-408 engine).

f. Nozzles — CHECK CREEP.

g. Press CMBT switch/light — SEL LIGHT AND CMBT LIGHT OUT.

A 5. HUD displays — CHECK.

Check the HUD display in A/G, A/A, NAV and VSTOL modes.

A 6. Weapon systems — FUNCTIONAL CHECK.

Check proper symbology and functioning of all sensor and delivery modes.

A B 7. IGV check — PERFORM.

Check the IGV angle against the provided charts with the engine fans speed set to 65 percent (-406 engine/Figure 7-3)/80 percent (-408engine/Figure 7-2). IGV angles between the maximum and minimum operating lines are normal as per the A1-AV8BB-NFM-700. Operation outside the minimum maximum lines should be an abort and require further investigation via a high power ground run.

PROFILE

10.14 3,000 TO 1,000 FEET

A

1. Low altitude warning — CHECK.

   Check operation of the LAWS light and LAWS warning tone (On TAV-8B 163856 and up, AV-8B 163519 and up, voice — ALTITUDE, ALTITUDE.)

A B

2. Water injection (200 knots, nozzles as required, altitude hold as desired) — CHECK.

   a. Set 88 percent rpm and place water switch to TO — Slowly advance throttle — CHECK WATER FLOW LIGHT ON AND OFF AT:

      (1) 94 to 96 percent rpm (-406 engine).

      (2) 103 to 105 percent (-408 engine).

   b. Set 97 percent rpm (-406 engine) or 106 percent rpm (-408 engine) — RECORD STABILIZED JPT.

   c. Water switch OFF, reset rpm to 97 percent (-406 engine) or 106 percent (-408 engine) — RECORD STABILIZED JPT.

      (1) Should rise at least 25 °C (-406 engine).

      (2) Should rise at least 15 °C (-408 engine).

   d. Water switch LDG.

      Water flow at:

      (1) 684 °C JPT (Night Attack aircraft with -406 engine and TAV-8B 164113 and up).

      (2) 687 °C JPT (Day Attack aircraft with -406 engine and TAV-8B 162747 to 163861).

      (3) 765 °C JPT (-408 engine).

   e. 15 SEC light — CHECK.

      (1) 702 °C JPT (Night Attack aircraft with -406 engine and TAV-8B 164113 and up).

      (2) 705 °C JPT (Day Attack aircraft with -406 engine and TAV-8B 162747 to 163861).

      (3) 780 °C JPT (-408 engine).

   f. Maximum rpm — CHECK.

      (1) 107 percent (-406 engine).

      (2) 120.2 percent (-408 engine).

PROFILE

g. Maximum stabilized JPT — CHECK.

(1) 727 ±5 °C maximum (-406 engine).

(2) 800 ±5 °C maximum (-408 engine).

A — 3. Landing gear warning system — CHECK.

With airspeed below 160 knots, altitude below 6,000 feet, landing gear up and rate of descent greater than 250 feet per minute, check the landing gear handle light flashes and warning tone sounds (On TAV-8B 163856 and up, AV-8B 163519 and up, voice — LANDING GEAR, LANDING GEAR.)

10.15 LANDING

A C — 1. Angle-of-Attack — CHECK (Record Gross Weight and AOA).

With GEAR down, AUTO flaps, NOZZLES aft, level flight and 10° AOA, airspeed should be 154 KCAS at 18,500 pounds gross weight. (Add ±1 KCAS for each ±250 pounds.) Verify recorded airspeed at 10° AOA is ±3 KCAS of the above calculated value.

A C — 2. Aileron high speed stops — CHECK DISENGAGED.

With gear down and below 0.4 Mach, check high speed stops disengaged.

Ashore:

A C — 3. Check for normal handling characteristics during the slow landing paying particular attention to the reaction control.

A — 4. Check function of antiskid system during rollout.

A C — 5. Perform STO.

Check for normal handling characteristics.

A C — 6. Check for normal handling characteristics during deceleration to a hover. Select water, ensure H_2O light comes on at 100 ±20 pounds (On TAV-8B 163856 and up, AV-8B 163519 and up, voice — WATER, WATER.)

Afloat:

A C — 7. Check handling characteristics during slow landing approach/waveoff.

A C — 8. Perform vertical landing.

Select water - ensure H_20 light comes on at 100 ±20 pounds (On TAV-8B 163856 and up, AV-8B 163519 and up, voice — WATER, WATER.)

PROFILE

10.16 HOVERS FROM A VTO

If flight controls or engine adjustments have been made, do not attempt a VTO or performance hover (PHOV) unless normal operation of the flight control system, nozzle system, DDI stabilator position, and engine governor/limiter systems have been verified. On hover checks that are not prescribed by A, B, or C card profile, the initial hover should be entered from a decelerating transition to ensure proper aircraft operation.

A B

1. Hover — PERFORM.

Check for normal hovering characteristics and allow the DDI/MPCD PHOV page to record performance Figures (two acceptable dry hovers minimum).

The technique for the hover performance check is as follows: prior to each hover request the ALTM setting and the accurate OAT from metro due to the fact that one degree of ambient temperature error can skew computed thrust by 100 pounds. Do not use ATIS. If using the A/C mission computer to determine a performance hover the correct BAW and current water weight (with C1+ and OMNI 7.1 only) must be entered on the VREST page via the ODU before the hover. Hovers should be performed dry. Water introduces a myriad of variables that current performance calculations are not capable of accounting for. From a VTO the aircraft should be brought to a steady hover at 100 ±10 feet and stabilized until the PHOV tape times out (10 seconds). The aircraft should be headed directly into the wind and hovered with minimum use of reaction controls. This will require the pilot to allow the aircraft to drift with the wind, rather than remain stationary over the pad. Hover checks should not be conducted with winds in excess of 10 knots. Accurate performance checks may not be possible with sustained winds above 10 knots, or under gusty conditions. Note the stabilized idle JPT prior to the initial performance hover and retarget that idle JPT prior to each additional hover. Cooling can be accelerated by repositioning the aircraft on the pad. After the PHOV tape times out, record the following parameters from the DDI PHOV page: stabilator position, RPM, JPT, fuel weight, RALT, STPR, OAT, and ALTM. Accurate performance hovers may not be possible aboard ship due to the lack of visual references and the inability to obtain a stable hover.

A

2. Low fuel level lights — CHECK.
   a. Fuel quantity selector switch — INT.
   b. Lights come on steady at 750 ±250 pounds of fuel remaining.
   c. Fuel quantity selector switch — FEED.
   d. Lights begin flashing at 250 ±100 pounds of fuel remaining. (On TAV-8B 163856 and up, AV-8B 163519 and up, voice — FUEL LOW LEFT, FUEL LOW LEFT or FUEL LOW RIGHT, FUEL LOW RIGHT.)

10.17 AFTER LANDING

A B

1. Auxiliary power unit — START.

A B

2. Water switch — DUMP, THEN OFF.

Ensure water dumps and is then secured.

A

3. After landing checks — COMPLETE.

Perform After Landing checks in accordance with paragraph 7.7.1.

PROFILE	
A	4. Probe heat — PRB HT.
	Ensure probe heat switch automatically resets to the AUTO position after engine shutdown.

10.18 ENGINE SHUTDOWN

A B	1. Engine RPM switch — HI.
A B	2. Throttle — OFF.
	a. Decelerate from 50 percent to 5 percent — 20 SECONDS MINIMUM.
A	3. After engine shutdown, check for a minimum of 25 brake applications.
A	4. Check OXY caution light.
A	5. Check AOA and pitot heaters for proper operation.

10.19 REAR COCKPIT CHECKFLIGHT REQUIREMENTS

10.19.1 Preflight

A	1. Before entering rear cockpit checks — PERFORM.
	Perform the Before Entering Rear Cockpit checks in accordance with paragraph 7.1.8.
A	2. After entering rear cockpit checks — PERFORM.
	Perform the After Entering Rear Cockpit checks in accordance with paragraph 7.1.9.
A	3. Warning and Caution lights — CHECK.
	Check caution and warning lights for proper operation.
A	4. Throttle/Limiter, Trip/Ignitors — CHECK.
	Check throttle movement, including override of JPTL switch then reset switch. Depress airstart button to check ignitor plugs. Place MFS on and check ignitor plugs then MFS off.
A	5. Auxiliary Power Unit — MONITOR START.
	The APU light comes on and the APU GEN light goes off.

10.19.2 Starting Engine

(Monitor JPT and RPM during start and compare with front cockpit).

A	1. At idle check the following:
	a. RPM — CHECK.
	(1) 25.8 to 26.2 percent (-406 engine).
	(2) 28.4 to 29.0 percent (-408 engine).

PROFILE

b. JPT — CHECK.

(1) 535 °C maximum (–406 engine).

(2) 545 °C maximum (–408 engine).

c. IGV 31° to 39°.

d. Fuel flow — CHECK.

(1) 18 to 24 PPM.

A 2. Landing gear position indicators — GREEN.

A 3. Select approach light from rear cockpit — CHECK.

Have ground personnel check light illumination.

10.19.3 Before Taxiing

A 1. Manual Fuel — CHECK, THEN OFF.

Place MAN FUEL switch ON and check MFS caution light on. Maintain idle limit. Place water switch to TO and note steady rpm. Place water switch OFF, then place MAN FUEL switch OFF. Check MFS light off.

A 2. Water switch — CHECK, THEN FWD.

Place water switch to TO and note rpm rise 3.3 to 4.3 percent (–406 engine) or 6.0 to 7.0 percent (–408 engine). Place water switch OFF and check idle.

A 3. Fuel proportioner — CHECK, THEN FWD.

Set FUEL PROP switch OFF and note PROP caution light on. Set FUEL PROP switch FWD and note PROP caution light off.

A 4. Trim — CHECK OPERATION IN ALL THREE AXIS, THEN SET.

A 5. Standby Attitude Indicator — ERECT.

A 6. Altimeter — SET.

Set barometric pressure. Check ±75 feet of field elevation.

A 7. DDI cue function — CHECK.

10.19.4 During Taxi

A 1. Antiskid — CHECK.

Check that the SKID light illuminates both cockpits when the ANTISKID switch is OFF.

A 2. STO stop indicator — CHECK.

Set STO stop in front cockpit then check STO stop indicator in rear cockpit accuracy.

PROFILE

10.19.5 Takeoff (Ashore)

A

1. Monitor a conventional takeoff. Check the following:
   a. RPM — CHECK.
      (1) 103.0 percent maximum (–406 engine).
      (2) 113.5 percent maximum (–408 engine).
   b. 15 SEC light — CHECK.
      (1) 684 °C JPT (TAV-8B 164113 and with –406 engine).
      (2) 687 °C JPT (TAV-8B 162747 to 163861, with –406 engine).
      (3) 765 °C JPT (–408 engine).
   c. JPT — CHECK.
      (1) 703 ±5 °C maximum (–406 engine).
      (2) 780 ±5 °C maximum (–408 engine).
   d. JPT cutback — CHECK.
      (1) 625 ±5 °C (–406 engine).
      (2) 710 ±5 °C (–408 engine).
   e. RPM cutback — CHECK.
      (1) 98.4 to 99 percent (–406 engine).
      (2) 108.8 to 109.2 percent (–408 engine).

10.19.6 Climb

A

1. Perform a functional check of the standby instruments and verify both cockpits read the same:
   a. AOA indicator.
   b. Altimeter.
   c. Attitude indicator.
   d. Vertical velocity indicator.
   e. Airspeed indicator.
   f. Turn and slip indicator.

PROFILE

10.19.7 17,000 to 10,000 Feet

A 1. Ensure AFC can be disengaged from the rear cockpit.

A 2. Inverted flight — CHECK COCKPIT FOR FOD.

10.19.8 Landing

A 1. AOA — CHECK.

Check airspeed within ±4 knots of front cockpit.

A 2. Braking Stop — CHECK.

Ensure Braking Stop can be selected form rear cockpit.

A 3. Hover Stop — CHECK.

Select Hover Stop from rear cockpit and check position, 81° to 83°.

10.19.9 Engine Shutdown

A 1. Secure engine from rear cockpit.

10.20 PERFORMANCE HOVER CHECKS

The performance hover (PHOV) is a precision maneuver meant to measure the condition of the total aircraft/engine system. To obtain accurate information, consistency and standardization of PHOV procedures is paramount. The data recorded during the (PHOV) is used to find the relative hover performance (RHOV) and relative JPT (RJPT) using either Figures 10-2 through 10-6 or the Boeing AV-8B Hover Performance Software. These relations shall be available to the pilot for computation of actual V/STOL performance capability.

The optimum configuration for performance hovers includes the centerline, inboard, intermediate, and outboard pylons (without stores), port and starboard strakes (or gun with ammunition pack), and the inflight refueling probe. LAU-7 launchers on the outboard pylons are acceptable. No additional stores should be on the aircraft due to CG effects and associated bleed requirements.

Before the Engine RPM Required to Hover and JPT in Hover chart may be used, it is necessary to correct the barometric pressure recorded in A1-AV8BB-NFM-700 to hover altitude and determine the actual weight of the aircraft during the hover.

To correct the recorded (ALTM) tower barometric pressure, which is corrected to sea level, add the field elevation and the hover height above ground level. With this value, enter the Barometric Pressure Correction chart (Figure 10-2) and proceed horizontally to the reflector curve. From the reflector curve proceed vertically to find the correction for the recorded barometric pressure. Sum the recorded pressure and the correction. This value is used to enter the Engine RPM Required to Hover chart (Figure 10-3 or 10-4) at the Corrected Barometric Pressure abscissa (horizontal axis).

PROFILE

If ADC measured static pressure at hover height (STPR) was valid (if invalid, asterisks will be displayed next to STPR on PHOV page) use the recorded STPR instead of ALTM. Make no corrections to STPR and enter the Engine RPM Required to Hover chart (Figure 10-3 or 10-4) at the Corrected Barometric Pressure abscissa (horizontal axis).

To determine aircraft hover weight, Form DD 365-4 must be adjusted for actual aircraft configuration and for the fuel and water quantity recorded in A1-AV8BB-NFM-700. The weight of the water is read from the DDI PHOV page. The weight of the fuel is read from the fuel quantity indicator. After the actual hover weight is determined, it is used to enter the Engine RPM Required to Hover chart (Figure 10-3 or 10-4) at the Hover Weight ordinate.

The stabilator position, RPM, JPT, OAT, and STPR recorded in A1-AV8BB-NFM-700 are used without correction, when entering the Engine RPM Required to Hover and JPT in Hover charts (Figures 10-3 through 10-6). The maximum allowable engine performance degradation is defined as being -2 percent in RHOV or +20 °C in RJPT from the zero datum for the -406 and -408 engines.

10.20.1 Relative Hover Performance

To find the percent hover weight, first enter the Engine RPM Required to Hover chart (Figure 10-3 or 10-4) at the hover weight ordinate and proceed horizontally to the corrected barometric pressure (or STPR). Parallel the reflector curves to the standard day pressure (29.92) and proceed horizontally drawing a line through the hover performance curves. Second, enter the chart at the recorded RPM abscissa and proceed vertically to the recorded OAT. Parallel the reflector curves to the standard day temperature (15 °C) and proceed vertically passing through the hover performance curves. The intersection of the horizontal and vertical lines define the relative hover performance to a 0 percent datum engine.

10.20.2 Relative JPT

To find the RJPT, first enter the JPT in Hover chart at the recorded JPT abscissa and move vertically to the reflector line (For F402-RR-408 engines, enter the JPT in Hover chart at the recorded JPT ordinate) (Figure 10-5 or 10-6). From the reflector line proceed horizontally to the recorded OAT then parallel the reflector curves to the standard day temperature (15 °C) then proceed vertically passing through the JPT curves. Second, enter the chart at the recorded RPM abscissa and move vertically to the recorded OAT. Parallel the reflector curves to the standard day temperature (15 °C) then proceed vertically passing through the JPT curves. The intersection of the horizontal and vertical lines define the RJPT to a 0° datum engine without bleed compensation.

To correct for RCS bleed effects enter the PHOV relative with bleed JPT in hover chart (Figure 10-5 or 10-6) at the recorded DDI stabilator position. Move horizontally right to the intersection with the RJPT line. Move vertically down from the intersection to read the RJPT in hover with bleed compensation.

The RJPT with bleed compensation is used with the following charts in A1-AV8BB-NFM-400: JPT in Hover, Hover Capability and Vertical Landing Capability.

PROFILE

Sample Problem:

1. Flight information recorded in A1–AV8BB–NFM–700 during Performance Hover Checks.

a. Engine	–406
b. DDI stabilator position	–↓1.5°
c. Fan rpm	95.8 percent
d. JPT	652 °C
e. Fuel quantity	980 pounds
f. Hover height (AGL)	100 feet
g. Water quantity	0 pounds

2. Atmospheric information.

a. OAT	20 °C
b. Barometric pressure (ALTM)	30.05 inches Hg
c. Sum of field elevation and hover height	
(1) Field elevation	+400 feet
(2) Hover height	+100 feet
(3) Sum	+500 feet
d. Correction for recorded barometric pressure	–0.55 inches Hg
e. Corrected hover barometric pressure (2b minus 2d)	29.50 inches Hg

3. Aircraft weight.

a. Basic aircraft weight from DD 365F of NA 01–1B–40 (excluding fuel and water quantity)	14,260 pounds
b. Fuel quantity (1e)	980 pounds
c. Water quantity (1g)	0 pounds
d. Hover weight (sum of 3a, 3b and 3c)	15,240 pounds

4. Hover performance check.

a. Fan rpm (1c)	95.8 percent
b. Hover weight (3d)	15,240 pounds
c. OAT (2a)	20 °C

PROFILE

d. Corrected hover barometric pressure (2e)	29.50 inches Hg
e. RHOV performance using 4a, 4b, 4c, 4d and Engine RPM Required to Hover	+0.8 percent

5. JPT check

a. Fan rpm (1c)	95.8 percent
b. JPT (1d)	652 °C
c. OAT (2a)	20 °C
d. RJPT using 5a, 5b, 5c, and Figure 10-5 (sheet 2 of 2) JPT in Hover	–8°
e. DDI stabilator position (1b)	–↓1.5°
f. RJPT using 5d, 5e and Figure 10-5, PHOV RJPT with bleed compensation	–20°C

10.21 MC PERFORMANCE HOVER CALCULATIONS

Aircraft with the PHOV option incorporate a function to automatically freeze engine data when criteria for a PHOV are satisfied. The MC calculates RHOV performance and corrected relative JPT (RJPT) automatically. (On Day Attack and TAV–8B aircraft with OMNI 7.1 with the F402–RR–408 engine installed, engine data is frozen and RHOV and RJPT are computed as a F402–RR–406 engine. NATOPS charts (Figure 10-2 through 10-6), the Mission Planning System (MPS) Operator Station (OPSTA) Program 9.0, or the Boeing AV–8B Hover Performance Software must be used to calculate RHOV and RJPT). The pilot is given options to accept and store data for three individual performance hovers and to reject or clear any data not deemed valid. An average of the RHOV performance and corrected RJPT calculations for the last three accepted hovers is provided on the PHOV display. The pilot retains the option to manually freeze (FRZ) the engine data if unable to achieve steady hover requirements for 10 seconds. Accurate PHOV numbers may not be possible by using the freeze option.

Note

Accurate RHOV and RJPT calculations from the MC rely on accurate BAW, water weight and OAT. Select the VREST option on the DDI menu display to ensure BAW is correct for current configuration, and prior to each VTO enter the correct water weight via the ODU for the most accurate MC calculations (with C1+ and OMNI 7.1 only). Call metro (or tower) while at the Hover Pad, obtain the current OAT, and cue the OAT into the MC via the Up Front Control (UFC) prior to each PHOV.

PROFILE

Select the PHOV option on the DDI engine display to obtain the PHOV display (Figure 10-7). Then select the HOV1 option for the first check. Reselect the engine data display and perform a VTO and stabilize the aircraft in a steady hover at 100 feet AGL. Steady hover requirements are:

1. Altitude — 100 ±10 feet for 10 seconds.
2. Vertical speed — less than ±6 feet per second (INS).
3. Stabilator movement — less than ±0.4°.
4. RPM — less than ±0.8 percent.
5. JPT — less than ±7 °C.
6. Horizontal velocities (E/W and N/S) — less than ±6 feet per second (radar altimeter) (INS).

After the aircraft has met the preceding stabilization limits for 10 seconds, PHOV data is automatically frozen on the DDI and the RHOV and corrected RJPT are computed and displayed.

The pilot is then cued to accept or reject the data via ACPT and REJ options on the ODU. If ACPT is pressed, the average RHOV and average corrected RJPT are computed and stored in the MC for display and manual entry into the V/STOL-REST module as usable RHOV and corrected RJPT. The hover may be rejected by selecting REJ on the ODU, deselecting FRZ (unboxed) on the PHOV display prior to selecting ACPT on the ODU, or scrolling to the next hover in the sequence by using the HOV option button. The PHOV data remains frozen until the data is accepted, the data is rejected, or the engine data display is deselected. Changing displays from the PHOV page before data is accepted may cause hover data to be lost.

A visual cue is provided on the HUD (Figure 10-7) for the pilot to more easily determine the length of time stabilized in the hover. A time scale, just above the angle of attack symbol on the HUD, climbs vertically to the top of the airspeed box as the 10-second period elapses. When any of the standard deviations in the preceding paragraph are exceeded, the time scale on the HUD resets to the 0 second time mark and again climbs when the standard deviation hover conditions are met.

Repeat the VTO and hover stabilization for subsequent checks. The legend next to the hover option button automatically increments to the next alphanumeric (HOV2, HOV3, HOV1, etc.) and engine data are unfrozen when the ACPT option is selected.

The three sets of hover data can be reviewed by scrolling the hover option button. A RHOV performance and RJPT calculation are provided for each check that is accepted adjacent to the RHOV and RJPT legends (Figure 10-7). Averages of these parameters for the last three accepted hovers are provided to the extreme right of the RHOV and RJPT legends.

Selecting the HCLR (hover clear) option clears performance data for the selected hover option (HOV1, HOV2, or HOV3). Average values for RHOV and RJPT are recalculated based on data for hovers which have not been cleared. Data for a particular hover may be overwritten by scrolling the hover option button to the desired number, performing a hover check, and accepting the data via the ODU (Figure 10-7).

Deselection of the PHOV option returns the DDI to the engine display.

PROFILE

Note

Following PHOV, the hover numbers should be reviewed for obvious discrepancies. The aircraft will become lighter during successive hovers due to fuel burn. This should be reflected by reduced RPM and JPT. Trim settings should only change slightly as the CG shifts with fuel burn. Trends other than these may reflect improper cooling, heat soaking the engine, rough hovering, or other situations that induce inaccuracies to the hover. These hovers should not be included in the final RHOV and RJPT calculations.

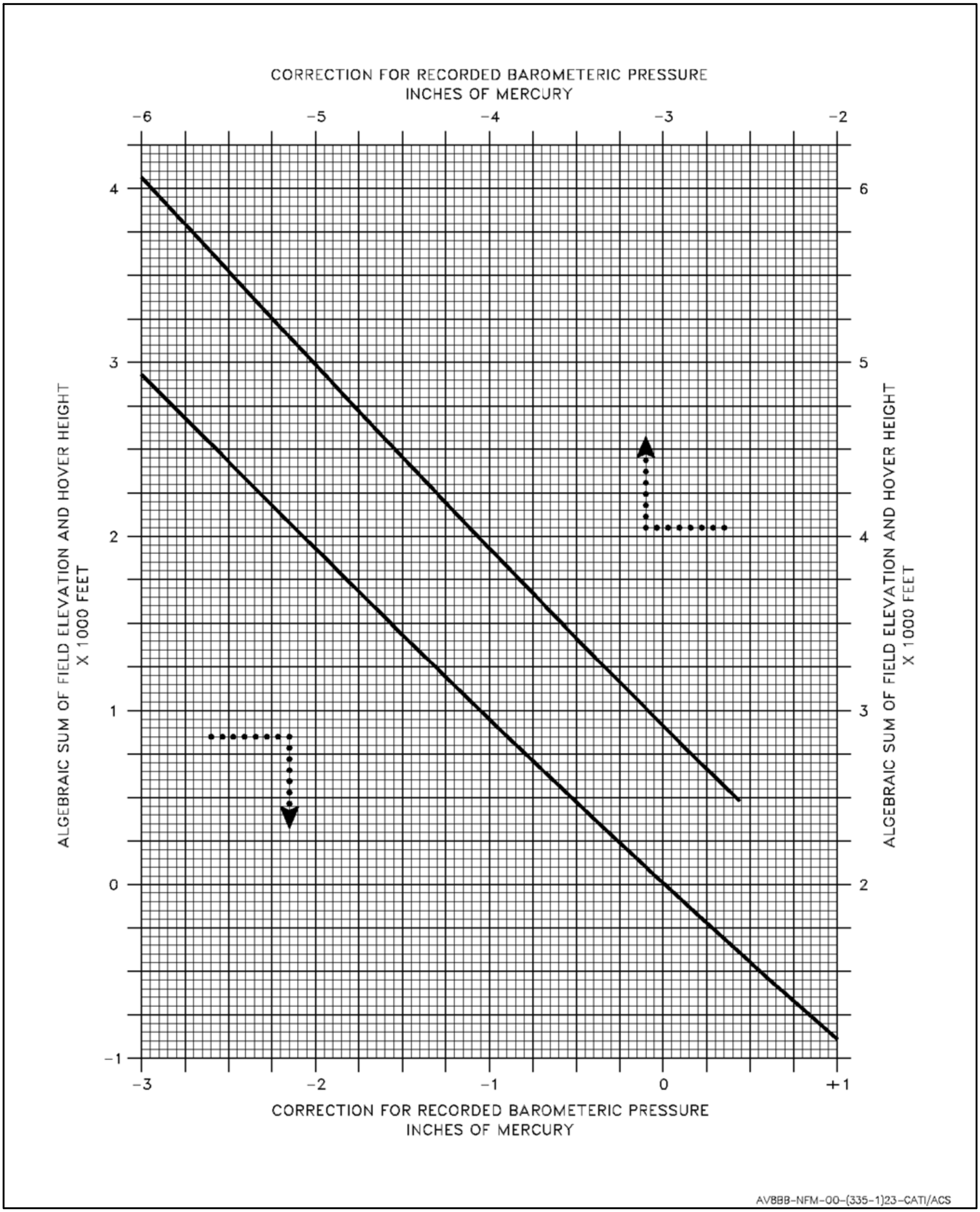


Figure 10-2. Barometric Pressure Correction

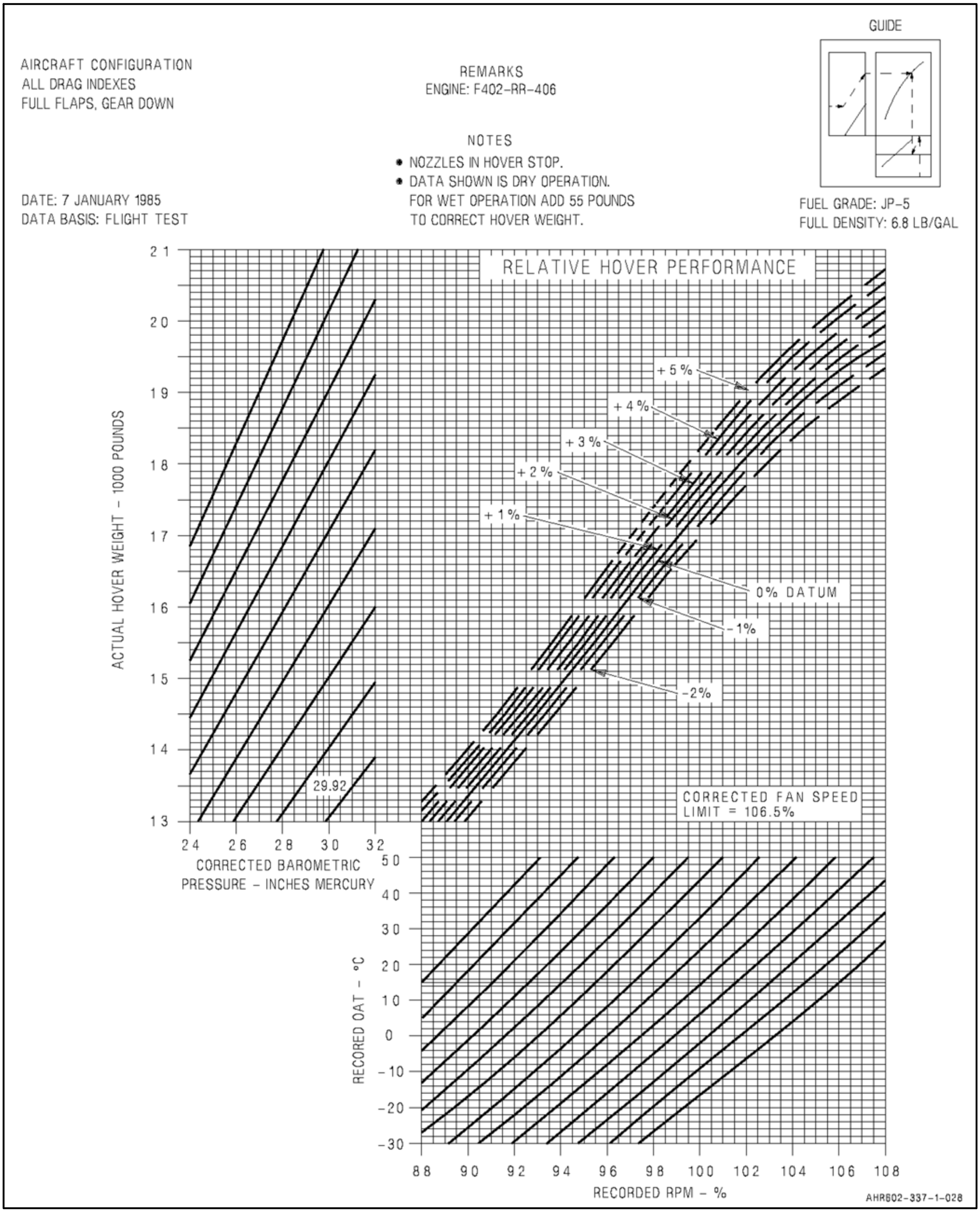


Figure 10-3. Engine RPM Required to Hover, F402–RR–406 Engine

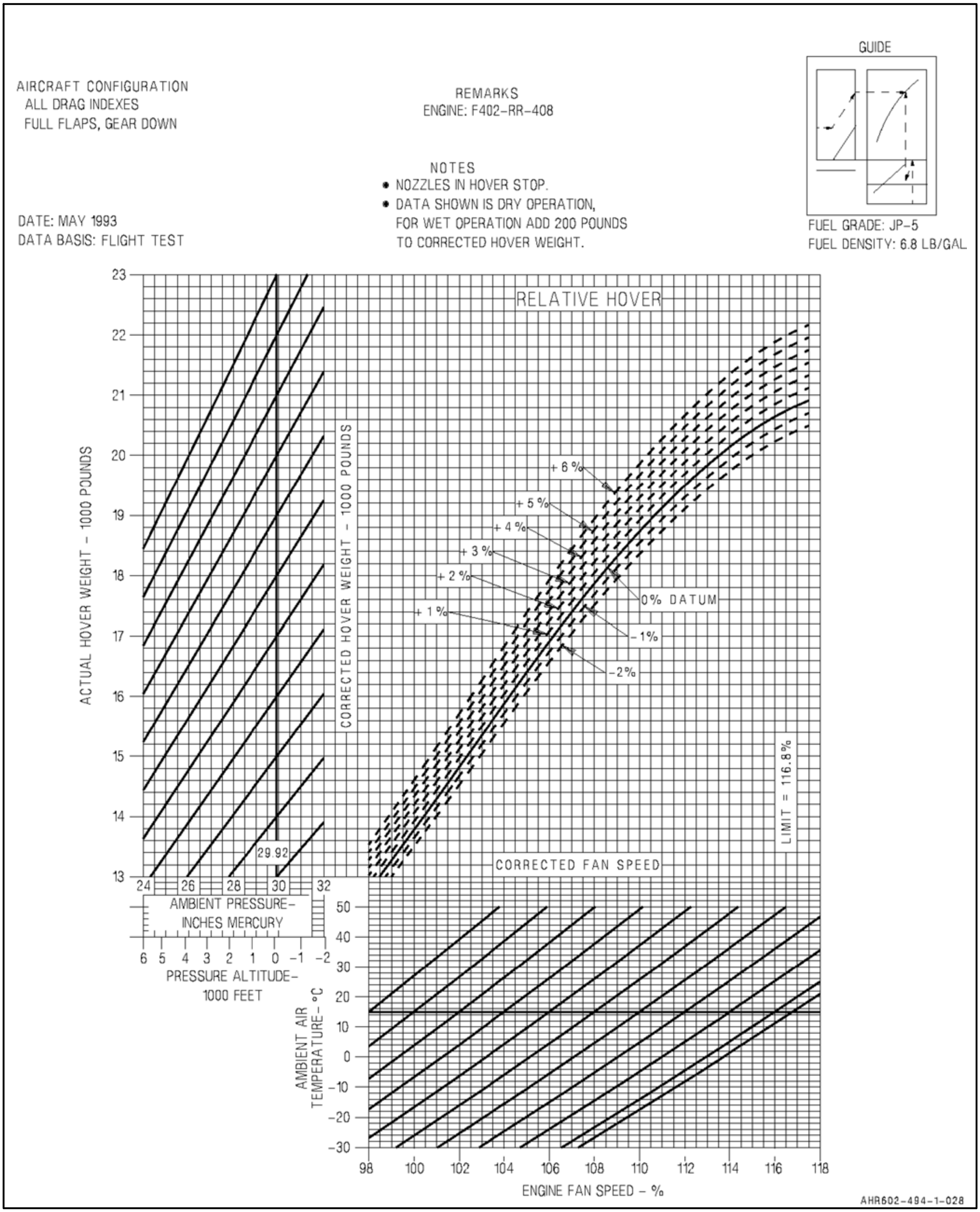


Figure 10-4. Engine RPM Required to Hover, F402–RR–408 Engine

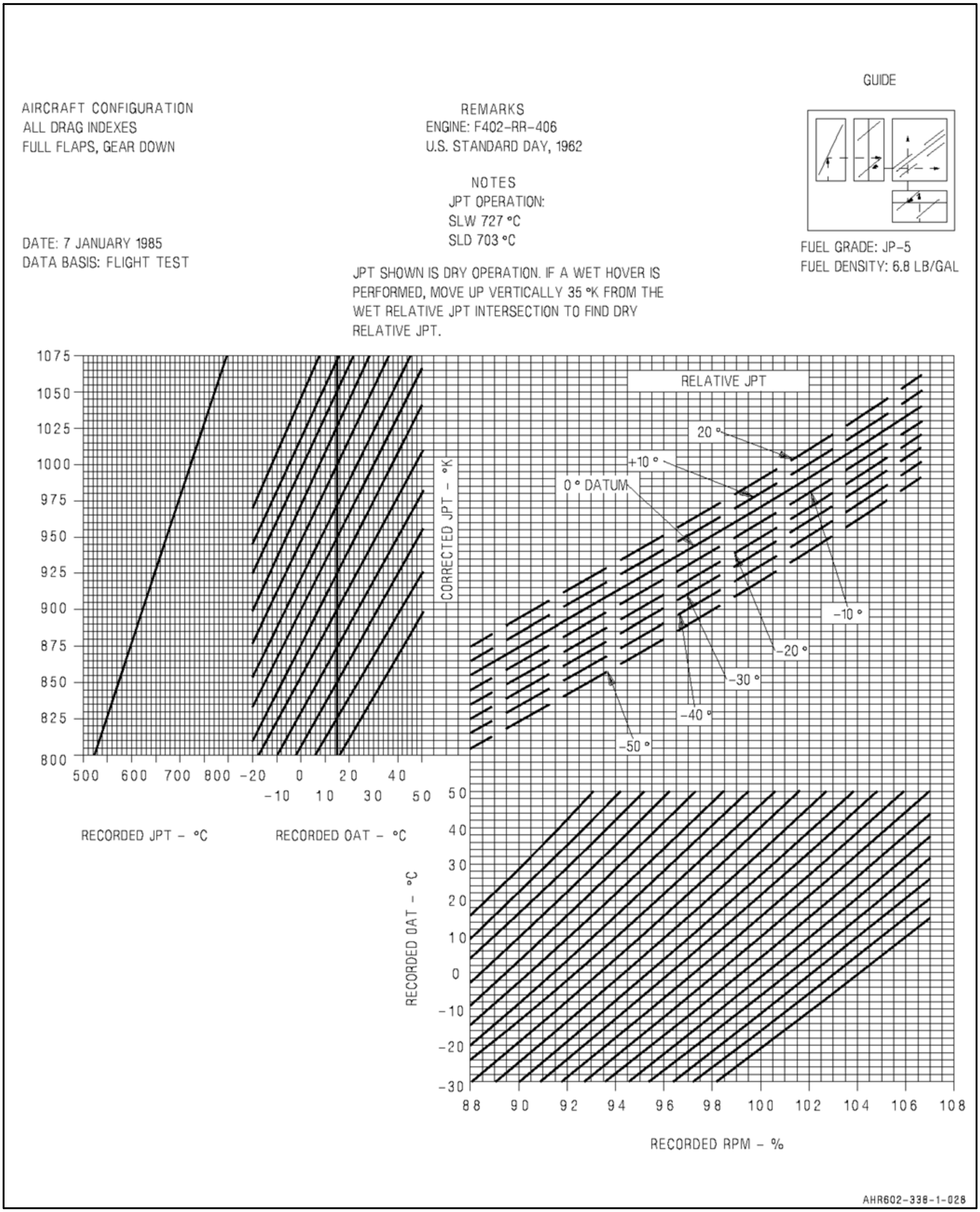


Figure 10-5. JPT in Hover, F402–RR–406 Engine (Sheet 1 of 2)

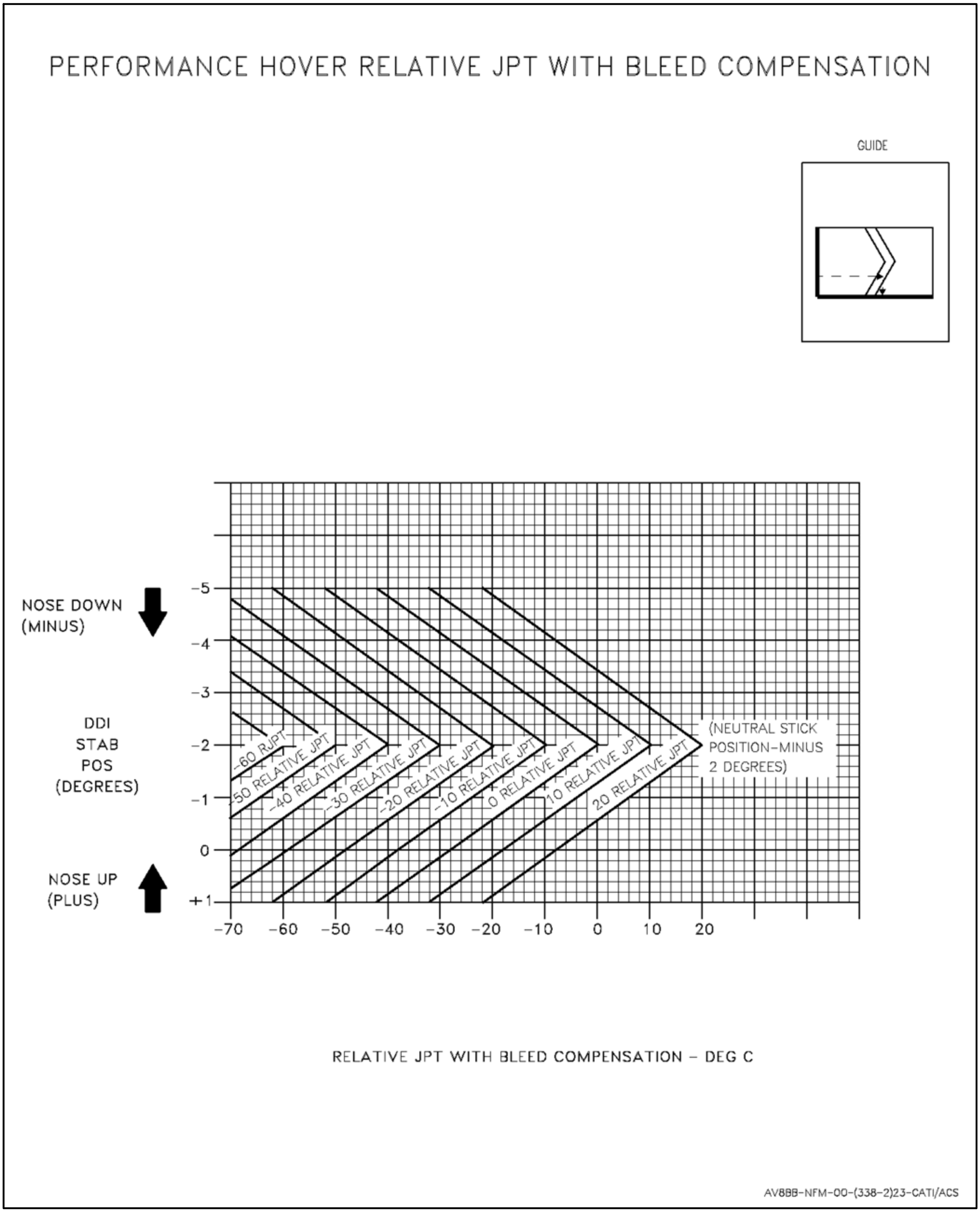


Figure 10-5. JPT in Hover, F402−RR−406 Engine (Sheet 2)

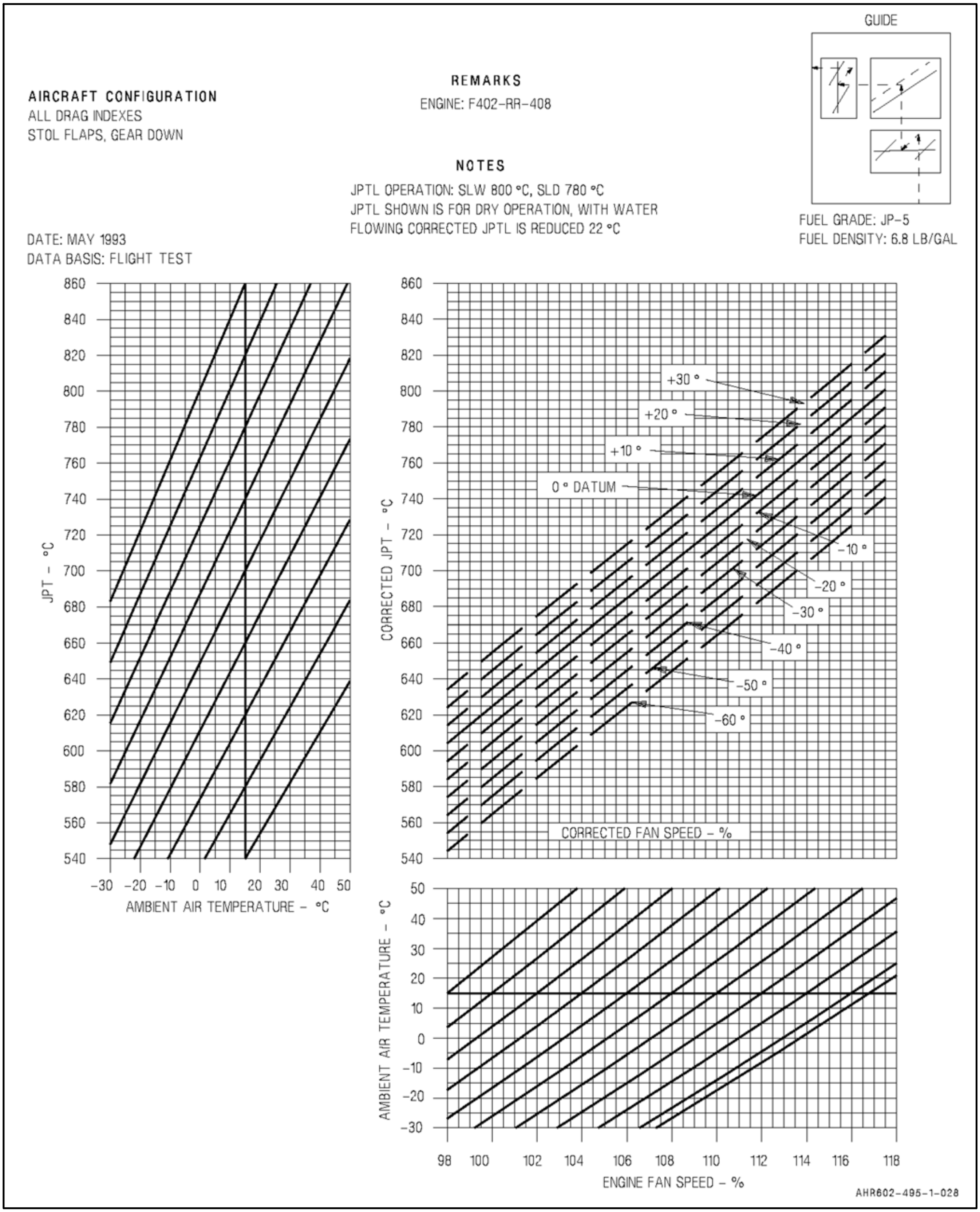


Figure 10-6. JPT in Hover, F402–RR–408 Engine (Sheet 1 of 2)

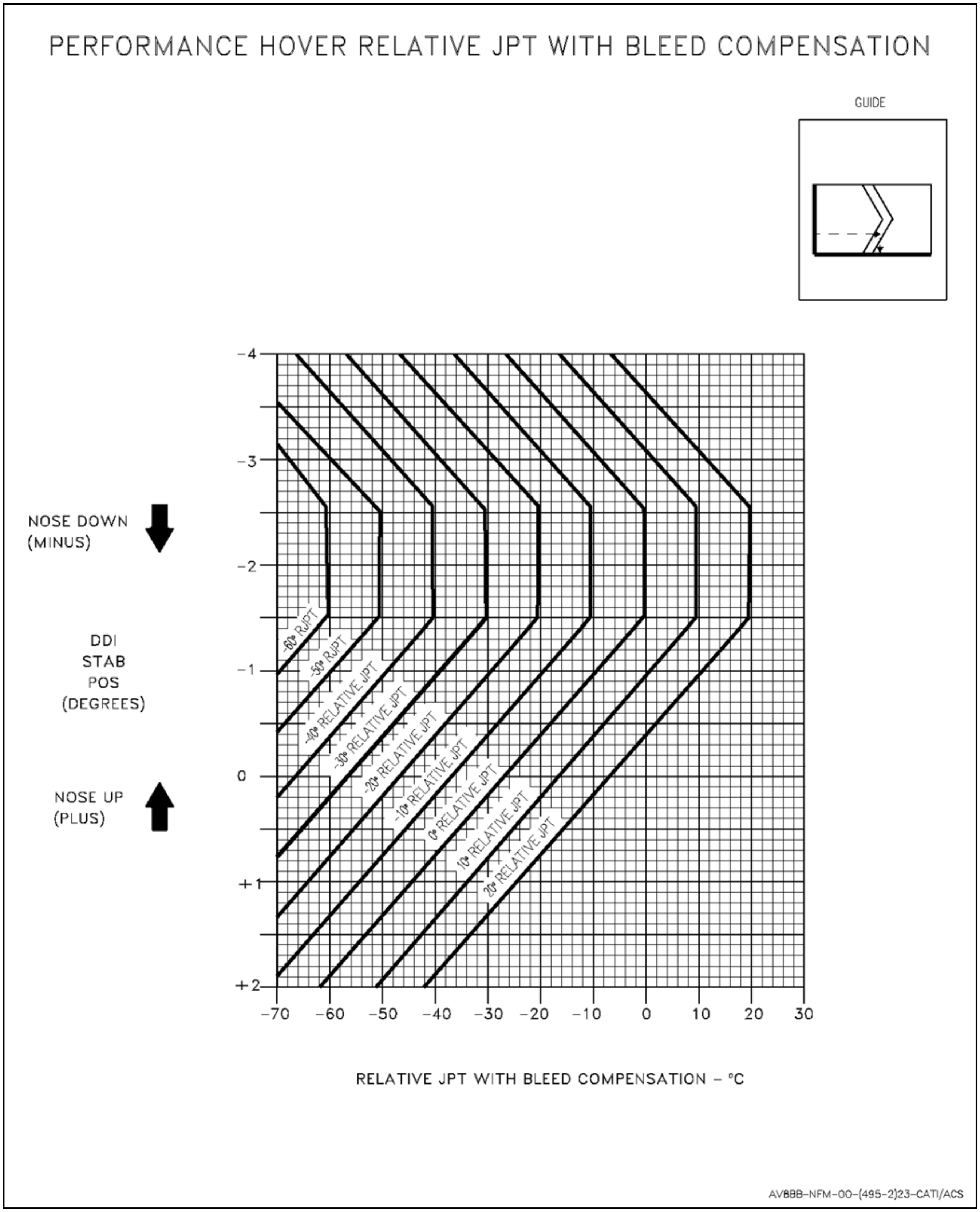


Figure 10-6. JPT in Hover, F402–RR–408 Engine (Sheet 2)

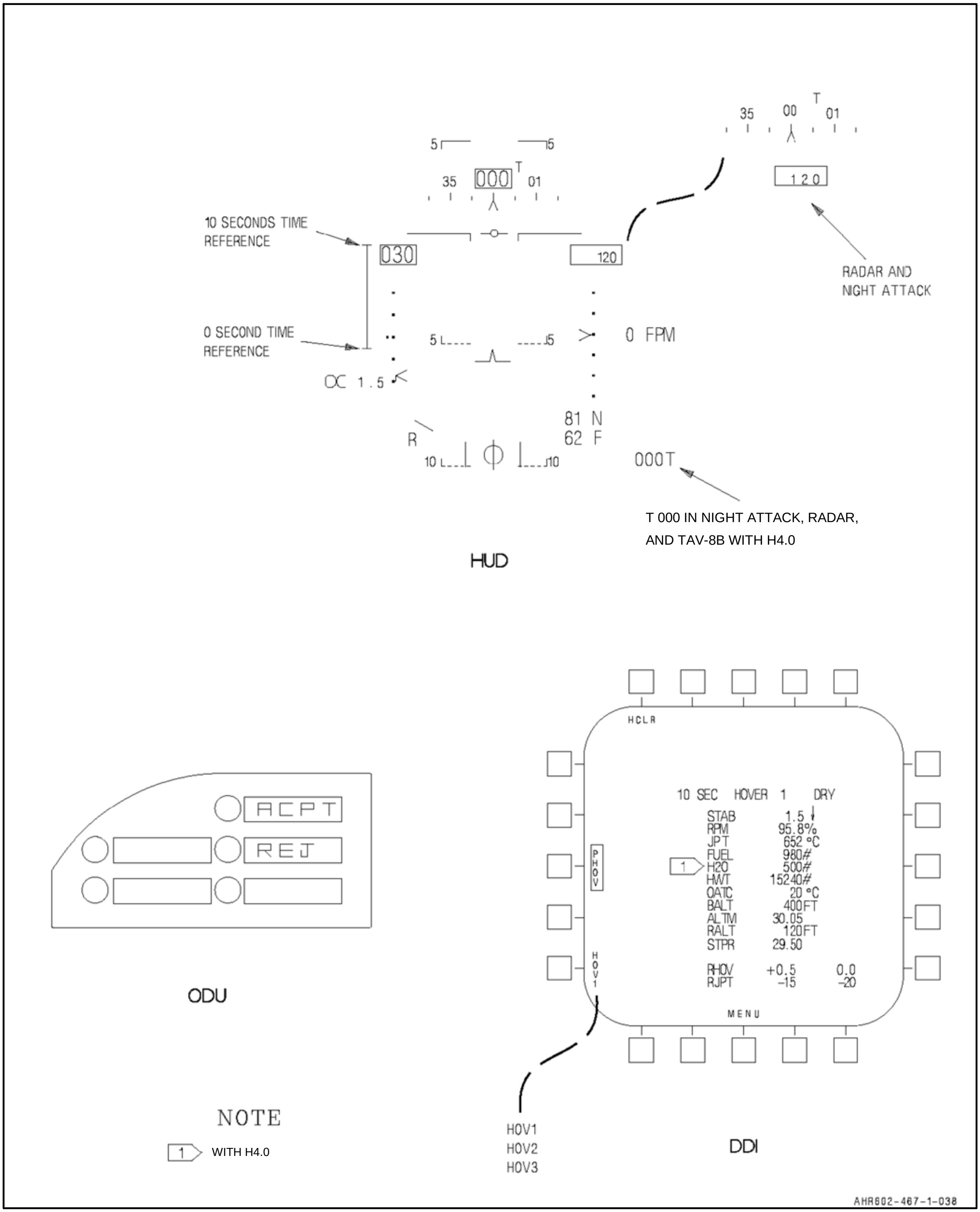


Figure 10-7. Performance Hover Display

PART IV

Flight Characteristics

CHAPTER 11

Flight Characteristics

11.1 INTRODUCTION

The AV–8B, by its design as a V/STOL and transonic attack aircraft has many unique flight characteristics. For an AV–8B pilot to fully realize the potential of the aircraft, a solid understanding of the flight characteristics in both conventional and V/STOL flight is mandatory.

11.2 GENERAL FLIGHT CHARACTERISTICS

In conventional flight the AV–8B behaves much like any other tactical jet. It is, however, a transonic aircraft and therefore has some high sub–sonic Mach considerations that must be understood. In addition, some of the design compromises required for V/STOL flight affect the conventional flight characteristics. As described later in this chapter some of these influences are beneficial and some are not.

In V/STOL flight, aircraft control is fairly intuitive: fore and aft stick still controls pitch, left and right lateral stick still produces a roll, and rudder pedal inputs still yaw the nose left and right. The only significant change is that when the aircraft is semi–jetborne and especially when it is jetborne, pitch does not control altitude; power controls altitude and pitch controls forward velocity or closure with the landing site.

11.2.1 Wake Turbulence

Wake turbulence is primarily a product of lift and takes the form of two counter–rotating cylindrical vortices rolling off the wing tips and trailing behind and below the aircraft. Vortex circulation is outward, upward, and around the wing tips when viewed from either ahead or behind the aircraft. The vortices maintain about a wingspan apart from one another downstream and sink approximately 400 to 500 feet per minute to a level–off altitude about 900 feet below the aircraft's flight path. The strength of the vortices is governed by the weight, speed, and shape of the wing of the aircraft. The greatest vortex strength occurs when the generating aircraft is heavy, clean, and slow. However, equally strong vortices are generated by small, lighter aircraft at faster speeds when pulling G's. An encounter with wake turbulence can be one or more jolts with varying severity depending upon the direction of the encounter, distance from the generating aircraft and point of vortex encounter, and may result in structural damage. However, the greatest hazard when flying up the core of a vortex is induced roll. If the ailerons of a long wingspan aircraft extend beyond the vortex, counter–control would be more effective than for short wingspan aircraft which may have the entire wingspan within the vortex. In the latter case, counter–control capability may not be great enough to stop the roll. Avoid the area below and behind the generating aircraft.

WARNING

Wake vortices must be avoided while maneuvering at low altitude. An encounter with wake vortices while maneuvering at low altitude may result in conditions from which recovery or successful ejection may be impossible.

Wake turbulence in the landing pattern creates hazards for AV–8B pilots because it is a rather small aircraft. When operating around larger aircraft (military or civilian) certain precautions should be made to ensure safe execution of takeoffs and landings. The following vortex avoidance procedures are recommended for the various situations:

1. Landing behind a larger aircraft – same runway. Stay at or above the larger aircraft's final approach flight path – note its touchdown point – land beyond it. This can be a factor even landing behind another AV–8B. Flight leads should brief this as part of straight–in approaches and designate appropriate landing spots.

2. Landing behind a larger aircraft – when parallel runway is closer than 2,500 feet. Consider possible vortex drift to your runway depending on the prevailing winds. Stay at or above the larger aircraft's final approach flight path – note its touchdown point.

3. Landing behind a larger aircraft – crossing runway. Cross above the larger aircraft's flight path.

4. Landing behind a departing larger aircraft – same runway. Note the larger aircraft's rotation point – land well prior to rotation point.

5. Landing behind a departing larger aircraft – crossing runway. Note the larger aircraft's rotation point – if past the intersection – continue the approach – land prior to the intersection. If larger aircraft rotates prior to the intersection, avoid flight below the larger aircraft's flight path. Abandon the approach unless a landing is ensured well before reaching the intersection.

6. Departing behind a larger aircraft. Note the larger aircraft's rotation point and rotate prior to the larger aircraft's rotation point. Continue climbing above the larger aircraft's climb path until turning clear of the larger aircraft's wake. This can be challenging depending upon your flight clearance and with a formation flight. Avoid subsequent headings which will cross below and behind a larger aircraft. Be alert for any critical takeoff situation which could lead to a vortex encounter.

7. Intersection takeoffs – same runway. Be alert to adjacent larger aircraft operations, particularly upwind of your runway. If intersection takeoff clearance is received, avoid subsequent heading which will cross below a larger aircraft's path.

8. Departing or landing after a larger aircraft executing a low approach, missed approach, or touch–and–go landing. Because vortices settle and move laterally near the ground (at approximately 2–3 mph outward), the vortex hazard may exist along the runway and in your flight path after a larger aircraft has executed a low approach, missed approach, or a touch–and–go landing, particular in light quartering wind conditions. You should ensure that an interval of at least 2 minutes has elapsed before your takeoff or landing.

9. En route VFR (thousand–foot altitude plus 500 feet). Avoid flight below and behind a large aircraft's path. If a larger aircraft is observed above on the same track (meeting or overtaking) adjust your position laterally, preferably upwind.

Air traffic controllers should have AV–8Bs land with an interval of 4 to 6 miles behind the larger aircraft depending if the aircraft is categorized as a large heavy or non–heavy aircraft (see Airman's Information Manual for further definitions).

AV–8Bs should also observe the air traffic control directed 3–minute interval when taking off behind (or on a parallel runway from) a large heavy or non–heavy aircraft.

11.3 DEFINITIONS

To continue with any discussion on aircraft flight characteristics, several key definitions need to be made. It is important to understand that the following definitions, although dealing with technical topics, are stated as they relate to what the pilot will experience in the cockpit.

11.3.1 Critical Mach

The free–stream Mach number at which there are first signs of local sonic airflow on the wing and hence shockwave formation. Critical Mach (Mcrit) is measured in 1 g flight. This occurs on the AV–8B at 0.82 to 0.85 IMN (indicated mach number).

11.3.1.1 Shock–induced Flow Separation

Loss of smooth (laminar) airflow over the wing can occur due to shock wave formation if the airflow over the wing is allowed to become supersonic.

11.3.1.2 Maneuvering Mcrit

Although Mcrit is measured in 1 g flight, the effect of shock wave formation can occur at Mach numbers below Mcrit due to AOA on the wing. The increasing AOA accelerates the airflow across the top of the wing so that it becomes supersonic at an IMN less than the 1 g critical Mach. In the AV–8B this effect becomes apparent when maneuvering above 0.78 IMN.

11.3.1.3 Transonic Wing Drop

All variants of the AV–8B can experience a sudden uncommanded roll–off, also called wing drop, caused by the abrupt asymmetric stall of the wings. Wing drop occurs suddenly, with little or no warning to the pilot, and may occur at AOAs below the maneuvering tone. The severity of wing drop increases as Mach number increases and as altitude decreases. At Mach numbers greater than 0.8 IMN, wing drop may occur 3° AOA below the maneuvering tone. At greater than 0.8 IMN wing drop may occur 3° AOA below maneuvering tone. The severity of wing drop increases as Mach number increases and as altitude decreases. If wing drop occurs, flying qualities can be improved by reducing AOA.

WARNING

Transonic wing drop may occur at angles of attack below the maneuvering tone. Extreme care should be exercised at elevated AOA when maneuvering near ground level above Mach 0.8.

11.3.1.4 Force Divergence Mach Number/Drag Rise

The indicated Mach number above critical Mach, which produces a sharp change in the drag coefficient (boundary layer separation due to shock wave formation) is termed the “force divergence” Mach number. It is also referred to as “drag divergence” and occurs on the Harrier at approximately 0.87 IMN and results in buffet, trim and stability changes, and a decrease in control surface effectiveness. If the buffet is quite severe or prolonged, structural damage or failure may occur when this boundary layer separation is experienced on the wing due to shock wave formation. There will be a loss of lift and a subsequent loss of downwash aft of the affected area. When shock induced separation occurs symmetrically at the wing root the decrease of downwash aft of this area results in a decrease in downwash on the horizontal stabilator and thus we notice the aircraft’s tendency to “tuck”. If the wings shock unevenly due to physical shape differences or sideslip, a rolling moment will be created in the direction of the initial loss of lift and will contribute to “wing drop” and control difficulty. If either of these conditions occurs reduce the throttle and decelerate the aircraft below 0.78 IMN while avoiding any large control inputs.

11.3.2 Dynamic Pressure

Dynamic pressure (q) is the pressure on the aircraft due to the velocity of the aircraft and the density of the air through which the aircraft is flying. Dynamic pressure is usually associated with the ability of the aircraft to maneuver due to the interaction of the dynamic pressure with the control surfaces on the aircraft. The most obvious measure of dynamic pressure to the pilot is the calibrated airspeed (KCAS) in the HUD. The relationship of pressure to velocity is critical to understanding how dynamic pressure/KCAS and thus the aircraft’s maneuverability and stability will vary with altitude. For a constant true airspeed (KTAS), an increase in altitude will cause a decrease in dynamic pressure/KCAS due to decreased air density. Another interesting relationship is that of KCAS to IMN with varying altitude. For a constant KCAS, increasing altitude increases the IMN of the aircraft. So, although 380 KCAS at 5,000 feet has the same dynamic pressure as 380 KCAS at 20,000 feet the aircraft will still suffer decreased stability and therefore maneuverability due to all the above effects of flow separation caused by shockwave formation by flying near critical Mach.

11.3.3 Control Authority

Control authority is a measure of the amount of deflection a control surface can move – i.e. 30°. Control authority as it is commonly related to the AV–8B flight characteristics (expressed as a percentage of total control system movement in any given axis) is the amount of control system movement the DEPRES can use to stabilize the jet. It is merely the measure of the range of motion the DEPRES is allowed to move the rudder and/or the aileron to resist departure. In the Harrier, the DEPRES has 30 percent authority in roll (ailerons) and 48 percent authority in yaw (rudder).

11.3.4 Control Power

Where Control Authority is merely a measure of control surface range of motion, Control Power is the actual force that is created by the surface area of a control surface deflection interacting with the airflow (dynamic pressure). Control power equals control effectiveness and this varies depending on aircraft altitude, airspeed, AOA and IMN.

11.3.5 Supercritical Airfoil (Wing)

A supercritical airfoil is an evolved wing design that allows aircraft to fly at transonic speeds while delaying the onset of critical Mach. This is possible due to the shape of the airfoil having a flatter top (see Figure 11-1) than a conventional airfoil. This does not allow the airflow to accelerate as much over the top of the wing and therefore delays shockwave formation. This would also create less lift for the airfoil if it did not have one other interesting design feature, the scooped out shape seen on the aft portion of the bottom of the airfoil. This creates more pressure on the bottom of the wing surface, which increases the pressure differential between the top and bottom of the wing that we refer to as "lift". It also more evenly distributes the pressure differential over the entire airfoil chord rather than having a majority at the front as is common with a conventional airfoil. The benefit of this is that for the high thickness to chord ratio of the AV–8B's wing the aircraft has a higher Mcrit than would be possible with a conventional airfoil. This allows the AV–8B to achieve higher transonic cruise speeds with greater fuel efficiency due to delaying the detrimental drag associated with shock wave formation. The aircraft needs a high thickness to chord ratio to increase the internal fuel capacity of the wing and to strengthen the wing for carriage of external stores. However, there are always compromises in aircraft design; the supercritical wing design is susceptible to sudden and drastic flow separation once Mcrit is exceeded in maneuvering flight.

11.3.6 Kinematic Coupling

Kinematic coupling, as it relates to AV–8B departure avoidance, is the interchange between AOA and sideslip as the aircraft rolls about its longitudinal axis. Kinematic coupling occurs when the longitudinal axis (around which the aircraft rolls) is not aligned with the velocity vector. This can be a good thing if the aircraft has developed sideslip and then rolls into the sideslip which will turn it into AOA (which the aircraft is more tolerant of). However, if the aircraft is rolled while AOA (velocity vector not aligned with the longitudinal axis) is present, kinematic coupling will turn the AOA into sideslip which must be compensated for (either by pilot input or DEPRES) or the aircraft is susceptible to a departure. Figure 11-2 shows the mechanics of kinematic coupling.

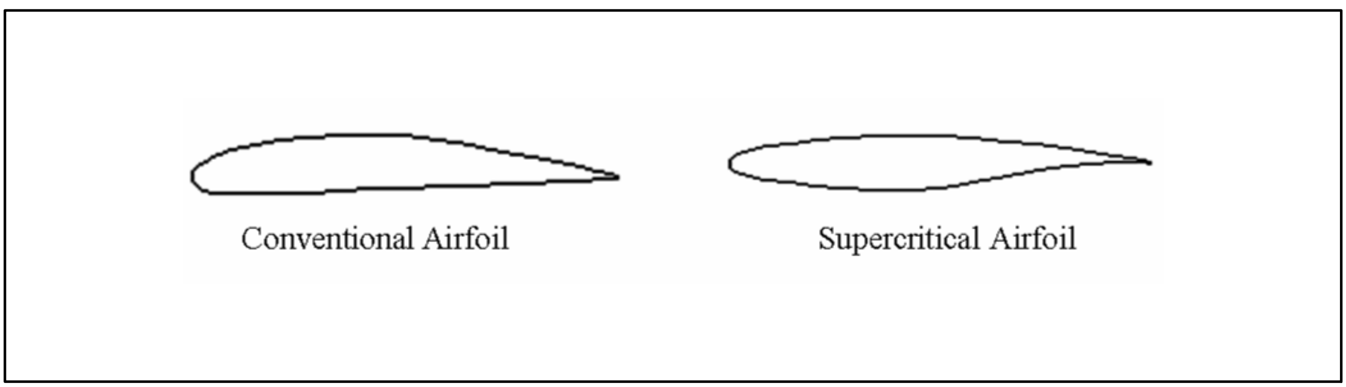


Figure 11-1. Airfoil Differences

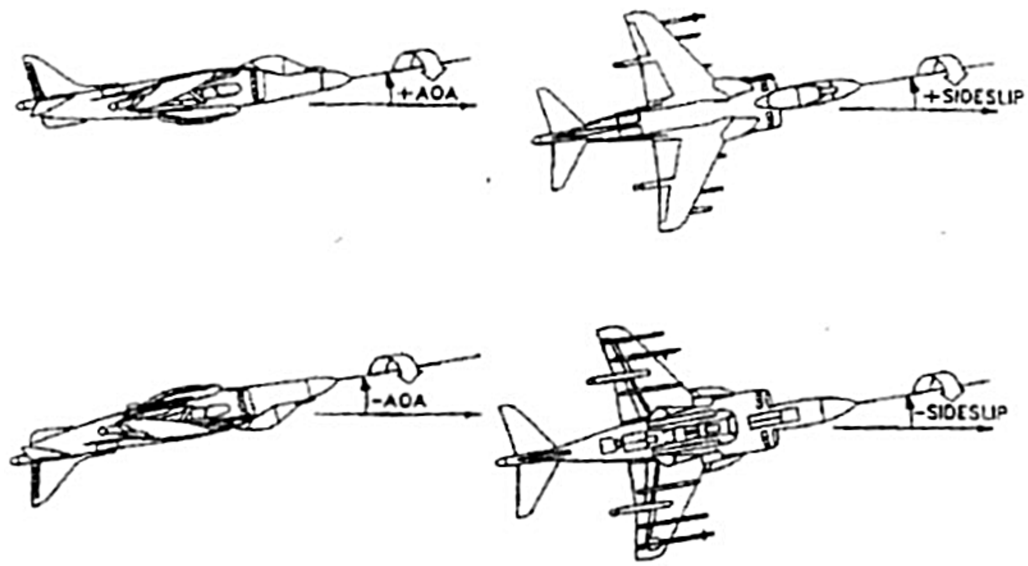


Figure 11-2. Kinematic Coupling

11.4 CONVENTIONAL FLIGHT

11.4.1 Three Aircraft Analogy

In conventional flight there are effectively three different regimes that the aircraft may operate in that determine the stability and maneuverability of the aircraft. This is analogous to flying three different aircraft based upon the limiting factor that determines the aircraft maneuverability and stability.

11.4.1.1 Mach Limited Aircraft

At tactical KCAS, above approximately 15,000 feet the aircraft will be approaching or above “maneuvering” Mcrit. The pilot must be aware of the IMN before attempting to maneuver the aircraft. If dynamic maneuvering is required, ensure the aircraft is decelerated below 0.78 IMN before adding AOA. Additionally, ensure the airspeed is not allowed to exceed 0.78 IMN while maneuvering or shock-induced flow separation will cause a decrease in the amount AOA that is controllable. The reduced AOA will not prevent the aircraft from continuing to accelerate, which will further reduce the controllable AOA. This compounding cycle of decreasing AOA and increasing IMN will continue (unless the throttle is reduced) until the pilot over-controls the AOA/sideslip and the aircraft departs or the aircraft reaches Force Divergence Mach, where it has no maneuvering capability and is very unstable in even 1 g flight.

11.4.1.2 AOA Limited Aircraft

At tactical speeds below 400 KCAS below 15,000 feet or above 15,000 at less than tactical KCAS, the aircraft becomes more “traditionally” AOA limited. Pilots should be familiar with this type of flight regime from their earliest days of flight training. There are two factors that can cause the AV-8B pilot maneuvering and stability problems in this regime.

11.4.1.2.1 AOA Lag

During high AOA and/or g onset rates the HUD AOA has been seen to lag by up to 5 units. Therefore, as a pilot is maneuvering in this regime if an attempt is made to pull instantaneously to a specific AOA the True AOA of the aircraft will exceed the HUD displayed AOA. If the True AOA overshoots the lift limit the aircraft will enter stall or a departure.

11.4.1.2.2 Loaded Rolls

Loaded rolls create stability problems in several ways. First, if the AOA is just beneath the lift limit, rolling the aircraft increases the camber of the up-rolling wing which may cause either laminar or shock-induced flow separation, resulting in a loss of lift and an increase in drag away from the initial roll direction. At lower IMNs this will result in wing rock; at higher IMNs it can accelerate immediately into a departure. Next, rolling the aircraft with AOA present increases the AOA on the down rolling wing, which can be thought of as “roll friction” because it is opposite the initial roll direction. Also, loaded rolls will induce the detrimental effect of kinematic coupling that turns AOA into sideslip. The result of these effects is that a loaded roll that creates sideslip and rolling moments beyond the ability of DEPRES to compensate will lead to a departure.

11.4.1.3 G Limited Aircraft

At tactical airspeeds below 5,000 feet the aircraft becomes g limited. Although it is possible to induce an “AOA” or “IMN” departure at these low altitudes, the inherent stability of the aircraft due to the high dynamic pressure and the low IMN at tactical airspeeds, make it more tolerant to all but the most gross pilot control input errors. Therefore, mishandling the aircraft will likely lead to an overstress instead of a departure.

11.4.2 Stability Augmentation and Attitude Hold System

The three axes stability augmentation and attitude hold system is installed to reduce pilot work load, effect of random disturbances, and sideslip in V/STOL flight. Normal operation of the yaw SAS decreases the tendency for sideslip to develop. The attitude hold functions provide additional pilot relief throughout the V/STOL regime. System authority is adequate for pitch and roll hold provided that relative wind changes or power changes are not excessive. Breakout forces for control stick steering are light (±1 pound) which allows normal pilot control and feel when desired but requires a light touch to prevent attitude hold disengagement. The pilot can override hardover failures in all three axes.

11.4.3 Departure Resistance

The departure resistance (DEP RES) control laws of the Stability Augmentation and Attitude Hold System (SAAHS) lessen the likelihood of departures by preventing build-up of sideslip angle. Sideslip control is provided by an aileron-to-rudder interconnect to improve roll coordination. A lateral acceleration feedback to the ailerons and rudder augments the lateral/directional static stability and a sideslip rate feedback to the ailerons and rudder augments the lateral/directional damping and reduces wing rock. At AOA close to the maneuvering tone, sideslip build-up is highly dependent upon the roll response of the aircraft. Consequently, the SAAHS roll axis provides the majority of the departure resistance at high AOA. Disengagement of the SAAHS roll axis will not increase roll performance and will significantly degrade the departure resistance of the aircraft.

The ability of the departure resistance system to control sideslip is also degraded to varying degrees by overriding the lateral high speed stop, by large rudder pedal deflections, by large lateral weight asymmetries, and by installation of the air refueling probe. These effects are cumulative and in combination can rapidly overwhelm the ability of the departure resistance system to prevent departures.

Inadvertent large rudder pedal deflections resulting in departures may occur at high airspeeds with the Q-feel system disengaged. On TAV-8B, and AV-8B (161573 through 164121), departures induced by large rudder pedal deflections primarily occur above the maneuvering tone when the air refueling probe is installed. Figure 11-3 shows the maneuvering characteristics with the 65 percent LERX. Figure 11-4 shows the maneuvering characteristics with the 100 percent LERX. Figure 11-5 is an example of how to determine maneuvering characteristics from one of these charts.

11.4.3.1 Aileron Rudder Interconnect

The yaw SAS also provides a lateral stick to rudder interconnect for improved turn coordination. Above 4° AOA, lateral stick commands increasing rudder in the direction of the roll and decreasing aileron in order to reduce adverse sideslip and improve high AOA roll performance. Lateral stick also commands nose-down stabilator to reduce AOA build-up from inertial and kinematic coupling. The maximum rudder commanded by the SAS is equivalent to 1/2 pedal and occurs at 8° AOA and above with lateral stick at the high speed stop.

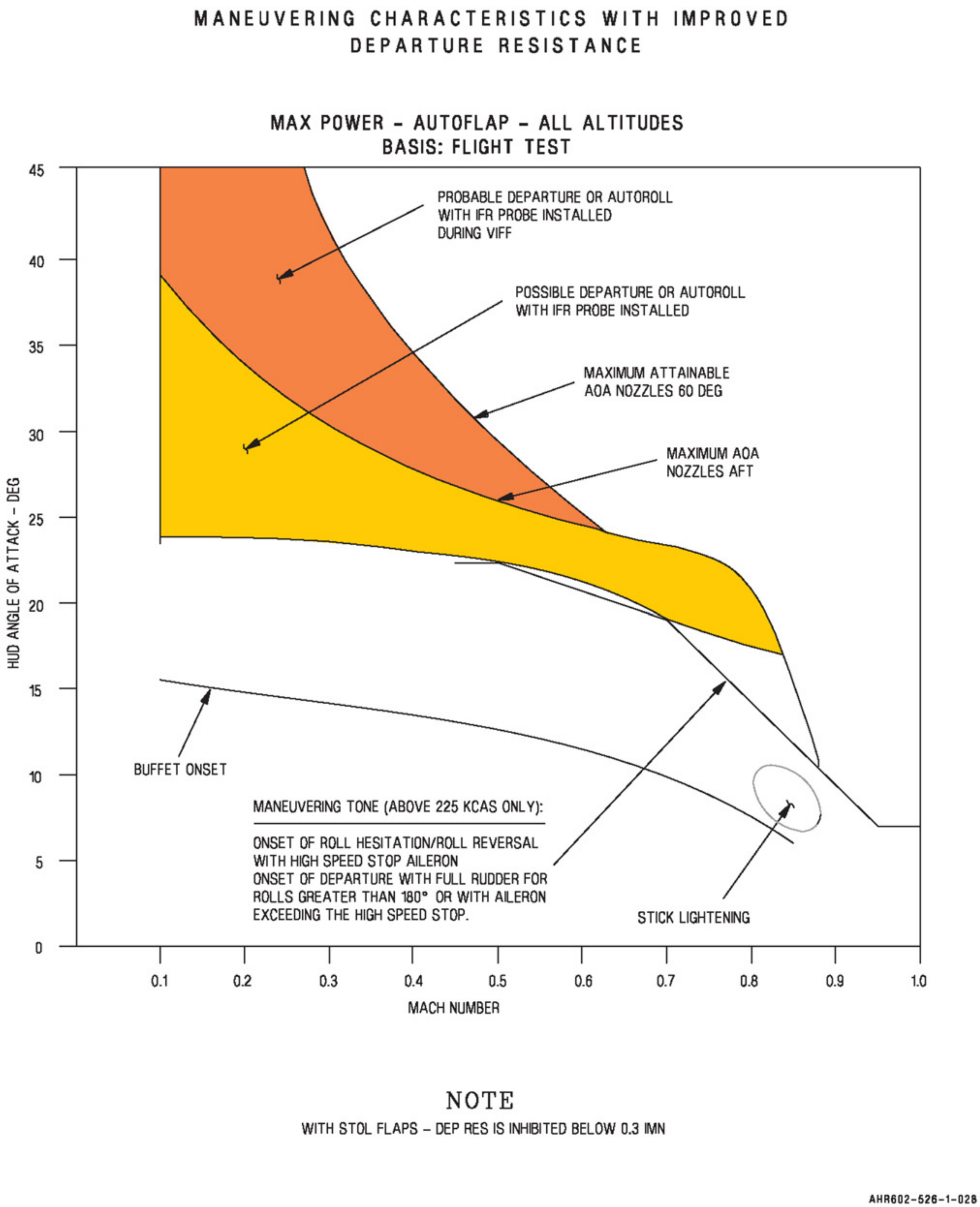


Figure 11-3. Maneuvering Characteristics with 65 Percent LERX

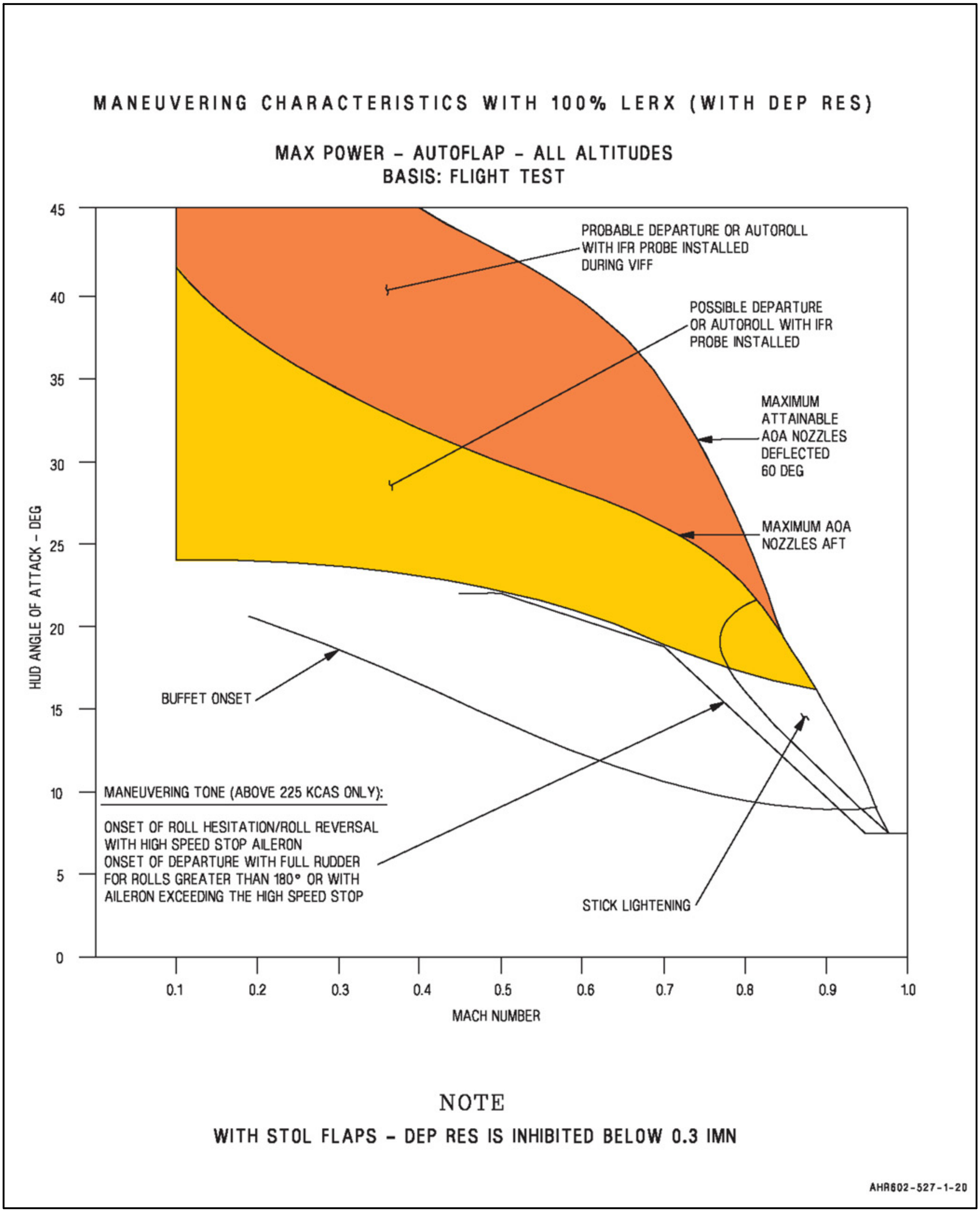
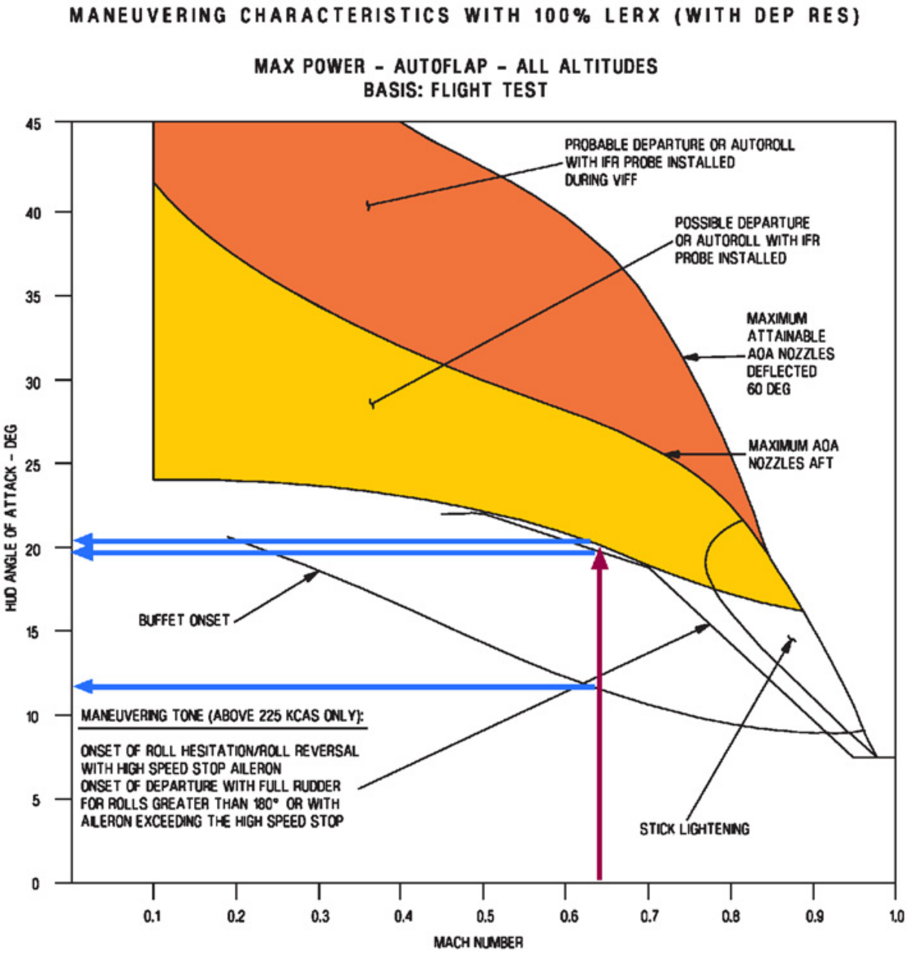


Figure 11-4. Maneuvering Characteristics with 100 Percent LERX



NOTE

WITH STOL FLAPS - DEP RES IS INHIBITED BELOW 0.3 IMN

Example:
400 KTAS at 17,000 feet for a 45° ordnance delivery.

1. Determine IMN (from NTRP 3-22.4-AV8B. For this example it is 0.63 IMN.
2. Enter Maneuvering Characteristics Chart from bottom with IMN.
3. Read up to buffet onset, Maneuvering Tone and Possible Departure Lines.
4. Read left at each of those data points to determine the corresponding AOA.

For this example:

- Buffet: 12 AOA.
- Maneuvering Tone: 19.5 AOA.
- Possible Departure: 20 AOA.

This builds an approximate "maneuvering envelope" for the flight regime.

Best sustained performance occurs approximately at buffet onset. This should be the target AOA if dynamic maneuvering is required.

Be careful of AOA lag and understand that these numbers are approximate and the numbers and flight characteristics will change with different aircraft configurations. Rapid application of g, rapid rolls to and past the high speed stop, loaded rolls, and many other factors can combine to result in a departure well below the 19.5 or 20 units shown above.

Figure 11-5. Determining Maneuvering Characteristics

11.4.4 Conventional Flight Characteristics

11.4.4.1 Pitch Stability

The aircraft is stable in maneuvering flight up to the maximum allowable AOA with all authorized loads. Flight beyond the maximum allowable AOA has resulted in violent departures. Care must be taken to avoid overshoots. When near maximum allowable AOA, reduce aft stick with a lateral input. Buffet and wing rock range from light at lower Mach numbers to moderate at maximum speeds and occur 4° to 5° below departure AOA.

On AV-8B aircraft with 100 percent LERX, buffet is reduced significantly. On these aircraft and TAV-8B, AV-8B 161573 through 164121, wing rock is reduced or eliminated at most airspeeds (above 120 KCAS) through flight control computer (FCC) control laws that provide improved lateral/directional dynamic damping. With Q-feel and pitch SAS engaged, stick forces are moderate throughout the flight envelope and pitch control is smooth and well damped. However, with Q-feel or SAS disengaged, pitch sensitivity is increased, particularly at high subsonic speeds. In this case, care should be taken to prevent a maneuvering overshoot of either AOA or load factor.

On AV-8B aircraft with 100 percent LERX, at low to moderate AOA, additional augmentation is provided by the pitch axis of the SAAHS in order to counter a loss in stability induced by the 100 percent LERX. Above 12° AOA, this additional pitch augmentation is gradually reduced in order to obtain additional maneuvering capability (4° to 5° higher AOA) with full back stick. With the SAAHS pitch axis disengaged, increased pilot compensation will be required to perform STOs and other low AOA tasks with aft centers-of-gravity and high stability index store loadings.

The aft mounted bobweight is a longitudinal control system device which uses the inertial effects of a mass to modify the stick forces under various maneuvering conditions. As the aircraft maneuvers, the inertial effects of the weight on the bellcrank alter the longitudinal stick forces felt by the pilot.

One of the key features of the bobweight is its response to various types of maneuvers. For instance, during slow pullups or steady state turns, the load factor acts on the bobweight to produce a force on the bellcrank in a direction that relieves the stick forces. For abrupt maneuvering inputs, large pitch accelerations are produced which result in a force that opposes stick movement, thereby increasing stick force. The net result is a control system which lightens stick forces under steady, high g maneuvers, while reducing aircraft pitch sensitivity during very abrupt maneuvers.

11.4.4.2 Roll/Yaw Stability

Aileron forces are light and response is crisp but well damped at all speeds. Above 0.9 Mach, aileron effectiveness is reduced and some lateral stick may be required to hold wings level. On aircraft with ASC 020 installed roll response at high speed is increased.

Rudder forces are moderate throughout and provide good response up to maximum allowable AOA. However, with Q-feel disengaged, rudder forces are extremely light, particularly at high subsonic speeds. In this case, care should be taken to prevent inadvertent rudder pedal deflections. Carriage of gun packs at high speed will cause some loss of yaw trim precision.

11.4.4.3 Angle of Attack Sensitivity

As airspeed decreases, AOA increases. It is important to recognize the aircraft’s sensitivity to AOA. At slow airspeeds, small amounts of back-stick pressure and in some cases the release of small amounts of forward-stick pressure may create a high AOA excursion. This may in turn lead to wing rock, directional instability, which the pilot will recognize as a wandering sideslip vane, and a possible departure from controlled flight. The target AOA during any slow speed flight should be 10 to 15 units AOA, although 15 to 20 units may be acceptable under certain circumstances. AOA will always increase with roll when any sideslip is present and can rapidly increase as a function of sink rate without significant pilot aggravation. During slow speed flight when the flight controls provide reduced effectiveness, AOA management becomes critical.

11.4.4.4 Lateral Weight Asymmetry Effects

Weight asymmetry simply reduces the ability of the Harrier’s dihedral effect to lift the heavy wing should the aircraft begin to yaw away from the asymmetry. Conversely, the weight asymmetry will also help the dihedral effect lower the heavy wing if the aircraft yaws into the asymmetry. The “beneficial” kinematic coupling that would control sideslip is thereby decreased yawing away from the heavy wing and vice versa. This results in a bias in lateral stability that promotes sideslip away from the heavy wing (nose right with a heavy left wing).

11.4.4.5 Stick Lightening

As seen in Figures 11-3 and 11-4 there is a portion of the AV-8B maneuvering envelope above 0.75 IMN that yields a disproportionately large pitch control response for a given aft stick input relative to the rest of the envelope. The danger here is that it occurs at high transonic Mach numbers where the aircraft is already susceptible to shock induced flow separation. The larger than expected pitch response will cause excessive AOA buildup leading to flow separation (likely asymmetric) with a departure or overstress (low altitude).

11.4.4.6 SAAHS Off

Having previously discussed all the beneficial “work” that SAAHS/DEPRES perform to maintain aircraft stability while increasing maneuverability, it should become apparent that if the SAAHS failed, the pilot will have to provide all the inputs necessary to maintain control of the aircraft. In order to do this, the pilot must have an understanding of what the flight characteristics of the aircraft are going to be if the SAAHS is off.

11.4.4.6.1 Pitch

With the SAAHS off or failed the aircraft is fairly stable in pitch at lower airspeeds (below approximately 0.5 IMN). The stick forces will be light and a little more sensitive to control inputs. As speed increases the sensitivity to control inputs also increases. Above approximately, 360 KCAS it is possible to overstress the aircraft with what would be a “normal pull” with SAAHS on. Below this airspeed, “normal pulls” can yield AOA excursions above stall. If the SAAHS has failed it is recommended that the pilot maintain airspeed below 300 KCAS/0.5 IMN and limit maneuvering to less than 12 units AOA.

11.4.4.6.2 Roll

Typically the first “seat of the pants” indication a pilot will get that the SAAHS has failed is the aircraft becomes fairly sensitive in roll. The aircraft is still stable in roll but the sensitivity is greater than the pilot is used to with the SAAHS on. This tends to lead to pilot induced oscillations (PIO). The loss of SAAHS will also cause the pilot to experience adverse yaw when a roll is initiated due to the loss of the ARI which normally deflects the rudder for the pilot to prevent this. Roll rates with SAAHS off should be kept low and the VSTOL HUD mode should be selected to help monitor sideslip during turns.

11.4.4.6.3 Yaw

The aircraft remains stable in yaw at conventional flight airspeeds due to the tail creating “lift” opposite any sideslip to eliminate it. There will be decreased stability, as compared to SAAHS on. This is evident to the pilot as a nose “swaying” sensation whenever sideslip is generated (by turbulence, adverse roll yaw, etc.). Again, the VSTOL HUD mode should be selected to monitor the sideslip. At low AOA, if the swaying is mild and self-dampening, the pilot may opt to not input a rudder correction, as this may create a yaw PIO condition. However, if the sideslip is excessive a rudder correction must be input to stop the sideslip build up prior to a departure while the source of the sideslip must be located and eliminated.

11.4.4.7 TAV-8B Mass Induced Oscillations

During the flight test program, the TAV-8B experienced a high frequency roll oscillation when the pilot in the aft cockpit had control of the aircraft and the pilot in the forward cockpit had his hands off the stick. These roll oscillations were excited solely by the lateral motion of the aft cockpit stick and were independent of SAS, AFC, Q-feel, or longitudinal stick inputs.

There are four conditions which contribute to this oscillatory mode. First, the aft cockpit stick center of gravity is above the roll center of the aircraft. The additional mass of the pilot’s hand and arm on the stick can generate stick deflections opposite the roll during aircraft roll accelerations. Second, the TAV-8B exhibits greater roll accelerations for the same commanded aileron deflection since the rolling moment of inertia is less than the single seat. Third, the moment arm of the aft cockpit stick is larger than the moment arm of the forward cockpit stick which will amplify the effect of large roll accelerations. Fourth, the addition of the aft cockpit stick doubled the mass of the control stick system. This caused a reduction to the system's effective damping.

To stop the oscillation, the pilot in the forward cockpit can place his hands on either side of the stick and slowly bring his palms together. At no time will the oscillations grow exponentially without pilot input. These oscillations will only occur during high dynamic pressure flight conditions.

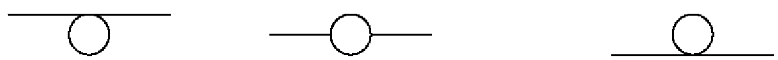
11.4.5 Stability Influences

11.4.5.1 Apparent Dihedral Effect

Apparent dihedral effect is defined as an aircraft's tendency to develop roll rate due to sideslip. Positive apparent dihedral effect equates to a roll rate into a sideslip (i.e. roll rate to the right due to a nose-right sideslip). It is produced by a lift increase on the upwind wing and a lift reduction on the downwind wing. Positive dihedral is a desired flight characteristic because kinematic coupling will tend to decrease sideslip, and thereby increase lateral and directional dynamic stability.

There are 3 major contributors to an aircraft's overall apparent dihedral effect:

Wing Location. Wing location with respect to fuselage (high wing, medium wing or low wing); high wing contributes to positive dihedral effect.



high wing   mid wing   low wing

Wing Sweep. Wing sweep (i.e. , the angle between the lateral axis of the aircraft and the leading edge of the wing); positively swept wing contributes to positive dihedral effect.

rectangular wing (no sweep)   positively swept wing

Geometric Dihedral. This is the "slope" of the wing; positive geometric dihedral contributes to positive dihedral effect.

Positive geometric dihedral   Negative geometric dihedral (anhedral)

Note that the Harrier has a high wing, which is positively swept. Both of these characteristics contribute to positive apparent dihedral. However, the Harrier's wing is also very anhedral, which contributes to negative apparent dihedral. The overall effect, though, is that the Harrier exhibits a positive apparent dihedral effect.

At low AOA, the Harrier exhibits dynamic directional stability – that is, if the nose becomes pointed out of the relative wind, it will tend to correct itself. The vertical tail is the big contributor here; when it gets kicked out of the relative wind, it is simply a wing on its side. It produces a net lift in the direction that puts the nose back into the relative wind.

At high AOA, however, the fuselage essentially blocks the vertical tail from much of the relative airflow, so the tail becomes largely ineffective. The tail's lack of effectiveness at high AOA causes a loss of directional stability.

Positive dihedral effect can help with the loss of directional stability at high AOA. The positive dihedral effect results in a roll rate into the sideslip direction. This roll rate will tend to reduce (or zero) sideslip.

11.4.5.2 Air Refueling Probe Effect

With the refueling probe retracted, the effect on flying qualities at low to moderate AOA is negligible. In maneuvering flight at AOA near and above the tone, the probe causes a left wing down rolling moment that increases with increasing AOA. This rolling moment is easily opposed with aileron but the combination of probe effect and opposing aileron may cause departures at AOA above the maneuvering tone. On TAV-8B, AV-8B 161573 through 164121, the combination of probe effect and rudder or aileron inputs may cause departures or positive AOA autorolls at AOA above the maneuvering tone. At extreme AOA induced by VIFFing, low departure resistance and the air refueling probe effect combine to increase the likelihood of departures in the absence of aileron or rudder inputs. With the probe extended, a small amount of drag and resultant yaw is generated. If the probe fails to retract, some pilot rudder compensation will be required for landing.

11.4.5.3 LERX

The LERX create a larger lifting surface forward of the center of gravity. This allows increased pitch rate in addition to allowing a higher attainable AOA due to large lifting area and through vortex generation along the wing root re-energizing the airflow and delaying laminar flow separation.

On AV-8B aircraft with 100 percent LERX, buffet is reduced significantly. Wing rock is reduced or eliminated at most airspeeds (above 120 KCAS) through FCC control laws that provide improved lateral/directional dynamic damping. On AV-8B aircraft with 100 percent LERX, at low to moderate AOA, additional augmentation is provided by the pitch axis of the SAAHS in order to counter a loss in stability induced by the 100 percent LERX. Above 12° AOA, this additional pitch augmentation is gradually reduced in order to obtain additional maneuvering capability (4° to 5° higher AOA) with full back stick. The liability for this increased pitch performance is decreased pilot feedback through wing rock/buffet of an impending departure.

11.4.5.4 External Stores

11.4.5.4.1 Maneuvering with Symmetric External Stores

Throughout its maneuvering envelope, the aircraft provides feedback to the pilot through flight-control response, airframe buffet, uncommanded yaw or roll, and roll hesitation/reversal. Each indication appears in varying degrees and rates. As the aircraft is maneuvered towards maximum angle of attack, a slight airframe buffet will occur. The angle of attack where this airframe buffet begins indicates best-sustained turn-rate performance for a given flight condition. Additional aft stick input will generate higher angles of attack and more airframe buffet with a slight increase in turn performance, while the airspeed begins to decrease (bleed). If the aft stick input is rapid, it will delay the initial onset of buffet, however the aircraft will transit directly into heavy buffet, or even a departure.

11.4.5.4.2 Gun Pack

CAUTION

The vibration from the GAU-12 firing can cause the nozzles to droop down from the aft position. The increase in lift due to having the nozzles deflected in conjunction with the RCS being energized increases the pitch sensitivity of the aircraft. A pilot who is unaware of the nozzles deflection, trying to perform the standard "conventional flight only" gun off target maneuver will be surprised by the increased pitch response and will likely depart or overstress the aircraft. Check the nozzles aft before pulling off target after firing the gun. See paragraph 11.8.1.

11.4.5.4.3 External Fuel Tanks

External fuel tanks make the aircraft less stable in pitch. Fuel in the drop tanks moves the CG aft and increases the inertia on the wings should wing rock develop. Also, the fuel tanks, due to their shape can create lift. In certain flight conditions this can create more AOA and buffet due to shedding disturbed airflow from the tank onto the wing. The same effect can occur directionally (yaw axis) as well, creating sideslip. The destabilizing effects of external fuel tanks is increased when the tanks are mounted on stations 2 and 6.

11.4.5.4.4 Maneuvering with Asymmetric Stores

At low angles of attack, the AV-8B has sufficient directional stability and low to neutral lateral stability, such that an asymmetric configuration will cause the heavy wing to drop with little yaw effect. Balanced flight can be reestablished by adjusting the lateral (aileron) trim to balance the asymmetric store and directional (rudder) trim to offset the yaw created by unbalanced ailerons and external stores drag.

At high AOA the AV-8B has abundant lateral stability and little to no directional stability due to the tail being blocked from the relative wind by the fuselage. The abundant lateral stability at high AOA is due to apparent dihedral effect. With an asymmetric store loaded, at high AOA the aircraft will be more prone to a departure in a direction away from the asymmetry. Weight asymmetry simply reduces the ability of the Harrier’s dihedral effect to lift the heavy wing should the aircraft begin to yaw away from the asymmetry. It can be thought of as being more difficult to “pick up” the heavy wing while trying to roll into the sideslip. Conversely, the weight asymmetry will also help the dihedral effect lower the heavy wing if the aircraft yaws into the asymmetry. The “beneficial” kinematic coupling that would control sideslip is thereby decreased yawing away from the heavy wing and vice versa. This results in a bias in lateral stability that promotes sideslip away from the heavy wing (nose right with a heavy left wing).

To optimize controllability and decrease the demands on the DEPRES while maneuvering with an air refueling probe installed and carrying an asymmetric store, the store should typically be loaded on the left side of the aircraft. A rough balance can then be achieved between the effects of the refueling probe and those of the wing mounted store; either a 190-pound store on station 1, a 250-pound store on station 2, or a 500-pound store on station 3. This will help avoid the de-stabilizing effect of the probe and balance the tendency of the aircraft to depart away from the heavy wing. Heavier stores or asymmetries larger than those described above could overcompensate for the refueling probe and adversely affect the DEPRES yawing to the right.

CAUTION

> High AOA maneuvering with the Litening TPOD or other right-wing asymmetry and AR probe installed will increase the likelihood of departures.

At asymmetries less than 60,000 inch-pounds, the aircraft requires minimal lateral (aileron) and directional (rudder) trim to maintain wings level balanced flight. Maneuvering characteristics at AOA greater than 1 g are similar to those of a symmetrically loaded aircraft, but require slightly more lateral stick to maintain the desired bank angle. Flying qualities cues in the form of roll and pitch hesitations are present to warn the pilot of impending departure. Post stall gyrations are generally similar to those of a clean aircraft with the exception that incipient spin motion is more likely to occur if departure occurs at high Mach number ($\geqq 0.7$). Spin direction will be away from the heavy wing. The aircraft, however, remains extremely spin resistant and neutral controls are sufficient to recover the aircraft within 1 to 2 turns.

Increasing asymmetry up to 148,000 inch-pounds will require progressively more lateral and directional trim to maintain wings level balanced flight. Sufficient trim authority is available, however, to trim for hands off 1 g flight. Increasing AOA will require significant lateral stick to hold the wings at the desired attitude until ultimately the aileron high speed stop is reached. This provides the pilot an excellent cue he is operating close to the departure boundary and further AOA increases should be avoided due to decreasing directional stability. The combination of asymmetric drag, loss of directional stability, and significant dihedral effect will require the pilot to gradually reduce the lateral stick away from the heavy wing and to hold the heavy wing down. Crossing the lateral stick over the neutral position into the heavy wing is an excellent cue to the pilot that significant sideslip is being developed and that departure is imminent.

Loaded rolls with the maneuvering tone are inadvisable. The best technique is to reduce AOA, roll with lateral stick, and then pull back into the turn. If a loaded roll must be made, then the ailerons should be coordinated with an appropriate amount of rudder. With a lateral weight asymmetry, departure resistance will be reduced for aileron-only rolls in the direction of the asymmetry or for rudder-only rolls away from the asymmetry.

11.4.5.4.5 Dive Recovery with Asymmetric External Loads

The intent here is to draw attention to the adverse effects on aircraft handling of large weight asymmetries and high IMN. This is generally experienced during ordnance delivery or recovery maneuvers when the aircraft is pointed at the ground. Knowledge of these effects and the appropriate timely pilot compensation will minimize altitude loss and uncommanded aircraft response. For odd quantity carriage, delivery, or dive recovery with asymmetry approaching or exceeding 100,000 inch-pounds, care should be taken not to exceed 0.88 IMN or 520 KCAS. If an uncommanded roll is experienced, the recovery technique is to slow the aircraft below 0.85 IMN, which will provide for increased lateral control authority. Reducing the throttle and extending the speed brake can expeditiously slow the aircraft. Additionally, since the rolling moment due to sideslip is based on the product of dynamic pressure (proportional to KCAS), angle of attack and sideslip, the aircraft will experience a rolling moment unless at least one of these three factors is zero. This means either zero airspeed, zero AOA, or zero sideslip. Understanding how to control these three factors, where to find their indications, and how they couple to produce a rolling moment is key to successful aircraft control during dynamic maneuvering, and is especially critical with asymmetric store loading.

11.4.5.5 Thrust/Power Setting

The engine, in conventional flight, will contribute to a destabilizing nose up pitch from idle to about 85 percent; above 85 percent it is considered a stabilizing force. The pitch-up occurs because the center of thrust is located slightly below the CG of the airplane, and the increasing jet blast causes a localized increase in dynamic pressure on the top of the stabilator. This effect is noticeable in all flight regimes, and can be used to help pitch the airplane at lower airspeeds (coming over the top of an overhead, or pulling the nose up in a dive). A noticeable forward push on the stick and forward trim is necessary to counteract the tendency to pitch up.

11.4.5.6 Nozzle Deflection

It is not the intent of this section to discuss the tactical employment of TVC; see Air NTTP 3.22-1. TVC affects aircraft aerodynamics in several ways. Some of these effects are not beneficial; however, their combination results in the overall increased capabilities described previously. Rotating the nozzles down at a constant attitude and thrust setting decreases the local wing angle of attack, and therefore reduces wing lift. However, this effect is more than compensated for at high power settings, because the perpendicular thrust vector component offsets the loss in wing lift, providing more g available. Tailplane effectiveness decreases slightly as high energy air is deflected away from its surface. At lower speeds, the loss in tailplane effectiveness is countered by the pitch reaction controls. (Reaction controls lose effectiveness at higher airspeeds.) The addition of reaction controls allow the pilot to maintain control of the aircraft at indicated angles of attack significantly higher than conventional flight stall angle of attack.

A characteristic pitch-up occurs when the nozzles are rotated down and the aircraft becomes more sensitive in pitch. Deflecting the nozzle increases downwash aft of the wing and the resultant more negative angle of attack at the tail causes the pitch up. The g should be monitored carefully during nozzle deflection to prevent overstress. The aircraft can be maneuvered at low speed with high AOA and will display the same characteristics as in V/STOL flight. There is little or no warning before a slow speed departure. At impending departure, defined by sideslip buildup or roll hesitation, recovery is immediate if the pilot reduces AOA and sideslip. If a departure occurs, the controls should be neutralized, throttle reduced to idle and nozzle selected aft.

11.4.6 Departure Contributors

11.4.6.1 Airspeed

Speeds above Mcrit, (0.82 to 0.85 IMN) in level 1 g flight significantly increases the tasking of the SAAHS/DEPRES to compensate for asymmetric shock-induced flow separation, which reduces the amount of DEPRES control power available to compensate for other departure contributors.

11.4.6.2 Airspeed and Altitude

Altitude changes the relationship between dynamic pressure (indicated airspeed) and indicated mach number. Even in 1 g flight, IMNs above Mcrit increase SAAHS/DEPRES saturation in order to compensate for shock-induced flow separation. If we hold IMN constant, e.g. 0.85, as we increase altitude, indicated airspeed decreases. On a standard day, at 5,000 feet, 0.85 IMN equates to about 530 KIAS. At 20,000 feet, 0.85 IMN is about 400 KIAS. For every doubling of indicated airspeed, dynamic pressure is squared. (e.g. dynamic pressure at 300 knots is roughly 4 times as great as it is at 150 knots) Therefore, at 0.85 IMN/400 KIAS at 20,000 feet there is roughly half the dynamic pressure acting on the jet as there is at the same IMN at 530 KIAS and 5,000 feet. In practical terms, that means that the aircraft has half the stability at 0.85 IMN at 20,000 feet than it has at 0.85 IMN at 5,000 feet due to decreased control power. If we consider any IMN above Mcrit to be our instability constant, control power is the means available to the DEPRES to compensate for that instability. Thus, the DEPRES has less control power at 0.85 IMN at 20,000 feet than it has 0.85 IMN at 5,000 feet because the dynamic pressure (IAS) is greater at 5,000 feet than it is at 20,000 feet even though the IMN is the same. Control authority is identical in both flight conditions.

11.4.6.3 Airspeed, Altitude, and Maneuvering

Flying the aircraft at high airspeeds and altitudes aggravates the total amount of instability the DEPRES must compensate for in 1g flight. Maneuvering the jet (pulling G) effectively lowers Mcrit (see maneuvering Mcrit) and increases the area over which shock-induced flow separation can occur. Therefore, instability is increased and the DEPRES must work harder (use more of its control authority for a given flight condition) to compensate.

11.4.6.4 Airspeed, Altitude, Maneuvering and Greater Fuel Weight

Greater fuel weights equate to more fuel in the wings. This creates more aft CG (requiring slightly more compensation from the SAAHS/DEPRES) but most significantly, heavier moment arms displaced laterally from the CG. In simple terms, heavier moment arms mean more inertia within the instabilities present at a given flight condition, and thus the DEPRES will be forced to use more of its control authority in order to compensate.

11.4.6.5 Airspeed, Altitude, Maneuvering, Greater Fuel Weight, and Commanding a Roll Rate

Going fast at altitude, turning the jet at higher fuel weights, and commanding a roll rate (making an aileron input) can exceed the DEPRES ability to compensate for with ARI to keep sideslip under control. There have been high-speed departures on intercept sorties because the pilot simply rolled the aircraft. One was flying around 25K feet at 0.89 IMN. Another happened at 13K feet/0.67 IMN and 4.5 Gs - because the pilot commanded a roll rate that exceeded the DEPRES ability to compensate and the jet had 5,500 pounds of fuel on board.

11.5 DEPARTURE AVOIDANCE

Most pilots understand that pulling back on the stick too much will generate excessive AOA, which will cause wing stall and eventually a departure. Most pilots also understand that standing on a rudder pedal will cause sideslip, which can be beneficial to induce a pro-verse yaw roll, but above 0.5 IMN dynamic pressure over the larger anhedral wing area actually prevents the roll due to the relative wind “trapping” the wing down and preventing the aircraft from rolling. The loss of the kinematic coupling of the sideslip to AOA due to this “trapping” causes excessive sideslip buildup, which will quickly lead to a departure. The use of rudder is tactically beneficial in some situations but those benefits must be weighed against the liabilities of a departure. If rudder is to be used, reducing “G” prior to rudder inputs will decrease the AOA. The liabilities associated with high-speed departures usually outweigh the benefits of rudder usage in most situations above 250 KIAS.

Because it is less intuitive, it is the aileron that is the most common culprit of departures in the AV-8B. A review of basic aerodynamics applied to the Harrier reveals why. As the ailerons are deflected opposite each other an increase in lift on one wing, caused by the increased camber due to aileron deflection, and a loss on the other creates a rolling moment. Additionally, the up-rolling wing is actually rolling away from the relative wind, which decreases the AOA on that wing, while the down-rolling wing is rolling into the relative wind which increases its AOA. The maximum roll rate of an aircraft is defined by the balance between the angular acceleration caused by the increased camber of the deflected aileron to the opposing angular acceleration caused by the increased AOA on the down-rolling wing. The penalty for this roll rate is the increase in lift on the up-rolling wing causes induced drag (proportional to the amount of lift a wing creates) on that wing which makes the aircraft yaw away from the direction of the roll. This sideslip if not corrected by either pilot or DEPRES (ARI) causes the down-rolling wing to accelerate into the relative wind which increases the lift created by that wing which counters the pilot induced roll rate. So it is possible in this aircraft to get a decreased roll rate with higher aileron deflection. The high aileron deflection is also increasing the risk of a departure due to increased camber on the up-rolling wing causing either laminar flow separation (stall) below transonic speeds or shock-induced flow separation due to decreasing Mcrit on the wing with the aileron deflected. From the above discussion seven recurring “rules” become apparent for departure avoidance:

CAUTION

- Avoid use of the rudder above 250 KCAS.
- Near “Maneuvering” Mcrit, reduce the throttle prior to aggressively maneuvering to ensure the airspeed remains less than Maneuvering Mcrit.
- Do not roll the aircraft with high roll rates under moderate (or greater) G/AOA.
- Do not roll the aircraft at higher G/AOAs. (Reduce G/AOA prior to rolling). Do not use high G/AOA onset rates.
- (Do not “snatch” on the G/AOA).
- Do not roll the aircraft with high roll rates at high mach numbers (Slow below Mcrit prior to rolling/turning).
- Do not try to pull to “normal” maneuvering AOAs at greater than 0.78 IMN. (Buffet onset can occur as low as 7 to 8 degrees AOA).

11.5.1 Impending Departure Indications

Most departures in the AV-8B are preceded (sometimes barely) by and indication of the impending departure. The most common impending departure indicators, in order that they are likely to be encountered, are wing rock, roll hesitation/reversal, heavy buffet and the maneuvering tone.

11.5.1.1 Wing Rock

Wing rock is a fast, uncommanded roll oscillation that occurs just prior to a departure. At low airspeeds (below approximately 250 KCAS), the wings may “rock” 3 to 4 times before the aircraft actually departs. At higher speeds (IMN), especially with 100 percent LERX, there may be no rock beyond just a single roll reversal followed instantly by a departure. Wing rock also contributes to sideslip buildup. By creating an oscillatory yaw divergence, wing rock usually leads to a departure unless the AOA is immediately reduced.

11.5.1.2 Roll Hesitation/Reversal

At slow speeds and high AOA the wing may not have the energy to develop a wing rock and instead creates a roll hesitation, where a lateral (aileron) input yields no response; or a roll reversal where a lateral input causes the jet to roll in the opposite direction to the input. The correction for either of these conditions is to quickly center the lateral stick and reduce the AOA.

11.5.1.3 Heavy Buffet/Pitch Hesitation

In some flight regimes, usually at lower airspeed, the aircraft may get into very heavy buffet, characterized by significant airframe vibration and stagnation of the pitch rate or “pitch hesitation” without first encountering wing rock. This is typically due to AOA exceeding 20 units. If allowed to persist the aircraft will typically enter a roll hesitation or reversal condition as soon as a lateral stick input is commanded or sideslip is encountered.

11.5.1.4 Maneuvering Tone

The maneuvering tone operates as a function of AOA and IMN. If AOA onset is smooth and progressive the tone will sound to warn the pilot that the aircraft is in a flight condition where the DEPRES is likely approaching saturation. However, since the tone operates as a function of AOA and because HUD AOA can lag significantly with high AOA onset rates, the aircraft can enter a departure condition without the tone sounding. The smart AV-8B pilot should not rely on the tone to warn of an impending departure and should keep AOA onset rates smooth and progressive. There have been quite a few high speed departures in this aircraft where the maneuvering tone begins to sound as the aircraft is in its first or second post-stall gyration from a departure.

11.6 STALLS

Stalls in conventional flight can be defined as flight at an AOA above that where the wing produces maximum lift. The stall AOA varies with aircraft configuration. Typical AV-8B values for normal stalls at sea level are 18° to 19° for the clean (gear up, nozzles aft, flaps cruise) configuration (Figure 11-1). With nozzles deflected, flight below the conventional stall airspeed for the given conditions requires engine thrust to augment wing lift in order to maintain level flight and the RCS system to maintain aircraft control.

Note

With nozzles deflected, flight characteristics are significantly different. Refer to V/STOL flight characteristics.

11.6.1 Normal Stalls

Normal (1 g) stalls are mild with little or no buffet. High sink rates can develop. With gear down and flaps CRUISE or AUTO and/or with external stores, the characteristics are similar. The usual characteristic at stall is left or right wing drop. Recovery is immediate when the back stick is relaxed.

11.6.2 Accelerated Stalls (with DEP RES)

In the accelerated stall, directional stability decreases and the wing stalls asymmetrically. The accelerated stall is characterized by any of the following: (a) wing rock, (b) sideslip buildup, or (c) full back stick. Wing rock usually occurs coincident with full back stick below 0.7 Mach. Wing rock is usually divergent with sideslip increasing with each oscillation until departure occurs.

Wing rock and oscillatory departures have been significantly reduced during accelerated stalls. However, sudden sideslip build-up may still occur without warning. Sideslip buildup is usually the result of control input. The rate of sideslip buildup increases with Mach number. Sideslip defines the point of stall and, if allowed to continue, will result in departure and post stall gyration (PSG). In the absence of wing rock or sideslip, full back stick defines the stall. For large lateral stick inputs at AOA above the maneuvering tone, the initial response is generally good but a roll hesitation with sideslip will occur after about 90° of bank angle change and departure is likely. Below 0.5 Mach, the roll rate can be improved with rudder. Above 0.5 Mach, the roll due to yaw is less effective and the aircraft becomes increasingly prone to rudder induced departure with increasing AOA and/or Mach number. Above 0.7 Mach and at AOA above the maneuvering tone, any appreciable rudder input will cause departure. Rudder pedal induced departures primarily occur above the maneuvering tone when the air refueling probe is installed.

11.7 DEPARTURE, POST STALL GYRATION AND DEPARTURE RECOVERY

11.7.1 Departure and Post Stall Gyration

A departure is not a flight condition in itself, but the event separating controlled from uncontrolled flight. Post stall gyration (PSG) is defined as uncontrolled motion about one or more aircraft axes following departure. Post stall gyration, spin and deep stall are examples of out-of controlled flight. Departures at airspeeds less than 120 KCAS are oscillatory and exhibit good warning with wing rock gradually increasing in severity until control is lost, Departures are characterized by continued increase in sideslip which abruptly couples with roll rate as the aircraft unloads. The roll rate is 2 to 3 times greater than the yaw rate which gives the pilot the sensation of a rolling departure. Departures between 120 and 250 KCAS gradually become more violent with increased airspeeds. Departures at airspeeds greater than 250 KCAS are usually non-oscillatory with little warning and can produce, at the pilot's seat, severe vertical, horizontal, and lateral accelerations that may abruptly reverse direction. Helmet/canopy impact is possible as the pilot's upper torso responds to these sudden accelerations. One or more uncommanded snap rolls in the direction of and away from the departure may occur during the PSG as the aircraft loses airspeed and assumes a steep, nose down attitude. Recovery from the PSG is prompt with neutral controls. If the departure occurred during vectoring in forward flight (VIFF), rapidly moving the nozzles aft may aggravate the departure and/or result in more violent PSG. Nozzle angle should be slowly reduced to zero; however, engine shutdown after locked-in surge may prevent the nozzles from retracting fully aft. Departure recovery will not be effected with the nozzles deflected. Airstarts have been successfully completed with nozzle angles up to 40°. Nozzle down airstarts resulted in slightly higher JPT levels than nozzle aft airstarts and no significant difference in recovery altitude. Post relight dive recovery and engine spool-up should be performed nozzles aft to prevent large nose up pitch/AOA excursions and possible departure. Moving the nozzles aft may prolong the PSG by momentarily inducing a negative AOA autoroll.

Due to the abrupt and extreme changes in aircraft attitude that can occur during a departure and subsequent PSG, the aircraft INS may cause erroneous maximum normal load factors (NZ) to be displayed on the HUD and the DDI Fatigue Life Counter display. Following a departure, the pilot should use the Maximum Possible Normal Load Factor Chart (see Figure 4-12) to estimate the maximum NZ attained by the aircraft. An over-g inspection of the aircraft per the A1-AV8BB-GAI-400 Maintenance Manual is required if this estimated NZ exceeds the allowable structural load factor limit.

11.7.2 Positive AOA Auto Roll

The positive AOA autoroll is characterized by positive AOA (20° to 45°), low to moderate yaw rate (35 to 70°/sec) and moderate roll rate (70 to 120°/sec). Positive AOA autorolls may follow rudder rolls above the maneuvering boundary with the IFR probe installed or may follow departures at extreme AOAs induced by VIFFing. This spin like motion can be disorienting regarding the nature of the motion or the number of rolls. Recovery with neutral controls normally occurs after 4 seconds or within 2 rolls. Recovery is aided with opposite rudder. Opposite aileron in not effective and may induce additional sideslip and aggravate the post stall gyration.

11.7.3 Negative AOA Auto Roll

The negative AOA autoroll is characterized by negative AOA (-5° to -10°), approximately 90° nose down pitch attitude and divergent roll rate (roll rates as high as 320 degrees/second have been recorded). This spin like motion is disorienting, uncomfortable and easily misinterpreted as an inverted spin. With neutral controls the motion is transient. With pro-spin control a spin will occasionally self-recover and deteriorate into a negative AOA autoroll. Neutral controls are effective in all cases in producing recoveries in one to two turns, however, altitude loss from the ensuing recovery is large (2,000 to 6,000 feet) because of the extreme nose down attitude and rapidly increasing airspeed.

11.7.4 Upright Spins

The aircraft is very reluctant to enter and maintain upright spins, requiring precisely timed inputs of aft stick along with crossed ailerons and rudder. The typical upright spin is steep and oscillatory in nature with yaw rates near 70°/second and AOA between 45° and 65°. For the symmetric aircraft, approximately 50 percent of all spin attempts with full aft stick and crossed controls result in post stall motions classified as spins. Of these spins approximately 50 percent are self recovering even with full pro-spin controls and in all cases neutral controls are effective in producing rapid spin recoveries within 7 seconds or 1 1/2 turns.

The effect of asymmetric store loadings on upright spins is to increase spin susceptibility and to decrease the ease of recovery, requiring full anti-spin controls for recovery in one case with an asymmetric 300 gallon tank on the intermediate station. The effects of weight asymmetries on upright spin characteristics are similar with a tendency towards somewhat flatter and faster spins than the symmetric case. Neutral control recoveries provided a 100 percent success rate only up to 12,000 inch-pounds asymmetry (example: AIM-9 on an outboard station = 29,700 inch-pounds). Neutral control recovery probability decreases rapidly with increasing asymmetry and becomes totally ineffective at 90,000 inch-pounds asymmetry (example: Mk-82 outboard = 88,000 inch-pounds). Only full anti-spin controls are 100 percent effective in upright spin recoveries for asymmetries between 12,000 inch-pounds and 90,000 inch-pounds, however, even at 90,000 inch-pounds asymmetry, recoveries using full anti-spin controls were rapid with recoveries occurring within 5 seconds or 1 turn.

11.7.5 Inverted Spins

Inverted spins are easily produced by sustained rudder and forward stick inputs. The typical inverted spin is steeper and less oscillatory than the upright spin. Yaw rates were near 55°/second with AOAs between –30° and –45°. Recoveries from inverted spins are almost immediate upon control neutralization, requiring 6 seconds or 1 1/2 turns.

For inverted spins the effect of lateral weight asymmetries is to flatten spins into the heavy wing, and to steepen those away from the heavy wing, with little to no significant change in associated roll and yaw rates. For all asymmetries tested, neutral controls resulted in rapid spin recoveries within 6 1/2 seconds or 1 1/2 turns.

11.7.6 Falling Leaf (TAV–8B and Radar Aircraft Only)

Departures and tailslides can result in prolonged, highly oscillatory PSGs that have been given the term Falling Leaf due to the violent reversing characteristics of the motion. The motion is similar in nature to spins only to the extent that equilibrium in the pitch axis is achieved through inertial coupling, thereby preventing a reduction in AOA. The motion can be quite severe and disorienting to the pilot since the aircraft repeatedly reverses direction and does not exhibit a predominant direction as does a left or right spin. Violent reversals in bank and heading angles can occur along with extreme oscillations in AOA and pitch attitude. Altitude loss rate can be as high as 24,000 fpm. Engine compressor stall, resulting in a locked surge requiring engine shutdown, is likely to occur. Recovery from the falling leaf PSG is best achieved with full forward stick and neutral ailerons and rudder. Recovery from the PSG motion to a nose down attitude can take several seconds. Additional time and altitude are required to regain flying speed, restart the engine, and recover to level flight.

11.7.7 Effects of Departure On Engine

Engine compressor stall/locked surge is likely to occur during high Mach/high altitude departures (less than 250 KCAS/greater than 0.7 Mach) or high airspeed/medium altitude departures (greater than 250 KCAS) and is indicated by increasing JPT with decreasing rpm. Compressor stall/locked surge can be accompanied by a pop or series of pops which can be felt in the airframe or be audible to the pilot. If engine rpm is low during the departure, locked compressor stall/surge may only be apparent to the pilot through cross check of rpm and JPT. Departures at high power setting will result in engine fan rub, possibly requiring engine removal. Fan rub can be greatly reduced by promptly retarding the throttle to idle at the first indication of departure.

During a high speed departure (greater than 250 knots), LP fan rub is likely. LP fan rub reduces the ablative materials that protect the engine casing from the fan blades. Minimize maneuvering and land the aircraft as soon as practical. Full authority of the engine is still available and should be used if necessary for a successful landing.

11.7.8 Recovery

Neutral controls are effective in producing recoveries from all departure post stall gyrations, inverted spins, positive or negative AOA auto–rolls, and upright spins with lateral weight asymmetries up to 12,000 inch–pounds. Neutral controls are defined as zero degree rudder, aileron and stabilator. The pilot can confirm neutral controls by centering the rudder pedals, centering the stick laterally and fore–aft in the cockpit, and by checking the stabilator position indicator on the EDP at zero degrees. Stabilator trim position can affect the pilot's workload in maintaining a consistent neutral control position due to stick pressure. Recovery from positive AOA auto–rolls may be hastened with opposite rudder. For upright spins with large store and/or lateral weight asymmetries full anti–spin controls (opposite rudder and aileron in the direction of the spin) may be necessary to effect spin recovery.

Unexpected forces during OCF can make it difficult for the pilot to operate flight controls and view cockpit instruments. A locked shoulder harness may help keep the pilot in a position to manipulate the flight controls and view the instruments. Consideration should be given to locking the shoulder harness prior to maneuvers where OCF may be encountered.

11.8 SEMI–JETBORNE/JETBORNE FLIGHT CHARACTERISTICS

The Harrier, in wingborne flight, is similar to any other jet aircraft, but, in the semi–jetborne and jetborne regime, it exhibits peculiar characteristics not readily apparent to those familiar only with conventional aircraft. The term semi–jetborne indicates that some of the lift required for flight is provided by engine thrust with the remainder supplied by wing lift. The semi–jetborne flight regime includes all altitudes and different aircraft configurations, including gear up or down and is not limited to flight near the ground. The term jetborne indicates that all lift is being generated by engine thrust (30 knots or less).

11.8.1 Pitch Stability

The aircraft exhibits neutral to unstable pitch stability characteristics in semi-jetborne flight. This is seen by the pilot as a progressive forward movement of the control stick with increasing pitch sensitivity as AOA increases. Factors which affect the stability are:

1. CG location. The greater the instability, the greater the tendency to over control. This characteristic is particularly evident during high-performance STO. When operating at an aft cg, coarse back stick movement should be avoided.

2. Carriage of forward extending inboard stores.

3. Engine thrust. Nose up pitching moments increase with increasing thrust. Use caution during turns or high AOA flight. AOA excursions due to power increases, especially idle to full throttle slams, can lead to departure. The effect increases with lower altitude, slower speed and increasing nozzle and wing flap deflection. AOA excursions greater than 10° have occurred during throttle slams at 30° nozzles.

CAUTION

The carriage of outboard stores and water produces an aft cg condition which increases pitch sensitivity.

11.8.2 Yaw Stability

Intake momentum drag which acts parallel to the relative wind and ahead of the cg is a destabilizing force in yaw. See Figure 11-6. This destabilizing force is much smaller than the stabilizing effect of the vertical stabilizer at normal wingborne flight speeds. It is obvious that the vertical stabilizer has no effect at zero airspeed; therefore, the intake momentum drag makes the aircraft unstable in yaw in the hover. The exact crossover point is dependent upon several factors, but the stability decreases progressively with decrease in airspeed. The aircraft is near neutral stability in yaw between 50 and 60 knots and is unstable below 50 knots. Appreciable yaw between 30 and 90 knots can lead to loss of control in roll.

11.8.3 Roll Stability

As in most aircraft, rolling moments are produced as a result of and proportional to sideslip. If the sideslip angle (angle between the aircraft centerline and the relative wind) becomes so large that the rolling moment exceeds that produced by the ailerons or other roll control devices, control is lost. At wingborne speeds the vertical stabilizer provides sufficient directional stability to prevent loss of roll control. The rolling moment produced by sideslip is proportional to the product of indicated air speed (q), AOA (α) and sideslip angle (β). If any two of the terms have a large value, it is obvious that even a small value for the third term will produce a large rolling moment. Thus if airspeed and AOA are high (120 knots and 15°), a small sideslip angle will produce a large rolling moment. Likewise, a large sideslip angle (30°) and a large AOA (15°) will produce a large rolling moment at a low airspeed.

While airspeed and sideslip angle can change fairly rapidly, it is obvious to the pilot from visual cues that this is occurring; however, AOA can increase rapidly without obvious visual or feel cues. AOA can be increased rapidly by stick application but, more dangerously because of poor visual cues, it can increase rapidly with sink rate. Most dangerous of all, the AOA will increase instantly with roll if there is a sideslip angle present. This can result in an almost instantaneous loss of control with very little or no warning. A typical loss of control sequence at low airspeed involves allowing a sideslip to develop which introduces a rolling moment which, if not counteracted, instantly increases AOA which increases the rolling moment so that the situation becomes progressive. This is why we keep the nose into the relative wind on all V/STOL evolutions and NEVER fly a crosswind approach using the wing-down top-rudder method.

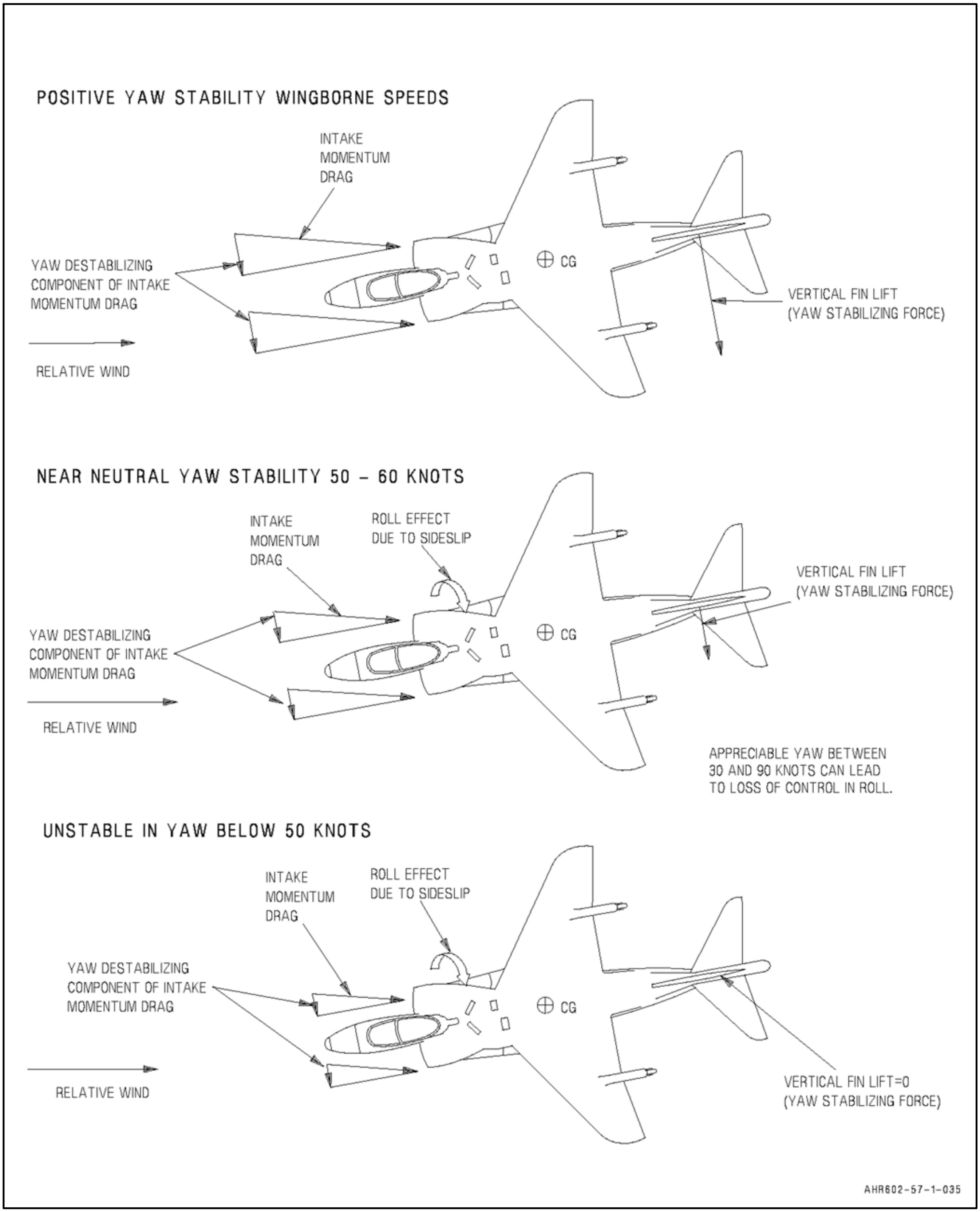


Figure 11-6. Intake Momentum Drag

11.8.4 Out-of-Control Roll Avoidance

From the preceding discussion it can be seen that, if the sideslip angle is zero, no rolling moment can exist. Control of sideslip is therefore the primary method of avoiding (but not recovering from) loss of control. The most reliable sideslip indicator is the yaw vane. The yaw vane points into the relative wind, in the direction of nose movement to zero sideslip, and in the direction of the rudder pedal to zero sideslip. The HUD sideforce symbol is in the direction of the relative wind and toward the rudder required to zero sideslip. The rudder pedal shaker shakes the rudder required to zero sideslip (push the shaking pedal). The rudder pedal shaker is set at a relatively low sideforce so that initiation of rudder pedal shaking does not indicate a requirement for large or coarse corrective action.

11.8.5 Reaction Control Power

Control in the semi-jetborne regime is provided by a combination of conventional aerodynamic controls and the reaction control system (RCS). The effectiveness of the aerodynamic controls decreases with decreasing airspeed. With SAS off, controls are sensitive in roll, fairly sensitive in pitch and sluggish in yaw. The pitch, roll and yaw stability augmentation noticeably steadies the aircraft and reduces pilot workload. Simultaneous application of control in more than one axis may result in a reduction of maximum available reaction control in all axes. This is because a maximum control deflection in one axis uses over half the total RCS bleed air available. As an example, full forward stick used to correct a pitch-up will degrade the pilot's capability to correct a disturbance in yaw or roll, and control inputs to correct this disturbance will reduce thrust of the rear pitch nozzle.

WARNING

Large nose-up pitch rates must be avoided in V/STOL flight because available tailplane and reaction control pitch authority maybe insufficient to prevent the angle of attack from rapidly increasing above the point where pitch control is lost. Uncontrollable pitch-up is most likely to occur at extreme aft cg loadings and/or with the wing flaps deflected more than 25°. Flap deflection more than 25° dramatically increases the downwash on the tailplane. In extreme cases, this increased downwash on the tailplane results in loss of pitch control. In these situations, the nose can be lowered by moving the nozzle lever forward (reducing the nozzle angle 20° is sufficient) followed by an immediate movement of the nozzle lever aft to the previous nozzle angle (to the STO stop on a STO). If pitch control cannot be regained with nozzle movement and altitude permits, initiate the out-of-control/spin recovery procedure.

11.8.5.1 Nose Tuck with Flap Programming

Loss of horizontal stabilator effectiveness when the flaps program down greater than 25° can cause a nose down pitching moment that must be arrested with RCS pressure from the forward RCS duct. This effect is most pronounced in the TAV-8 and to a lesser extent the RADAR variant due to their heavier nose. The problem develops when the flaps are allowed to program with the throttle at idle, providing very little pressure to the RCS. A typical scenario that induces this is a weak pull in the break that does not decelerate the aircraft quickly so on the downwind the pilot is fast abeam with the throttle still at idle while selecting gear down, nozzles to 60° and flaps to STOL. At the 180 position the pilot starts the approach turn descent and as the aircraft finally decelerates through the 165 KCAS the flaps program from 25° to 62° near instantly causing a strong nose down pitching moment. Because the aircraft is fast, the pilot still has the throttle at idle trying to get on-speed with little RCS pressure to stop the nose. This coupled with already being in a descending approach turn can put the aircraft in an extreme nose low attitude with a high rate of descent and very little altitude to recover. The fix for this problem is to add power prior to the flaps programming to energize the RCS system to provide control power to stop the nose down pitch.

11.8.6 Nozzle Blast Impingement

Nozzle blast impingement occurs when exhaust gases from the rear (hot) nozzles are directed onto the flap surfaces resulting in a moderate to severe nose down pitch rate. Impingement will occur anytime the flap angle exceeds the proper value dictated by the nominal STOL flap/nozzle interconnect schedule as shown in Figure 11-7. For example, with a nozzle angle of 40°, a flap angle greater than 47° will result in impingement. Conversely, if flaps were failed locked at 47°, a nozzle angle less than 40° would result in impingement. Since the flaps are located aft of the center of gravity, any force acting on the flap surface will cause a rotation of the aircraft about the C.G. In the case of nozzle blast impingement, the force of the engine exhaust from the rear nozzles acting on the underside of the flaps will result in a nose down pitching moment. The severity of the pitch moment and pitch rate will vary with the magnitude of flap impingement, engine rpm, and aircraft loading. Time and altitude to stop the pitch rate and recover the aircraft will vary with pilot reaction time to apply aft stick and lower the nozzles, attitude at initiation of recovery, engine rpm (thrust), airspeed (aerodynamic control), and initial aircraft pitch, roll, and yaw rates. Severe pitch rates of 40 to 50 degrees per second, cockpit load factors of –2.5 g, and a rapidly descending flight path can be generated by an aircraft operating at light gross weight, nozzles aft, at full power, and flaps failed full down. Generally, full aft stick with nozzles moved to 40° or greater is required to stop the pitch rate and recover the aircraft from this failure scenario.

The extreme aircraft response to full flap deployment generally exists for nozzle angles of 20° or less. However, beyond 20° nozzle, aircraft pitch rate response to full flap deployment quickly diminishes. Full flap deployment with nozzle angle at 25° requires only aft stick to stop the pitch rate and establish the desired nose attitude for rapid recovery. Full flap impingement with nozzles positioned at 30° requires little to no aft stick input to maintain the desired climb attitude. In both cases, the aircraft maintains a zero to positive rate of climb flight path throughout the initial impingement and subsequent recovery.

CAUTION

- Rotation of the nozzles aft with failed flaps can cause a severe nose down pitch due to nozzle blast impingement on flap surfaces. The nose down pitch rate will be arrested by a combination of aft stick and selection of a nozzle angle greater than 40°. The aircraft must then be recovered from the nose down attitude.
- Uncommanded programming of the flaps greater than 25° with nozzles less than 20° will cause a severe nose down pitch rate. The extreme attitudes coupled with negative g of up to –2.5, as experienced by the pilot, will be extremely disorienting and make cockpit functions difficult to perform. A combination of full aft stick and rotation of the nozzles to an angle greater than 40° are required to arrest this condition.

11.8.7 Crosswind Accelerations

When conducting VTO–Accelerating Transitions, the preferred technique is to perform the maneuver directly into the wind and then turn into the landing pattern once wingborne flight is achieved. However, there may be occasions when local traffic procedures or the proximity of obstacles preclude this technique. When required, the accelerating transition can be conducted along a track line that does not coincide with the wind line. After a normal into the wind VTO, the pilot conducts a pedal turn until the nose of the aircraft is pointed down the desired acceleration path. When the pedal turn has been completely stopped, a normal accelerating transition begins. Once forward velocity has been established along the desired track, the pilot then centers the wind vane. This action must occur prior to reaching 30 KCAS. This normally requires the pilot to apply a moderate amount of rudder back toward the wind line shortly after the accelerating transition begins. As aircraft velocity increases during the transition, less and less crab will be required. This technique is referred to as a Continuous Crosswind Accel due to the fact that there is no pause between the VTO and the transition, and the power remains at full throttle throughout the maneuver. When the desired track substantially differs from the wind line, there is a risk that the pilot will lose adequate hover references before he can establish a proper transition. This problem becomes more severe when excess performance is very high, the pedal turn is conducted slowly or visual cues are degraded due to darkness. If the pilot lacks proper visual cues to conduct the maneuver or if the pilot begins the transition before stopping the pedal turn rotation, then a rapid loss of control can occur. In order to minimize this risk, the pilot may elect to perform a Non-continuous Crosswind Accel. Due to the use of a hover phase, this maneuver must be performed at or below hover weight. (MC computed VL weight can be used as an in-flight substitute.) This maneuver starts with a normal into the wind PRESS-UP to a HOVER. The pilot conducts a pedal turn until the nose of the aircraft is pointed down the desired acceleration path. When the pedal turn has been completely stopped, the throttle is advanced to FULL and a normal accelerating transition begins. Once forward velocity has been established along the desired track, the pilot then centers the wind vane. This action must occur prior to reaching 30 KCAS. This normally requires the pilot to apply a moderate amount of rudder back toward the wind line shortly after the accelerating transition begins. As aircraft velocity increases during the transition, less and less crab will be required. Use of the hover helps to ensure that visual cues are maintained and increases the likelihood that pedal turn will be fully stopped before the transition begins.

11.8.8 Short Takeoff

Takeoff distance charts in the Performance Data, Part XI, are based on use of the high performance Short Takeoff (STO) technique. The essential difference between the normal and high performance STO is that, in the high performance STO, the aircraft is rotated to a 14° pitch attitude which is maintained until all obstacles are cleared.

On a STO, the angle of attack shall not be greater than 15° Over rotation or high rotational rates may result in the AOA rising uncontrollably even with stick full forward. When this occurs a nose down pitch may be induced by moving the nozzle lever forward (reducing the nozzle angle 20° is sufficient) followed by an immediate movement of the nozzle lever aft to the STO stop. Uncontrollable pitch-ups are most likely to occur at extreme aft cg loadings and/or with the wing flaps deflected more than 25°.

During STOs with high lateral asymmetries:

1. Pilots should attempt to position the relative wind under the heavy wing (if feasible) or, if known in advance, load the aircraft according to the prevailing relative wind.

CAUTION

Flight test results have indicated that with asymmetries greater than 80,000 inch pounds pilot workload is dramatically reduced by positioning the relative wind under the heavy wing.

2. During initial ground roll, NWS will be required to correct tendency to drift toward the heavy wing.
3. With lateral asymmetries above 32,000 inch-pounds, increase STO NRAS by 10 KCAS.
4. With lateral asymmetries above 80,000 inch-pounds pilot workload is reduced and comfort level increases by adding 15 KCAS to the NRAS.
5. Rotating nozzles aft too quickly will reduce total roll control power requiring large lateral stick inputs away from the heavy wing. The rate of nozzle rotation is dependent on excess performance and should be performed at a rate which will allow the wings level attitude to be controlled without excessive lateral stick deflections.

Note

Takeoffs at aft cg positions in high crosswinds will require more forward stick position and increased reaction control system demands. For short takeoffs, AUTO flaps will require more forward stick displacements than STOL flaps. AUTO flap STOs at cg positions approaching the aft limit in crosswinds in excess of 10 knots are approaching the limits of control authority. For crosswinds of more than 10 knots, a CTO is recommended if runway length permits, otherwise a STOL flap STO is recommended.

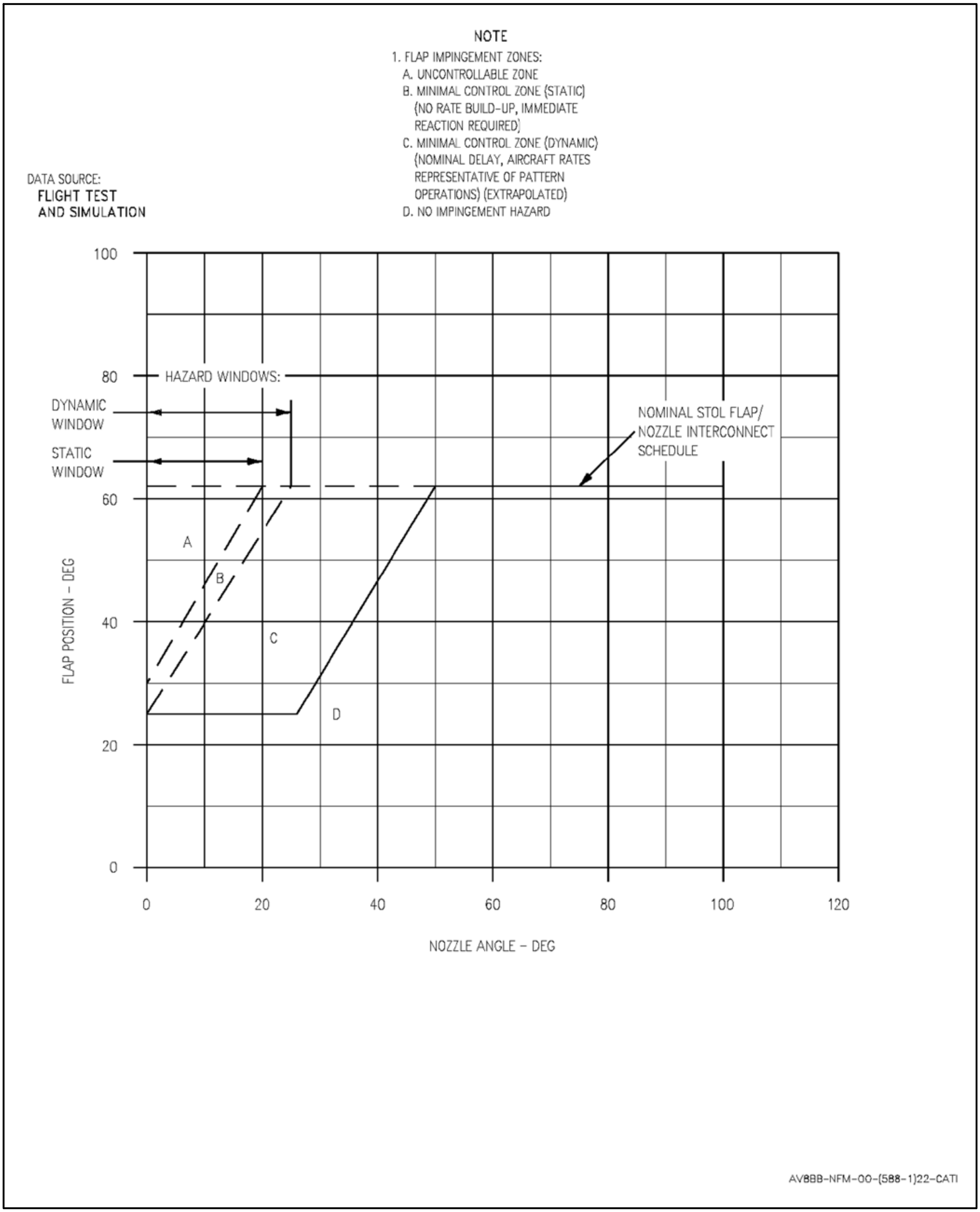


Figure 11-7. Flap Impingement Envelope

11.8.9 Vertical Takeoff

With SAS and LIDS operable and strakes or gun packs installed, VTOs are very smooth throughout and minimal pilot control is required. For a maximum performance VTO, a small amount of back stick just after lift off may be required to initially capture more of the LIDS lifting pressure. If the SAS and/or LIDS are not operable, upsets in ground effect will be more noticeable and will require more aggressive pilot control to compensate.

During a VTO, some instability due to ground effect may occur resulting in uncommanded roll at lift-off. A crosswind VTO may also result in uncommanded rolls at lift-off. It can be aggravated by: low performance margin, improper longitudinal and lateral trim, lateral stick interference, allowing the heading to diverge downwind, and nozzle misrigged/inaccuracy. To minimize those effects, VTO performance must be accurately computed, trim properly set, stick interference avoided and heading maintained during lift-off.

Unstable rolling moments due to bank can reach a maximum at only 5° to 6° bank angle. This occurs very close to the ground (1 foot above the deck). Crosswind during a VTO has little effect at low heights but produces a rolling moment at zero bank angle as height increases. It is critical that any bank angle at lift-off be immediately recognized. Scan at lift-off on a VTO should be primarily straight ahead in order to more easily notice a roll attitude change. Should a wing start to drop during a VTO, an immediate application of corrective control is needed to overcome the instability. Both coarse rudder and aileron (frequently full opposite stick for a short period of time) may be required to arrest a roll and maintain the desired heading into the wind. When too little corrective control has been applied, or it has been applied too late, recovery to wings level may be impossible due to insufficient authority of the roll reaction controls.

Should a roll be experienced and the bank angle cannot be reduced by full opposite control, the throttle should be reduced and the aircraft landed if lateral velocity has not developed. Whenever possible VTOs should be executed with nose into wind.

A VTO from a surface with lateral slope should be avoided, if possible, as the aircraft may tend to skip and skid during engine acceleration due to the side component of lift relative to the true vertical. The wings cannot be leveled to prevent the slide until wing gear freedom is attained and this occurs at a thrust level which exceeds that at which skip and skid occurs. With the aircraft positioned heading up or down the slope, the nozzles may be adjusted away from the hover stop by an angle equal to the slope so that a clean unstick may be achieved. Preferably, the aircraft heading should be up the slope to minimize the recirculation effect.

11.8.10 Hovering

The aircraft is unstable in yaw and has neutral stability in pitch and roll in hovering flight. The reaction controls are acceleration demand controls as opposed to the normal rate demand control of aerodynamic surfaces. This difference requires no conscious change of pilot technique but can lead to over control until experience is gained. Turns with very small angles of bank can be made at speeds up to 30 knots. Large sideslip angles can inadvertently develop due to directional instability at low speed which results in yaw out of the relative wind. The sideslip which can be developed causes large rolling moments which, in extreme cases, can lead to loss of control. If significant sideslip develops, use rudder to reduce the sideslip and aileron to level the wings. If roll is used to reduce sideslip, a sudden increase in incidence will occur with a resultant increase in rolling moment and possible loss of control.

11.8.11 Accelerating Transition

The aircraft is unstable in pitch during an accelerating transition. A constant attitude transition simplifies the pilot task. If pitch attitude must be increased during transition, aim for 12° AOA and do not exceed 15° AOA. The pitch reaction control bleed air required for trim during transition will cause a JPT increase; therefore, the JPT must be monitored during transition. After sufficient wing lift has been attained, the throttle may be reduced to control JPT. Transitions near performance limits require smooth and cautious nozzle control and stick movement to avoid excessive pitch trim changes and resultant coarse corrective control. Coarse control may result in a reduction in engine thrust due to excessive control bleed or JPT cutback. Smooth and cautious control is particularly important when operating in confined sites where obstacle clearance is a factor.

Below 120 knots, pilot action is required to minimize sideslip to prevent large mid-transition rolling moments. A large aileron application to maintain roll attitude is an indication that excessive sideslip has developed. Rudder in the same direction as aileron corrects sideslip. Above 120 knots, there is sufficient directional stability to control sideslip with little pilot input required.

11.8.12 Crosswind Landing

During operations in crosswind conditions, the aircraft, in concert with the SAAHS system, reliably seeks and maintains a zero sideslip, crabbed condition throughout the landing approach with little to no pilot input required. The magnitude of the crab angle will vary as a function of approach speed and crosswind component. As the aircraft enters ground effect at approximately 20 to 30 feet AGL, some natural alignment of the aircraft heading to the established ground track will occur. The amount to which the aircraft aligns itself varies with approach speed and rate of decent. During conventional landings, stabilized crab angles may be up to 6°, however, very little natural alignment will occur prior to touchdown. During slow landings, the aircraft will tend to reduce approximately 50 to 75 percent of the stabilized crab angle prior to touchdown. During RVL landings, the aircraft will tend to nearly align itself completely with the established ground track. Assuming that the aircraft does not stagnate in ground effect during this natural alignment, very little deviation from the established ground track will be noted. Similarly, there will be little to no rolling tendency associated with the natural alignment requiring pilot input to maintain a wings level attitude for touchdown. Stagnation in ground effect or other delay in touchdown even in the presence of natural alignment will permit sufficient lateral drift to develop resulting in sharply degraded handling qualities. Post touchdown handling qualities will vary with gross weight, groundspeed, touchdown crab angle, and lateral drift.

While all these factors will ultimately determine how the aircraft behaves at touchdown, it is most sensitive to lateral drift. With little to no lateral drift prior to touchdown, the aircraft completes its alignment and continues along the established ground track with little to no initial pilot input required. If the aircraft is landed in a crab, side forces applied to the landing gear at touchdown will result in the aircraft rolling away from the upwind wing as it aligns itself. The apparent severity and magnitude will vary with crab angle and touchdown speed, however the aircraft will seek and maintain the ground track established prior to touchdown. The recommended technique for landing in the presence of crosswinds is a crabbed approach with pilot augmentation of whatever natural alignment occurs prior to touchdown. The aircraft may be safely landed in a crabbed condition up to 10° within the crosswind envelope, however, minimizing the crab angle prior to touchdown will minimize the touchdown aircraft motion described above. The magnitude to which the pilot elects to further reduce the crab angle during alignment will be based on his comfort level and proficiency. It is critical that the pilot not attempt to reduce the crab angle too early in the approach nor stagnate in ground effect in order to minimize the opportunity for significant lateral drift to develop.

If the pilot is uncomfortable with the established crab angle during the approach and landing, he may reduce the crab angle by either one or combination of two methods. The pilot may elect to increase his approach airspeed via use of lower nozzle angle or flap angle with due consideration for runway length and stopping distance. If the pilot elects to fly a faster airspeed, he should ensure that an on speed condition is maintained. Electing to fly the aircraft at a faster airspeed by reducing the angle of attack to less than 10° units will effectively reduce the crab angle during the approach, however, this will degrade touchdown and post touchdown handling qualities. His second option may be to reduce crab angle just prior to touchdown via aircraft natural alignment or rudder input. If the pilot favors this method, rudder input should be made after the landing attitude has been set, and prior to touchdown, generally 20 to 30 feet AGL. This will preclude development of lateral drift at touchdown optimizing aircraft handling and rollout characteristics.

During landing rollout, aircraft control and steering may be enhanced by selecting flaps to CRUISE. Selecting 4° nose down trim when below 100 KIAS will also reduce the porpoising effect common to conventional landings. Lateral stick into the wind will also assist with maintaining a wings level attitude during landing rollout. Forward stick during landing rollout and PNB will result in more weight shifting to the nose gear sharply reducing controllability and steering effectiveness. Runway centerline tracking immediately after touchdown should be accomplished using rudder aerodynamic forces. As the rudder loses its effectiveness to maintain desired track, NWS should be used for steering the aircraft. Care must be taken to ensure that the rudder pedals are centered prior to engaging the nosewheel steering to preclude undesirable swerve and potential loss of control.

11.8.13 Decelerating Transition

Power must be applied to maintain the desired flight path during deceleration. Use the stick to maintain 8° to 10° AOA and the rudder to minimize sideslip. Should application of aft stick to the aft stick stop be required to maintain approach angle of attack when not associated with flap transition in a V/STOL configuration, the aft RCS nozzle may have failed in the open position. If this situation is encountered, emergency procedures for Reaction Control failure should be initiated. With AUTO flaps, an appreciable power increase is required between 80 knots and 40 knots to prevent sink as wing lift decreases rapidly. With STOL flaps, this power increase is delayed to below 40 knots. Maintain 8° to 10° AOA until below 50 knots. Lower AOA will reduce nozzle angle and increase deceleration distance. A combination of lower AOA and braking nozzle can be used to improve forward visibility when approaching a restricted site but this is an inefficient balance between wing lift and jet lift. The optimum compromise between performance and handling is 10° AOA which is the target value for all decelerating transitions.

Minimize sideslip, particularly with a crosswind. Aircraft directional stability will minimize sideslip above 120 knots, but, below 120 knots, and increasingly until 30 knots is reached, sideslip must be minimized by rudder to yaw into the relative wind with the wings maintained as level as possible. If the surface wind is over 30 knots, judgement of the deceleration path is particularly important since drift may induce the pilot to bank to achieve the desired hover position. The desire to turn the aircraft toward a landing site after a late deceleration or misaligned approach must be resisted until below 30 knots. At altitudes near 100 feet, significant speed relative to the ground may exist while the aircraft appears stationary. For fine range correction to a landing site, vary the thrust axis by changing attitude. Coarse range correction may require excessive throttle adjustment to compensate for wing lift change. A wave-off from any point in a decelerating transition may be made by progressively moving the nozzle lever forward. A wave-off should be made immediately if any control difficulties are encountered, or if JPT or rpm do not remain within planned limits.

11.8.14 Vertical Landing

Without LIDS during a vertical landing, at about 15 feet above the ground, cobblestoning (random attitude disturbances) may occur. Control stick activity will increase in order to hold attitude. Frequent coarse control movements may be required just prior to touchdown. If the rate of descent is correct, only small power changes are required close to the ground; however, a too fast descent will require a large power increase to arrest the descent. A too slow descent may result in reingestion and a large throttle movement to compensate for the reduction in engine thrust.

With LIDS, ground effect disturbances are reduced and control activity is small. The LIDS will cushion the descent, normally requiring a power reduction below 10 feet. If the rate of descent is correct, only small power changes are required close to the ground; however, a too fast descent will require a large power increase to arrest the descent. A too slow descent may result in reingestion and additional power may be required to compensate for thrust loss due to reingestion. Also, winds greater than 10 knots can reduce the effectiveness of the LIDS.

If the fast deceleration solenoid is disabled, the rate of descent for a vertical landing should be maintained at no more than 200-300 feet per minute. Knowing that wind in excess of 10 knots can cause a “suck down” effect at approximately 10 feet off the deck, using this modest rate of descent initially may keep the aircraft from developing an excessive rate of descent just prior to landing that would require a large power addition and engine acceleration with no countering “fast decel” effect after landing. Conversely, if the winds are light, as previously discussed, the aircraft’s rate of descent will decrease just prior to landing due to encountering the LIDS cushion (“hung up in cobblestones”). As the pilot senses the rate of descent decreasing the power may be reduced (decelerating the engine) to maintain a constant rate of descent to touchdown, which will partially fulfill the function that the fast decel solenoid would have performed. While descending through 10 to 20 feet AGL on a VL, pitch attitudes above 10 degrees can result in a rapid increase in rate of descent due to loss of LIDS effectiveness and potentially hot gas reingestion.

11.8.15 Slow Approach and Landing

Fixed 60° nozzle STOL flap approaches optimize the entrained flow effects of the wing, flap, and nozzle geometry. This reduces the average engine power and fuel flow required for approach, as well as affording the easiest and most precise control of glideslope. Selection of the hover stop just prior to touchdown is an option to reduce landing rollout distance.

If considerations for maximum available engine power or minimum stopping distance dictate, a fixed throttle approach can be flown with the following considerations:

With over 80 percent rpm in a slow approach, nozzle angles are typically 60° and above. A small change in nozzle angle produces a large change in horizontal thrust but only a small change in vertical thrust. Higher rpm requires a larger nozzle angle and the effect of change in nozzle angle is more marked. A wave-off, initiated on approach without applying power, will result in a slight tendency to sink unless AOA is increased. Increased rpm will reduce the AOA almost instantly, increase the airspeed, and reduce the rate of descent. Do not exceed 15° AOA during wave-off.

If the speed brake does not extend when the gear is lowered, a directional oscillation may occur during the approach which can be controlled with rudder. Automatic speed brake extension does not occur when the landing gear emergency lowering system is used.

During SL with high lateral asymmetries the following recommendations apply:

1. Relative wind should be placed under the heavy wing if feasible.

CAUTION

Flight tests have shown a drop off in handling qualities with asymmetries greater than 80,000 inch-pounds without the relative wind under the heavy wing.

2. Maximum lateral asymmetries will require considerable pilot compensation due to degraded flying qualities.
3. Full lateral trim authority may be required.
4. Pilot workload can be reduced by decreasing nozzle angle from 60° to 50°, or by using the variable nozzle SL technique with auto flaps selected.
5. A firm touchdown should be utilized to minimize time in ground effect.

11.8.16 Center of Gravity Effects (Trim Bleed Rise)

The aircraft with a forward cg requires bleed from the forward RCS duct to balance the aircraft in a hover. This requirement is due to a large difference between the cg of the aircraft and the thrust center of the engine. All AV-8B aircraft experience this cg shift as fuel is burned from the fuselage tank. This is especially evident in the TAV-8B and radar aircraft due to increased weight in the forward fuselage.

The problem of a forward cg manifests itself only during hot weather when the aircraft is performance limited by the engine JPT. During these periods, the aircraft can perform V/STOL maneuvers only at light gross weights. As the gross weight is adjusted to enable vertical operations, greater bleed demands from the forward RCS valve is required to adjust for the forward shift in cg.

11.8.17 V/STOL with Asymmetric Loading

All sideslip aids utilizing lateral accelerometer inputs (yaw stab aug, shakers, HUD sideslip symbol) will operate erroneously. The external sideslip vane should be used to minimize sideslip. If landing is required with significant asymmetric loads, refer to Asymmetric Landing, Part V. A long straight-in approach will reduce pilot workload. Small lateral/directional oscillations may occur during an approach in turbulence or gusts. If a steady approach has been achieved, these oscillations will damp out. If a vertical landing is required, the decelerating transition shall be made directly into the wind. The transition should be flown in as near level attitude as possible to avoid a need to reduce power for altitude control as this significantly reduces available roll reaction control power. If control difficulties or severe lateral/directional oscillations occur, immediately initiate a waveoff.

11.8.18 SAAHS-Off V/STOL

11.8.18.1 Flight Characteristics

Any discussion on the skills and procedures for safe recovery of an aircraft that has degraded or failed SAAHS must begin with an understanding of the aircraft's inherent stability in the various regimes of flight.

11.8.18.1.1 Pitch

The airplane is neutral to unstable in pitch in the V/STOL regime. As the airspeed decreases below approximately 120 KCAS, during a decel with the nozzles down, the pilot must begin to program the stick forward and trim nose down to counter the increasing nose-up pitch tendency. There is a “neutral point” around 100 to 110 KCAS where the airplane will tend to maintain its attitude. Forward extending stores, water, and engine thrust (adding power) can further increase the instability. In ground effect on roll-on landings and during the decel, approaching the hover, and while executing the vertical landing, the AV-8B II+ and TAV-8B’s nose often tends to drop unless this is anticipated by the pilot.

11.8.18.1.2 Yaw and Roll

The jet is increasingly stable in yaw and roll at speeds above 60 to 70 KCAS as the airflow over the vertical stabilizer contributes a strong counter-force to yaw and aerodynamic flight controls regain effectiveness. The jet, however, is near neutral stability in yaw and roll between 50 to 60 KCAS and unstable below 50 KCAS. In addition to honoring the one-half lateral stick limitation, the pilot must control yaw at all times using the wind vane, rudder pedal shakers, and VSTOL ball (HUD sideslip indicator) because appreciable yaw between 30 to 90 KCAS can lead to loss of control due to sideslip-induced roll.

11.8.18.2 SAAHS-Off Landing (RVL and Decel/VL)

In many cases a degraded SAAHS or SAAHS-off landing will be performed as the result of another system malfunction that provides inputs to the SAAHS. In these cases the pilot must make the appropriate decisions in light of the malfunction, but must also deal with the SAAHS-off flight and landing of the airplane. By itself SAAHS-off flight is manageable, but can be complicated by other malfunctions or external conditions so it is important for the pilot to understand the considerations of operating without the SAAHS. Most of the system malfunctions that cause the SAAHS to become degraded or fail will also require you to do an RVL or VL to land the aircraft therefore the pilot must understand the capabilities of the primary flight control in the semi-jetborne and jetborne environment, the Reaction Control System.

11.8.18.2.1 RCS

The reaction controls are relatively weak compared to aerodynamic controls in conventional flight. Reaction controls are an “acceleration demand” control which means that their thrust displaces the aircraft in the desired direction at a slowly increasing rate. Aerodynamic controls, on the other hand, are more powerful “rate demand” controls which cause a more dramatic and immediate displacement of the aircraft (assumes that there is sufficient wind across the control surfaces - starts at approximately 60 KCAS and increases with airspeed.) This is why holding the nose of the aircraft at the desired attitude is so important. If the nose movement is not controlled, it can accelerate at a rate at which the reaction control system cannot overcome. The TAV-8B in a hover at lower fuel weights (approximately 2,000 lbs and below) uses approximately two-thirds of the available RCS power to hold the nose up because the CG is slightly forward of the center of thrust. Care must be taken so momentum, gravity, and pitch rate do not overtake the reaction control effectiveness. There is only a finite amount of control effectiveness available from the reaction control system. A simultaneous demand from all axes results in a reduced amount of power from each RCS and, therefore, a relatively diminished reaction control capability. Flying the aircraft in balanced flight (wings-level and into the relative wind) will help reduce the overall bleed demand and provide more available pitch and roll control power/effectiveness.

11.8.18.2.2 Approach and Landing

The key to a successful SAAHS-off V/STOL landing is anticipation, smooth airwork, and proper trimming of the aircraft. The pilot essentially has to do the job of the SAS by immediately correcting any excursions from balanced flight that may build up a rolling moment and prevent a safe landing. SAAHS-off V/STOL should be done into the wind to keep sideslip at zero and maintain balanced flight. In addition to reducing the opportunity for a rolling moment to build, this reduces the number of variables the pilot must account for and thereby reduces pilot work load. When performing a SAAHS-off landing, the pilot should lower the landing gear early and trim it for level flight (either for a straight-in or in the landing pattern). The pilot should then fly a slightly longer pattern to allow more straight away to trim and ensure the approach is into the relative wind. The pilot should fly a slightly flatter approach (avoiding unnoticed AOA buildup with increased rates of descent) and look for normal cues for the proper position to select hover stop. Hover stop should be selected so braking stop and excessive nose up profiles are not required to stop the aircraft over the landing spot. This would dramatically increase pilot workload. If this condition occurs, a wave off should be initiated and the approach tried again. During the decel and in the hover until landing, the vane must be kept into the wind at all times. This may be a challenge because the nose will want to wander due to intake momentum drag with no balancing effect from the vertical stabilizer and the pilot will need to actively control the aircraft to keep it centered. Any deviations in roll or yaw must immediately be countered so rates that exceed control power/effectiveness are not exceeded (remember the finite capability of the accelerating reaction controls). As with all V/STOL, on SAAHS-off V/STOL the pilot must fly the aircraft all the way to the deck. Deviations cannot be allowed to go unchecked and the rate of descent must be kept under control. If there are winds approaching or exceeding 15 knots, a power addition in close must be anticipated so a controlled descent can be made and a power bounce can be avoided. This is especially important if the fast deceleration solenoid is disabled. The selection of an RVL or VL is a factor of several considerations. The first of these considerations starts with the type of landing NATOPS recommends for the aircraft malfunction. Other considerations include winds, runway length, condition, and surface, type of malfunction(s), available performance, and others. For example, on a calm day, a SAAHS-off RVL (there will rarely be a time when a 5 to 6 degree RVL is required, -3 degrees should be sufficient in most cases) should be easily controllable. However, with a significant crosswind, a vertical landing may be a better choice as long as the additional power requirement is anticipated and performance margin is available.

11.9 ENGINE HANDLING CHARACTERISTICS

11.9.1 Engine Handling on Takeoff

When accelerating from low power, the limiting rpm may be reached before reaching the limiting JPT due to thermal lag. This condition is not a steady state. The JPT will continue to rise. The JPT will approach the limiting datum where the JPTL will reduce fuel flow, hence rpm, to maintain the JPT limit. Three important factors which act to determine the final JPT/RPM relationship are bleed usage, reingestion, and ambient temperature.

11.9.1.1 Bleed Usage

Refer to paragraph 2.3.8.1 for description of bleed effects on engine performance and thrust available. Large bleed demands are associated with accelerating and decelerating transitions, particularly if accomplished at an AOA other than optimum. Downward thrust from the wing RCS valves causes a nose down pitching moment that may be countered by increasing downward thrust from the forward RCS valve. Increased forward RCS bleed demands required to balance the aircraft in a hover are associated with lighter aircraft weights and the resulting forward cg.

11.9.1.2 Hot Gas Ingestion

Reingestion effects are small during a normal into-wind VTO. A no-go or excessively slow VTO, a downwind VTO, a VTO where the aircraft drifts backwards, or a VTO where the nose is high can result in reingestion, large JPT increases, and compressor stalls.

11.9.1.3 Ambient Temperature Effects

The JPT varies as a function of ambient temperature. As the ambient temperature decreases the JPT will decrease.

11.9.2 JPT Limiter

The engine fuel system reduces rpm as the short lift (wet or dry) limit is reached if the nozzles are deflected more than 16° or the landing gear is selected down. The throttle must be reduced to enter normal lift from short lift. Allowing the engine to continue to operate at the short lift limit, when not required, rapidly increases the life count.

When the landing gear are up and the nozzles are rotated up through 12 to 7 toward fully aft the JPTL will signal DECS to reduce RPM to maintain JPT limits within the maximum thrust datum.

The JPTL reduces engine rpm to the maximum thrust datum when both the landing gear is selected up and the nozzles are rotated up through 12° to 7° toward fully aft.

11.9.3 Water Injection

Water injection lowers the JPT about 35 °C for the -406 engine and about 20 °C for the -408 engine for a given thrust. Water injection does not change engine handling technique. With the water injection switch in TO or LDG, the engine fuel system is reset to allow a 3.3 to 4.3 percent increase in maximum rpm for the –406 engine and 6.0 to 7.0 percent increase for the –408 engine, even if water does not flow and the FLOW light does not come on.

When water is exhausted with the engine above the short lift dry limit, JPT will not be automatically reduced to the short lift dry limit. When water is exhausted with the engine below the short lift wet limit, JPT will rise. If the JPT reaches the short lift wet limit, a small thrust loss may occur. Whether or not water is flowing, the rpm (thrust) can be maintained by overriding the limiters if required. The JPT will exceed the short lift dry limit.

Water flow is stopped by reducing the throttle below 94 to 96 percent rpm for the –406 engine, 103 to 105 percent rpm for the –408 engine, or by selecting the water arm switch off. If water conservation is desired, the water switch may be selected off before rpm is reduced. If the water switch is turned off above about 87 percent rpm, whether or not water is flowing, there will be a 3 to 4 percent rpm reduction with the –406 engine and a 7 to 8 percent rpm reduction with the –408 engine, due to governor limit reset.

After takeoff, if it is desired to use the water rather than jettison it, the throttle should be maintained at the lowest rpm which will keep the water flowing. This will reduce engine wear caused by a slightly inferior flame pattern with water.

11.9.4 Engine Life Versus JPT

Engine life is determined by flight hours and Engine Life Counts (ELC) and can be expended in either. Engine operating time is one measure of engine life. If engine JPT is not considered, the engine would be pulled at the end of the flight hour limit. Engine life counts is another measure of engine life and is a function of the thermal stress placed on the engine. The greater the thermal stress, the more engine life that is expended. Over–temperature conditions, besides using the entire engine life count, can literally melt the turbine section of an engine. Thermal stress is measured in Engine Life Counts.

The engine life of the –406/–408 engines are as follows:

ENGINE	TIME (HOURS)	COUNTS
406A	500	5,500
406B	750	7,500
408A Pre–PPC 192	1,000	35,000
408A PPC 192/408B	1,000	50,000

The engine count rate (engine life counts per minute) is a logarithmic function of engine JPT, Figure 4-3. To help explain this relationship, a comparison of –408A/B engine lift ratings versus engine life rate is as follows (a different but similar relationship exits for the –406):

LIFT RATING	JPT	COUNT RATE (PER MINUTE)
SLW	800	Approximately 1,500
SLD	780	Approximately 600
Combat	750	Approximately 60
Max Thrust	710	Approximately 5

It is apparent that time spent at or near the engine lift ratings (SLW, SLD) greatly reduces engine life. Even a 15° reduction in JPT (from 800° to 785 °C) can save hundreds of counts. Every attempt should be made by the pilot to reduce aircraft gross weight when conducting vertical landings to avoid premature engine removal as a result of excessive engine life counts.

11.9.5 Accelerating Transition

After a VTO, RVTO, or STO, JPT will increase during the transition due to RCS bleed demands needed to trim for the transition. A progressive reduction in throttle cannot be made simultaneously with reduction of nozzle angle so one or more step reductions in rpm may be necessary during the transition.

11.9.6 P3 Limiter Fan Speed Fluctuations

When operating at high airspeeds (greater than 450 KCAS), low altitudes (below 3,000 feet) with low ambient temperatures (ISO standard day temperature and below for -408), the engine operates on the P3 limit and fluctuations in fan rpm of approximately 1 to 3 percent may occur. These fluctuations will occur at a rate of 2 to 3 times per second, reducing the throttle slightly will cause the fluctuations to stop.

11.9.7 Decelerating Transition

Before commencing a decelerating transition pay due regard to landing site pressure altitude, temperature, wind, and aircraft weight. As nozzles are lowered and deceleration begins, increase power to replace wing lift loss. With STOL flaps, an appreciable power increase is required below 40 knots to prevent sink. A long slow deceleration with gentle nozzle rotation and power application requires less bleed than one which uses the braking stop throughout the deceleration. A braking stop deceleration will require about 2 percent more rpm than an equivalent hover stop deceleration. Very coarse nozzle application and control usage can cause high bleed demands and JPT rise which will dangerously reduce the performance margin. If either an rpm or JPT limit is approached, perform a wave-off and reduce aircraft weight before commencing another approach.

11.9.8 Landing

Landing, like takeoff, can be an RPM or JPT limited maneuver. Use of the LDG position of the water injection switch will increase power and save water by delaying flow until about 684 ±5 °C JPT with the -406 engine or 765 ±5 °C JPT with the -408 engine. This flow point will occur late in the deceleration therefore extra attention to power margin available is required. If wave-off is not feasible and JPT is limiting power, consider overriding the JPT limiter.

11.10 JET EXHAUST INTERACTION

11.10.1 Energy Levels in V/STOL Flight

The front nozzles exhaust emerges at about 700 knots, 105 °C (220 °F) and 16 psi. The rear nozzles exhaust emerges at about 1,050 knots, 645 °C (1,195 °F) and 11 psi. The reaction control valves exhaust emerges at about 1,500 knots, 400 °C (750 °F) and 150 psi. Although velocity, pressure, and temperature drop off with distance, the exhaust velocity at ground level in a low hover can be 300 to 400 knots at 4 psi. If this pressure is permitted to build up under a surface such as a landing mat or manhole cover by penetrating through holes or around unsealed edges, the lifting force becomes tremendous. A pressure of 4 psi will lift 4-foot-thick concrete or 8-inch-thick steel. The aircraft has proven to be an efficient manhole cover remover although it displays no discretion in depositing them after removal. The aircraft has raised an 11 ton mat 4 feet above the ground. Pneumatically supported mats do not soften the landing; therefore, all landing mats should be thoroughly sealed including the perimeter. The aircraft should never cross the edge of a mat in V/STOL flight at less than 50 feet.

11.10.2 Single Exhaust Pattern

A jet exhaust will interact with a surface upon which it impinges to form a flow pattern as shown in Figure 11-8. In the V/STOL mode the predominate surface is the ground which may be considered as a plane approximately normal to the exhaust; however, the presence of other large surfaces in the immediate area, such as buildings or vehicles, may alter the flow pattern to some extent. The jet exhaust will mix with the surrounding air by jet edge shear resulting in a rapid drop in temperature and velocity but with a relatively small reduction in mass flow.

11.10.3 Complex Exhaust Patterns

Figure 11-9 is a pictorial representation of the interaction of the four exhaust nozzles and the ground for the aircraft in a low level hover. Interactions of the control reaction jets are not shown in order to simplify the representation and discussion. Their interaction has a considerably smaller though similar effect on the complete pattern.

Note that there are two intersecting surfaces of symmetry labeled A-A and B-B. Their point of intersection on the ground is the initiation point for a relatively focused jet fountain which angles toward the tail of the aircraft. This angle is due to the higher energy of the forward nozzles in comparison with the aft nozzles due to their exhausting cooler air with a consequent higher mass flow.

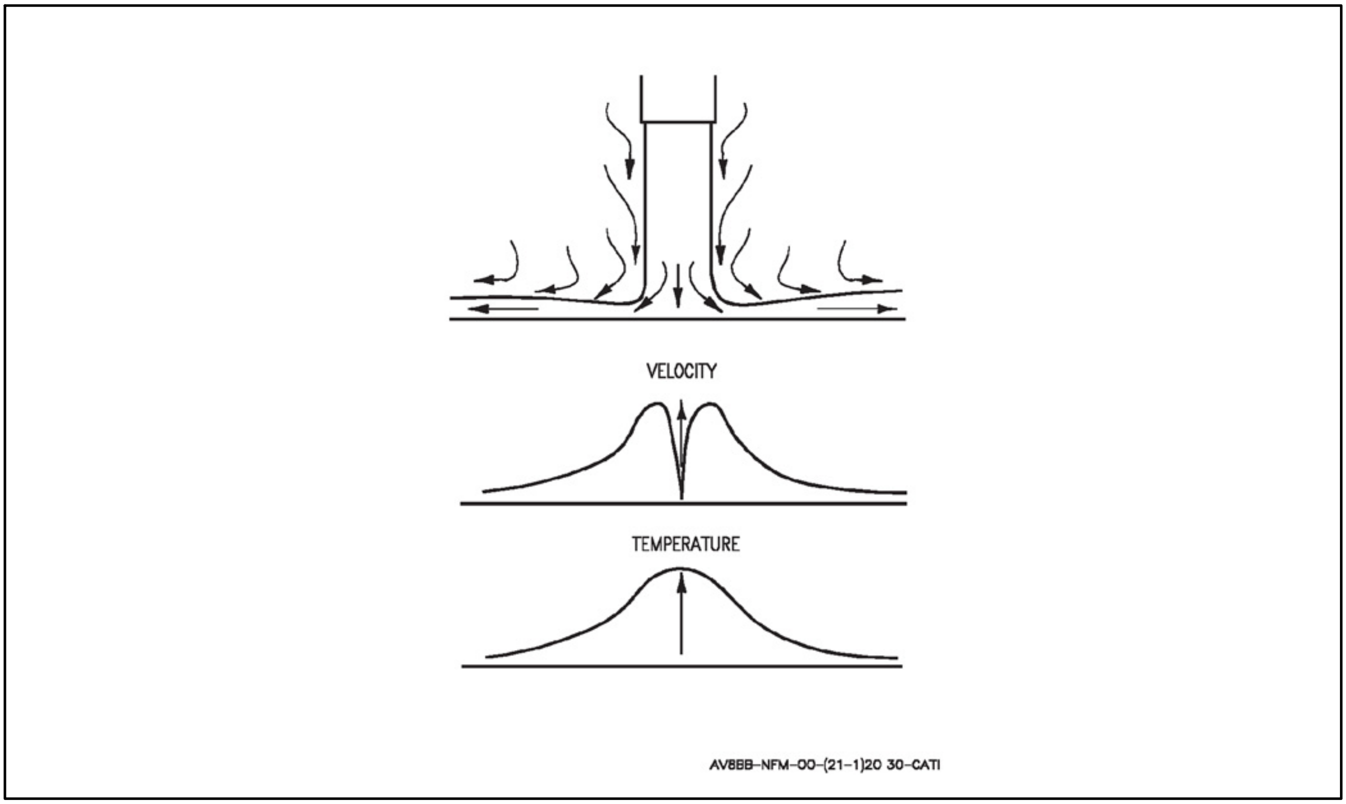


Figure 11-8. Single Exhaust Pattern

11.10.4 Instability Due to Ground Effect

Figure 11-10 illustrates two instability mechanisms associated with the jet fountain. As the aircraft reaches a critical altitude the jet fountain moves forward from aft of the aircraft and commences to impinge on the tail surfaces causing a nose down trim change. As the aircraft descends, the center of pressure moves forward on the aircraft and at the same time, becomes more powerful. These two actions tend to cancel each other, however, as the jet fountain moves forward, its force is expended on varying surface areas resulting in random pitch trim changes. As the aircraft is rolled, the jet fountain moves toward the high wing. If it then impinges upon the aircraft it will tend to increase the roll angle and may cause a pitch trim change. If it leaves the aircraft surface it will cause a nose up pitch trim change. Surface irregularities will also cause deflection of the jet fountain causing rapid trim changes or turbulence sometimes known as cobblestoning. Wind gusts will also cause random trim changes. If LIDS is used, these effects are greatly reduced.

11.10.5 FOD

V/STOL aircraft are particularly adept at creating their own FOD and then ingesting it. FOD can cover a wide range of effects ranging from covering aircraft with dirt and dust to severe damage to the airframe and engine possibly resulting in failure and catastrophic destruction to the aircraft as well as possible death or injury to the pilot. The most FOD-sensitive component of the aircraft is the engine. The Pegasus engine is inherently capable of dealing with ingested debris better than smaller engines in conventional fighters and has been qualified to withstand impact of a 1 pound bird at 600 knots when running at 97 percent N_f. If engine damage due to FOD is suspected airborne a pilot should perform the Engine Mechanical Failure/Engine Vibration emergency procedures. In most cases FOD is not noticed until post flight inspection by the pilot or maintenance personnel. Despite the ability of the Pegasus to withstand FOD, it is highly susceptible to FOD due to the fact that the Harrier in V/STOL operations tends to disturb more surface debris than conventional aircraft. The chance of FOD ingestion is dependent to a great degree on the observance of correct operating procedures.

11.10.5.1 Engine

The low pressure fan blades of the Pegasus engine are made of high-strength titanium alloy. These blades rotate at over 6,000 rpm and can ingest objects at a relative speed in excess of 1,000 mph. Soft objects generally do not cause damage, however harder objects such as stones or metallic objects that impact the blades at these high relative speeds can seriously damage the engine. FOD is normally discovered on the LP fan blades or stator vanes, but not always on the first stage. The first evidence of damage may occur on the second or third stage. The HP compressor blades are also liable to be damaged. The 408 engine is more susceptible to later stage damage than the 406 engine due to a reduced number of blades on the first stage (23 vice 26) and thus greater gaps through which objects can pass. Some objects may shatter on impact and generally do not cause further damage to the engine. Harder objects have a tendency to make multiple impacts as they bounce around the engine. Blade leading edges can be damaged causing poor aerodynamics, reduced engine performance, possible surge and stress concentrations that can lead to blade failure within a short time. Blade failures will cause further damage down the engine and may cause catastrophic engine failure.

11.10.5.2 Jet/Ground Interaction

If a jet of air is directed at a solid surface like the ground it does not bounce off. The jet flows away smoothly in a radial pattern as a sheet of air from the center of the impact area. This is called a wall jet, and at the center point of impact a high pressure exists (stagnation point). When two or more of these sheets meet the effect is a rising jet sheet flow. Close to the ground the Harrier's four exhaust jets, in a normal hover attitude, interact to create a rising fountain at a point centered laterally about the aircraft and slightly aft of the center point between the nozzles. This interaction results in a fountain that rises and flows rearward. As the aircraft descends the upflow increases in strength and the fountain moves forward relative to the aircraft. At touchdown the fountain impinges at maximum strength directly on the main gear and belly just forward of the main gear doors. This fountain is the cause of the "cobblestone" effect identified by a high frequency buffet of the aircraft when in close proximity to the ground in a hover. The fountain describes the concentration of the upflows, but in reality there exists a sheet of rising flow all along the center line of the aircraft fore and aft. While FOD has the possibility to ride this upflow and damage the airframe aft of the intakes, its most dangerous region is the part of the upflow that goes to the intakes. When the nozzles are deflected aft the upflow biases in a rearward direction, however some forward-moving upflow persists down to jet impact angles as small as 20° to the ground. When the aircraft is moving forward the upflow tends to move rearward. This effect is dependent on throttle position and nozzle angle. As the ground speed decreases the upflow will move progressively forward towards the intakes until 50 knots, at which point the upflow will move forward of the intakes. It is this reason that RVLs should target 60 knots ground speed, and should never be flown at less than 50 knots. It is also the reason than PNB should cease at 60 knots. If lower airspeeds are used it must be understood that the risk of FOD increases. After PNB, selecting idle below 50 knots will also help reduce FOD.

The energy output of the Pegasus engine exhaust flows in V/STOL flight is approximately 30,000 horsepower. In V/STOL flight the forward cold nozzles have a jet velocity of around 800 mph, a stagnation pressure of 16 psi, and a temperature of 105 °C. The rear hot nozzles have a jet velocity of about 1,200 mph, a stagnation pressure of 11 psi and temperatures of about 700 °C. In V/STOL flight the reaction control system output is up to 1,700 mph jet velocity, 150 psi stagnation pressure, and 400 °C temperature. An object lying on the surface exposed to these high velocity jet sheets can acquire speeds of up to a hundred or more mph in a relatively short distance. If the surface is rough or uneven it almost inevitably bounces and may be deflected sharply up into the air. This path could be toward the intake, particularly if the motion is caused by the front jet sheets.

The Pegasus engine also has the ability to damage surfaces that are not suitable. If the ground is granular a crater will form immediately starting at the stagnation point. If unprepared surfaces are used, such as grass, the jets have a tendency to dry the covering causing it to lose its cohesion and break up. This can occur in as little as a few seconds over the same spot and thus requires the pilot to keep the aircraft and exhaust from residing over the same spot. For this reason VTOs or VLs should never be attempted over unprepared natural ground, no matter how firm and stable the surface appears. True vertical take-offs and landings always require a prepared surface (mat or concrete pavement).

AM-2 aluminum mats can be used for V/STOL operations if prepared properly. The edges of the mats should be sealed and anchored at the edges. If the aircraft's exhaust sheet crosses the edge of a mat at a low hover height and the mat is not anchored or sealed properly the mat and entire pad can become airborne. The same applies for the connections between mat sections. AM–2 mats should always have their edges properly sealed and should be securely staked to the ground. Never rely on weight alone to hold down a pad. The aircraft should never cross the pad at less than 50 feet to preclude the jet sheets from lifting the surface at the edges. Debris may be raised at these heights and blown onto the pad or into the intakes and as such the Harrier should not perform a decelerating transition over a surface where debris may get lifted or disturbed below 150 feet. Harriers should also avoid performing V/STOL operations over manhole covers or other objects that may be picked up by the jet sheets. Concrete pads are normally segmented slabs to allow for expansion. The joints of these slabs can contain loose debris and if unsealed may allow for the pressure from the engine exhaust to lift the slabs. Any debris contained in these joints may also be blown out violently and may cause FOD. These joints must be sealed continuously otherwise the jet can penetrate even a small slot. If a gap is present the sealant may also be blown out and into the air by the aircraft. It is for this reason that Harrier pilots should ensure that vertical takeoff and landing areas are free from FOD, slots in pavements are free from loose debris and are properly and continuously sealed. The seal should extend the full slot depth and should not be cracked or gapped.

Poor workmanship or inadequately repaired surfaces can produce unexpected hazards for FOD during V/STOL operations. Care must be taken to inspect the surface for damage and cracking in areas that V/STOL operations may be conducted that could result in high velocity exhaust exposing potential weaknesses in the surface. Asphalt or other softer substance heat up quickly and can be damaged easily by the Harrier’s exhaust. If using a surface other than properly sealed concrete or if in doubt about the integrity of the surface the aircraft should be operated to minimize jet exhaust residence time on any one spot by using STO or RVTO and RVL or SL procedures to reduce the chances of damage. Prolonged and repeated operations over the same surface will accelerate the wear and possible damage to that surface. Consideration should be given to varying V/STOL spots on asphalt or soft surfaces to maximize their serviceability.

Vertical takeoffs and landings should only be performed on clean surfaces. Stabilizing above 50 feet for several seconds over a landing spot may clear debris prior to landing and possibly reduce the chances of FOD. Vertical takeoffs can benefit from reduced FOD risks by being performed after an aircraft has performed a vertical landing at a spot in order to ensure any debris has been blown off the pad.

11.10.5.3 Taxi Operation

At low power settings the engine will not normally pick up objects that are not already airborne. The ground attitude of the aircraft is greater than that of conventional aircraft. Even with the nozzles fully aft the jets meet the ground close behind the aircraft, presenting a FOD hazard to following aircraft from surface debris which may be disturbed and swept to the rear. The Harrier also has a much wider area of rearward jet flow than conventional aircraft since the jets are separated by the fuselage and splayed outwards by 50 each side. The best formation for multiple aircraft taxiing for FOD avoidance is line abreast with each aircraft’s intakes forward of the other cold nozzle exhaust. If it is required to taxi in trail the distance behind another Harrier should be no less than 600 feet with 1,000 feet normally sufficient. Taxiing in a staggered formation may also help reduce the chances of following aircraft picking up debris from preceding aircraft. When operating in close proximity to other aircraft the nozzles should be placed aft since the exhaust tend to splash out to the sides more when the nozzles are deflected, causing a wider area of surface disturbance. When taxiing nozzles should never be more than 60°, and if the surface is questionable 30° is the maximum nozzle angle that should be used. Aircraft should not be taxied backwards as FOD risk is increased.

11.10.5.4 Reaction Control System

The reaction control system is energized when the nozzles are down. The front reaction control valve (RCV) is open at stabilator positions of less than 2° nose down. The front RCV is forward of the intakes and has the greatest chance of sending objects into the intake causing FOD. When taxiing, pilots shall ensure the front RCV is closed by maintaining the stabilator position at least 2° nose down. If the nozzles are aft the RCV position is not critical since the reaction control system is not energized. When landing, this RCV can kick up objects which can then be ingested by the engine. If excessive nose attitude is used during the landing, the nozzle angle and jet sheet are biased forward causing a greater risk of FOD to the engine. Additionally, when landing with the nozzles deflected, any nose attitude greater than the normal landing attitude will increase the front RCV output, increasing the FOD risk. It is also good airmanship to avoid prolonged time in ground effect, which can increase the risk of FOD.

11.10.5.5 Formation V/STOL

Aircraft performing a formation takeoff or landing must ensure that intakes are forward of cold nozzle exhaust or is far enough aft that the following aircraft are airborne before the preceding aircraft's takeoff point. When performing line abreast takeoffs or landings the potential for FOD is greatly increased if following aircraft become sucked on bearing. When performing trailing takeoffs or landings FOD risks can be reduced by alternating sides of the runway. Generally a 300 foot buffer added to the takeoff distance is enough to ensure following aircraft get airborne prior to picking up any "energized" FOD from preceding aircraft.

11.10.5.6 Ground Operations

There are numerous apertures, holes and cavities in the airframe through which dirt, stones, and other objects may enter the aircraft and cause damage. Of special concern to a pilot are the following areas.

11.10.5.6.1 Intake Suction Doors

These should never be used as steps and nothing should ever be placed on these. Objects can rest on the inside of these doors, especially the lower doors, and get ingested by the engine on start. The only way to be sure they are free from FOD is to enter the intake to look at them from the inside. If this is done extreme care must be taken to ensure the inspector is free from all objects which may FOD the intake.

11.10.5.6.2 Boundary Layer Doors

Small objects can get stuck inside the bottom landing behind these doors and make their way into the engine. With the canopy closed objects can fall into this area from the ducts on top of the aircraft in the rear skirt of the canopy. During preflight careful attention to looking inside the doors at the bottom of the landing is necessary.

11.10.5.6.3 Cockpit Conditioning System Cooling Ducts

Care must be taken anytime someone is on top of the aircraft. Objects falling into openings may enter the engine or the GTS and cause FOD. Inlets on top of the intake cowl allow air to enter the heat exchanger and then pass through the bullet fairing in the intake to the motor. Objects that enter these inlets may FOD the motor.

11.10.5.6.4 Footsteps

The footstep receptacles are potential debris traps. Boots should be free of mud and any objects before stepping on the aircraft or the footsteps so that debris does not enter the cockpit, get stuck in the footsteps or fall into another aircraft cavity and cause damage.

11.10.5.6.5 Intake

The intake should never be used as a shelf on which to hold anything. It should not be used as a step either since debris on the soles of foot gear can be deposited in the intakes. Care must be taken to limit the items taken in the cockpit. Everything must be secure and accounted for when entering and leaving the cockpit. Items should never be placed on the glare shield or canopy edge as they may get sucked out and down the engine.

11.10.6 Hot Gas Ingestion

In a normal hover at 50 to 60 feet, the jets from the nozzles merge prior to reaching the surface and there is, therefore, no interaction as at lower levels. Instead, the merged exhaust acts as a single jet and upon striking the surface, expands radially through 360°. The ground jet sheet velocity decays rapidly and, as the velocity approaches zero, the warm exhaust gases commence to rise by convection. The gases break from the surface and commence to raise at a radius of 50 to 100 feet dependent upon hover height, wind, surface roughness and ambient temperature. As the gases rise they are blown by the wind. The gases which are upwind will be blown toward the aircraft and will envelope it. Ingestion of this warm gas will reduce engine thrust if JPT-limiting is reached. Figure 11-11 illustrates the best and worst case. With the aircraft pointed into the wind, the ingested gases will be predominantly from the front nozzles, thus cooler than in the case where the aircraft is pointed downwind and thus ingesting gas predominantly from the rear nozzles. At lower hovers, convection is still present but the major part of the gas is blown directly back by the exhaust reaction with the surface and reaches the aircraft much hotter than the convection gas, therefore, low hovers cannot usually be sustained and are not recommended. Reingestion can become critical at low forward speeds on or near the ground (Figure 11-12).

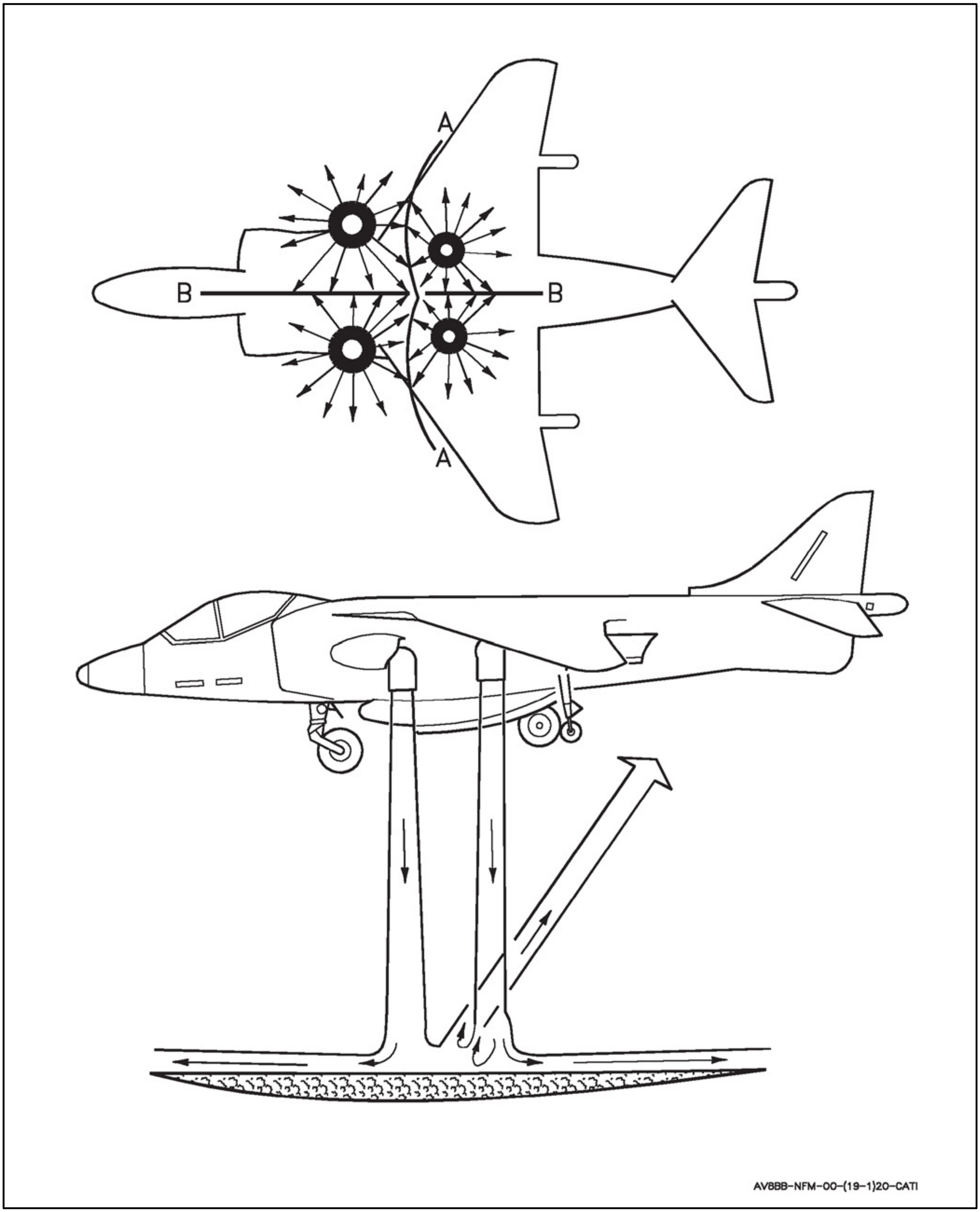


Figure 11-9. Nozzles Exhaust Pattern

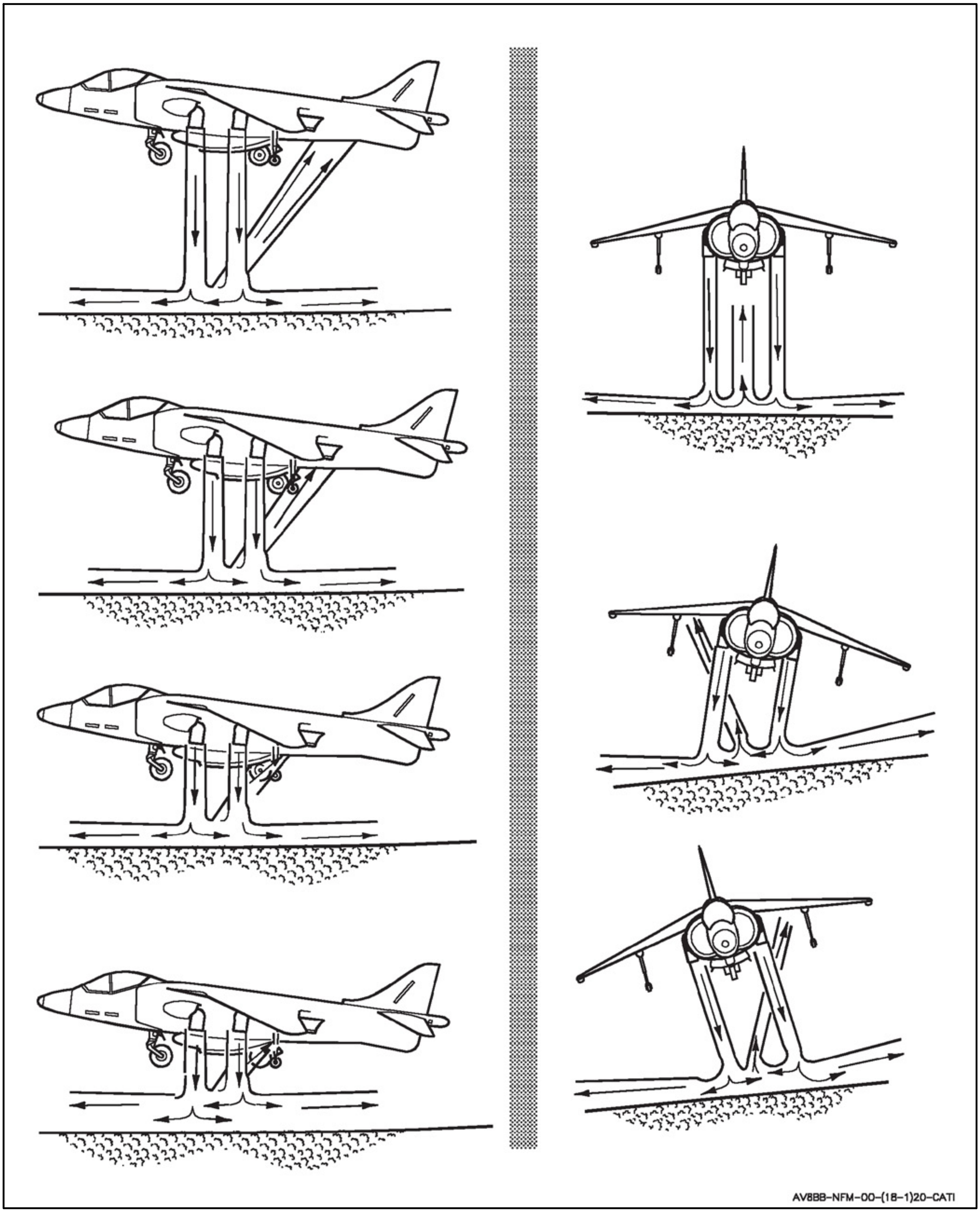


Figure 11-10. Instability Due to Ground Effect

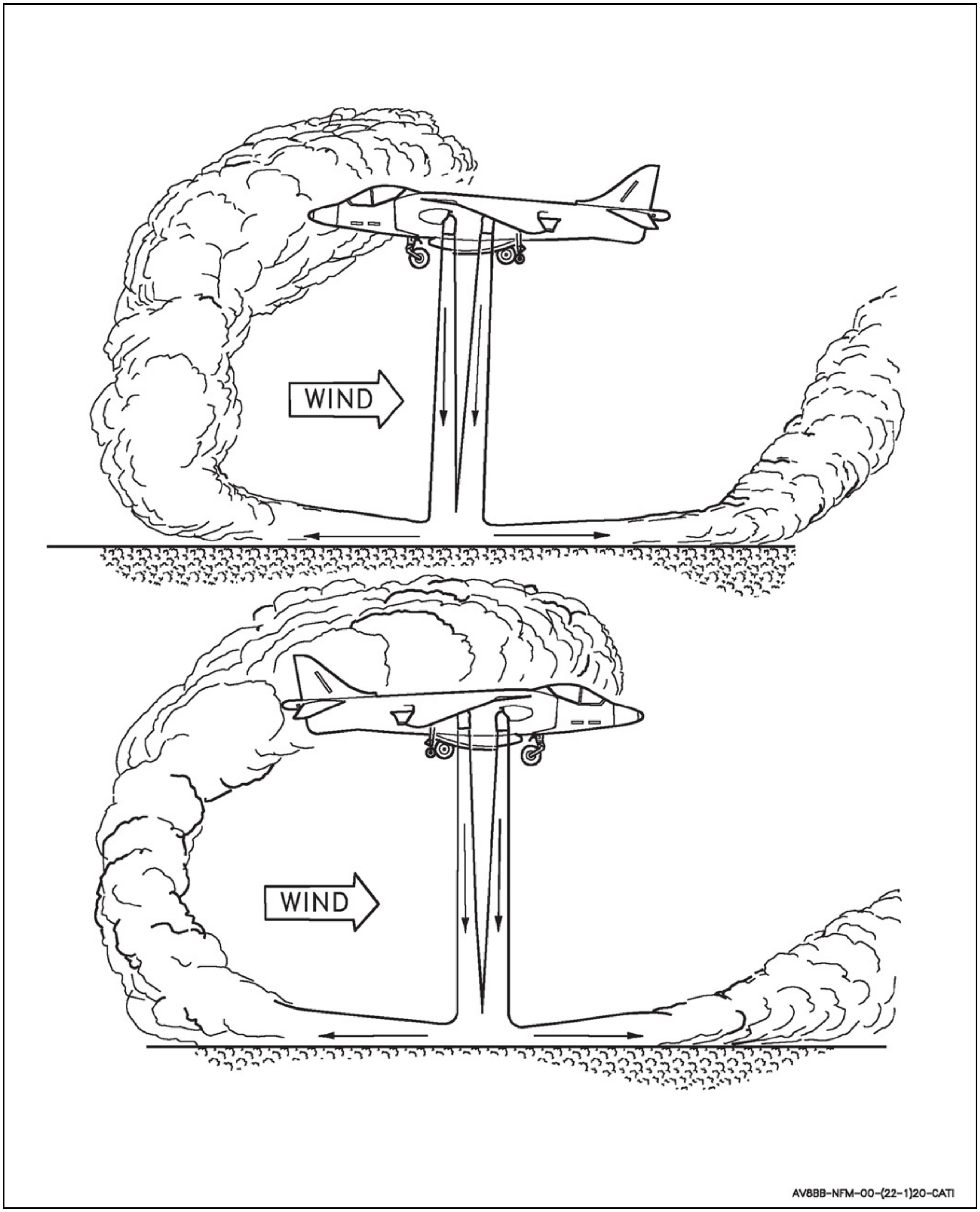


Figure 11-11. Hot Gas Reingestion

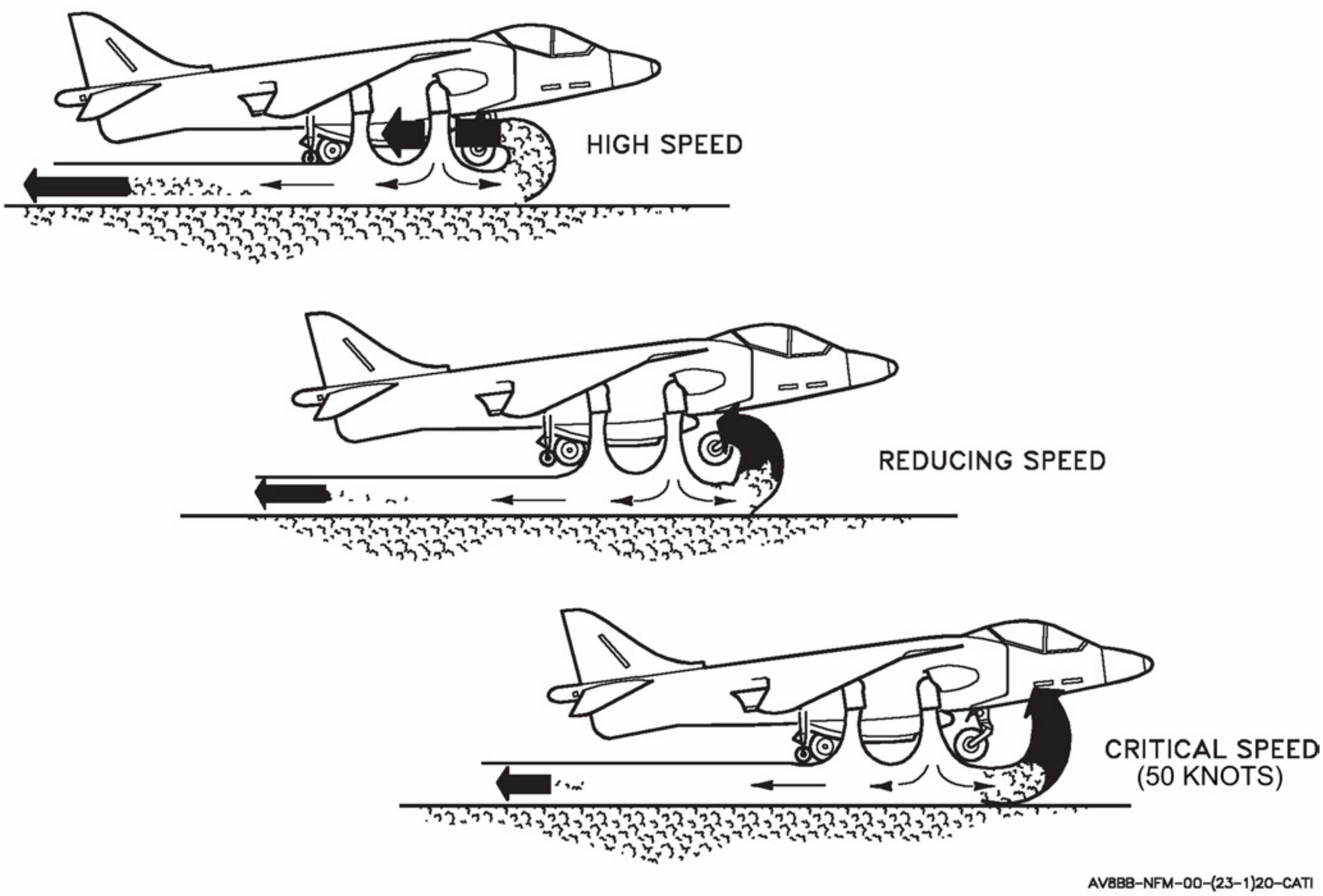


Figure 11-12. Reingestion Critical Speed

PART V

Emergency Procedures

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CHAPTER 15 — IN-FLIGHT EMERGENCIES

CHAPTER 12

General Emergencies

12.1 GENERAL EMERGENCY PROCEDURES

This part contains procedures to be followed to properly respond to and manage a system malfunction or emergency condition. These procedures will ensure maximum safety for the pilot and/or aircraft until a safe landing or other appropriate action is accomplished. Multiple emergencies, adverse weather and other peculiar conditions may require modification of these procedures. It is essential, therefore, that pilots determine the correct course of action by use of common sense and sound judgement. The pilot must assess many factors that will dictate the options available to him. These factors include, but are not limited to, aircraft speed, drift rate, engine status, airworthiness, configuration, and the environmental conditions of the pad/runway and the surface adjacent to the pad/runway, such as winds, ambient lighting, and weather. These factors must be evaluated and remain part of the operating mind set during flight operations. As soon as possible, the pilot should notify the flight/flight leader and appropriate controlling agency of any existing emergency and of the intended action. When practical notify the Operations Duty Officer (ODO). When an emergency occurs, three basic rules are established which apply to airborne emergencies. They should be thoroughly understood by all pilots:

1. Maintain aircraft control.
2. Analyze the situation and take proper action.
3. Land as soon as practical.

When an airborne emergency occurs and flight conditions permit, the pilot should record and/or broadcast all available information such as airspeed, altitude, power settings, instrument readings and fluctuations, warning lights illuminated, loss of thrust and unusual noises. Flight leaders, wingmen, other pilots, or any ground station receiving such information should copy it and record their observations of vapor, smoke, flames or other phenomena. Whenever possible, an effort should be made to escort an aircraft with a declared emergency until it has safely landed. This escort should observe the distressed aircraft for any external indications or symptoms of the problem, provide assistance or advice that may be required, and assist in a search and rescue (SAR) effort if required. ODOs, when assisting distressed aircraft, may call the 24 hour Boeing Hotline number, (314) 232–9999 or (888) 222–0058, for technical assistance. ODOs should identify themselves and request Conference X–Ray assistance. They will then be connected with the appropriate department for assistance and guidance for the airborne emergency.

WARNING

In troubleshooting a system discrepancy or in accomplishment of an emergency procedure, the operation of a system control (such as flap, throttle, flight control, electrical switch, etc.) is usually required. Due to the nature of some failures and/or the occurrence of successive malfunctions, some control operations may occasionally result in undesirable aircraft responses, such as unexpected roll or pitch, smoke, unstable engine operation, etc. Often the most prudent action to take to eliminate such an undesirable response is to immediately return the operated control to its former setting. The pilot must be mentally conditioned to take that action promptly when appropriate.

12.1.1 Immediate Action Items

Procedural steps preceded by an asterisk (*) are considered immediate action items. Pilots should be able to accomplish these steps without reference to the checklist.

12.1.2 Warning/Caution/Advisory Lights

The warning, caution, and advisory lights are listed in Figure 12-1 together with the cause and corrective action. They are listed under three major headings:

1. Warning Lights.
2. Caution Lights.
3. Advisory Lights.

Each light is listed alphabetically under its major heading; however, if preceded by L or R that letter is not used to place the light alphabetically. Emergency procedures associated with a warning or caution display are shown in this figure and are not repeated elsewhere in this manual.

WARNING LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
AAA AI CW (AV-8B only)	Refer to A1-AV8BB-TAC-100/(S).	
EFC 1 (Voice - FUEL CONTROL, FUEL CONTROL)	Number 1 and 2 DECU failed. ★ Refer to paragraph 15.16.3 Dual DECS Failure.	**IN V/STOL FLIGHT (Takeoff/Approach/Landing)** **Time Critical** *1. MFS — SELECT. *2. Water switch — OFF. **If rpm does not recover:** 3. EJECT. **IN CONVENTIONAL FLIGHT** *1. Throttle — IDLE. *2. MFS — SELECT. *3. Throttle — ADVANCE SLOWLY. **If unable to select MFS and sufficient power not available:** *4. EFC switch — CHANGE LANE. **If available power insufficient for recovery:** 5. EJECT. **If MFS fails to restore control but sufficient power:** 6. Cautiously use nozzles to control airspeed. 7. Flaps — AUTO. 8. Land as soon as practical. **After landing:** 9. Use nozzle braking as required. 10. Throttle — OFF. 11. Fuel shutoff handle — OFF.

Figure 12-1. Warning/Caution/Advisories (Sheet 1 of 13)

WARNING LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
FIRE 1 (Voice - ENGINE FIRE, ENGINE FIRE)	Fire in the engine compartment. -- GROUND FIRE (ENGINE) ★ Refer to paragraph 13.2 Ground Fire. -- TAKEOFF/LANDING/VERTICAL/INFLIGHT ★ Refer to paragraph 15.27 Fire.	**GROUND** *1. Execute emergency shutdown. **TAKEOFF/LANDING/VERTICAL/OPERATION** *1. Abort or land immediately. *2. Execute emergency shutdown. **INFLIGHT** *1. Nozzles — AFT AS SOON AS POSSIBLE. *2. APU GEN — OFF. *3. Master arm/gun — OFF. *4. Throttle — MINIMUM REQUIRED. **If fire persists:** *5. EJECT. **If light goes out:** 6. Land as soon as possible.
FLAP 1 (Voice - FLAP FAILURE, FLAP FAILURE)	Flap failure. ★ Refer to paragraph 15.36 Flap Failure.	**TAKEOFF/LANDING/VERTICAL/OPERATION** *1. Nozzles — 40° OR GREATER. 2. Stores — JETTISON (if required). 3. Land as soon as practical. **If flap retraction required:** 4. Emergency flaps retract button — SLOWLY BEEP FLAPS UP. **INFLIGHT** 1. Climb to safe altitude (5,000 feet AGL minimum, 250 KCAS maximum). 2. Flap mode switch — CRUISE. 3. Land as soon as practical. **If flap retraction required:** 4. Emergency flap retract — SLOWLY BEEP FLAPS UP. **If asymmetry occurs:** 5. Do not attempt further retraction. 6. Flap power switch — OFF. 7. Nozzles as required (no less than 20° less than flap position).
GEAR Gear Handle 1 (Voice - LANDING GEAR, LANDING GEAR)	Steady light - In transit or unsafe. ★ Refer to paragraph 14.6 Landing Gear Fails to Retract or paragraph 16.1 Landing Gear Unsafe/Fails to Extend. -- Flashing light - Gear up and below 6,000 feet slower than 160 knots and rate of descent over 250 feet/minute.	**STEADY:** 1. Check gear down indicators. -- **FLASHING:** 1. Gear — DOWN. 2. Increase airspeed or altitude.

Figure 12-1. Warning/Caution/Advisories (Sheet 2)

WARNING LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
GEN 1 (Voice - GENERATOR, GENERATOR)	AC generator off the line. ★ Refer to paragraph 15.9 Main Generator Failure.	1. Generator switch — CYCLE. **If GEN resets:** 2. Continue flight. **If GEN warning, DC, and STBY TR cautions still on or after reset, generator drops off line:** 3. Generator switch — OFF. **-406/-408A engine:** 4. MFS — SELECT. **All aircraft:** 5. APU GEN — ON (when in APU starting envelope). **If APU comes on line:** 6. MFS — AS REQUIRED. **If APU GEN caution comes on:** 7. APU GEN — RESET/ON (attempt as required). **If APU GEN caution still on:** 8. APU GEN — OFF. **-406/-408A engine:** 9. MFS — SELECT. **All aircraft:** 10. Nonessential DC equipment — OFF. 11. Landing Gear — DOWN AS SOON AS POSSIBLE (below 200 knots and 16 volts minimum). 12. Do not select STOL flaps above 165 knots and less than 25° nozzles. 13. Fuel boost pump switches — DC (before landing). 14. Land as soon as practical. Perform a VL if possible (HOT NWS).
HYD 1 (Voice - HYDRAULICS, HYDRAULICS)	HYD 1 and HYD 2 failed. ★ Refer to paragraph 15.47 Hydraulic System Failure.	**INFLIGHT** 1. Slow to 250-300 knots. 2. Hydraulic systems pressures — CHECK. **If both hydraulic systems failing:** 3. EJECT. **ON GROUND** 1. Throttle — OFF. 2. Parking brake — SET WHEN STOPPED.
JPTL 1 (Voice - LIMITER OFF, LIMITER OFF)	JPTL control inoperative: • JPTL switch set to OFF. • Failure detected in controlling DECU JPT limiting function. • Electrical power lost to either or both DECUs (EFC warning or caution also illuminated). • State input fault external to DECU (fast deceleration solenoid may be inoperative).	1. JPTL switch — CHECK ON. **If no EFC warning or caution light:** 2. EFC switch — SET TO OTHER DECU. **If light remains on:** 3. JPTL switch — OFF. 4. Maintain JPT/RPM limits manually.

Figure 12-1. Warning/Caution/Advisories (Sheet 3)

WARNING LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
LAW 1 (Voice - ALTITUDE, ALTITUDE)	Below set altitude.	Information.
1 (Voice - OBSTACLE, OBSTACLE)	Aircraft is at or below the set obstacle clearance elevation angle of the AWLS ground station.	Information.
MASTER WARNING (Radar/Night attack aircraft)	A warning has been activated.	Check warnings.
OT 1 (Voice - OVERTEMP, OVERTEMP)	JPT limits exceeded: • Before AFC-394, an open thermocouple circuit will result in JPT indications rising to 999 °C.	**If JPT exceeds 765 °C with -406 engine or 820 °C with -408 engine. (OT light):** 1. Land as soon as practical (conventionally if possible). 2. Use minimum power. **If conventional landing not possible:** 3. Jettison fuel and stores if feasible.
R FEED (TAV-8B only) 1 (Voice - RIGHT FEED, RIGHT FEED)	Crossfeed system failure or valve in wrong position.	1. Fuel quantity indicator switch — FEED. **If left and right fuel quantities above 300 pounds:** 2. Fuel proportioner switch — DL. 3. R FEED warning and advisory lights — OUT. **If left fuel quantity less than 300 pounds and right fuel quantity above 300 pounds:** 4. Fuel proportioner switch — RT. 5. R FEED advisory light — ON. 6. R FEED warning light — OUT. **If both left and right fuel quantities below 300 pounds:** 7. Fuel proportioner switch — OFF. 8. R FEED warning and advisory lights — OUT.
SAM (AV-8B only)	Refer to A1-AV8BB-TAC-100/(S).	
L TANK R TANK 1 (Voice - LEFT TANK, LEFT TANK or RIGHT TANK, RIGHT TANK)	Fuel tank overpressure or overtemperature.	**DURING AIR REFUELING.** *1. Break away. **IN NORMAL FLIGHT.** 1. Throttle — MINIMUM REQUIRED. 2. A/R switch — CHECK (out of PRESS position). 3. Fuel dump switches — NORM. **DURING HOT REFUELING.** *1. Throttle — OFF.

Figure 12-1. Warning/Caution/Advisories (Sheet 4)

CAUTION LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
AFC	AFC malfunction or AFC deselected.	1. Assume control.
AFT BAY	Aft bay ECS failed. Selection of reset will remove the AFT BAY Caution from the Caution/Advisory Panel for 45 seconds. If the overheat condition still exists, the AFT BAY Caution can be expected to return. Repeated AFT BAY lights should be considered a system fault. Repeated selection of RESET can result in aircraft damage.	**NON-RADAR AIRCRAFT.** 1. EQUIP RESET switch — RESET (No more than three RESETs allowed in a flight). **If AFT BAY caution reilluminates three consecutive times or does not reset:** 2. EQUIP RESET switch — OFF. 3. Limit airspeed as follows: Below 5,000 feet - 0.7 Mach. 5,000 to 10,000 feet - 0.8 Mach. 10,000 to 15,000 feet - 0.9 Mach. 4. Land as soon as practical. **RADAR AIRCRAFT.** 1. AFT EQUIP switch — RESET (No more than three RESETs allowed in a flight). **If AFT BAY caution reilluminates three consecutive times or does not reset:** 2. Limit airspeed as follows: Below 5,000 feet - 0.4 Mach. 5,000 to 10,000 feet - 0.6 Mach. 10,000 to 15,000 feet - 0.7 Mach. 3. For operational necessity up to 0.2 Mach increase over the above speeds is acceptable for 30 minutes. 4. Land as soon as practical.
APU GEN	APU selected and emergency generator failed. ★ Refer to paragraph 15.12 APU Generator Failure.	1. APU switch — RESET/ON (attempt several times). **If APU GEN caution still on:** 2. APU switch — OFF. 3. Land as soon as practical.
AUT FLP	Auto flap mode or ADC failed. ★ Refer to paragraph 15.37 AUTO Flap Failure.	1. Flap control switch — RESET. **If flaps do not reset or AUT FLP caution reilluminates during flight:** 2. Flap mode switch — CRUISE OR STOL (below 165 knots and nozzles greater than 25°). 3. BIT display — CHECK FOR ADC FAILURE (ADC 1). 4. If ADC failure confirmed — do not extend landing gear at airspeeds >200 KCAS.
BINGO 1 (Voice - BINGO, BINGO)	Fuel below bingo setting.	Information.
CANOPY	Canopy not locked closed. ★ Refer to paragraph 15.5 Canopy Unsafe Inflight.	1. Descend below 25,000 feet. 2. Cabin pressure switch — DUMP. 3. Slow below 250 knots. **If unsafe latch can be determined:** 4. Land as soon as practical.
CASTER	On AV-8B 163677 and up; light is not used, illuminates on lights test only.	Information.

Figure 12-1. Warning/Caution/Advisories (Sheet 5)

CAUTION LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
CIP AUT	SMS unable to operate in computed delivery mode (AUTO and CCIP).	Information.
CMBT	Combat thrust activated. Flashes after 2 1/2 minutes.	Information.
CS COOL	Cockpit avionics cooling fan failed. Affected equipment: HUD, ODU, DC, DDI, and ACP.	1. Cockpit temperature — AS COLD AS PRACTICAL. 2. Affected avionics — OFF (if not required). 3. Land as soon as practical.
CW NOGO (AV-8B only)	Refer to A1-AV8BB-TAC-100/(S).	
DC	Main transformer-rectifier failed ★ Refer to paragraph 15.10 Main TRU Failure. NOTES • Hot NWS, perform RVL or VL if possible. • Below 16 volts, normal manual fuel selection cannot be guaranteed. • DC equipment to consider for step 8: DC boost pumps. Radios (transmit drains more power). Seat adjust. Trim.	1. Confirm DC failure by checking hydraulic gauges. 2. Fuel boost pump switches — NORM OR OFF. 3. Voltmeter and STBY TR caution — MONITOR. 4. Do not select STOL flaps above 165 knots and less than 25° nozzles and do not lower landing gear greater than 200 kts. 5. Land as soon as practical. **If STBY TR caution on and/or voltmeter below 26 volts:** 6. MFS — SELECT (16 volts minimum). 7. Landing gear — DOWN AS SOON AS POSSIBLE (below 200 knots and 16 volts minimum). 8. Nonessential DC equipment — OFF.
DEP RES	Departure resistance reduced.	Observe Prohibited Maneuvers and AOA Limitations without departure resistance.
EFC	DECU number 1 or 2 has failed. ★ Refer to paragraph 15.6.2 Single DECS Failure (EFC caution).	1. Do not change lanes. 2. Land as soon as practical.
ENG EXC	Engine overspeed, overtemperature, or over g was detected.	Information.
FLAPS 1 - - - - - - - - - - FLAPS 2	Flaps channel 1 failed. - Flaps channel 2 failed. ★ Refer to paragraph 15.36 Flaps Channel Failure.	**FLAPS 1 and FLAPS 2.** 1. Flaps — AUTO. 2. Flap power switch — RESET (single channel failure only). **If FLAPS 1 or FLAPS 2 does not reset or reilluminates during flight:** 3. Flap mode switch — CRUISE OR STOL (below 165 knots and nozzles greater than 25°). **For FLAPS 2.** 4. If flap circuit breaker popped — RESET.
L FUEL R FUEL 1 (Voice - when fuel is less than 250 pounds: FUEL LOW LEFT, FUEL LOW LEFT or FUEL LOW RIGHT, FUEL LOW RIGHT)	Steady light - left or right fuel 750 pounds. Flashing light - left or right fuel 250 pounds. ★ Refer to paragraph 15.32 Fuel Low Level.	**Flashing Light.** 1. Fuel quantity indicator switch — FEED. 2. Apply negative and then positive g's. **If single feed tank decreasing:** 3. Fuel proportioner switch — OFF. 4. Boost pump switch (flashing side) — OFF. 5. Boost pump switch (nonflashing side) — ON. 6. Fuel asymmetry — MONITOR. 7. Land as soon as practical. **If both feed tanks decreasing:** 8. Drop tanks — JETTISON. 9. Both boost pumps — NORM. 10. Fuel proportioner switch — OFF. 11. Land immediately.

Figure 12-1. Warning/Caution/Advisories (Sheet 6)

CAUTION LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
FWD BAY (Radar aircraft)	Forward ECS failure.	1. FWD EQUIP switch — RESET. **If FWD BAY caution reilluminates or does not reset:** 2. Descend to below 25,000 feet. 3. Limit airspeed as follows: Below 5,000 feet - 0.4 Mach. 5,000 to 10,000 feet - 0.6 Mach. 10,000 to 15,000 feet - 0.7 Mach. 4. If radar mode is in OPR or STBY, limit airspeed above 15,000 feet to 0.7 Mach. **If no ECS airflow from cockpit louvers:** 5. PRESS switch — RAM.
3 GPS	GPS not valid, aggressive maneuvering or vertical and horizontal position error not within tolerance for mode selected. **CAUTION** Continued INS operation in IFA following a GPS caution can lead to INS failure.	**If not in maneuvering flight:** 1. Check GPS BIT and EHPE/EVPE status. **If BIT and EHPE/EVPE indicate GPS failure:** 2. INS knob to NAV.
H_2O 1 (Voice - WATER, WATER)	Less than 15 seconds water remaining.	Information.
H_2O SEL	Over 250 knots and water switch not OFF.	1. Water switch — OFF.
HYD 1	HYD 1 pressure ≤1,400 psi. Speedbrake and LIDS not available. Expect about 500 pounds decrease in VTOL/VL lift. ★ Refer to paragraph 15.46 HYD 1 Failure. HYD 1 Caution is accompanied by the prop caution due to the dependence of the fuel flow propotioner hydraulic motor on HYD 1 system pressure.	1. Fuel proportioner — OFF. **If failure indications persist:** 2. Land as soon as practical (VL/RVL if practical). 3. Fuel asymmetry — MONITOR. 4. Below 210 knots, landing gear handle — DOWN, TURN AND PULL. **After touchdown.** 5. Throttle — OFF. 6. Parking brake — SET WHEN STOPPED. **If VL/RVL not practical:** 7. Make slow landing. 8. Use power nozzle braking (60 knots minimum) then steady brake pressure without antiskid cycling. Braking will be lost if brake accumulator pressure drops below 1,000 psi. 9. Shut down engine and set parking brake when stopped.
HYD 2	HYD 2 pressure ≤1,400 psi.	1. Land as soon as practical. 2. Throttle — OFF WHEN CLEAR OF RUNWAY.
IFF	Mode 4 off, zeroized, or not responding.	Information.

Figure 12-1. Warning/Caution/Advisories (Sheet 7)

CAUTION LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
INS	INS aligning or failed.	1. Use the standby attitude indicator for attitude reference. 2. INS switch — OFF (5 seconds - ASN-139/ 3 minutes - ASN-130). 3. Maintain straight and level flight. **If attempting an in-flight alignment (IFA):** 4. Master mode — NAV. 5. INS switch — IFA. 6. Make any required turns using greater than 30° AOB. 7. EHSD — Monitor alignment time and quality. 8. Alignment complete when HUD attitude information returns. (GPS IFA with good satellite data may take up to 10 minutes). **If attempting a radar IFA:** 9. Master mode — NAV. 10. Radar mode — Land or Sea based on terrain. 11. INS switch — IFA. 12. Make any required turns using greater than 30° AOB. 13. A/C data page — RIFA (GPS data page — RIFA with C1+). 14. EHSD — Monitor alignment time and quality after 2 minutes. 15. INS caution — Verify extinguished (may take up to 20 minutes). 16. INS switch — NAV. **If IFA is unsuccessful, attempt a GYRO recovery:** 17. INS switch — OFF (5 seconds - ASN-139/ 3 minutes - ASN-130). 18. INS switch — GYRO.
JMR HOT (Night Attack)	ASPJ Overtemp.	Information.
L	Left wing gear in transit.	Information.
LIDS	LIDS not in correct position.	**With gear up:** 1. Do not exceed 200 knots. **With gear down:** 1. LIDS switch — CHECK NORM. 2. Expect about 500 pound decrease in VTO/VL lift.
LOAD	Fuel asymmetry over VL limit.	Refer to Asymmetric Landing.
M	Main landing gear in transmit.	Information.
MASTER CAUTION 1 (Voice - CAUTION, CAUTION)	A caution has been activated.	Check cautions.
MFS 1 (Voice - MANUAL FUEL, MANUAL FUEL)	Manual fuel system on. **CAUTION** Verify the MFS switch has returned to neutral position prior to activating the emergency MFS battery. The MFS switch in OFF will direct battery power away from the MFS solenoid and prevent MF activation.	1. MAN FUEL switch — POSITIVELY SELECT ON AND RELEASE. 2 2. MFS EMER BATT switch — CHECK.

Figure 12-1. Warning/Caution/Advisories (Sheet 8)

CAUTION LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
N	Nose landing gear in transit.	Information.
5 NWS	Nosewheel Steering Malfunction. ★ Refer to paragraph 16.3 NWS Failure.	**INFLIGHT** 1. Perform VL. **If unable to perform VL:** 2. Determine available steering mode. 3. Perform RVL as slow as practical with minimum crab angle. **TAKEOFF/LANDING ROLL OUT** *1. Attempt to get airborne. **If unable to get airborne:** *2. Engage NWS button at minimum practical ground speed.
OIL	Oil pressure low. ★ Refer to paragraph 15.24 Oil System Failure.	*1. Throttle — MAINTAIN CONSTANT RPM (75 to 85%, -406) (80 to 85%, -408). 2. Minimize g-loading. 3. Land as soon as possible using VNSL. 4. Use nozzles, speedbrake, flaps, and landing gear to control airspeed. 5. Fuel/Stores — JETTISON AS REQUIRED. 6. If vertical landing is the only option, use throttle slowly and progressively and be prepared for engine failure. 7. Throttle — OFF AS SOON AS PRACTICAL.
OXY	OBOGS malfunction. ★ Refer to paragraph 15.4 OBOGS Failure.	*1. Emergency oxygen actuator — PULL. *2. Oxygen switch — OFF. 3. Descend below 10,000 feet cockpit altitude. 4. Oxygen mask — RELEASE.
PITCH	Pitch stab aug off or failed.	1. AFC — RESET. **If erroneous input occurs:** 2. Paddle switch — PRESS AND HOLD. 3. Pitch stab aug switch — OFF. 4. Paddle switch — RELEASE.
P NOGO (AV-8B only)	Refer to A1-AV8BB-TAC-100/(S).	
PROP	Fuel proportioner off or failed.	1. Fuel proportioner switch — OFF. 2. Monitor fuel quantity indicators. 3. Balance fuel by switching lowest feed group boost pump switch OFF until balanced.
L PUMP R PUMP	Left or right boost pump pressure low.	1. Boost pump switch (failed pump) — DC OPR. **If pump still failed:** 2. Boost pump switch (failed pump) — OFF. 3. Fuel asymmetry — MONITOR. 4. Land as soon as practical.

Figure 12-1. Warning/Caution/Advisories (Sheet 9)

CAUTION LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
R	Right wing gear in transit.	Information.
ROLL	Roll stab aug off or failed.	1. AFC — RESET. **If erroneous input occurs:** 2. Paddle switch — PRESS AND HOLD. 3. Roll stab aug switch — OFF. 4. Paddle switch — RELEASE.
4 SKID	If light stays on (antiskid failure). If light goes out (caster failure). → NOTE A skid failure will mask a caster failure.	**ON GROUND** *1. ANTISKID switch — NWS. 2. Brakes — MINIMUM REQUIRED. **INFLIGHT** 1. Check ANTISKID switch — ON. 2. Select NWS on stick grip. 3. ANTISKID switch — NWS. 4. Perform VL. **If unable to land vertically:** 5. Minimize crab angle. 6. Perform RVL as slow as practical. 7. Brakes — MINIMUM REQUIRED.
5 SKID	Antiskid System Malfunction.	1. Brakes — MINIMUM REQUIRED.
STBY TR	Standby TRU inoperative or off line. ★ Refer to paragraph 15.11 Standby TRU Failure.	1. Voltmeter and DC caution — MONITOR.
L TRANS R TRANS	Low air pressure to left or right feed tanks. ★ Refer to paragraph 15.31 Fuel Transfer Failure.	1. Descend below 30,000 feet. 2. Air refuel switch — IN. 3. Dump switches — NORM. 4. Fuel quantity indicator switch — AS REQUIRED. **SINGLE FEED TANK DECREASING:** **If L FUEL or R FUEL caution flashes:** 1. Fuel proportioner switch — OFF. 2. Boost pump switch (flashing side) — OFF. 3. Boost pump switch (non-flashing side) — ON. 4. Fuel asymmetry — MONITOR. 5. Land as soon as practical. **BOTH FEED TANKS DECREASING:** **If both L FUEL and R FUEL cautions flash:** 1. Drop tanks — JETTISON. 2. Both boost pump switches — NORM. 3. Fuel proportioner switch — OFF. 4. Land immediately.
WSHLD	Windshield hot.	Information.
YAW	Yaw stab aug off or failed.	1. AFC — RESET. **If erroneous input occurs:** 2. Paddle switch — PRESS AND HOLD. 3. Yaw stab aug switch — OFF. 4. Paddle switch — RELEASE.
15 SEC 1 (Voice - FIFTEEN SECONDS, FIFTEEN SECONDS)	JPT above normal lift rating (flashing after 15 seconds).	1. Monitor JPT.

Figure 12-1. Warning/Caution/Advisories (Sheet 10)

ADVISORY LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
1 (Voice - ACNIP GO, ACNIP GO)	ACNIP BIT passed.	Information.
1 (Voice - ACNIP FAIL, ACNIP FAIL)	ACNIP BIT failed.	Information.
#AFC	AFC selected in front cockpit.	Information.
A/G	Air-to-ground HUD mode Information.	Information.
#ALTHD	Altitude hold selected in front cockpit.	Information.
APU	APU operating.	Information.
#AUTO (Flap)	Flaps AUTO mode selected.	Information.
AUTO (VRS)	VRS AUTO mode selected.	Information.
AV BIT	Light de-activated.	
CW JAM (AV-8B only)	Refer to A1-AV8BB-TAC-100/(S).	
#CRS	Flaps CRUISE mode selected.	Information.
DROOP	Ailerons dropped.	Information.
#H_20	H_20 switch in TO or LDG.	Information.
L	Left wing gear locked down.	Information.
LEFT	Flashing - Left feed group full with air refuel probe extended. --------------------------------------- Steady - 4 external tanks aboard and left inboard external tank full with air refuel probe extended.	Information.
M	Main landing gear locked down.	Information.
N	Nose landing gear locked down.	Information.
NAV	Navigation HUD mode.	Information.
P JAM (AV-8B only)	Refer to A1-AV8BB-TAC-100/(S).	
R	Right wing gear locked down.	Information.
R FEED (TAV-8B only)	TAV-8B crossfeed valve in right feed position.	Information.
READY	Air refuel probe extended and locked without fuel pressure/flow or tank pressurization.	Information.
REPLY	IFF responding to Mode 4 interrogation.	Information.
RIGHT	Flashing - Right feed group full with air refuel probe extended. --------------------------------------- Steady - 4 external tanks aboard and right inboard external tank full with air refuel probe extended.	Information.
RUN	VRS RUN mode selected.	Information.
SEL	Combat thrust limiter selected.	Information.
SPD BRK	Gear up and speed brake extended Gear down and speed brake not 25°.	Information.

Figure 12-1. Warning/Caution/Advisories (Sheet 11)

ADVISORY LIGHTS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
STO	Flap switch in STOL.	Information.
#STOL	Flaps STOL mode selected.	Information.
VSTOL	VSTOL HUD mode.	Information.
W	Water is flowing.	Information.

* Immediate action item
★ Discussion in Part V
#Rear cockpit indicator

1 AV-8B 163519 and up, TAV-8B 163856 and up.

2 AV-8B 164151 and up; also TAV-8B, AV-8B 161573 through 164150 after AFC-328.

3 AV-8B 165384 and up; also 161573 through 165383, TAV-8B 162963 through 164542 after AFC-354 RevA/Part 2/Part 3.

4 AV-8B 161573 through 165312, TAV-8B.

5 AV-8B 165354 and up; also 161573 and up after AFC-391 Part 2, TAV-8B 162963 and up after AFC-391 Part 4.

Figure 12-1. Warning/Caution/Advisories (Sheet 12)

GPWS VOICE WARNINGS

INDICATOR	CAUSE/REMARKS	CORRECTIVE ACTION
PULL-UP	Activated when the altitude is ≤90 feet and the airspeed is ≥250 KCAS, or ≥200 KCAS, at least 60 seconds after takeoff or waveoff, or aircraft calculates a dive recovery is required.	1. Immediate pull up using the direction-of-pull arrow on the HUD.
ROLL OUT	If <150 feet, between 100 and 200 KCAS, at least 60 seconds after takeoff or waveoff, and at bank angle >45° for 1 second, ROLL OUT is annunciated.	1. Immediate roll to wings level and pull up using the direction-of-pull arrow on the HUD.
POWER	**Landing Phase.** If altitude <150 feet, <200 KCAS, more than 60 seconds after take-off or waveoff, and sink rate = a threshold for 0.3 seconds, POWER is annunciated. **Takeoff Phase.** If altitude <150 feet, <250 KCAS, <60 seconds after take-off or waveoff, and a sink rate ≥300 fpm, POWER is annunciated.	1. Immediate power addition to control sink rate and pull up using the direction-of-pull arrow on the HUD.
CHECK GEAR	• GPWS detects the gear is not down and locked. • If <150 feet, between 100 and 200 KCAS, more than 60 seconds after take-off or waveoff, and descending, warning is activated if gear not down and locked for 0.3 seconds.	1. Lower landing gear.

TAV-8B with H4.0 and Night Attack/Radar Aircraft Only.

Figure 12-1. Warning/Caution/Advisories (Sheet 13)

CHAPTER 13

Ground Emergencies

13.1 EMERGENCY SHUTDOWN

*1. Throttle — OFF.

*2. Fuel shutoff handle — OFF.

*3. Engine start switch — OFF.

*4. APU GEN — OFF.

*5. Battery switch — OFF.

6. Egress.

13.2 GROUND FIRE

The first indication of a fire is normally illumination of the FIRE warning light. There are multiple sources of fire while operating on the ground such as Engine Fire, GTS/APU Fire, and Brake Fire.

If a fire is suspected or is indicated by ground crews:

*1. Execute Emergency Shutdown.

13.3 ABNORMAL START

If the JPT rises rapidly between 350° and 400° (hot start), or if rpm stabilizes below idle (hung start), or if engine does not light off within 10 seconds after selecting idle (wet start):

*1. Throttle — OFF.

If wet start:

*2. Engine start switch — OFF.

Perform dry cycle, if required:

3. Ignition isolate switch — ON.
4. Engine start switch — ENG ST (motoring automatically stops after 40 seconds).
5. Repeat cycle as necessary.

13.4 LOSS OF ENGINE CONTROL ON GROUND

If engine RPM-JPT indications on EDP freeze at approximately 22 percent or display an abnormal indication during start, the voltmeter drops to zero when the DC test switch is set to STBY during standby TRU check, or during any undemanded engine acceleration.

*1. Throttle — OFF.

*2. Fuel shutoff handle — OFF.

13.5 BRAKE FAILURE

13.5.1 Ground

*1. ANTISKID switch — NWS.

2. Steer toward safe area.

3. Nozzles — HOVER/BRAKING STOP AS REQUIRED.

4. Throttle — OFF WHEN PRACTICAL.

13.5.2 Air

1. ANTISKID switch — NWS.
2. Perform VL.
3. Throttle — OFF WHEN CHOCKED.

13.6 HOT BRAKE

Brake energy zones for the two scenarios are provided in Figure 13-1. Chart A assumes that the nozzles are stuck in the aft position and PNB is not available. Chart B assumes the nozzles are at the hover stop, engine speed maintained at idle, and PNB is not available. In either scenario, brake overheat occurs when the energy absorbed by an individual brake exceeds normal zone limits. Tire deflation due to wheel thermal fuse plug activation generally occurs within 50 seconds after exceeding the normal zone. In the fuse plug release zone, fuse plug release is expected, wheel/brake damage may occur, and brake fires are possible.

In the brake fire zone, fires are usually fueled by wheel or brake contaminates, and are easily extinguished. In the brake fire zone, brake energies exceed all tested conditions and wheel/brake damage is certain. Hydraulic fluid fires are possible in the brake fire zone due to the deterioration of seals within the brake assembly. Setting the parking brake or applying pressure on the brake pedals will pressurize the brake assembly and drastically increase the probability of fire due to hydraulic seal failure. The brake energy limit charts should be used whenever a takeoff is aborted, and for emergency landings. As stated before, the effects of brake usage/heat buildup are cumulative. If brake overheat occurs, the aircraft must not be operated for 90 minutes to allow the brakes to cool and have sufficient energy capacity should the ensuing takeoff be aborted.

Brake overheat should be considered when:

1. Brakes are applied at speeds in excess of 80 knots.
2. Brakes are dragging during taxi.
3. Successive stops resulting in cumulative energies within the fuse plug release zone.

If brake overheating is suspected:

1. Taxi aircraft to closest safe location. Use brakes only as needed to stop or turn.
2. Turn aircraft into the wind.
3. Wheels — CHOCKED.
4. Brakes — RELEASE.
5. Place nozzles to 30° at idle rpm.
6. Shutdown engines after firefighting equipment arrives.

WARNING

- When brake overheat occurs, stay clear of an area extending at least 300 feet in a 45° cone around the axle on both sides of the wheel until brakes have cooled or until thermal release plugs have deflated the tires.
- Due to the possibility of hydraulic seal failure with hot brakes and blown main tires, a hydraulic fire may develop. Parking brake application will increase the probability of fire.

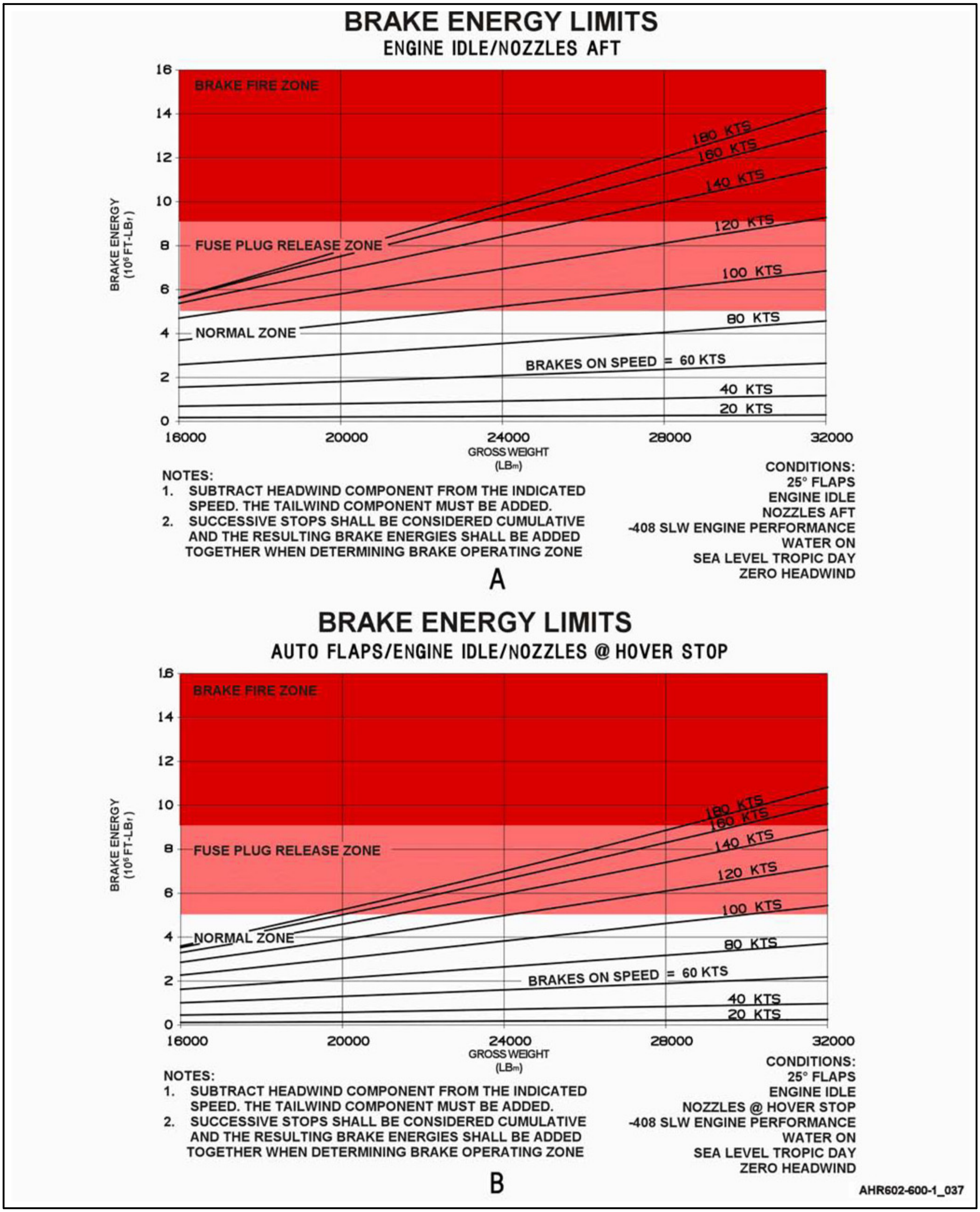

Figure 13-1. Brake Energy Limits

CHAPTER 14

Takeoff Emergencies

14.1 ABORT

14.1.1 Ashore (CTO or STO)

At all speeds, PNB is more effective at stopping the aircraft then the brakes alone. If PNB is not available due to questionable engine control, combine idle PNB and braking. If the brake energy required to stop the aircraft is anticipated to be above the normal energy zone (see Figure 13-1), bring the aircraft to a stop using maximum braking. Light braking will cause heat build up and the main tire fuse plug release prior to stopping, greatly reducing braking effect and causing damage to the wheel assembly. Expect the main tire fuse plugs to release shortly after stopping.

*1. Throttle — IDLE.

WARNING

Manual fuel may be required in the event of EFC warning or loss of engine control.

*2. Nozzles — BRAKING STOP.

*3. Throttle — AS REQUIRED.

*4. Brakes — AS REQUIRED.

If hot brakes are suspected:

5. Refer to Hot Brake procedure.

Note

Consideration should be given to ejecting prior to leaving a prepared surface.

14.1.2 Afloat (STO)

WARNING

Any delay in the decision to abort beyond about 2 seconds after throttle slam may preclude a successful abort.

*1. Throttle — OFF.

*2. Brakes — FULL.

If unable to stop:

3. EJECT.

14.2 NO LIFTOFF ON STO

*1. Nozzles — AFT.

*2. Increase speed 20 knots.

*3. Nozzles — STO STOP.

14.3 RPM STAGNATION/LOSS OF THRUST AFLOAT

*1. MFS — SELECT.

*2. STO at nozzle rotation line.

*3. Stores — JETTISON (if required).

*4. Water switch — OFF.

5. Land as soon as practical.

If unable to sustain level flight:

6. EJECT.

14.4 OVER ROTATION ON STO

*1. Stick — FULL FORWARD.

*2. Nozzles — REDUCE 20 DEGREES.

*3. Nozzles — STO STOP.

If control not Regained:

4. EJECT.

14.5 BLOWN TIRE ON TAKEOFF

If takeoff is continued:

1. Leave gear down.
2. Perform a VL if possible.

14.6 LANDING GEAR FAILS TO RETRACT

1. Gear handle — DOWN.
2. Landing gear circuit breaker — CHECK IN.
3. Obtain visual check.

If unable to obtain visual check:

4. Land as soon as practical.

If visual check indicates no damage:

5. Gear handle — UP.

If unsafe indication still present:

6. Gear handle — DOWN AS SOON AS PRACTICAL.
7. Land as soon as practical.

CHAPTER 15

In-Flight Emergencies

15.1 MISSION COMPUTER FAILURE

If the mission computer fails, the following items are inoperative:

1. AFC.
2. AWLS.
3. Radar beacon.

TAV-8B, Day Attack and Night Attack Aircraft:

4. Dual mode tracker.

All Aircraft:

If the mission computer fails, the following items are affected:

5. HUD — Reverts to back-up display. See Figure 15-1.
6. DDI — See Figure 15-1.
   a. TAV-8B, AV-8B Day Attack, reverts to HUD backup displays.
   b. AV-8B Night Attack and Radar Aircraft, right DDI reverts to HUD backup display and left DDI reverts to map backup display.
7. SAS — Degraded.
8. VHF/UHF — Operates in manual mode using radio set control.
9. TACAN — Only X channels available. If Y channel selected, reverts to same number X channel. Range and bearing displayed on HUD. Can be turned ON/OFF.
10. INS — No steering. Pitch, roll, true heading and present position displayed.
11. IFF — Goes OFF but can be turned ON. Modes 1 and 2 inoperative. Mode 3 code initialized to zero but can be reset.
12. Radar altimeter — Goes OFF but can be turned ON. Low altitude warning light fixed at 200 feet.
13. HOTAS — Target designator control (TDC) and sensor select inoperative. The display alternate toggle function is now performed with the WINC switch.
14. SMS — No computed delivery modes, CIP/AUT light on.
   a. Weapon delivery possible in DSL, DSL-1, or DIR modes using the roll stabilized site reticle.
   b. The standby reticle can also be used on day attack and TAV-8B aircraft.
15. RWR — No head-down ECM threat lethality display. Head-up ECM display provided on HUD and DDI.
16. EMCON — Goes OFF but can be turned on.

TAV-8B WITH OMNI 7.1 AND DAY ATTACK AIRCRAFT

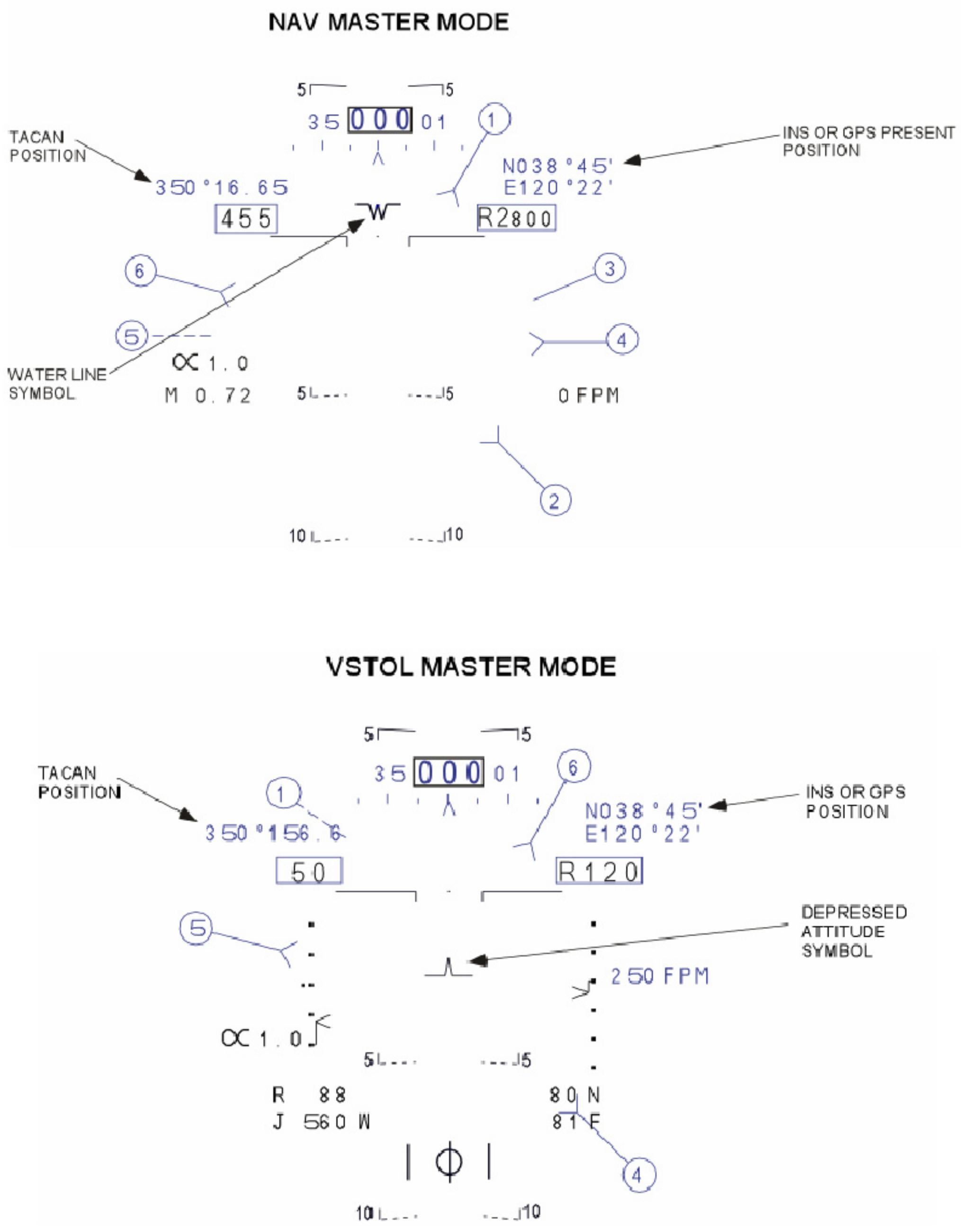

Figure 15-1. Mission Computer Failure Displays (Sheet 1 of 5)

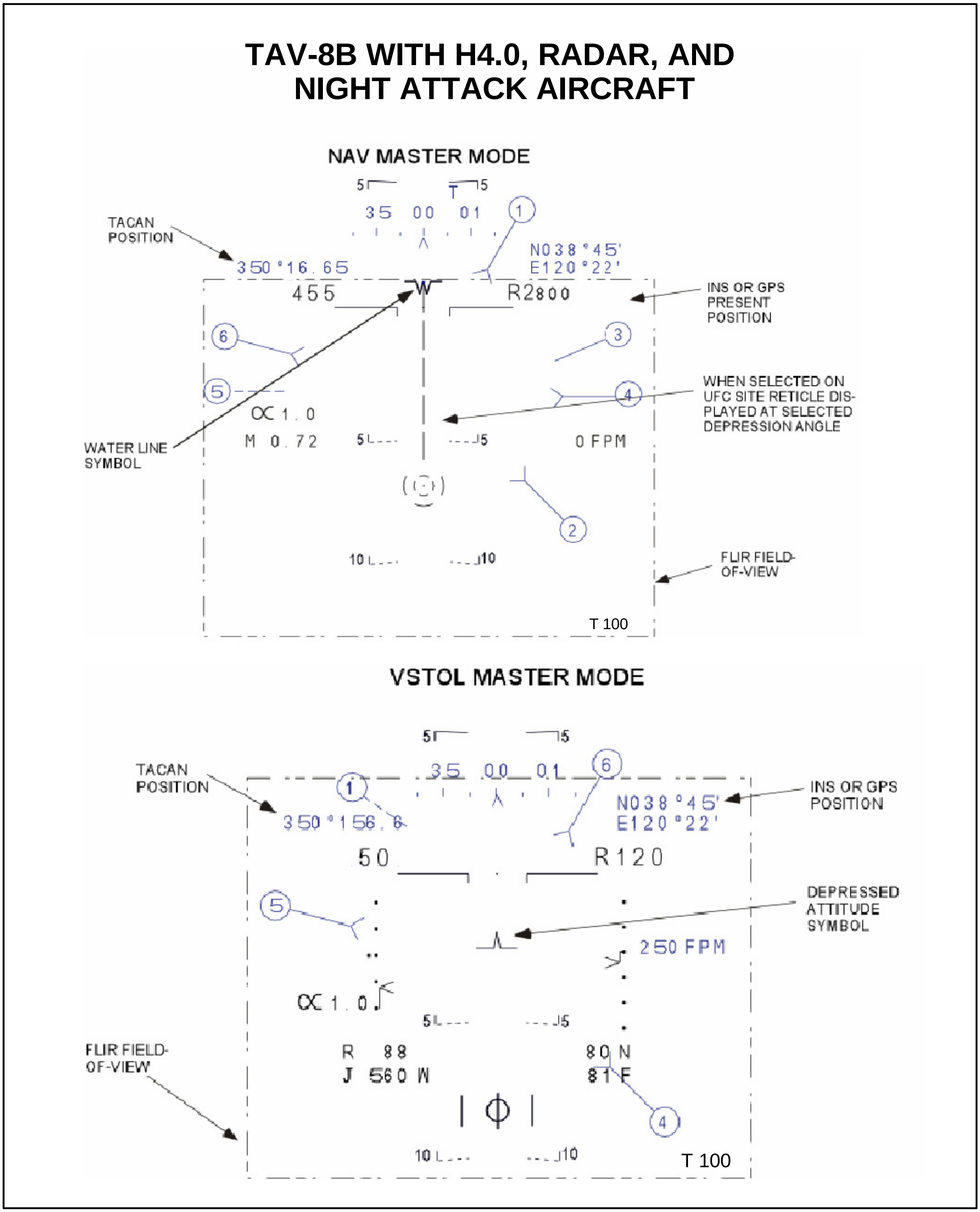

Figure 15-1. Mission Computer Failure Displays (Sheet 2)

TAV-8B WITH H4.0, RADAR, AND NIGHT ATTACK AIRCRAFT

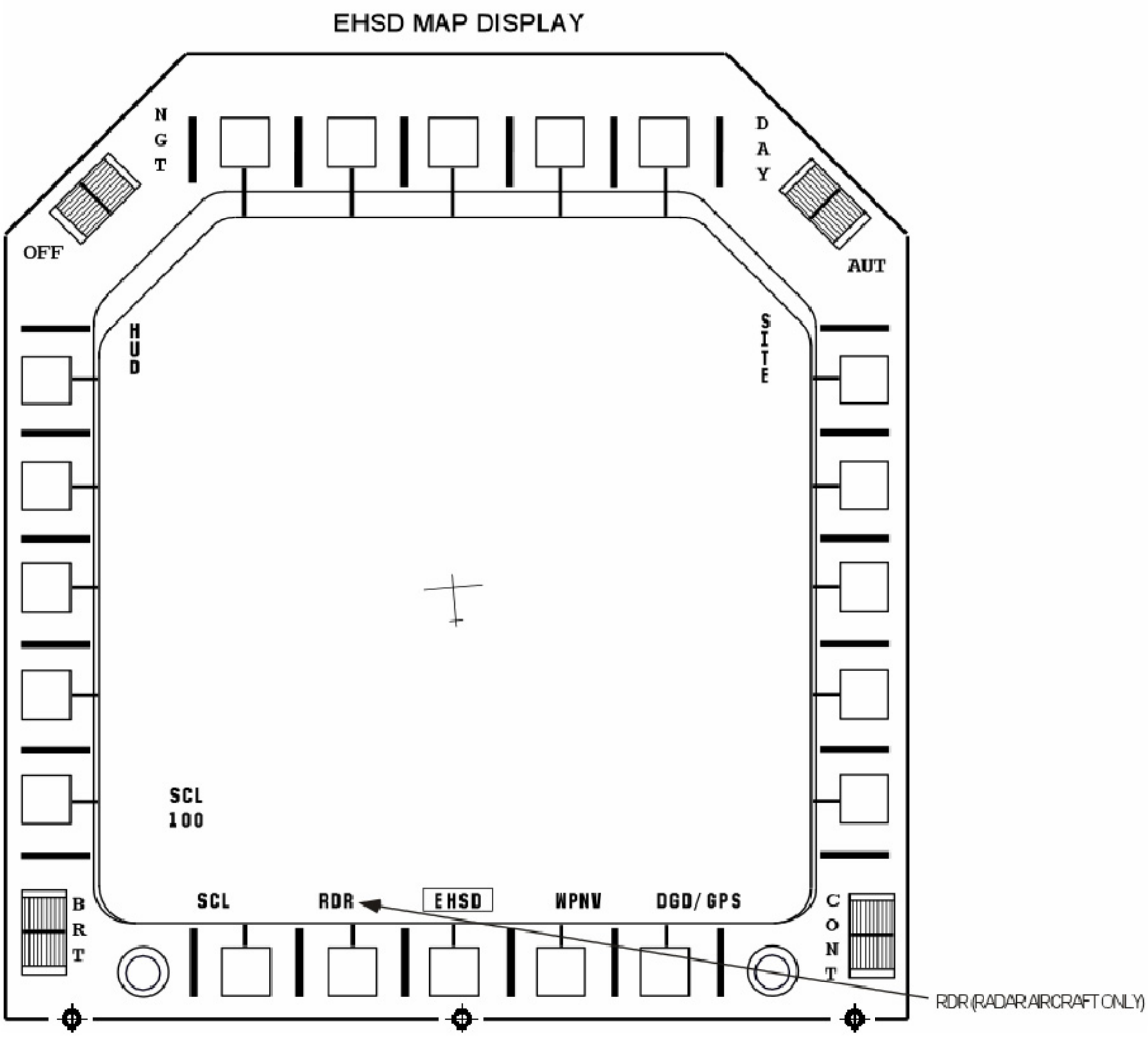

Figure 15-1. Mission Computer Failure Displays (Sheet 3)

RADAR AIRCRAFT

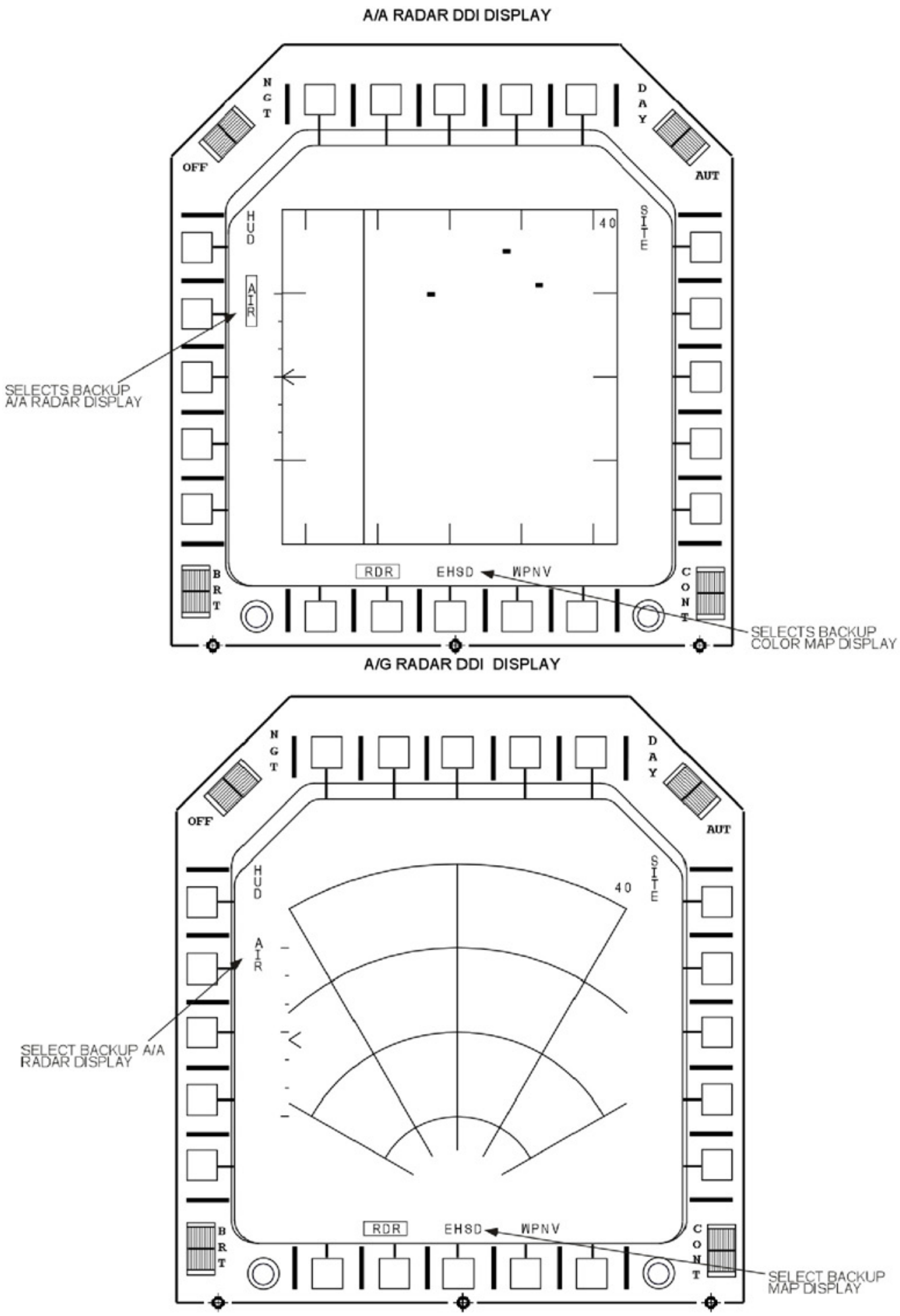

Figure 15-1. Mission Computer Failure Displays (Sheet 4)

TAV-8B WITH H4.0, RADAR, AND NIGHT ATTACK AIRCRAFT

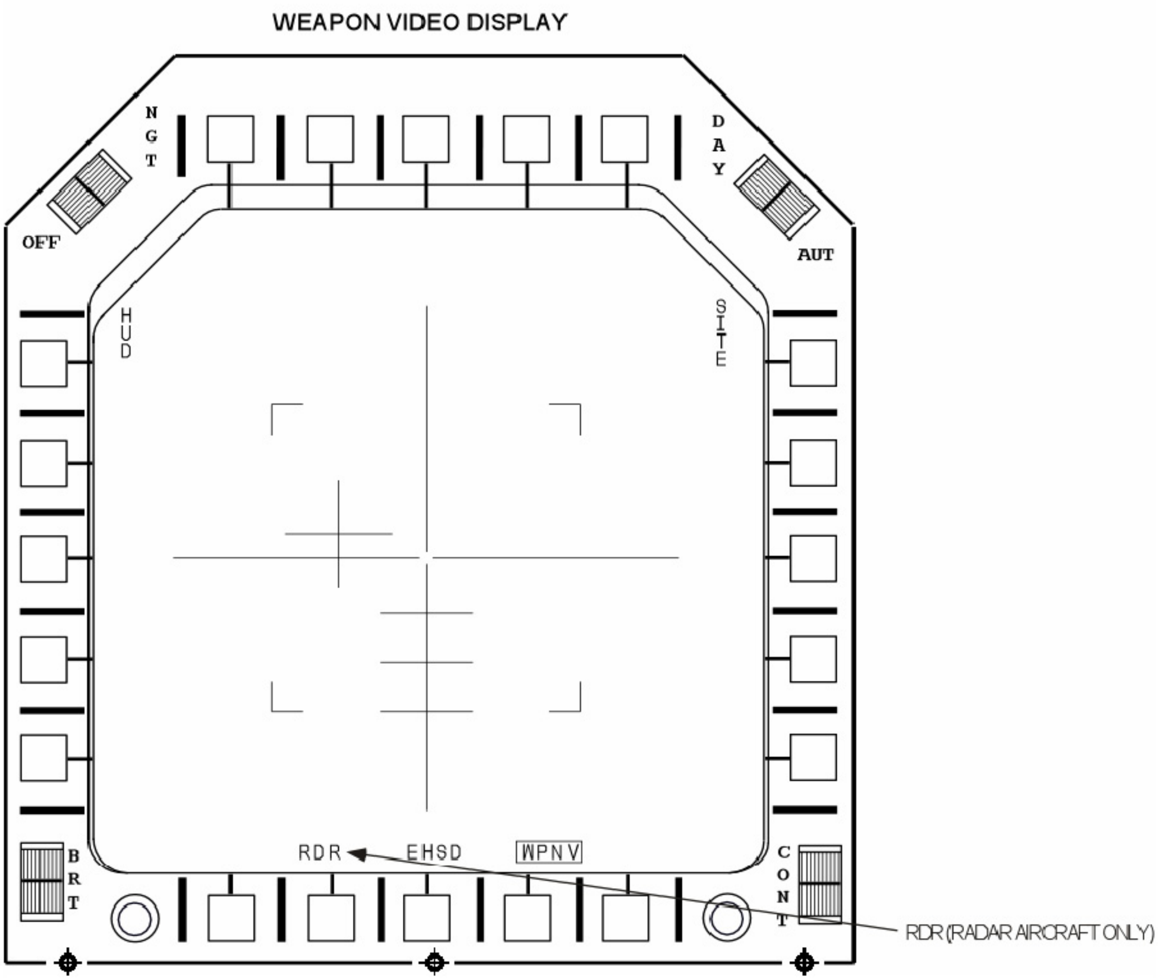

Figure 15-1. Mission Computer Failure Displays (Sheet 5)

17. FLIR — On radar and night attack aircraft only the FLIR video is provided for display on the HUD and right DDI backup displays. No DDI options, pushbutton legends, are available.

18. Map — On radar and night attack aircraft, backup map display provided on left DDI.

19. Radar — Backup radar display provided on right DDI. A/G program is limited to RBGM with a fixed 40 nm range scale, 120° scan, and AUTO scan A/A program limited to RWS/with a fixed 40 nm range scale, INTL PRF, 2 bar/140° scan, and 2 second target aging.

If backup display appears on the HUD and DDI:

20. MC switch — OVRD.

If normal operation not restored (STANDBY appears on displays or displays remain blank):

21. MC switch — OFF.

15.2 AIR DATA COMPUTER FAILURE

Air data computer failure may cause some or all air data (airspeed, Mach, altitude, AOA, rate of climb) to disappear from the HUD. The Q-feel fails on. SAAHS reverts to fixed low gains. Aileron high speed stops fail disengaged. The LIDS will extend with the landing gear regardless of airspeed. Landing gear warning, stall warning, departure resistance, auto flaps, and IFF altitude reporting fail. The CIP/AUT and DEP RES lights will come on. The mission computer and INS operate from degraded data.

If ADC failure is suspected:

1. BIT display — CHECK FOR ADC FAILURE (ADC 1).

CAUTION

- With an ADC failure, exercise caution in applying lateral stick above 250 knots. With the aileron high speed stops not engaged, excessive lateral stick may cause structural damage.
- With an ADC failure, do not lower the landing gear above 200 knots to prevent LIDS structural failure.
- With an ADC failure ensure airspeed is below 165 knots and nozzles are 25° or greater prior to selecting STOL flaps. Flap scheduling may occur and, at high speed, this will cause a severe nose down pitch.

2. Flaps — OFF.

3. Determine appropriate landing type with consideration to flap position.

4. Land as soon as practical.

WARNING

Faulty or fluctuating ADC airspeed signals sent to the Digital Flap Controller (DFC) can cause sudden, unexpected flap movement. With Auto Flaps selected, the Digital Flap Controller will reposition the flaps between 5 and 25 degrees any time an airspeed signal greater than 275 KIAS is received, regardless of the gear position.

CAUTION

After landing with flaps secured, any flap position greater than 25 degrees will require flaps to be emergency retracted prior to going nozzles aft to preclude flap damage due to exhaust temperatures.

15.3 INS FAILURE

If there is an INS failure while in NAV master mode (see Figure 15-2), the HUD symbology is affected as follows:

The velocity vector, aircraft g, max g, and flight path/pitch ladder symbols are not displayed. If the INS reverts to AHRS or if GYRO mode is selected, the flight path/pitch ladder symbol is displayed but the velocity vector, aircraft g, and max g symbols are not displayed. If there is an INS failure while in VSTOL master mode, the flight path/pitch ladder, sideslip acceleration, and pitch caret symbols are not displayed. If the INS reverts to AHRS or if the GYRO mode is selected, the flight path/pitch ladder and pitch caret symbols are displayed but the sideslip acceleration symbols are not displayed.

CAUTION

To prevent damage to the gyros on the AN/ASN-130A inertial navigation system, after an INS failure, the OFF position of the INS mode switch must be momentarily selected prior to selecting GYRO.

1. Use the standby attitude indicator for attitude reference.
2. INS switch — OFF (5 seconds - ASN-139/3 minutes - ASN-130).
3. Maintain straight and level flight.

If attempting an in-flight alignment (IFA):

4. INS switch — IFA.
5. Make any required turns using greater than 30° AOB (see note).
6. EHSD — MONITOR ALIGNMENT TIME AND QUALITY.
7. Alignment complete when HUD attitude information returns. (GPS IFA with good satellite data may take up to 10 minutes).

If attempting a radar IFA:

8. Master mode — NAV.
9. Radar mode — LAND OR SEA BASED ON TERRAIN.
10. INS switch — IFA.
11. Make any required turns using greater than 30° AOB (see note).
12. A/C data page — RIFA (GPS data page — RIFA with C1+).
13. EHSD — MONITOR ALIGNMENT TIME AND QUALITY (after 2 minutes).
14. INS caution — VERIFY EXTINGUISHED (may take up to 20 minutes).

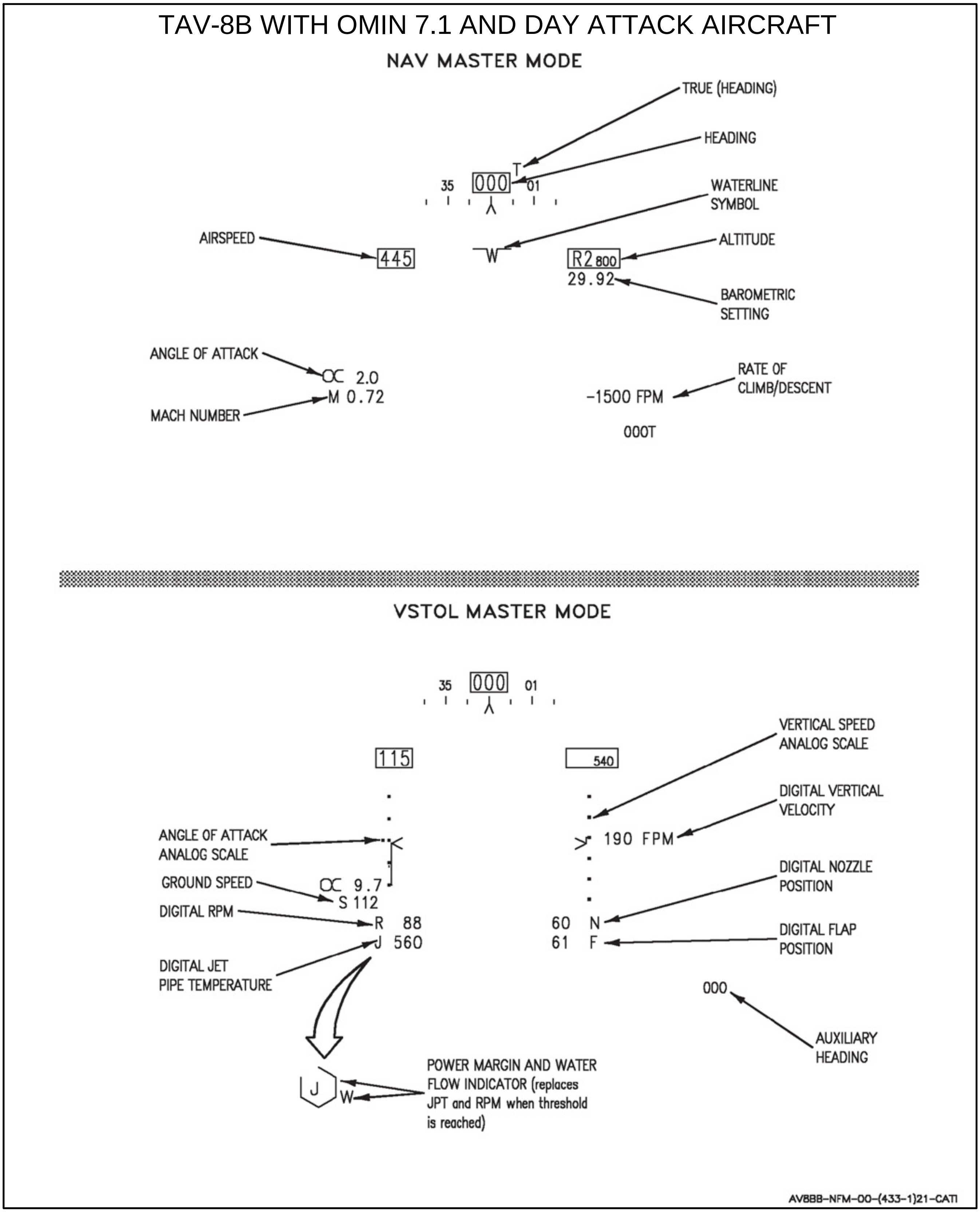

Figure 15-2. Total INS Failure Displays (Sheet 1 of 2)

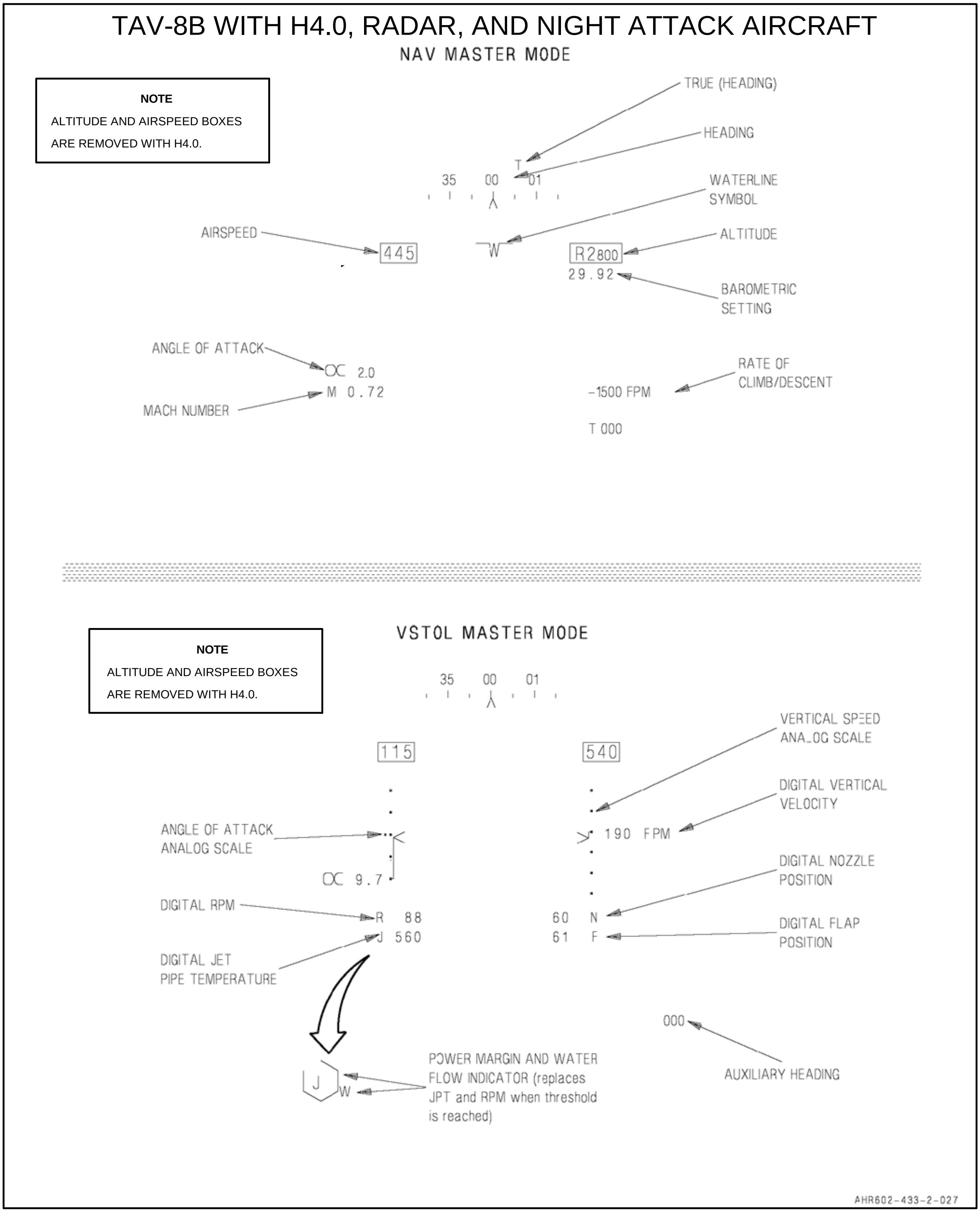

Figure 15-2. Total INS Failure Displays (Sheet 2)

15. INS switch — NAV.

If IFA is unsuccessful, attempt a GYRO recovery:

16. INS switch — OFF (5 seconds - ASN-139/3 minutes - ASN-130).
17. INS switch — GYRO.

Note

The NAV system will enter align hold during an in-flight alignment when aircraft roll exceeds 30° in order to reduce alignment time in non-wings level flight.

15.4 OBOGS FAILURE

On-board oxygen generating system (OBOGS) failure may be indicated by the OXY caution light, reduced pressure and/or quantity of breathing gas, or hypoxia symptoms. The failure may be a high temperature bleed air leak, a heat exchanger, shut off valve or concentrator failure resulting in insufficient oxygen concentration. Any failure should be treated as though the OXY caution light is on. Refer to the OXY light in the Warning/Caution/Indicator Lights chart.

WARNING

Failure to turn the OBOGS off and breathe from an alternate source when a failure is indicated may result in system damage, fire, and hypoxia.

15.5 CANOPY UNSAFE INFLIGHT

An unsafe canopy may be indicated by a CANOPY caution light, a yellow latch or white off center indication in the canopy latch viewport, or canopy movement. A partially engaged latch may disengage as cabin pressure differential increases.

15.5.1 Canopy Explosion Inflight

*1. EMERGENCY DESCENT — IF REQUIRED.

*2. LOWER SEAT — AS REQUIRED.

*3. Throttle — AVIOD ABRUPT THROTTLE MOVEMENTS.

4. Minimize g-loading.

5. Land as soon as practical.

15.6 COCKPIT TEMPERATURE HOT/COLD

1. Cabin pressure switch — NORM.
2. Cabin air temperature knob — MANUAL - REGULATE TEMPERATURE.

If temperature stays too hot/cold:

3. Descend to below 25,000 feet MSL.
4. Cabin pressure switch — RAM.

5. Limit airspeed as follows:

   Below 5,000 feet – 0.4 Mach.
   5,000 to 10,000 feet – 0.6 Mach.
   10,000 to 15,000 feet – 0.7 Mach.

15.7 COCKPIT UNDER PRESSURE

1. Descend below 25,000 feet MSL.

15.8 COCKPIT OVER PRESSURE

1. Descend below 25,000 feet MSL.

2. Cabin pressure switch — DUMP.

If cockpit still over pressure:

3. Cabin pressure switch — RAM.

4. Limit airspeed as follows:

   Below 5,000 feet – 0.4 Mach.
   5,000 to 10,000 feet – 0.6 Mach.
   10,000 to 15,000 feet – 0.7 Mach.

15.9 MAIN GENERATOR FAILURE (GEN, DC AND STBY TR CAUTION LTS)

If the main generator fails with APU not selected on in the standby mode, the GEN, DC and STBY TR caution lights will come on. The APU will have to be selected on if the main generator is not restored on the line.

Note

Loss of ac power will cause cockpit lights to come on full bright.

If the main generator fails with the APU selected on in the standby mode, the APU advisory light and the GEN warning light will be on (but not the DC and STBY TR caution lights). For equipment lost/available, refer to Emergency Power Distribution, see Figure 15-3.

On the ground, a main generator failure will cause the loss of all warning, caution, and advisory lights except the FIRE light. In this case, the main generator failure can be recognized by the loss of all ac powered equipment and absence of the green gear down lights. Pressing the COMP/LTS TEST switch momentarily will restore operation of the emergency warning, caution, and advisory lights. Should generator failure occur on takeoff, the emergency warning, caution, and advisory lights will be restored when the aircraft becomes airborne.

DECS operation requires DC power which is supplied by the generator, battery, or APU. In some cases, attempts to start the APU may drain the battery power to a level which would preclude MFS selection. On –408B engines, LANE 2 DECU is also powered continuously by the EVICS HMU permanent magnetic alternator. For aircraft equipped with –408B engines and Emergency MFS batteries, DECS control as well as the potential to select MFS (if required) will be maintained. For –408B engines, operation in EFC POS 2 will minimize battery drainage. For aircraft without –408B engines or Emergency MFS batteries, MFS should be selected prior to placing additional drainage on the battery and before battery voltage drops below 16 volts.

On AV–8B 164151 and up; also AV–8B 161573 through 164150, TAV–8B after AFC–328, manual fuel selection and emergency landing gear extension can be accomplished with less than 16 volts indicated using the MFS emergency battery and the LDG emergency battery. The MFS emergency battery provides an alternate source of electrical power for manual fuel selection in time critical selection scenarios. Below 16 volts, normal manual fuel selection cannot be guaranteed.

WARNING

On aircraft not equipped with –408B engines or MFS Emergency batteries, failure to expeditiously switch to MFS could result in loss of engine control. If generator failure is the result of electrical fire, switching to MFS may not be possible.

CAUTION

- A main generator failure will cause the AUT FLP caution light to come on. Ensure airspeed is below 165 knots and nozzles are 25° or greater prior to selecting STOL flaps.
- Nosewheel steering hot/No antiskid.

15.10 MAIN TRU FAILURE (DC CAUTION LIGHT)

Illumination of the DC caution light indicates the main transformer rectifier (TRU) has failed. Normally, the standby TRU output automatically switches to power the emergency dc bus. Subsequent failure of the standby TRU is indicated by the STBY TR caution light coming on and/or the dc voltmeter dropping below 26 volts. Below 16 volts, normal manual fuel selection cannot be guaranteed. The pilot can consider securing the following systems if the main and standby TRU fail in order to preserve battery life:

1. DC boost pumps.
2. Radios (transmit drains more power).
3. Seat adjust.
4. Trim.

For equipment lost/available refer to Emergency Power Distribution, see Figure 15-3.

CAUTION

- Do not lower landing gear above 200 knots.
- Nosewheel steering hot/No antiskid.
- Landing gear should be lowered before battery discharges below 16 volts.
- On aircraft not equipped with –408B engines or MFS Emergency battery, MFS should be selected before battery discharges below 16 volts.

Note

Emergency MFS and LDG emergency battery activation may be required if DC voltage depletes below 16 volts indicated.

MAIN GENERATOR FAILED
APU GENERATOR OPERATING

GEN APU

USABLE EQUIPMENT

MAIN GEN FAILED
APU GEN OPERATING
MAIN TRU OK
STBY TRU OK

GEN
APU

ENGINE/FUEL–
- APU/Engine Start
- Bingo Light
- DECU No. 1 & 2
- Engine Ignition (L and R)
- Engine Life Recorder
- Engine RPM Indicator
- Fire/Overheat Detection
- Fuel Boost Pumps (DC)
- Fuel Dump
- Fuel Flow Indicator
- Fuel Flow Proportioner
- Fuel Quantity Indicator
- In-flight Refueling
- JPT Indicator
- Manual Fuel Control
- Nozzle Position Indicator
- Water Select/Dump/Quantity/Anti-freezing Valve

FLIGHT CONTROLS–
- Aileron Droop
- Aileron Stop Solenoid
- Emer Flap Retract Solenoid
- Flaps (All Modes)
- Flaps Controller No. 1
- 5 Flaps Controller No. 2
- Position Indicator (Flaps & Stab)
- RCS Duct Pressure Indicator
- Rudder Pedal Shaker

- Q-Feel
- SAAHS
- Speed Brake
- Trim Indicators (Aileron & Rudder)
- Trim (Manual)
- Trim (SAAHS)

FLIGHT INSTRUMENTS–
- Altimeter Vibrator
- HUD
- 15 Radar Altimeter
- Standby AOA Indicator
- Standby Attitude Indicator
- Turn and Slip Indicator

LIGHTING EQUIPMENT–
- Anti-collision Lights
- Aux Landing/Taxi Light
- Emer Flood and Chart Lights
- Emer Warning/Caution Lights
- Flood Lights
- Instrument Lights
- Kneeboard Light
- Master Caution Light
- 9 Master Warning Light
- Sideslip Vane Lights
- Utility Light

NAVIGATION EQUIPMENT–
- 16 ATHS
- AWLS
- 9 DMS
- 13 GPS
- IFF (except mode 4)
- INS
- KY-58
- 8 HSI
- Tacan
- UHF/VHF R/T No. 1 and No. 2

OTHER–
- Air Data Computer
- Air Data Computer Airspeed and Altitude Relays
- Anti-skid/Nosewheel Steering
- Brake Pressure Indicator
- Cockpit Pressure Dump
- Cockpit Temperature Control
- DDI
- DC
- DC Voltmeter
- 7 DSS
- ECS Aft Equipment Shutoff Valve
- ECS Cabin Shutoff Valve
- ECS Cooling Fans
- Emergency Jettison
- Emergency Landing Gear
- 9 FLIR
- Hydraulic Pressure Indicator
- Landing Gear Control
- LIDS Control
- L, R Pitot and AOA Probe Htrs
- Mission Computer
- OBOGS
- Seat Adjust
- Upfront Control
- Video Recording System
- Windshield Overtemperature Control

EQUIPMENT LOST

ENGINE/FUEL–
- Fuel Boost Pumps (AC)
- In-flight Refueling Light (Ext)

FLIGHT INSTRUMENTS–
- 14 Radar Altimeter

LIGHTING EQUIPMENT–
- Approach/Hover Lights
- Console Lights
- Formation Lights
- Position Lights

NAVIGATION EQUIPMENT–
- IFF Mode 4
- Radar Beacon
- 10 Radar

OTHER–
- Battery Heater
- Chaff Dispenser
- 11 DMT
- ECM
- IR Coolant Control
- OBOGS Heaters
- RWR
- Selective Jettison
- Total Temperature Probe Htr
- Weapons Fire/Release/Launch

MAIN GEN FAILED
APU GEN OPERATING
MAIN TRU OK
STBY TRU FAILED

GEN
APU
STBY TR

USABLE EQUIPMENT
(Same as above)

EQUIPMENT LOST
(Same as above)

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Figure 15-3. Emergency Power Distribution (Sheet 1 of 4)

MAIN GENERATOR FAILED
APU GENERATOR OPERATING (CONT)
MAIN TRU FAILED

GEN APU

USABLE EQUIPMENT

MAIN GEN FAILED
APU GEN OPERATING
MAIN TRU FAILED
STBY TRU OK

GEN APU DC

ENGINE/FUEL–
- APU/Engine Start
- Bingo Light
- DECU No. 1 & 2
- Engine Ignition (L and R)
- Engine RPM Indicator
- Fire/Overheat Detection
- Fuel Boost Pumps (DC)
- Fuel Dump
- Fuel Flow Indicator
- Fuel Flow Proportioner
- Fuel Quantity Indicator
- Inflight Refueling
- JPT Indicator
- Manual Fuel Control
- Nozzle Position Indicator
- Water Select/Dump/Quantity

FLIGHT CONTROLS–
- Aileron Droop
- Emer Flap Retract Solenoid
- Flaps (All Modes)
- Flaps Controller No. 1
- 5 Flaps Controller No. 2
- Flaps Indicator
- Position Indicator (Flaps & Stab)
- Trim (Manual, Aileron & Stab)

FLIGHT INSTRUMENTS–
- Altimeter Vibrator
- HUD
- Standby AOA Indicator
- Standby Attitude Indicator
- Turn and Slip Indicator

LIGHTING EQUIPMENT–
- Emer Flood and Chart Lights
- Emer Warning/Caution Lights
- Flood Lights
- Instrument Lights
- Kneeboard Light
- Master Caution Light
- 9 Master Warning Light
- Sideslip Vane Lights
- Utility Light

NAVIGATION EQUIPMENT–
- 13 GPS
- IFF (Emer)
- INS
- KY-58
- UHF/VHF R/T No. 1 and No. 2 (Manual Mode Only)
- 9 DMS

OTHER–
- Air Data Computer
- Brake Pressure Indicator
- Cockpit Pressure Dump
- Cockpit Temperature Control
- DDI
- DC
- DC Voltmeter
- ECS Cabin Shutoff Valve
- ECS Cooling Fans
- Emergency Jettison
- Emergency Landing Gear
- Landing Gear Control
- LIDS Control
- L, R Pitot and AOA Probe Htrs
- Mission Computer
- Nosewheel Steering (Hot Only)
- OBOGS
- Seat Adjust
- Windshield Overtemperature Control

EQUIPMENT LOST

ENGINE/FUEL–
- Engine Life Recorder
- Fuel Boost Pumps (AC)
- In-flight Refueling Light (Ext)
- Water Anti-freezing Valve

FLIGHT CONTROLS–
- Aileron Stop Solenoid
- Q-Feel
- RCS Duct Pressure Indicator
- Rudder Pedal Shaker
- 3 SAAHS
- Speed Brake
- Trim Indicators (Aileron & Rudder)
- 3 Trim (Manual Rudder)
- 3 Trim (SAAHS)

FLIGHT INSTRUMENTS–
- 1 HUD
- Radar Altimeter

LIGHTING EQUIPMENT–
- Anti-Collision Lights
- Approach/Hover Lights
- Aux Landing Taxi Lights
- Console Lights
- Formation Lights
- Position Lights

NAVIGATION EQUIPMENT–
- 16 ATHS
- AWLS
- IFF (Normal)
- Radar Beacon
- 8 HSI
- Tacan
- 10 Radar

OTHER–
- Air Data Computer Airspeed and Altitude Relays
- Anti-Skid
- Battery Heater
- Chaff Dispenser
- 11 DMT
- 7 DSS
- ECM
- ECS Aft Equipment Shutoff Valve (Deenerigized Open)
- 9 FLIR
- Hydraulic Pressure Indicator
- IR Coolant Control
- OBOGS Heaters
- Probe Heater Control (Htrs operate on ground)
- RWR
- Selective Jettison
- Total Temp Probe Htr
- Upfront Control
- Video Recording System
- Weapons Fire/Release/Launch

MAIN GEN FAILED
APU GEN OPERATING
MAIN & STBY TRU'S FAILED

GEN APU DC STBY TR

USABLE EQUIPMENT
(Same as above until battery discharged)

EQUIPMENT LOST
(Same as above until battery discharged)

USABLE EQUIPMENT WHEN BATTERY DISCHARGED

ENGINE/FUEL–
- Fuel Flow Indicator

LIGHTING EQUIPMENT–
- Emer Warning/Caution Lights
- Flood Lights
- Instrument Lights

NAVIGATION EQUIPMENT–
- INS

OTHER–
- Air Data Computer
- DDI
- DC
- ECS Cooling Fans
- L & R Pitot and AOA Heater Probes
- Mission Computer

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Figure 15-3. Emergency Power Distribution (Sheet 2)

TRU(S) FAILED
MAIN GENERATOR OPERATING DC STBY TR

USABLE EQUIPMENT

MAIN GEN OPERATING
MAIN TRU FAILED
STBY TRU OK
DC

ENGINE/FUEL–
- APU/Engine Start
- Bingo Light
- DECU No. 1 & 2
- Engine Ignition (L and R)
- Engine RPM Indicator
- Fire/Overheat Detection
- Fuel Boost Pumps (AC and DC)
- Fuel Dump
- Fuel Flow Indicator
- Fuel Flow Proportioner
- Fuel Quantity Indicator
- In-flight Refueling
- JPT Indicator
- Manual Fuel Control
- Nozzle Position Indicator
- Water Select/Dump/Quantity

FLIGHT CONTROLS–
- Aileron Droop
- Emer Flap Retract Solenoid
- Flaps (All Modes)
- Flaps Controller No. 1
- 5 Flaps Controller No. 2
- Position Indicators (Flaps & Stab)
- Trim (Manual, Aileron & Stab)

FLIGHT INSTRUMENTS–
- Altimeter Vibrator
- HUD
- Standby AOA Indicator
- Standby Attitude Indicator
- Turn and Slip Indicator

LIGHTING EQUIPMENT–
- Console Lights
- Emer Flood and Chart Lights
- Emer Warning/Caution Lights
- Flood Lights
- Instrument Lights
- Kneeboard Light
- Master Caution Light
- Master Warning Light
- Sideslip Vane Lights
- Utility Light

NAVIGATION EQUIPMENT–
- 13 GPS
- IFF (Emer)
- INS
- 12 9 DMS
- KY-58
- UHF/VHF R/T No. 1 and No. 2 (Manual Mode Only)

OTHER–
- Air Data Computer
- Battery Heater
- Brake Pressure Indicator
- Cockpit Pressure Dump
- Cockpit Temperature Control
- DDI
- DC
- DC Voltmeter
- ECM
- ECS Cabin Shutoff Valve
- ECS Cooling Fans
- Emergency Jettison
- Emergency Landing Gear
- Landing Gear Control
- LIDS Control
- L, R Pitot and AOA, and Total Temperature Probe Htrs
- Mission Computer
- Nosewheel Steering (Hot Only)
- OBOGS
- Seat Adjust
- Windshield Overtemperature Control

EQUIPMENT LOST

ENGINE/FUEL–
- Engine Life Recorder
- In-flight Refueling Light (Ext)
- Water Anti-freezing Valve

FLIGHT CONTROLS–
- Aileron Stop Solenoid
- Q-Feel
- RCS Duct Pressure Indicator
- Rudder Pedal Shaker
- 3 SAAHS
- Speed Brake
- Trim Indicator (Aileron & Rudder)
- 3 Trim (Manual Rudder)
- 3 Trim (SAAHS)

FLIGHT INSTRUMENTS–
- 1 HUD
- Radar Altimeter

LIGHTING EQUIPMENT–
- Anti-Collision Lights
- Approach/Hover Lights
- Aux Landing Taxi Lights
- Formation Lights
- Position Lights

NAVIGATION EQUIPMENT–
- 16 ATHS
- AWLS
- IFF (Normal)
- Radar Beacon
- 8 HSI
- Tacan
- 10 Radar

OTHER–
- Air Data Computer Airspeed and Altitude Relays
- Anti-Skid
- Chaff Dispenser
- 11 DMT
- 7 DSS
- ECS Aft Equipment Shutoff Valve (Deenergized open)
- 9 FLIR
- Hydraulic Pressure Indicator
- IR Coolant Control
- OBOGS Heaters
- Probe Heater Control (Htrs operate on ground)
- RWR
- Selective Jettison
- Upfront Control
- Video Recording System
- Weapon Fire/Release/Launch

MAIN GEN OPERATING
MAIN & STBY TRU'S FAILED
DC STBY TR

USABLE EQUIPMENT
(Same as above until battery discharged)

EQUIPMENT LOST
(Same as above until battery discharged)

USABLE EQUIPMENT WHEN BATTERY DISCHARGED

LIGHTING EQUIPMENT–
- Console Lights
- Emer Warning/Caution Lights
- Flood Lights
- Instrument Lights

NAV EQUIPMENT–
- INS

OTHER–
- Air Data Computer
- DDI
- DC
- ECM (w/o Chaff Dispenser)
- ECS Cooling Fans
- L, R Pitot, AOA, & Total Temp Probe Htrs
- Mission Computer

MAIN GEN OPERATING
MAIN TRU OK
STBY TRU FAILED
STBY TR

ALL EQUIPMENT USABLE

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Figure 15-3. Emergency Power Distribution (Sheet 3)

GEN

STBY TR | DC | APU GEN

MAIN AND APU GENERATORS FAILED BATTERY AT HIGH STATE OF CHARGE

USABLE EQUIPMENT

ENGINE/FUEL–
- APU/Engine Start
- Bingo Light
- DECU No. 1 & 2
- Engine Ignition (L and R)
- Engine RPM Indicator
- Fire/Overheat Detection
- Fuel Boost Pumps (DC)
- Fuel Dump
- Fuel Flow Proportioner
- Fuel Quantity Indicator
- In-flight Refueling
- JPT Indicator
- Manual Fuel Control
- Nozzle Position Indicator
- Water Select/Dump/Quantity

FLIGHT CONTROLS–
- Aileron Droop
- Emer Flap Retract Solenoid
- Flaps (STOL & Cruise Modes)
- Flaps Controller No. 1
- 5 Flaps Controller No. 2
- Position Indicator (Flaps & Stab)
- Trim (Manual, Aileron & Stab)

FLIGHT INSTRUMENTS–
- Altimeter Vibrator
- Standby AOA Indicator
- Standby Attitude Indicator
- Turn and Slip Indicator

LIGHTING EQUIPMENT–
- Emer Flood and Chart Lights
- 4 Emer Warning/Caution Lights
- Kneeboard Light
- Sideslip Vane Lights
- Utility Light

NAVIGATION EQUIPMENT–
- IFF (Emer)
- KY-58
- UHF/VHF R/T No. 1 and No. 2 (Manual Mode Only)

OTHER–
- Brake Pressure Indicator
- Cockpit Pressure Dump
- Cockpit Temperature Control
- DC Voltmeter
- ECS Cabin Shutoff Valve
- Emergency Jettison
- Emergency Landing Gear
- Landing Gear Control
- LIDS Control
- Nosewheel Steering (Hot Only)
- OBOGS
- Seat Adjust
- Windshield Overtemperature Control

EQUIPMENT LOST

ENGINE/FUEL–
- Engine Life Recorder
- Fuel Boost Pumps (AC)
- Fuel Flow Indicator
- In-flight Refueling Light (Ext)
- Water Anti-freezing Valve
- 6 MFS

FLIGHT CONTROLS–
- Aileron Stop Solenoid
- Flaps (Auto Mode)
- Q-Feel
- RCS Duct Press Indicator
- Rudder Pedal Shaker
- 3 SAAHS
- Speed Brake
- Trim Indicators (Aileron & Rudder)
- 3 Trim (Manual Rud)
- 3 Trim (SAAHS)

FLIGHT INSTRUMENTS–
- HUD
- Radar Altimeter

LIGHTING EQUIPMENT–
- Anti-Collision Lights
- Approach/Hover Lights
- Aux Landing Taxi Lights
- Console Lights
- Flood Lights
- Formation Lights
- Instrument Lights
- Master Caution Light
- 9 Master Warning Light
- Position Lights

NAVIGATION EQUIPMENT–
- 16 ATHS
- AWLS
- 9 DMS
- EHSD
- 13 GPS
- IFF (Normal)
- 2 INS
- Radar Beacon
- 8 HSI
- Tacan
- 10 Radar

OTHER–
- Air Data Computer
- Air Data Computer Airspeed and Altitude Relays
- Anti-Skid
- Battery Heater
- Chaff Dispenser
- DDI
- DC
- 11 DMT
- 7 DSS
- ECM
- ECS Aft Equipment Shutoff Valve (Deenergized open)
- ECS Cooling Fans
- 9 FLIR
- Hydraulic Pressure Indicator
- IR Coolant Control
- L, R Pitot, AOA, and Total Temperature Probe Heaters
- Mission Computer
- OBOGS Heaters
- Probe Heater Control (Htrs operate on ground)
- RWR
- Selective Jettison
- Upfront Control
- Video Recording System
- Weapons Fire/Release/Launch

ALL EQUIPMENT LOST WHEN BATTERY DISCHARGED

NOTES

1. HUD information available on DDI.
2. If interrupted ac power is restored within 90 seconds, INS may not be lost.
3. If failure occurs above 0.4 Mach and 8 AOA, equipment remains usable until aircraft goes below 0.4 Mach or 8 AOA for more than 30 seconds.
4. If airborne, all lights good. With weight-on-wheels, except for FIRE light, lights not operational until COMP/LT TEST switch is activated to TEST.
5. After RESET of flaps power switch.
6. Inability to select manual fuel on with battery under 16vdc.
7. AV-8B 163176 and up; TAV-8B 163180 and up.
8. TAV-8B, AV-8B 161573 thru 163852.
9. AV-8B 163853 and up.
10. AV-8B 164549 and up.
11. AV-8B 161573 thru 164547.
12. Presently displayed map coverage and overlays only.
13. AV-8B 165384 and up; also AV-8B 161573 thru 165383, TAV-8B 162963 thru 164542 after AFC-354 Rev A/ Part 2/ Part3.
14. AV-8B 163853 thru 164547, TAV-8B 164113 thru 164542 before AFC-368.
15. AV-8B 164549 and up; also AV-8B 163853 thru 164547, TAV-8B 164113 thru 164542 after AFC-368.
16. AV-8B 165305 and up; also AV-8B 163853 thru 165006 after AFC-326/Part 3.

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Figure 15-3. Emergency Power Distribution (Sheet 4)

15.11 STANDBY TRU FAILURE (STBY TR CAUTION LIGHT)

Illumination of the STBY TR caution light indicates the standby TRU has failed or, during GTS start, is off line. When the standby TRU fails, the main TRU powers the entire dc system, including charging of the battery. Subsequent failure of the main TRU is indicated by the DC caution light coming on and/or the dc voltmeter dropping below 26 volts.

15.12 APU GENERATOR FAILURE (APU GEN CAUTION LIGHT)

Illumination of the APU GEN light indicates the APU generator is malfunctioning with the APU selected on. This could occur in the standby mode before main generator failure, or it could occur after main generator failure in which case the aircraft has lost all ac power and is operating on the battery unless one of the ac generators is restored. With nominal load, the battery will provide power for about 30 minutes. With one DC boost pump operating, this time is reduced to 15 minutes and with both DC boost pumps operating, this time is reduced to 8 minutes. Below 20 volts, operation of battery powered equipment may be erratic. For equipment lost/available, refer to Emergency Power Distribution, see Figure 15-3.

15.13 TOTAL ELECTRICAL FAILURE (GEN, APU GEN, DC, STBY TRU)

Aircraft not equipped with -408B engines:

1. MFS — SELECT.

All Aircraft:

2. Landing gear — DOWN (below 200 knots before dc power lost, if not fuel critical).
3. Non-essential dc power equipment — OFF.

If VMC:

4. Battery switch — ALERT (if necessary to reattempt communications).

Note

- Emergency MFS and LDG emergency battery activation may be required if DC voltage depletes below 16 volts indicated. Below 16 volts, normal manual fuel selection cannot be guaranteed.
- To minimize the drain on the battery, the igniters may be secured by momentarily selecting the BATT switch to OFF or ALERT. However, operating in MFS without continuous ignition gives a slightly increased chance of engine flame out on slam deceleration.
- Hot NWS perform VL or RVL if possible.
- Selecting ALERT will secure standby AOA indicator, attitude gyro, and turn and slip indicator.
- With hot NWS, perform VL. Engine fast deceleration solenoid function lost.

15.14 EMERGENCY DC BUS FAILURE

The emergency DC bus is defined as the “emergency” DC bus because it is supposed to be one of the last busses to lose power during any type of electrical failure. The emergency DC bus powers multiple components critical to normal and emergency flight regimes. If the power to the emergency DC bus is lost it constitutes a serious compound emergency situation. The aircraft’s electrical priority is designed to provide power to the emergency DC bus even when two of the three electrical supply components are lost. Since the alert bus is normally powered from the emergency DC bus, both busses will be lost during an emergency DC bus failure. It is important to first understand which components you lose and the effects of each component if you have an emergency DC and alert bus failure. It is also important to understand how the emergency DC and alert busses are powered, how they can lose power and the ways power can be regained as well as the anomalies associated with certain power loses.

Systems affected and how they affect the operation of the aircraft.

15.14.1 DC Emergency Bus, Circuits

15.14.1.1 Landing Gear

Purpose: Powers solenoids in landing gear control valve which open/close doors and lower/raise the landing gear.

Indication/consequence to pilot if lost: Landing gear cannot be raised or lowered via normal means using the landing gear handle.

15.14.1.2 Emergency Landing Gear

Purpose: To fire impulse cartridge (CAD) which discharges the landing gear emergency extension bottle (blow down bottle) when the landing gear handle is turned 90 degrees and pulled.

Indication/consequence to pilot if lost: Emergency gear blow down does not occur when the landing gear handle is turned 90 degrees and pulled. Note: CAD can still be fired and landing gear blown down using the landing gear emergency battery.

15.14.1.3 Brake Pressure

Purpose: Powers the main landing gear brake pressure transmitter in the NLG wheel well and the hydraulic pressure indicator in the cockpit.

Indication/consequence to pilot if lost: PSI X10 BRAKE indicator wheels will be driven to the striped position (barber pole) indicating brake pressure indication is invalid. HYD-1 and HYD-2 pressure indications are also driven to striped position (barber poles) and will indicate zero pressure. Actual hydraulic brake pressure is not affected.

15.14.1.4 Landing Gear Relay

Purpose: Energizes the landing gear handle down, MLG down and locked or MLG not down and locked relays if condition exists.

Indication/consequence to pilot if lost: Neither the approach or the hover light can/will be turned on when the main landing gear is down and locked. The total temperature probe heater will not be automatically turned off when the landing gear handle is set to the down position. The side slip vane light will not illuminate when the landing gear handle is set to the down position. The speed brake will not automatically deploy to between 23 and 27 degrees when main landing gear is down and locked. With the landing gear down and locked, the speed brake can be fully extended (to 66 degrees) and retracted. When the gear is not down and locked, erroneous JPTL datum will be provided to DECU. IFF Mode-4 codes will be zeroized (due to de-energized MLG not down and locked relay). When gear is not down and locked, an erroneous landing gear down signal will be provided to the DFC (due to de-energized MLG not down and locked relay).

15.14.1.5 Nose Wheel Steering

Purpose: To energize the nosewheel steering switchover solenoid in NWS switchover valve when NWS is selected, weight is on wheels and HYD-1 pressure is below 1,600 PSI.

Indication/consequence to pilot if lost: No indication. The switchover solenoid will be unable to automatically switch NWS operation to HYD-2 if needed.

15.14.1.6 Anti Skid/Nose Landing Gear Steering

Purpose: Used to energize the nose wheel steering (NWS) control valve solenoid when ANTISKID is selected. It is also used to energize the NWS selector solenoid when high gain NWS is selected.

Indication/consequence to pilot if lost: When power to the NWS control valve solenoid is lost with ANTISKID selected, the system will be stuck in low gain NWS instead of castor mode. When high gain is selected, the system will stay in low gain NWS because power is not available to the NWS selector solenoid.

15.14.1.7 Aileron Droop

Purpose: Allows pilot to select aileron droop with flaps to produce greater lift.

Indication/consequence to pilot if lost: Unable to droop ailerons.

15.14.1.8 Flap Indicator

Purpose: Powers flaps position indicator on landing gear/flaps panel.

Indication/consequence to pilot if lost: No change in flaps position indicator with change in flaps. HUD flap indication will still be valid.

15.14.1.9 Yaw SAAHS

Purpose: Powers YAW portion of SAAHS. Indication/consequence to pilot if lost: If DC emergency bus loses power the yaw system would disengage and power to the rudder servo cylinder would discontinue. No auto control.

15.14.1.10 Flap Controller

Purpose: Powers the emergency flap retract switch on the engine throttle lever and retract solenoid P/O flap hydraulic controller.

Indication/consequence to pilot if lost: Unable to retract flaps using the emergency flap retract switch.

15.14.1.11 Mission Computer (OMNI 7.1 and C1+)

Purpose: Powers the MC Relay which will remove AC power from the mission computer when the display computer is in back-up mode and is therefore acting as the mux bus controller. This ensures that there is only one mux bus controller at a time. The display computer enters back-up mode if it has not been able to communicate with the mission computer for 2 seconds. After the display computer has entered back-up mode it energizes the Mux auto switching relay, which in turn energizes the mission computer control relay.

Indication/consequence to pilot if lost: None, under most circumstances. If in back-up mode and the mission computer comes back on-line, indications are erratic and/or incorrect data on the displays. In this case, the pilot can switch the mission computer switch to either OVRD (mission computer control only) or Off (display computer control only) to force only one of the computers to be the Mux controller.

15.14.1.12 Mission Computer (H4.0 Only)

Purpose: None. With H4.0, the mission computer control relay is no longer utilized. The mission computer software ensures that there is only one MUX bus controller. Before becoming the MUX bus controller, the mission computer will determine if the display computer is acting as the controller. If the display computer is acting as the MUX bus controller, then the mission computer will initiate a handshaking process to resume control of the mux bus.

Indication/consequence to pilot if lost: None.

15.14.1.13 ACNIP Emergency Power

Purpose: Powers the ACNIP (28Vdc emergency input). If the 28Vdc emergency is not supplied, the ACNIP can be powered from the alert bus by placing the battery switch in the ALERT position. The ACNIP is then turned on in a power conservation mode to reduce the power drain on the aircraft storage battery.

Indication/consequence to pilot if lost: No audio in headset. No audible warnings. Loss of Radio Communication.

15.14.1.14 IFF

Purpose: Powers APX–100 IFF transponder.

Indication/consequence to pilot if lost: Transponder indicator lights out (edge–lit panels will remain lighted). Unable to transmit in all IFF modes.

15.14.1.15 Jettison Busses A/B

Purpose: Energizes Jettison Bus A and B contactors if landing gear handle is up or weight is off wheels.

Indication/consequence to pilot if lost: The pilot will be unable to selectively jettison stores and Emergency Jettison is inoperable.

15.14.1.16 AOA Indicator

Purpose: Powers angle of attack indicator ID–2276/A.

Indication/consequence to pilot if lost: No head–down AOA indication (indicator back light remains on). AOA will still be displayed on HUD.

15.14.1.17 Annunciator Light Circuits

Purpose: Together, these four circuits provide all of the electrical power for the Annunciator Light Controller.

Indication/consequence to pilot if lost: All warning, caution and advisory lights will be off. Amber and green landing gear position lights will not be seen in cockpit as landing gear is lowered down and locked. Landing gear control handle lights will not light. No audible warnings even when switched to ALERT mode. For TAV–8B only, landing gear position lights will be seen during Emergency DC Bus failure.

15.14.1.18 Seat Adjust

Purpose: Powers seat height adjust motors through seat adjust switch.

Indication/consequence to pilot if lost: Pilot is unable to adjust seat height.

15.14.1.19 OBOGS Bleed Air Shut Off

Purpose: Powers OBOGS bleed air shutoff valve and oxygen concentrator.

Indication/consequence to pilot if lost: Loss of on board oxygen generation system without any indication to the pilot. Setting the oxygen switch to the OFF position will not close the OBOGS bleed air shutoff valve. Shutoff valve will remain open; engine bleed air will be supplied to pilot.

15.14.1.20 Oxygen Monitoring Unit

Purpose: Powers Oxygen Monitoring Unit.

Indication/consequence to pilot if lost: No indication of failure. Oxygen is no longer being monitored, no caution light or ACNIP message will be provided if oxygen concentration falls below safe level.

15.14.1.21 Cockpit Temperature Relay

Purpose: Powers the cabin temperature control/selector and opens/closes the temperature regulating valve. Also, energizes windshield over–temperature relay when windshield over–temperature switch senses windshield temperature to be 250 ±8 °F.

Indication/consequence to pilot if lost: Loss of control of cabin temperature and windscreen overtemp protection. Temperature regulating valve stays at same setting.

15.14.1.22 Cabin Pressure Control Circuit Breaker

Purpose: Powers pressure reducing and shutoff valve, emergency ram air vent control valve and cabin dump control valve when pressurization switch is in the RAM position.

Indication/consequence to pilot if lost: Unable to dump pressure but the pressure regulator and safety relief valve will continue to regulate pressure.

15.14.1.23 Cabin ECS Circuit Breaker #2

Purpose: Powers pressure reducing and shutoff valve, emergency ram air vent control valve and canopy seal control valve when pressurization switch is in the NORM position.

Indication/consequence to pilot if lost: Canopy seal will not deflate, the canopy will be harder to open. Ram air vent cannot be opened, if needed.

15.14.1.24 Water Select

Purpose: Powers water selector switch, water injection pump solenoid and water dump switch.

Indication/consequence to pilot if lost: Unable to either inject water into engine or dump water overboard.

15.14.1.25 Flow Proportioner Indicator MFS Ignition Relay

Purpose: Powers fuel flow proportioner indicator and energizes manual fuel ignition relay when the MFS switch is set to the ON position.

Indication/consequence to pilot if lost: No fuel flow proportioner caution light. No fuel priming or igniters when the MFS switch is set to the ON position.

15.14.1.26 Right and Left Ignitor Engine Start

Purpose: Powers engine right and left igniter plugs and DC Boost Pump Contactors.

Indication/consequence to pilot if lost: No indication to pilot. Right and left igniters will not be functioning. Boost Pumps cannot be operated in DC OPR mode.

15.14.1.27 Fuel Priming

Purpose: Powers the torch igniter (fuel priming) solenoid valve.

Indication/consequence to pilot if lost:No indication to pilot. The torch igniter will not be functioning.

15.14.1.28 Emergency Cockpit Power

All of the below.

RUDDER SERVO

Purpose: Powers the rudder servo valve for hydraulic control of rudder position.

Indication/consequence to pilot if lost: Loss of automatic control of rudder position.

STABILATOR TRIM

Purpose: Electrical trim control of stabilator (pitch trim).

Indication/consequence to pilot if lost: Pilot cannot manually trim stabilator.

AILERON TRIM

Purpose: Electrical trim control of ailerons (roll trim).

Indication/consequence to pilot if lost: Pilot cannot manually trim ailerons.

15.14.1.29 Emergency Flood Chart Light

Purpose: Powers cockpit emergency floodlights No.1 and No.2 and emergency NVG floodlights No. 1 and No. 2 through the instrument panel control and floodlight control. Powers the cockpit chart light through the chart light switch and brightness control.

Indication/consequence to pilot if lost: Emergency floodlights and chart light are off and cannot be turned on.

15.14.1.30 Right and Left IFR

Purpose: Powers the right and left fluid pressure regulator valve solenoid. When powered during ground or in-flight refueling, this valve removes engine bleed air pressure and vents right-side fuel tanks to atmosphere.

Indication/consequence to pilot if lost: Cannot perform in-flight refueling.

15.14.1.31 Fuel Dump Control

Purpose: Powers the left and right fuel jettison (dump) valve motors through the fuel control panel left and right dump switches.

Indication/consequence to pilot if lost: Unable to dump fuel.

15.14.1.32 Right and Left Boost Pumps

Purpose: Energizes the right and left AC boost pump relays when fuel control panel right and left pump switches are set to NORM. This applies 3-phase AC power to the right and left boost pumps.

Indication/consequence to pilot if lost: Right and left boost pumps do not run when the fuel control panel right and left pump switches are set to NORM but will run (powered from 28 Vdc Ground Service Bus) when the fuel control panel right and left pump switches are set to DC.

15.14.1.33 Fuel Gauge Monitor

Purpose: Powers the fuel quantity processor and fuel digital display indicator.

Indication/consequence to pilot if lost: No fuel quantity information is displayed in cockpit. Fuel readings on the fuel display panel will freeze at last state.

15.14.1.34 Fuel Prop Shut Off

Purpose: Powers the fuel flow proportioner solenoid selector valve when the fuel prop control switch is set to OFF.

Indication/consequence to pilot if lost: Unable to turn off fuel flow proportioner.

15.14.1.35 Fire Overheat Detector

Purpose: Powers the fire detector controller and engine fire warning circuit.

Indication/consequence to pilot if lost: Loss of engine fire warnings (visual and aural).

15.14.1.36 EMS

Purpose: Powers the engine monitoring unit, P3 pressure transducer and EMU incident recorder.

Indication/consequence to pilot if lost: Loss of the HUD power margin indicator.

15.14.1.37 EFC BIT

Purpose: Powers DECU BIT.

Indication/consequence to pilot if lost: No indication or consequence to pilot. Maintenance personnel would be unable to perform DECU BIT check.

15.14.1.38 EFC 2

Purpose: Powers DECU 2 and, through a diode arrangement, also powers DECU 1 if switched battery bus power is lost.

Indication/consequence to pilot if lost: No indication to pilot. The selected DECU will continue to perform EFC functions via the switched battery bus and backup DC power source to lane 2 DECU provided by permanent magnet alternator on 4080-B EVICS engines.

15.14.1.39 JPT Limiter

Purpose: Powers JPTL switch and JPTL system.

Indication/consequence to pilot if lost: Loss of the DECS automatic jet pipe temperature limiting feature (same as tripping JPTL switch on throttle quadrant) will limit the engine to short lift wet speed datum with no JPT limiting (the lower of 120 percent indicated or 116.8 percent corrected regardless of JPT).

15.14.1.40 GTS Power

Purpose: Powers the GTS/APU digital control unit.

Indication/consequence to pilot if lost: Unable to start GTS/APU.

15.14.1.41 Engine Display Panel

Purpose: Powers the engine performance indicator (EPI).

Indication/consequence to pilot if lost: All EPI displays (fuel flow, duct PSI, stabilator position, RPM percent, JPT degrees C, H_2O remaining) will freeze. HUD display of engine performance data will disappear.

15.14.1.42 Altimeter Vibrator

Purpose: Powers vibrator in standby pressure altimeter.

Indication/consequence to pilot if lost: No indication to pilot but head down (standby) pressure altitude instrument will become inaccurate.

15.14.1.43 Attitude Gyro

Purpose: Powers vertical reference gyroscope indicator.

Indication/consequence to pilot if lost: Off flag will be displayed. Gyro inertia maintains attitude reference within ±6° for a minimum of 9 minutes after electrical power is lost.

15.14.1.44 Turn/Slip Indicator

Purpose: Powers the turn and slip indicator.

Indication/consequence to pilot if lost: Off flag will be displayed in the turn and slip indicator.

15.14.2 Alert Bus, 7 Circuits

15.14.2.1 Communication Control

Purpose: Provides 28 Vdc alert power to the V/UHF radios.

Indication/consequence to pilot if lost: Cannot control V/UHF Radios via backup control panel. Power may be regained if the battery switch is set to the ALERT position.

15.14.2.2 ACNIP Alert Power/IFF Eject Seat

Purpose: To partially power the ACNIP when the battery switch is set to ALERT position and power the ejection seat IFF Switch which zeroizes KY and KIT and sets the IFF to the eject mode.

Indication/consequence to pilot if lost: No audio in headset. No audible warnings. Loss of radio communications. On ejection, IFF will not transmit distress code 7700 on mode 3A; mode 4A and 4B secure codes will not be zeroized. Power may be regained if the battery switch is set to the ALERT position.

15.14.2.3 Voltage Indicator

Purpose: Provides a path for the alert and emergency DC bus voltage to be displayed on the DC voltmeter.

Indication/consequence to pilot if lost: The voltmeter will read zero volts (full left deflection) when the DC test switch is in normal (center) position and the battery switch is set to BATT but will read battery voltage when the battery switch is set to ALERT.

15.14.2.4 Utility Kneeboard Light

Purpose: Powers the left utility floodlight, utility floodlight and kneeboard light.

Indication/consequence to pilot if lost: The left utility floodlight, utility floodlight and kneeboard light are off and cannot be turned on.

15.14.2.5 UHF/VHF Receive/Transmitter No. 1 and 2

Purpose: Powers both UHF/VHF receiver/transmitters.

Indication/consequence to pilot if lost: Unable to communicate via COMM 1 or COMM 2.

15.14.2.6 Communication Control

Purpose: Energizes COMM 1 and COMM 2 ON/OFF relays. Powers KY-58 NO.1, KY-58 NO.2 and the antenna selector switch.

Indication/consequence to pilot if lost: Loss of secure radio communications. Unable to select UHF antenna.

A short or wire fire could lead to initial indications of an emergency DC bus failure only to turn into a much larger emergency as failures develop. There are emergency procedures for other types of electrical emergencies to include total electrical failure and dual DECS failure. The emergency DC bus failure procedure is focused on some type of disconnect or breakage between the power source and the emergency DC bus. There are multiple terminal lugs, contactors, and wires where a break can occur; it would be impossible to define every possible failure and indication in this manual. If a breakage occurs between an operating power source and the emergency DC bus, the pilot has options to change the power source supplying power to the emergency DC bus. A thorough understanding of the system as described in paragraph 2.10 (Electrical Power Supply System) and this emergency procedure discussion is necessary for a pilot to cope with this type of failure.

15.14.3 Failure Analysis

If an emergency DC bus failure occurs the pilot should immediately set the DC test switch to STBY.

If power is regained with DC test switch set to STBY, there is a failed connection between the main TRU output and the emergency DC bus contactor. In this case the main TRU is operating correctly therefore the relays are operating to supply power to the emergency DC bus from the main TRU. However, emergency DC bus is not working because of the failed connection. By selecting STBY on the DC test switch the system is removing main TRU output power from the DC emergency bus and connecting standby TRU output power. Once the standby TRU takes over as the aircraft's emergency DC bus power supply, certain relays open and others close providing power to the DC emergency bus. As long as the DC test switch remains in the STBY position, all components that were previously lost will work correctly to include vital systems like fuel quantity, fuel dump, communications and normal gear operation.

If power is not regained with DC test switch set to STBY, the DC test switch should be set to MAIN. In this case the emergency DC bus contractor has failed. The main TRU and the standby TRU are operating correctly but the failed contactor is preventing DC power from reaching the emergency DC bus. To recover, aircraft battery power must be connected to the emergency DC bus by de-energizing the standby TRU contactor. Setting the DC test switch to MAIN will deenergize the standby TRU contactor but, depending on battery state-of-charge, it will take two to three minutes. The standby TRU contactor will remain energized until battery voltage discharges to about 24.5 volts. When the DC test switch is set to MAIN, a valid battery voltage indication will appear on the BATT VOLTS indicator and this voltage must be monitored.

If power is regained, with DC test switch set to MAIN and battery discharge to about 24.5 volts, the emergency DC bus is being powered by the battery and its rate of discharge will increase. Only 15 or 20 minutes will be available for lowering landing gear, communicating, jettisoning stores, dumping fuel etc. before the battery discharges to 16 volts and must be recharged. The battery can be recharged by setting the DC test switch to the center position for a few minutes then returning it to MAIN. Power to the emergency DC bus is lost while the DC test switch is in the center position (BATT VOLTS will read zero) but restored in MAIN after battery discharges to about 24.5 volts.

If power is not regained with DC test switch set to MAIN and battery discharged to less than 24 volts, multiple DC power system failures have occurred and power cannot be regained. Set the DC test switch to the center position. The pilot will have to estimate fuel state and perform the LANDING GEAR UNSAFE/FAILS TO EXTEND procedures in proper sequence to include using the landing gear emergency battery.

15.14.4 Discussion

If using the previously mentioned methods to regain power to the emergency DC bus fail, and communications are required, a pilot may select the ALERT position of the battery. When selecting ALERT, the emergency DC bus is bypassed and the battery is connected directly to the alert bus.

If an emergency DC bus failure is experienced and the battery switch is in BATT, the battery voltage will always read ZERO. The voltage readout on the gauge is supplied through the emergency DC bus while in the BATT position. Moving the battery switch to ALERT will give a true reading of battery voltage. If the ALERT position is used it is important to monitor the voltmeter and periodically return the battery switch to the BATT position to recharge the battery.

Inability to communicate will be the first indication that something is wrong. If the radios have failed, look at the HYD and Brake Pressure indications. They will read ZERO with barber poles. The HUD will be missing RPM, JPT and PMI indications. Battery voltage will read ZERO. If a lights test is performed and the warning, caution and advisory lights are inoperative, the emergency DC bus failure is confirmed.

15.14.5 Emergency DC Bus Failure Procedures

Initial evidence of an EMERGENCY DC BUS failure is indicated by the following:

1. Loss of communications.
2. Loss of hydraulic pressure indications (barber pole) — READS ZERO.
3. Loss of brake pressure indications (barber pole) — READS ZERO.
4. Loss of warning, caution and advisory lights (confirm with lights test).
5. Loss of fuel flow indications.
6. Loss of fuel quantity indications — Fuel quantity displayed will not be valid/current. Fuel quantity indication will be frozen at amount when failure occurred.
7. Loss of RPM, JPT and PMI indications in HUD.
8. Stabilator Trim INOP.
9. Yaw SAS INOP.

If emergency DC bus failure suspected:

If above 10,000 feet cabin pressure.

*1. Emergency oxygen actuator — PULL.

*2. Descend below 10,000 feet cabin pressure.

WARNING

Activating emergency oxygen with an emergency dc bus failure does not guarantee flow of 100 percent emergency oxygen to the mask. Failure to achieve 10,000 feet cabin pressure altitude immediately increases the possibility of hypoxia.

With emergency oxygen activated or below 10,000 feet cabin pressure:

*3. DC test switch — SET TO STBY.

If power is regained:

4. DC test switch — LEAVE IN STBY

5. Land as soon as practical.

If power is not regained:

*6. DC test switch — SET TO MAIN.

7. BATT VOLTS indicator — VOLTS slowly decreases to 24. (two to three minutes)

If power is regained:

8. DC test switch — LEAVE IN MAIN.

9. Land as soon as practical. If required, battery can be recharged by temporarily setting DC TEST switch to the center position.

If power is not regained:

10. DC test switch — SET TO CENTER POSITION.

11. FUEL state — begin to calculate elapsed time for fuel quantity. Fuel quantity displayed will not be valid/current. Fuel quantity indication will be frozen at amount when failure occurred.

If radio communication required:

12. Battery switch — ALERT to restore communications.

Note

When battery switch is in BATT voltage will read zero.

Prior to voltmeter reaching 16V:

13. Battery switch — BATT to charge batteries. Return to ALERT for communication as required.

Prior to landing:

14. LANDING GEAR UNSAFE/FAILS TO EXTEND procedures — PERFORM.

Note

Landing gear indication lights and the approach light are inoperative. TAV-8B only will have landing gear indication lights but no approach light.

When prepared to land:

15. Land as soon as practical using a gentle VL if possible.

CAUTION

No antiskid. No JPT or RPM indications.

If unable to perform VL:

16. Land as slow as possible using a minimum rate of descent.

CAUTION

The canopy seal will not deflate quickly. If rapid egress is required the emergency canopy shattering handle may be required.

15.15 OUT-OF-CONTROL

15.15.1 Jetborne/Semi-Jetborne

Out-of-Control Recovery. Always reduce angle of attack by placing the stick forward. Further, reducing the nozzle angle will reduce AOA due to a decrease in down wash on the tail plane thus reducing nose up pitching moment. The initial rudder requirement to bring the aircraft nose into the relative wind will be in the same direction as the required aileron (i.e., right aileron right rudder, left aileron left rudder). Do not overcontrol as this can cause sideslip and bank angle to diverge in the opposite direction. The primary piloting cue during recovery is lateral response to aileron. If lateral response to recovery control is normal, vary control inputs as required to maintain wings level and minimize sideslip. If lateral response is not immediate when recovery control is applied, ejection may be the only alternative.

Note

This procedure is designed to counter high AOA, uncontrolled nose up pitch and roll due to sideslip at high angles of attack and will provide the pilot with the best possible reaction to loss of control while in semi-jetborne flight near the ground (landing pattern), where the reaction should be immediate and positive to regain roll control.

*1. Stick — FORWARD.

*2. Throttle — FULL.

An increase in rpm will increase the reaction control duct pressure and thus the control available. In addition, the increased thrust will reduce AOA even without attitude change due to the flight path change.

*3. Stick — AGAINST ROLL.

*4. Rudder — AGAINST SIDESLIP.

Note

Steps 1 through 4 should be applied simultaneously but the priority is in the order shown.

If AOA not recovered and time and altitude permit:

*5. Nozzles — REDUCE 20 DEGREES.

When AOA recovered:

*6. Nozzles — AS REQUIRED.

15.15.2 Out of Control/Spin/Falling Leaf Recovery

Neutral controls are defined as zero degree rudder, zero degree aileron, and zero degree stabilator. The pilot can confirm neutral controls by centering the rudder pedals, centering the stick laterally and fore-aft in the cockpit, and by checking the stab position indicator on the engine display panel at zero degrees.

Unexpected g-forces during OCF can make it difficult for the pilot to operate flight controls and view cockpit instruments. A locked shoulder harness assists the lap restraints with keeping the pilot in a proper position in the ejections seat under these g-forces. Consideration should be given to locking the shoulder harness prior to non-tactical maneuvering (i.e. intentional departures, practice TVC drills, approach to stalls, FCF DEP RES checks) where OCF may be encountered. For the same reason, the shoulder harness should be selected to the locked position (if not already locked) if an aircraft departure is encountered. However, completion of the first three boldface procedures takes precedence over locking the harness.

*1. Controls — NEUTRAL.

*2. Throttle — IDLE/OFF IF COMPRESSOR LOCKED IN STALL.

CAUTION

If throttle is not promptly retarded to idle at first indication of departure, engine fan rub requiring engine removal is possible.

*3. Nozzles — AFT.

WARNING

Rapid nozzle movement during the early phase of a departure may aggravate the departure and/or result in more violent post-stall gyrations. Nozzles should be moved aft smoothly (at a rate equivalent to from hover stop to fully aft in three to five seconds).

If spin positively confirmed after 2 turns with neutral controls:

*4. Rudder — FULL OPPOSITE SPIN DIRECTION.

*5. Aileron — FULL WITH SPIN IF UPRIGHT, NEUTRAL IF INVERTED.

If Falling Leaf positively confirmed after 5 seconds with neutral controls (TAV-8B and Radar aircraft only):

*6. Stick — FULL FORWARD.

When recovered:

*7. Initiate airstart (if required).

*8. Nozzles — AFT.

If still out-of-control below 10,000 feet AGL:

*9. EJECT.

15.16 FUEL CONTROL

15.16.1 EFC CAUTION AND JPTL WARNING LIGHTS ON

1. DECS enable switch — CHECK ON.

If lights extinguish:

2. The mission may be continued at the discretion of the pilot in command.

If lights do not extinguish:

3. Execute SINGLE DECU FAILURE procedures or select MFS and perform MFS RECOVERY procedures.

Note

The Caution light takes precedence over the JPTL Warning and the SINGLE DECU FAILURE procedures are to be executed.

15.16.2 SINGLE DECS FAILURE (EFC CAUTION LIGHT)

1. Do not change lanes.

2. Land as soon as practical.

CAUTION

The EFC switch should not be repositioned during an in-flight DECU failure. This could erroneously reset a failed DECU.

15.16.3 DUAL DECS FAILURE (EFC WARNING LIGHT)

Loss of engine control can be caused by a malfunction within the engine fuel control systems or a throttle linkage failure. Probable failure modes within the current -408B configuration that may result in dual DECS Failure include noise detected on fan or compressor speed signals and internal FMU actuator faults. Probable faults that may result in apparent loss of throttle response without a corresponding DECS failure include: loss of P3 air signal to the FMU (power restricted), internal FMU scheduled flow reset (power restricted), IGVs failed at high angle (power restricted), IGVs failed at low angle (restricted deceleration) and throttle linkage failure. MFS selection will restore full engine control for any of the probable mechanisms responsible with the exception of IGV faults and throttle linkage failure. If the engine does not respond to throttle movement, time permitting, the engine page should be checked to verify IGV functionality before selection of MFS. In conventional flight the throttle should be set to idle to reduce the risk of compressor stall before MFS is selected.

Note

- Care should be taken not to move the throttle faster than the engine will normally accelerate when controlled by the primary fuel control system. Moving the throttle from the idle stop to the mid-throttle position in less than approximately six seconds or moving the throttle without appropriate engine rpm response greatly increases the risk of engine surge. Since the possibility of surge is greater at low rpm, throttle movement must be slowest in the lower portion of the rpm band. (Approximately 4 seconds from idle to 55 percent and 2.5 seconds from 55 percent to 100 percent).
- MFS is fuel flow limited to a maximum scheduled flow of approximately 260 pounds per minute. Selection of MFS near sea level static conditions may result in significantly less thrust than that available under DECS control depending upon engine operating conditions (bleed, water, and prevailing ambient conditions).

If loss of engine control occurs in V/STOL flight, the decision to select MFS should be made with an understanding of the expected thrust available. On aircraft with MFS battery, the MFS emergency battery provides an alternate means for manual fuel selection. The required engine power should be adjusted after MFS selection has been achieved. If the throttle has been retarded from the setting at which the failure occurred, the rpm will decrease rapidly when MFS is selected. If after selecting MFS engine control is not restored, it is an indication of a throttle linkage failure.

CAUTION

Selection of MFS with low engine rpm and high throttle lever angle position will significantly increase the likelihood of engine surge.

The EFC warning light indicates complete DECS failure has occurred. The FMU stepper motor is magnetically latched in its last commanded position. However, total scheduled fuel flow is dependent upon stepper motor position and P3 air pressure signal. Subsequently, engine power may change depending upon the last demanded stepper motor movement prior to failure. If failure occurred during a demanded acceleration or deceleration, the engine will likely continue to accelerate or decelerate as scheduled fuel flow from the FMU continues to change with changes in P3 pressure. In the extreme case, the engine may either overspeed or run down to sub-idle. If failure occurred at a steady speed setting below 35 percent fan speed, the engine may eventually either run down to sub-idle or accelerate to approximately 75 percent over a period of approximately 30 seconds with the initial change occurring slowly and increasing rapidly in the last 5 seconds. If failure occurred at a steady speed setting between 35 and 90 percent fan speed, the engine may either decelerate or accelerate depending upon the response of the FMU to small changes in spool speed and P3 pressure. The initial response will be slow, progressing rapidly through the range of 35 to 75 percent fan speed before eventually stabilizing. If failure occurred at a steady speed setting above approximately 90 percent fan speed, the engine speed will most likely remain at the level set prior to failure. In all cases, selection of MFS will be required to restore full engine control.

DECS consists of two fully independent lanes of control with minimal potential single point failures by design. Simultaneous failure of both lanes (complete DECS failure) indicates that both DECUs have either detected a fault within one of the common input signals or components, or have both lost electrical power if accompanied by a JPTL warning light. For the current -408B configuration, shared signals and components common to both lanes of DECS within which a detected fault could result in failure of both lanes include the fan and compressor speed signals and the FMU stepper motor. Selection of MFS will restore engine control.

Failure of the Variable Inlet Guide Vane System (VIGVS) will change the matching relationship between the fan and compressor, and subsequently alter the response of the DECS. For all current –408 configurations, DECS failure will not occur as a result of VIGV failure. Failure of the IGVs to the fully closed (high angle, 31 to 39 degrees) position during demanded engine acceleration will be apparent to the pilot as slow engine response with eventual engine stagnation at approximately 75 percent fan speed. Failure of the IGVs to the fully closed position at high engine speed may result in a brief fan stall, with rapid uncommanded deceleration to approximately 75 percent fan speed. In each case, initial control by the DECU in response to the IGV error will be on the HP corrected speed limiter (105 percent NH). Engine JPT will be abnormally higher in each case, and active control may shift to the JPT limiter with further reduction in available engine power occurring depending upon ambient conditions. Selection of MFS and attempted acceleration above approximately 75 percent NF will result in engine compressor stall. Failure of the IGVs to the fully open (low angle, 0 to –4 degrees) position at high power settings will be apparent to the pilot as an inability to decelerate the engine below approximately 70 percent fan speed. Selection of MFS and attempted deceleration below approximately 70 percent will result in engine stall and flameout with little chance for recovery.

Throttle linkage failure may occur at any point within the throttle system. Most probable points of failure include the throttle cable, the interface connection between the throttle cable and engine control system and the linkage attachment point at the FMU. The engine response to throttle linkage failure depends upon the point of failure. Failure at any point between the throttle quadrant and input connection to the engine control system Pilots Lever Angle Unit (PLAU) will result in complete loss of input to the engine control system including MFS. In this case, failure will be apparent to the pilot as a complete lack of response to throttle input, with potential for uncommanded changes in engine speed which occur with changing altitude and airspeed. Failure of the interface connection between the PLAU and FMU shut–off valve will result in loss of physical control of the shut–off valve and create the potential for linkage jamming. The unrestrained shut–off valve may assume any position from off to fully open under the action of internal hydraulic forces. Under DECS control, provided that the shut–off valve remains at any position greater than approximately IDLE, full engine control will be available. Under MFS engine power available will change with movement of the unrestrained shut–off valve.

WARNING

If throttle linkage fails, the fuel control can assume any position from OFF to FULL and may not remain stable at any power setting.

In V/STOL flight (Takeoff/Approach/and Landing):

Time Critical.

*1. MFS — SELECT.

Note

On aircraft after AFC–328, the MFS emergency battery provides an alternate means of manual fuel selection.

*2. Water switch — OFF.

If rpm does not recover:

3. EJECT.

WARNING

The ejection decision must be timely. The development of a high sink rate can prevent a successful ejection.

In Conventional Flight:

*1. Throttle — IDLE.

WARNING

DECUs will prevent rpm reduction below 70 percent with IGVs failed at low angles. Selection of manual fuel with throttle at idle will result in engine surge with little chance of recovery. Time permitting, verify IGV position commensurate with engine speed prior to selection of MFS.

*2. MFS — SELECT.

*3. Throttle — ADVANCE SLOWLY.

If unable to select MFS and sufficient power not available:

*4. EFC switch — CHANGE LANE.

If available power insufficient for recovery:

5. EJECT.

If MFS fails to restore control but sufficient power available:

Note

If MFS achieved, throttle linkage failed, or MFS fuel valve position constant, rpm will increase approximately 1 percent per 1,000 feet altitude gain and decrease by approximately 1 percent per 1,000 feet altitude lost.

Note

If MFS not achieved and DECS frozen, the rpm will increase in a descent at constant Mach number and decrease during deceleration at constant altitude. A descent from high altitude cruise to pattern altitude and speed can result in a loss of rpm of up to 5 percent. As nozzles are selected and as bleed is demanded, rpm will decrease. If the initial rpm prior to nozzle selection is at 80 percent or below, the effect of bleed may run the engine to a sub-idle condition. At higher initial rpm and with maximum bleed the reduction in rpm may be up to 20 percent.

6. Cautiously use nozzles to control airspeed.
7. Flaps — AUTO.
8. Land as soon as practical.

After landing:

9. Use power nozzle braking as required.
10. Throttle — OFF.
11. Fuel shutoff handle — OFF.

15.17 MINOR RPM FLUCTUATION

For the current configuration of engine control system, the most probable causes for minor fluctuations in engine speed are associated with excessive wear in the interface connection between the Pilots Lever Angle Unit (PLAU) input lever and aircraft throttle linkage system, excessive wear in the aircraft throttle linkage system inboard transverse shaft assembly, and instability or fluctuation in VIGV position driving changes in high pressure spool speed. In each case, fluctuations of up to 3 percent NF may be apparent near sea level conditions, and may become larger with increasing altitude with no corresponding engine control system cautions or warnings. Typically, fluctuations resulting from excessive wear in the throttle system are on the order of 1 percent NF, and are throttle position dependent. Therefore, reducing throttle position may eliminate the fluctuation. If necessary, selection of MFS may also reduce or eliminate the fluctuation due to the differences in throttle system interface and stiffness between primary and backup control. Fluctuations driven by instability or fluctuation in VIGV position will be most likely in the upper speed range operating near zero degrees VIGV position where aerodynamic loads on the VIGVs are low. In this case, engine stall may become more likely in MFS. In all cases, if the engine fluctuations are not detrimental to aircraft control, retaining DECS control of the engine is preferable to MFS operation.

In conventional flight:

1. Throttle — REDUCE.

If fluctuation continues:

2. Throttle — IDLE.
3. Verify IGV angle (time permitting).

If IGVs commensurate with throttle setting:

4. MFS — SELECT.
5. Throttle — ADVANCE SLOWLY.
6. Land as soon as practical.

15.18 MFS RECOVERY

WARNING

Maximum throttle position in MFS will provide approximately 111.0 percent corrected fan speed versus the 116.8 percent corrected fan speed limitation provided under DECS control. Actual mechanical speed and thrust achieved in MFS will vary with ambient conditions. RCS bleed, and water injection usage. Anticipate maximum achievable MFS performance with nozzles at 10 degrees and neutral flight controls equal to or slightly less than short lift dry performance under DECS control when operating near sea level static conditions. Increase in RCS bleed or use of water injection will reduce maximum speed and thrust available.

CAUTION

If the engine RPM goes sub-idle, the generator falls off line and consequently NWS is hot, antiskid is off, and external lights are out.

1. Throttle — SMOOTHLY ADJUST (NO SLAMS) TO REMAIN WITHIN NORMAL LIMITS.
2. Climbs — LIMIT TO 90 percent (-406 engine) OR 100 percent (-408 engine) FOR SAFETY MARGIN.

3. Recommend straight in approach. Any type landing may be performed:

   a. If runway available — VNSL (rpm 80 to 95 percent).

   b. If VL essential — VL.

   Reduce aircraft weight to minimum practical and perform a smooth throttle deceleration.

4. PNB — ONLY IF REQUIRED USING SLOW SMOOTH THROTTLE MOVEMENT.

5. Throttle — IDLE, MAINTAIN IDLE RPM LIMITS.

Note

- For MFS recovery, consideration should be given to dumping fuel and water to reduce landing airspeed.
- Inflight, once manual fuel has been selected, it should not normally be deselected.

15.19 COMPRESSOR STALL

If the pilot experiences a loud bang with falling rpm and steady/rising JPT, compressor stall is likely. This is usually a result of a combination of high AOA, low airspeed, and high power settings. At first indications of compressor stall, the throttle should immediately be brought to idle to prevent a locked in stall. Monitor JPT closely. If the stall does not clear, the JPT will rise rapidly and the engine will overtemp unless the throttle is immediately placed OFF. Due to the possibility of structural damage, a VNSL is recommended.

*1. Throttle — IDLE.

*2. AOA — REDUCE TO LEVEL FLIGHT AOA.

If JPT continues to rise; before 590 °C:

*3. Throttle — OFF.

4. Emergency oxygen actuator — PULL.

5. Initiate airstart.

If time and altitude permit following a successful airstart:

6. Slowly advance power and monitor engine page for proper IGV operation.

7. If IGV angle does not decrease as rpm increases, execute IGV failure procedure.

15.20 ENGINE MECHANICAL FAILURE/ENGINE VIBRATION

If the pilot experiences a bang or bangs without a high AOA, low airspeed, and high power setting condition, or if other indications accompany the bang or bangs, mechanical failure is likely. These other indications could include any or all of the following: loss of rpm or seizure, vibration possibly accompanied by ENG EXC caution, increased JPT, loss of thrust, and sparks from the hot nozzles. Vibrations that are specifically felt in the rudder pedals may be the result of the radar slamming against the stops and may be eliminated by turning the radar to STBY or OFF.

Inflight.

If engine flames out or surges:

1. Follow compressor stall procedures.

If engine continues to run:

2. Follow oil system failure (OIL caution light) procedures.

CAUTION

If the engine is still running, establish a constant rpm setting (75 to 85 percent -406 engine, 80 to 85 percent -408 engine is recommended). Unnecessary movement of the throttle may increase the likelihood of engine failure.

On ground.

1. Throttle — OFF.
2. Fuel shutoff handle — OFF.

15.21 IGV FAILURE

The IGVs may be visualized as a valve controlling corrected air mass flow into the high pressure compressor. Complete failure of the variable inlet guide vane system will change the matching relationship between the fan and compressor, and subsequently alter the response of the DECS. Potential failure modes for the current configuration of engine and engine control system include failure of the IGV control system and binding/jamming of the IGV linkage or operating mechanism. In the event of a complete EVICS failure the IGV will proceed to the fully closed position (high angle, 31 to 39 degrees), resulting in limited available thrust. In this case, follow procedure for IGV Failure - Stuck at High Angle. In the event of an inlet guide vane failure in non -408B equipped aircraft, the IGVCU may freeze the vanes or command them to either the fully open or fully closed position. In the event of binding/jamming of the IGV linkage or operating mechanism, the IGVs may remain either fixed or restricted in range of travel.

IGVs failed at a high angle during attempted engine acceleration from low speeds will result in a slow engine response with eventual engine stagnation at approximately 75 percent fan speed. Failure of the VIGV system to the fully closed position (high angle) at high engine speed may result in a brief fan stall, with rapid uncommanded deceleration to approximately 75 percent fan speed. In each case, initial active control by the DECU in response to the VIGV error will be on the high pressure compressor corrected speed limiter (105 percent NH). Thrust available will be degraded. Engine JPT, fuel flow rate and high pressure compressor speed will all be abnormally high. In high ambient temperatures, active DECU control may eventually shift from RPM limiting to JPT limiting with further reduction in available engine power occurring to maintain selected short lift datum. In this case, selecting the JPTL switch to OFF may restore available thrust back to that initially available on the corrected high pressure compressor speed limiter without compromising stall margin. Selection of water will increase the JPT limiting datum to short lift wet; however, water flow may compromise engine stall margin making engine stall more likely and is therefore not recommended. Selection of MFS and attempted acceleration above approximately 75 percent fan speed will result in engine compressor stall.

IGVs failed at a low angle position (0 to -4 degrees) at high power settings will be apparent to the pilot as abnormal throttle response and inability to decelerate the engine below approximately 70 percent fan speed. Active control by the DECU in response to the VIGV error will minimize potential for flameout. Sustained operation below approximately 80 percent fan speed with IGVs failed open may result in catastrophic failure of the engine. Selection of MFS and attempted deceleration below approximately 70 percent will result in engine stall and flameout with little chance for recovery.

For the current configuration of engine and engine control systems, the engine will be better protected during IGV failure in DECS control with the JPTL switch ON and water injection selected OFF, rather than in MFS. If the JPTL switch is selected OFF, sustained operation at JPT values in excess of 800 degrees increases the probability of engine hot end component failure.

15.21.1 Stuck at High Angle

1. Throttle — IDLE, CHECK FOR SURGE.
2. Boost pumps — ON.
3. PROP — ON.

If locked in surge:

4. Follow compressor stall procedure.

If IGVs respond to throttle movement:

5. Land conventionally as soon as practical with cautious use of engine.

If IGVs fail to respond to throttle movement:

6. Land conventionally as soon as possible using minimum power and slow, smooth throttle movements. Do not use nozzles. Consider reducing aircraft weight by jettisoning fuel, water and stores.

WARNING

Continued operation of the engine at high JPT may result in engine failure. Use of nozzles will result in engine surge with mechanical failure likely. The risk of surge is increased during throttle movement and as rpm is increased. Use of water may result in engine surge.

Note

- If the JPTL is set OFF then ON, up to 15 seconds delay may occur before the limiter actively controls the JPT under DECS control.
- Fuel flow may be increased by 50 percent, the JPT at 70 percent may be as high as 850 °C (JPTL OFF).
- PNB is available but engine surge is highly likely.
- Do not select MFS.
- Limiters may be selected OFF to increase the available thrust if engine is JPT limited, but engine failure becomes more likely with sustained operation at high JPTs.

15.21.2 Stuck at Low Angle

1. Maintain maximum feasible power, avoid continuous operation below 80 percent rpm.
2. Perform fixed throttle variable nozzle slow landing as soon as practical.
3. Throttle — OFF (after touchdown).

Note

Do not select MFS.

15.22 LOSS OF ENGINE CONTROL INFLIGHT

In conventional flight:

*1. Menu - Engine - IGVs — MONITOR.

*2. Throttle — SLOWLY REDUCE TO IDLE.

If IGV failure indicated (stuck IGVs or wandering with constant throttle position):

*3. Execute IGV failure procedures.

If IGV failure not indicated:

*4. MFS — SELECT.

Note

RPM fluctuations due to mechanical linkage wear are easier to manage in MFS.

5. Throttle — ADVANCE SLOWLY.

6. Land as soon as practical.

15.23 AIRSTART

The manual fuel control should be used if there is time for only one airstart attempt. At low altitude, below 5,000 feet AGL, all airstart attempts should be initiated in manual fuel. If time permits, JPT should be allowed to cool below 300 °C to minimize the possibility of a hot start. If time does not permit JPT to cool below 300 °C, attempts should be initiated while windmill rpm is above 20 percent with corresponding JPT below 400 °C to reduce the probability of exceeding the starting JPT limit. Attempts made at greater than 250 KCAS within 10 seconds of shutdown from high power setting will increase the chances of a satisfactory start. Positive indications of a relight should be visible in 15 seconds; however, full power may not be available for 30 seconds or more. Time permitting, rpm and JPT should be allowed to stabilize at idle before advancing the throttle. If required, airstarts performed with deflected nozzles should be attempted above 250 KCAS to reduce the probability of hot start. Stagnant or falling rpm with JPT increasing toward 475 °C during a relight is a clear indication of a hot start and the attempt should be terminated.

If practical, when in manual fuel control, throttle advance from OFF to IDLE should be done slowly to minimize possibility of a hot start. If an airstart is made using manual fuel control, do not deselect manual fuel control. Climbs in manual fuel control at a constant throttle setting will result in approximately 1 percent rpm increase per 1,000 feet of altitude and will require continuous throttle reduction to prevent exceeding engine limits. The optimum airstart envelope is below 25,000 feet (20,000 feet manual fuel) at an airspeed between 250 and 325 knots.

If time and altitude permits multiple airstart attempts and no fuel control malfunction is suspected, airstarts with primary fuel may be made.

Considerations should be given to jettisoning external stores (see Figure 15-4) prior to executing immediate action procedures. Stores should be jettisoned in accordance with NWP 3-22.5-AV8B VOL II to provide better aerodynamic performance.

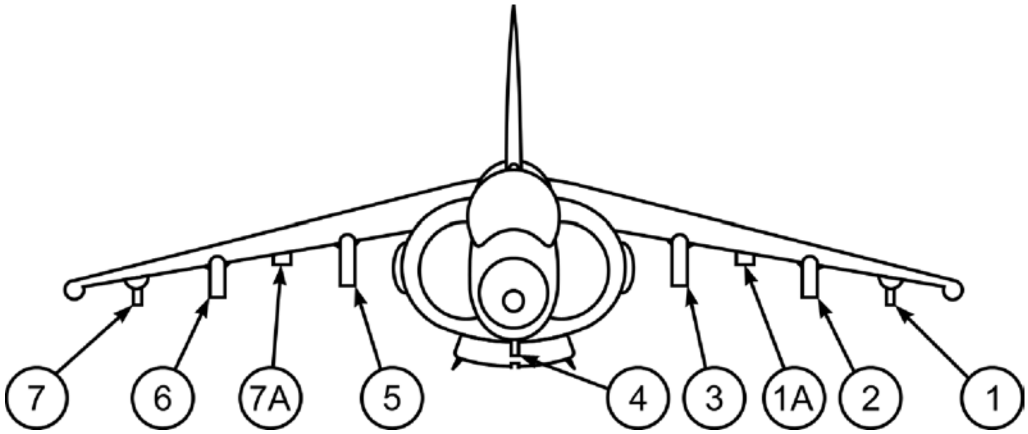
*1. Nozzles — AFT.

*2. Stores — JETTISON (if required).

*3. Throttle — OFF.

*4. Emergency oxygen actuator — PULL.

*5. MFS — AS REQUIRED.



EXTERNAL STATION(S) (STORES JETTISONED)	INTERLOCKS	JETTISON CONTROLS	JETTISON PROCEDURE
All Stations (Emergency Mode) (All stores and suspension equipment on BRU-36 bomb racks. AIM-9/AGM-122s suspended from LAU-7 launchers on stations 1, 1A, 7 and 7A are retained).	Gear handle UP or aircraft weight off wheels. 1	Emergency Jettison Button.	Emergency Jettison Button — PUSH.
All Stations (Combat Mode) (All stores and suspension equipment on BRU-36 bomb racks, except all AIM-9/AGM-122s are retained).	Gear handle UP and aircraft weight off wheels.	Selective Jettison Knob, Selective Jettison Pushbutton.	Selective Jettison Knob — CMBT. Selective Jettison Pushbutton — PUSH.
2, 3, 5, 6 (Fuel Tank Mode) (Fuel tanks dropped in pairs from 2 and 6, then 3 and 5).	Same as above.	Selective Jettison Knob, Selective Jettison Pushbutton.	Selective jettison Knob — FUEL. Station Select Buttons — PRESS. APPROPRIATE BUTTON(S). Selective Jettison Pushbutton — PUSH.
(Station Mode) All Selected Stations 1, 2, 3, 4, 5, 6, and/or 7 (All stores, including suspension equipment on BRU-36 bomb racks. AIM-9/AGM-122s suspended from LAU-7 launchers on stations 1, 1A, 7 and 7A are retained).	Same as above.	Selective Jettison Knob, Station Select Buttons, Selective Jettison Pushbutton.	Selective Jettison Knob — STA. Station Select Buttons — PRESS. APPROPRIATE BUTTON(S). Selective Jettison Pushbutton — PUSH.
(Stores Mode) All Selected Stations 1, 2, 3, 4, 5, 6, and/or 7 (All stores and suspension equipment on BRU-36 bomb racks except: stores mounted on ITERs are jettisoned while retaining ITERs. AIM-9/AGM-122s suspended from LAU-7 launchers on stations 1, 1A, 7 and 7A, are retained).	Same as above.	Selective Jettison knob, Station Select Buttons, Selective Jettison Pushbutton.	Select Jettison — STOR. Station Select Buttons — PRESS. APPROPRIATE BUTTON(S). Selective Jettison Pushbutton — PUSH.

1 A weight-on-wheels failure will inhibit jettison and prevent raising the gear handle. Emergency jettison can be enabled by using the DN LOCK OVRD to raise the gear.

2. On Day Attack/TAV-8B aircraft, if emergency jettison is selected in A/G master mode with a weapon selected SMS lock up will result. The weapons will be jettisoned, but weapon inhibit symbology will appear in the HUD and WPN FAIL will be displayed on DDI. The STRS page will not show cleared and VRST calculations will be affected. Selection of other master modes will not be possible until DSL-1 on the ACP is selected by rotating MAN knob from NORM to N/T and selecting NAV or VSTOL master mode.

Figure 15-4. External Stores Jettison Chart

*6. Airstart button — PRESS AND HOLD.

*7. Throttle — ADVANCE SLOWLY TO IDLE.

*8. JPT — MONITOR (475 °C MAX).

WARNING

Do not continue airstart attempts below safe ejection altitude.

15.24 OIL SYSTEM FAILURE (OIL CAUTION LIGHT)

Operation of the engine with an oil system failure requires that the pilot ensure minimum loads are maintained on the engine bearings. Set the minimum practical rpm within the band 75 to 85 percent (-406 engine) or 80 to 85 percent (-408 engine) and maintain it constant with slow smooth throttle movement. Minimize the g loading and land as soon as possible using a VNSL. Use nozzle braking if required, ensuring smooth throttle movements and be prepared for engine failure. Set throttle off as soon as practical after landing. Nozzles, speedbrake, flaps and landing gear may be used to control airspeed. If a vertical landing is the only option, use throttle slowly and progressively and be prepared for engine failure.

*1. Throttle — MAINTAIN CONSTANT RPM.

a. 75 percent - 85 percent RPM (-406 engine).

b. 80 percent - 85 percent RPM (-408 engine).

15.25 NOZZLE DRIVE FAILURE

A nozzle drive failure will affect a single nozzle or either the front or rear nozzles, and will cause either a roll or pitch as the nozzles are rotated. In either case, attempt to match the operating nozzles with the failed nozzle(s) and make a fixed nozzle slow landing. The nozzle position indicator in the cockpit reads forward nozzle position only.

15.26 NOZZLE CONTROL FAILURE

Exact technique to be used in event of nozzle control failure depends on the position at which the nozzles are failed and the phase of flight in which they fail. The following procedures provide a general guide which may require modification due to the circumstances of a specific failure.

15.26.1 During STO

If not enough runway remains for either abort or CTO:

1. EJECT.

15.26.2 During Transition

1. Set nozzle lever to angle shown on indicator.
2. Lighten aircraft to HOVER weight (if feasible).
3. Make landing consistent with nozzle angle.
4. Be prepared for possible uncommanded nozzle rotation on approach.
5. Throttle — OFF WHEN STOPPED.

With nozzle in braking position:

6. Accelerate to 50 knots.

7. Flare to hover attitude.

8. Touchdown before airspeed falls to zero.

9. Throttle — OFF WHEN STOPPED.

15.26.3 During Conventional Flight

1. Maintain 300 knots minimum until hover weight is reached.

15.27 ENGINE FIRE (FIRE WARNING LIGHT)

The first indication of fire is normally illumination of the FIRE warning light. If the FIRE warning light comes on during ground operations or flight operations where an immediate landing can be accomplished, i.e., short final, or vertical operations, the aircraft should be stopped and secured using the Engine Fire emergency procedures. If the aircraft is airborne or in a position where an abort or immediate landing is not possible, the in-flight fire procedure should be followed.

There are three possible sources of ignition in an engine bay fire: the RCS system, the GTS/APU, and the engine. If the nozzles are down, they should be placed aft as soon as conditions allow. This means rapid acceleration to wingborne flight if in the jetborne/semi-jetborne flight region and an immediate landing is not possible. The GTS/APU should be secured, if it is operating, to eliminate it as the fire source. The throttle should be pulled to the minimum power required for safe flight. This could be IDLE or MAX power depending on whether you are at 20,000 feet or on the deck in an accelerating transition. If the engine air valve is open (only applicable to an aircraft with a fuselage gun on board) it should be closed by deselecting gun and placing the master arm switch to SAFE. The gun will be deselected by switching to NAV or V/STOL master mode. Even with the gun deselected, it is still necessary to secure Master Arm switch in order to close the engine air valve.

The engine air valve is open if a gun is present AND any of the following are true:

1. Master Arm — ON.

2. A/G Master Mode and gun selected (Master Arm OFF or ON).

3. A/A Gun selected (Master Arm OFF or ON).

For these reasons the Master Arm must be selected OFF and the gun (either A/G or A/A) must be deselected to secure the valve.

After following the first four steps of the in-flight fire procedure, check for confirmatory signs of the fire. Engine fires are normally accompanied by one or more of the following: abnormally high JPT, abnormally high or erratic fuel flow, erratic or rough engine operation, or visible flames or smoke trail. If a FIRE warning light persists with no other signs of fire, use minimum power and land as soon as possible.

If required runway length is available, keep nozzles aft during landing rollout. However, due consideration must be given to the stopping distances required when PNB is not used after a conventional landing. Recommend landing as light and as slow as possible. To achieve minimum braking distance, the antiskid system operates most efficiently when the brakes are applied 2 seconds after touchdown using a quick, full pedal input held steady until taxi speed is reached. Do not cycle, pump or lightly ride the brakes.

A momentary illumination of the FIRE warning light may indicate the circuitry has burned through so the circuit should be tested by placing the COMP/LTS TEST switch to LTS TEST. If the circuit fails the test, further investigation is required.

CAUTION

Use nosewheel steering judiciously after engine shutdown. About three cycles (neutral to 3° L to 3° R and back to neutral) are available after rpm below 10 percent.

15.27.1 Ground

*1. Execute Emergency Shutdown.

15.27.2 Takeoff/Landing/Vertical Operation

*1. Abort or Land Immediately.

*2. Execute Emergency Shutdown.

15.27.3 Inflight

*1. Nozzles — AFT AS SOON AS POSSIBLE.

*2. APU GEN — OFF.

*3. MASTER ARM/GUN — OFF.

*4. Throttle — MINIMUM REQUIRED.

If fire persists:

*5. EJECT.

If light goes out:

6. Land as soon as possible.

15.28 ELECTRICAL FIRE

-406/-408A Engine:

1. MFS — SELECT.

Note

Emergency MFS battery activation may be required if unable to select MFS.

All Aircraft:

2. Generator switch — OFF.

3. Cabin pressure switch — RAM.

4. Limit airspeed as follows:

   Below 5,000 feet - 0.4 Mach.
   5,000 to 10,000 feet - 0.6 Mach.
   10,000 to 15,000 feet - 0.7 Mach.

5. All electrical equipment — OFF.

If fire persists:

6. Battery switch — OFF ECS reverts to normal with battery switch OFF.
7. Emergency oxygen actuator — PULL.

   The OBOGS will not operate with the battery switch OFF.

8. Descend below 10,000 feet cockpit altitude.
9. Land as soon as practical.

15.29 ELIMINATION OF SMOKE AND FUMES

Consider all fumes in the cockpit as toxic. Do not confuse condensation from the air conditioning system with smoke. The most probable source of visible smoke or fumes in the cockpit is from engine bleed. This smoke is blue gray in color, has a characteristic pungent odor, and may cause the eyes to sting. Another source of smoke or fumes is an electrical malfunction or overheat of equipment located in the cockpit. In the event of electrical short or overload condition, this equipment may generate electrical smoke (usually white or gray in color) but should not cause an open fire since cockpit equipment uses very little electrical current. Cockpit electrical wiring insulation may smolder and create smoke, but will not erupt into a seriously damaging fire.

1. Emergency oxygen actuator — PULL.
2. Cabin pressure switch — RAM (requires DC power).
3. Limit airspeed as follows:

   Below 5,000 feet – 0.4 Mach.
   5,000 to 10,000 feet – 0.6 Mach.
   10,000 to 15,000 feet – 0.7 Mach.

4. Descend below 10,000 feet MSL.

If unable to clear smoke:

5. Slow aircraft.
6. MDC RING — PULL (eyes closed and visor down).

15.30 CROSSFEED FAILURE (R FEED WARNING LIGHT)

On the TAV–8B the R FEED warning light indicates automatic control of the crossfeed valve has failed and the valve is in the incorrect position. Three situations can result in this warning light. In all situations, placing the Fuel Quantity Indicator to FEED and checking the fuel quantity remaining in the feed tanks will determine subsequent required actions. The fuel quantity will require monitoring.

1. R FEED warning with less than 300 pounds in the left feed tank and 300 pounds or greater in the right fuel system — set the fuel proportioner switch to RT and check the R FEED advisory light comes on and the R FEED warning light goes out.
2. R FEED warning with both feed tanks full, 300 pounds in each fuel system — set the fuel proportioner switch to DL and verify the R FEED warning and advisory lights go out.
3. R FEED warning light with both right and left feed tanks indicating less than 300 pounds — set the fuel proportioner switch to OFF and verify the R FEED warning and advisory lights go out.

15.31 FUEL TRANSFER FAILURE (L TRANS/R TRANS CAUTION LIGHT)

Fuel transfer pressure failure may occur in one or both sides of the fuel system and is indicated by the illumination of the L TRANS and/or R TRANS caution light(s). With a fuel transfer pressure failure, internal fuel will still transfer via siphon. Care must be taken not to uncover the mouth of any transfer pipe in the fuel tanks or siphon transfer will be broken. If this occurs, the feed tanks, depending on aircraft fuel state, could deplete significantly before siphon transfer can be re-established. Restrict altitude to 30,000 feet to prevent the possibility of fuel cavitation due to low tank pressures. Do not maneuver excessively or exceed 5,000 feet/minute rate-of-descent to minimize negative pressures in the tanks and to avoid the possibility of uncovering the tank transfer pipes.

With a transfer pressure failure, the feed tank fuel quantities should be monitored closely. If the quantity gauge on the affected side indicates a steady reading of approximately 300 pounds, transfer is taking place. If the quantity gauge shows a continuing decrease and fuel is in the transfer tanks, transfer has ceased. If both feed tanks are decreasing after following checklist procedures, an immediate landing will be necessary due to fuel shortage.

If an external tank stops transferring fuel to the wing, transfer pressure is lost to that associated feed group. Transfer from the wing tank to the next tanks downstream will continue but pressure in the internal wing tank will decrease as fuel is consumed and the L TRANS or R TRANS caution light will eventually come on.

Transfer from the external tank may resume as the pressure in the wing tank decreases. If this does not occur, an attempt to reestablish transfer from the external tank can be made after the wing tank is empty by opening the fuel dump switch on the appropriate side. The dump switch must be held in the DUMP position. This will create an increased pressure differential between the external tank and wing, increasing the potential for fuel transfer. When fuel starts dumping from the dump mast, terminate dumping and check fuel gauges for continued transfer. If transfer is not sustained, repeat the procedure until transfer is established or the external tanks are empty.

If fuel does not transfer from the external tank with the dump valve open, close the dump valve. Leaving the fuel dump valve open for a prolonged period may result in a wing overtemperature condition.

Fuel jettison rates with transfer pressure failure will be slower than normal. If range is critical, jettison the failed side external tank. With the fuel selector switch set to TOTAL, monitor fuel quantity for asymmetry. Follow asymmetric landing procedures if wing fuel out-of-balance exceeds 250 pounds or if otherwise required.

WARNING

Only 250 pounds of fuel or less is available from the feed tank associated with the flashing FUEL caution. The engine will flameout when either feed tank empties while the fuel flow proportioner is ON.

15.32 FUEL LOW LEVEL (L FUEL/R FUEL CAUTION LIGHT(S) FLASHING)

A flashing L FUEL or R FUEL caution light indicates the respective feed tank fuel level is 250 ±50 pounds. If this light flashes when there is more than 300 pounds in the corresponding fuel group, the vapor release valve may have failed closed allowing a high pressure air bubble to form and stop fuel transfer. Place the fuel quantity indicator switch to FEED and check the feed tank fuel status. If the fuel level is low, apply negative and positive g's in an attempt to free the vapor release valve. If the fault persists, switch off the flow proportioner and failed side boost pump. If range is critical, the boost pump can be turned on to use available feed tank fuel. If range is not critical, leave the failed side boost pump off to conserve its fuel for landing. Place the quantity indicator switch to TOTAL to monitor fuel asymmetry. Follow asymmetric landing procedures if wing fuel out-of-balance exceeds 250 pounds or otherwise required.

WARNING

Only 250 pounds of fuel or less is available from the feed tank associated with the flashing FUEL caution. The engine will flameout when either feed tank empties while the fuel flow proportioner is ON.

15.33 EXTERNAL FUEL TANK TRANSFER FAILURE

1. Wing tank (failed side) — BURN USABLE FUEL.
2. Dump switch (failed side) — DUMP (hold if necessary).

CAUTION

Do not leave dump switch in DUMP for an extended period if fuel fails to transfer from external tank.

When fuel starts to dump from dump mast:

3. Dump switch — NORM.
4. Fuel quantity indicator — MONITOR FOR TRANSFER INDICATION.
5. Repeat procedure, as required, to use external fuel.

If fuel does not transfer from external fuel tank:

6. Balance internal wing tank fuel to minimize asymmetry for landing.

15.34 FUEL LEAK

1. Minimize maneuvering.
2. Air refueling switch — OUT.
3. Boost pumps — OFF.
4. Fuel flow proportioner — OFF.
5. Execute Inflight Fire procedure.

Note

Excessive maneuvering may discontinue fuel syphoning and may cause fuel pooling in the bottom of the fuselage to come in contact with hot motor sections. Use of nozzles may also increase the likely hood of igniting fuel pooled in the fuselage.

15.35 AIR REFUEL PROBE FAILS TO RETRACT

1. A/R switch — CYCLE - IN.

If probe remains out:

2. Do not exceed 300 knots.

If L TRANS/R TRANS caution(s) come on:

3. A/R switch — PRESS. (With the A/R switch in PRESS, automatic fuel transfer shutdown with an L TANK/R TANK warning light is lost.)

15.36 FLAPS CHANNEL FAILURE (FLAPS 1 OR FLAPS 2 CAUTION)

For aircraft without ECP-255 R1:

A FLAPS 1 failure may result in failure of the nozzle position indicator, the HUD nozzle indication in V/STOL, and the flap position indicator. A FLAPS 2 failure may result in failure of the HUD flap indication in V/STOL. Either a FLAPS 1 or FLAPS 2 failure may result in the ailerons being commanded out of the droop position when in the STOL mode below 165 knots.

For aircraft with ECP-255 R1:

Either a FLAPS 1 or FLAPS 2 failure may result in the ailerons being commanded out of the droop position when in the STOL mode below 165 knots.

15.37 AUTO FLAP FAILURE (AUT FLP CAUTION)

An AUT FLP caution may be an indication of ADC failure.

WARNING

- When STOL flaps are selected with the AUT FLP caution on, aileron droop and flap scheduling may occur as the nozzles are rotated past 25° regardless of airspeed. At high speed, a severe nose down pitch will occur. Ensure airspeed is below 165 knots and nozzles are 25° or greater prior to selecting STOL flaps.
- With an AUT FLP caution light the LIDS fence may extend when the gear is lowered regardless of airspeed. Ensure airspeed is below 200 KCAS before lowering the landing gear.

15.38 FLAP FAILURE (FLAP WARNING LIGHT)

Beeping the flaps under certain flap system failures may result in an upward or downward movement of a single flap at a significantly higher than normal rate. Momentarily depress emergency flaps retract button and monitor flaps for increased asymmetry. If significant divergence is apparent, do not attempt further flap retraction. After landing, beep flaps up to avoid flap damage.

WARNING

Rotation of the nozzles aft with failed flaps greater than 25° can cause a severe nose down pitch due to nozzle blast impingement on flap surfaces. The nose down pitch rate can be arrested by selecting a nozzle angle greater than 40°. The aircraft must then be recovered from the nose down attitude.

Note

- In aircraft without ECP-255 R1, a dual channel failure (FLAP-1 and FLAP-2 lights on) can result in a slow flap drift. Turning the flaps power switch off will preclude further movement of the flaps.
- In aircraft with ECP-255 R1, if the FLAPS warning light is not cleared, the FLAP FAILURE, FLAP FAILURE voice warning will recur once after 15 seconds if the flaps remain greater than 25°.

15.39 UNCOMMANDED FLAP MOTION

*1. Nozzles — 40 DEGREES OR GREATER.

2. Flaps power switch — OFF.

WARNING

- Cycling flap power, mode or resetting flaps may cause large uncommanded flap transient motion.
- Uncommanded programming of the flaps greater than 25° with nozzles less than 20° will cause a severe nose down pitch rate. The extreme attitudes coupled with the negative g’s of up to –2.5, as experienced by the pilot, will be extremely disorienting and make cockpit functions difficult to perform. A combination of full aft stick and rotation of the nozzles to an angle greater than 40° are required to arrest this condition.

15.40 UNCOMMANDED NOSE DOWN PITCH MOVEMENT

*1. Nozzles — 40 DEGREES OR GREATER.

WARNING

For any uncommanded nose down pitching that is not recoverable with backstick, lowering the nozzles is the only remaining option to regain control. Any delay at low altitude in lowering the nozzles, if uncommanded nose down pitching occurs, may result in loss of aircraft.

15.41 RUDDER TRIM FAILURE

1. RUD SVO circuit breaker — PULL.

Rudder trim series servo will center. Rudder trim and yaw stab aug inoperative.

15.42 AILERON OR STABILATOR TRIM FAILURE

If circuit breaker is out:

1. Applicable circuit breaker — RESET (one time only).

If circuit breaker is in:

2. Applicable circuit breaker — CYCLE.

15.43 Q-FEEL FAILURE

1. Q–FEEL switch — OFF.
2. Maintain airspeed below 500 knots/0.8 Mach.

15.44 SAS FAILURE

1. AFC — RESET.

If erroneous input occurs:

2. Paddle switch — PRESS AND HOLD.

3. Appropriate stab aug switch(es) — OFF.

4. Paddle switch — RELEASE.

15.45 FLIGHT CONTROL MALFUNCTION

Stiff or jammed flight controls can be caused by improper maintenance, FOD, structural damage, ice, binding reaction control shutter, or flight control system malfunctions. When this occurs, the SAAHS should be checked as follows:

*1. Paddle switch — PRESS AND HOLD.

If condition has cleared:

2. Appropriate stab aug switches — OFF.

3. Paddle switch — RELEASE.

4. Land as soon as practical.

If condition has not cleared (possible jammed flight controls):

*5. Transition to conventional flight.

Note

If pitch control is restricted, nozzles may be used for pitch control. If roll control is restricted, rudder may be used for lateral flight control. Trim control may still be available with jammed flight controls.

6. Land as soon as possible.

15.46 HYD 1 FAILURE (HYD 1 CAUTION LIGHT)

If HYD 1 is not restored the following services will be lost:

Normal landing gear extension.
Fuel proportioner.
Air refueling probe.
LIDS Fence.
Speed brake.
Stab aug.
AFC.
Q-feel.
Aileron droop.
Powered rudder.

15.47 HYDRAULIC SYSTEM FAILURE (HYD WARNING LIGHT)

CAUTION

Use nosewheel steering judiciously. About 3 cycles (neutral to 3° L to 3° R and back to neutral) are available following dual hydraulic system failure.

15.48 GUN NOT CLEAR

Gun not clear is indicated by a NOT CLEAR legend on the DDI store display. The NATIP, NTRP 3–22.4–AV8B contains a thorough discussion of gun operation/malfunctions.

1. Master arm switch — OFF.
2. Gun — DESELECT.

WARNING

Failure to place the master arm switch to OFF and deselect the gun can result in gun damage, gun pack overheat, and cook–off of rounds in the breech area.

Before landing:

3. Notify landing facility of Hot Gun.

After landing:

4. Proceed immediately to Hot Gun area for dearming.

CHAPTER 16

Landing Emergencies

16.1 LANDING GEAR UNSAFE/FAILS TO EXTEND

An unsafe gear indication may result from HYD 1 failure, electrical failure, airframe damage, actuator failure, or a faulty gear position indicator. With a confirmed gear malfunction, perform a VL. If required, water may be selected to gain additional performance, with or without water on-board. If performance is inadequate for a VL, perform an RVL as slow as possible. Recommend use of an LSO. The approach/hover or aux light will come on only if the main landing gear is down and locked. The nose landing gear doors will close only if the nose landing gear is down and locked. If the nose landing gear microswitch malfunctions, the nose landing gear doors may not close, but the gear may still be down and locked. On AV-8B 165354 and up, an unsafe NLG may result in lo and hi gain steering failing to centered steering mode, in which case the NWS legend on the Caution/Advisory Panel will be illuminated. If the NLG doors are open due to a T handle failure (popped) the NWS will function normally. Blowing the gear down will eliminate the steering failures. In the event the emergency gear extension system does not function, the steering failures will persist. Steering should not be selected until there is no crab angle and the aircraft has an acceptable heading.

WARNING

If ground speed is excessive, NWS may not be adequate for directional control during an RVL with a wing gear in trail.

Landing Gear Status Unknown

If one or more gear fails to indicate down:

1. Lights test switch — TEST.
   Check 4 green, 4 amber, red GEAR and gear handle lights on. If green gear down light failed with red GEAR and gear handle lights and amber in transit lights out, consider the gear down.

If lights test good:

2. Gear handle — DOWN.

If gear indicates unsafe or gear status remains unknown:

3. Landing Gear Unsafe/Fails to Extend Procedures — PERFORM.

Landing Gear Unsafe/Fails to Extend

1. Landing gear circuit breaker — CHECK IN.
   (second circuit breaker from left on bottom row)

2. Request visual check (if circumstances permit).

3. Gear handle — CYCLE.

If gear does not extend:

4. Landing Gear Emergency Extension Procedures — PERFORM.

If gear still indicates unsafe after emergency extension:

5. Fuel/Stores — JETTISON TO MINIMUM GROSS WEIGHT FOR LANDING (as required).
6. Perform gentle VL . Throttle — OFF, IF GEAR COLLAPSES.
7. Do not taxi. Install wing gear locks before engine shutdown.

If nose gear fails to extend:

8. Perform gentle VL, slowly lowering nose to ground.
9. Throttle — OFF.

Note

Nozzles angles greater than hover stop may be used to decrease attitude.

Landing Gear Emergency Extension

1. Gear handle — DOWN.
2. Landing gear circuit breaker — PULL (second circuit breaker from left on bottom row).

With Airspeed below 210 knots:

3. Gear handle — ROTATE 90° CLOCKWISE AND PULL.
   If the gear is extended by the emergency method with a HYD1 failure, the speedbrake and LIDS will not extend and VL capability will be reduced by 500 pounds. If gear handle will not move, rotate the handle 90° and pull. The gear will extend by the emergency method with the gear handle up.

If gear still does not extend:

4. LDG GEAR EMER BATT — ACTUATE.
   (after AFC-328)

16.2 BLOWN TIRE

WARNING

Directional control will probably be lost if wing gear tire fails with taxi speed above 25 knots.

1. Perform vertical landing.

If vertical landing not feasible or tire blows during landing roll:

2. ANTISKID switch — NWS (if main tire blown).
3. Use maximum nozzle braking.
4. Use nosewheel steering and reaction controls to maintain directional control.

If hot brakes suspected:

5. Do not set parking brake.

WARNING

Due to the possibility of hydraulic seal failure with hot brakes and blown main tires, a hydraulic fire may develop. Parking brake application will increase the probability of fire.

16.3 NOSEWHEEL STEERING/CASTER FAILURE

16.3.1 Before AFC-391

To determine whether the caster system or antiskid system has failed, press the NWS button. If the SKID light goes out with the button pressed, suspect a caster failure. If the light stays on with the button pressed, suspect antiskid system failure. A NWS failure can mask a caster failure.

1. ANTISKID switch — NWS.
2. Perform VL.

If unable to land vertically:

3. Minimize crab angle.
4. Perform RVL as slow as practical.

WARNING

If the nosewheel steering system is suspected of a failure (i.e. failure to respond to commands, caster failure, etc.) a vertical landing should be performed. A failure of the nosewheel steering system during a rolling landing may result in a loss of control and subsequent loss of aircraft.

Note

- A timely decision to perform a touch and go while the aircraft is still on the runway may prevent damage or loss of the aircraft.
- When nosewheel steering failure is suspected, have wingman check for motion by pressing NWS button and cycling rudder to move nosewheel.
- If necessary, use reaction controls for steering. Nozzles should be near hover stop and rpm over 50 percent.

16.3.2 After AFC-391 (Hi/Lo Gain NWS System)

Illumination of NWS light on the caution/advisory panel is an indication of a NWS system failure. NWS failure mode is ascertained by comparing the mode selected by the pilot with the mode displayed on the HUD. If CAST displayed in the HUD with ANTISKID switch ON, engaging NWS button will result in either HI gain or centered steering mode. If NWS displayed in HUD with ANTISKID switch on, caster mode has failed to LO gain NWS (“hot” NWS) and will remain in LO gain when the NWS button is engaged. The mode displayed on the HUD is the active steering mode.

INFLIGHT.

1. Perform VL.

If unable to perform VL:

2. Determine failure mode.
3. Perform RVL as slow as practical with minimum crab angle.

WARNING

If the NWS system is suspected of a failure (i.e. failure to respond to commands, etc.) a vertical landing should be performed. Failure of the NWS system during a rolling landing may result in a loss of control and subsequent loss of aircraft.

Note

When NWS failure is suspected, have wingman check for motion by pressing NWS button and cycling rudder to move nosewheel. Alternatively, nosewheel motion can be verified by pressing the NWS button, cycling rudder pedals and observing the gear centered indication on the HUD cycles between displayed and non-displayed.

TAKEOFF/LANDING ROLL OUT.

*1. Attempt to get airborne.

If unable to get airborne:

*2. Engage NWS button at minimum practical ground speed.

WARNING

If CASTdisplayed in HUD, engaging NWS button will result in either HI gain or centered steering mode. If NWS displayed in HUD, engaging NWS button may result in HI gain. Failure of the NWS system during a rolling landing may result in loss of control and subsequent loss of aircraft.

Note

A timely decision to perform a touch and go while the aircraft is still on the runway may prevent damage or loss of the aircraft.

16.4 SPEEDBRAKE FAILURE

With an electrical or hydraulic failure, airloads will close the speed brake.

If SPD BRK light on with gear down:

1. Speed brake circuit breaker — PULL.

If SPD BRK light still on:

2. Perform gentle RVL. Do not taxi.

16.5 DAMAGED AIRCRAFT

When structural damage or any other failure is known or suspected that may adversely affect aircraft handling characteristics, a controllability check should be performed as follows:

1. Proceed to a safe altitude.

Note

If conditions allow climb above 10,000 feet AGL. If unable to climb to 10,000 feet AGL it is recommended to climb to the highest feasible altitude prior to performing a controllability check.

2. Reduce gross weight to minimum practical.

3. Perform controllability check with gear down.

4. Determine if and what type of landing can be made.

If wing leading edge damage is suspected or confirmed:

Plan for an auto flap conventional landing. In the approach do not slow below 10 AOA or, in any case to an airspeed where greater than 1/2 control input, in any axis, is required to maintain control. Use a 2° to 3° approach and make shallow turn. If desired after touchdown, nozzles may be moved to the braking stop position, but power left at idle, to assist in stopping the aircraft.

If wing trailing edge damage is suspected or confirmed:

Select flaps OFF, do not beep or extend flaps in order to avoid a split. Make only shallow AOB turns, if necessary use rudder to turn aircraft. Use nozzles as required, perform a FNSL, gradually increasing nozzle angle, ensure ground speed is below 180 knots at touchdown. If certain nozzles are not damaged a VNSL may be made.

5. If adequate control available, maintain configuration and make straight-in approach.

16.6 CRUISE FLAPS LANDING

A cruise landing is basically the same as a normal VL. For a CL or SL, the landing roll will increase due to the increased airspeed at the landing AOA. The pattern should be expanded slightly. If possible, perform an SL or VL. Do not touchdown above 180 knots ground speed, if possible.

16.7 SAAHS OFF RECOVERY AND LANDING

CAUTION

During a SAAHS off recovery and landing the pilot workload will be substantially increased. Care must be taken to perform all transitions early to allow the pilot time to trim the aircraft and gain familiarity with the changing flight characteristics in the SAAHS off condition. This will also allow time to assess the environmental conditions. Excursions from balanced flight must be corrected immediately to maintain adequate control power with the reaction control system.

1. Fly a straight-in approach if possible.

If wind, runway condition, aircraft malfunction(s) allow:

2. Perform a FNSL (Select a nozzle angle that produces a 90 to 120 KCAS approach).

Note

Many aircraft malfunctions that degrade the SAAHS will also require an RVL or VL to land due to other aircraft system degradations.

If wind, runway condition, aircraft malfunction(s) or other conditions prevent performing a FNSL:

3. Perform RVL or VL (Recommend a flatter than normal approach and avoid excessive closure).

WARNING

A high, fast approach SAAHS off, especially on a decelerating transition to a VL will increase likelihood of pilot over-controlling the aircraft leading to loss of altitude awareness, AOA excursions, loss of sideslip control and a possible loss of aircraft control in close proximity to the ground.

4. Prior to touchdown — Ensure pitch attitude is maintained on the horizon; minimize yaw and roll angle.

16.8 REACTION CONTROL FAILURE

Reaction control failure may be caused by loss of RCS pressure/flow or by disconnection of an RCS shutter.

Loss of RCS pressure/flow is most often accompanied by low duct pressure and/or excessive nose-up pitch as the nozzles are lowered. During a decelerating transition, the aircraft will become increasingly sluggish in response to control inputs and, eventually, all control will be lost. Loss of RCS may indicate a bleed air duct failure which can cause a fire.

Disconnect of an RCS shutter will cause degraded control authority or loss of control in one axis during jetborne flight. A disconnect during wingborne flight will not become apparent until below 120 knots where it will appear as an increasing pitch, roll, or yaw tendency as the aircraft slows. Disconnect of the front or rear pitch shutter will probably result in a closed shutter and a lack of response from the failed shutter. The position of the yaw shutter after a disconnect is not predictable. Disconnect of a roll shutter will probably result in full up-blowing on the failed side and will be indicated by increasing opposite lateral stick required to maintain wings level as the aircraft slows.

The type of failure can be distinguished by a general degradation in control in all axes with loss of RCS pressure/flow as opposed to degradation in only one axis with an RCS shutter disconnect. Disconnect of the rear pitch shutter may, at first, appear similar to loss of RCS pressure/flow but, in this case, normal yaw and roll control is still available.

For any reaction control failure, the proper corrective action is to transition to conventional flight as fast as possible or land immediately.

WARNING

With an RCS shutter disconnect, especially with a roll shutter disconnect, abrupt application of power may cause complete loss of control with shutters down.

*1. Transition to conventional flight.

If transition to conventional flight not feasible:

2. Land immediately or eject.

16.9 ASYMMETRIC LANDING

An asymmetric moment can result from fuel transfer failure or stores imbalance. An asymmetric vertical landing may require use of water or reduced weight due to JPT rise from increased RCS bleed requirements (about 4 °C per 10,000 inch-pounds asymmetry). For an asymmetric slow landing, lateral control is improved by use of AUTO vice STOL flaps. CG near the aft limit should be avoided during AUTO flap landings with more than 60° nozzles due to low longitudinal control margin. Combinations of lateral asymmetry and longitudinal fuel imbalance should be avoided due to inertia effects and decreased control authority. The relative wind should be placed under the heavy wing if possible. Time in ground effect should be minimized.

CAUTION

Flight test results have shown a drop off in handling qualities with asymmetries greater than 80,000 inch-pounds without the relative wind under the heavy wing.

16.9.1 Asymmetric Stores Landing

The inboard pylon is 75.17 inches from the aircraft centerline, the intermediate pylon is 127.49 inches from the aircraft centerline, and the outboard pylon is 157.06 inches from the aircraft centerline; therefore, a single store over 1,065 pounds on an inboard pylon, a single store over 628 pounds on an intermediate pylon, or a single store over 510 pounds on an outboard pylon will exceed the vertical landing limit. If two or more stores are retained, the algebraic sum of their individual moments must be calculated to determine if the asymmetric moment is in excess of the vertical landing limit (- for stations 1, 2, and 3; + for stations 5, 6, and 7). See Figure 16-1. For store and suspension equipment weights refer to the aircraft loading chart in part XI, A1-AV8BB-NFM-400. An AUTO flap slow landing using 50° fixed nozzles will generally provide the most comfortable lateral control margin and landing roll-out characteristics; however, nozzle setting may be varied depending on other factors such as touchdown speed versus runway length, longitudinal control margin, RCS condition, etc. The two most important items for controllability are use of AUTO flaps and limiting AOA to 12° maximum. Do not make sudden or large rpm reductions during approach to prevent RCS control power reduction.

If asymmetric load over VL limit and VL required:

1. External stores — JETTISON.

If asymmetric load over 80,000 inch-pounds:

2. Climb to a safe altitude (3,000 feet AGL).

Note

If conditions allow climb above 10,000 feet AGL. If unable to climb to 10,000 feet AGL it is recommended to climb to the highest feasible altitude prior to performing a controllability check.

3. Slow to 250 knots.
4. Landing gear — DOWN.
5. Flaps — AUTO.
6. Slow to desired approach speed using nozzles (recommend 50° nozzles) and rpm to limit AOA to 12°.
7. Perform controllability check. (If rudder pedal shakers fire with a centered yaw vane, turn shakers off. Retain stab aug.)

Note

All sideslip aids utilizing lateral accelerometer inputs (yaw stab, shakers, HUD sideslip symbol) will operate erroneously.

If lateral control margin inadequate and stores cannot be jettisoned:

8. EJECT.

16.9.2 Asymmetric Fuel Landing

Fuel imbalances will cause lateral asymmetry when the low side is above 1,400 pounds, and longitudinal cg shift when the low side is below 1,400 pounds.

Depending on aircraft loading, fuselage fuel imbalance as low as 250 pounds may place the cg out of limits. When a combination of lateral asymmetry and fuselage fuel imbalance exists, control authority may be substantially reduced due to abnormal stick position and/or excessive bleed requirements.

If fuel imbalance exceeds 250 pounds:

1. Fuel proportioner — OFF.
2. Low side boost pump switch — OFF UNTIL FUEL BALANCED.

If fuel does not balance:

3. Heavy side wing fuel — JETTISON.
4. Low side boost pump switch — ON FOR LANDING.
5. Land as soon as practical.

If low side fuel below 850 pounds:

6. Perform a Fixed Nozzle Slow Landing if possible.

If total asymmetry including fuel and stores exceeds 80,000 inch-pounds:

7. Refer to Asymmetric Stores Landing.

To calculate asymmetry due to wing tank imbalance, enter Figure 16-2 with fuel in each wing tank. Asymmetry in inch-pounds is (+) for the right wing tank and (-) for the left wing tank. Calculate the algebraic sum. Lateral control authority is degraded with asymmetries above 85,000 inch-pounds at airspeeds below 200 knots with nozzles aft.

16.10 LANDING WITH ENGINE FAILURE

Landing with the engine inoperative shall not be attempted.

16.11 PRECAUTIONARY EMERGENCY APPROACH

The standard precautionary emergency approach is a straight-in approach to a conventional or slow landing, modified as aircraft configuration and power available dictates. For conventional precautionary approaches, recommend landing as light and as slow as possible. For conventional landings when PNB is not an available option, such as for a fire light or nozzle malfunction, apply full brakes two seconds after touchdown. Do not cycle, pump or lightly ride the brakes.

CAUTION

Conventional landings greater than 140 KGS above 20,000 LBS gross weight without PNB will result in main tire fuse plug release. Landings at this weight have exhibited this characteristic approximately 1 minute after coming to a stop.

If engine control is in question but nozzles can be moved, recommend combining wheel brakes and idle PNB.

16.12 CANOPY SEAL FAILS TO DEFLATE

If the canopy seal fails to deflate after landing, the canopy cannot be opened in the normal manner.

1. Cabin pressure switch — RAM.
2. Attempt to manually open the canopy.

   With the canopy seal inflated, it takes at least 110 pounds of pull force to open the canopy.
3. Engine — SHUT DOWN.
4. Have maintenance personnel disconnect weight-on-wheels plug in main wheelwell.

If seal still inflated:

5. Have maintenance personnel check CS COOL circuit breaker — IN.

If canopy still will not open:

6. Puncture the canopy seal with a sharp object.

   The aircraft may be flown below 25,000 feet cabin altitude with a punctured canopy seal.

ASYMMETRY (INCH-POUNDS)
VL LIMIT 80,000 INCH-POUNDS

STORE			STATION 1(-) 7(+)	STATION 2(-) 6(+)	STATION 3(-) 5(+)
AIM-9L/M [1]			29,684	24,096	—
AGM-65E [2]			—	81,594	48,109
AGM-65F [2]			—	85,291	50,289
TGM-65E			—	81,594	48,109
CATM-65F			—	85,291	50,289
TACTS [1]			19,161	15,554	—
AN/AAQ 28, Litening Pod [5]			—	62,470	36,833
CBU-78/B			76,802	62,343	36,758
CBU-99/100			79,315	64,382	37,961
Mk 20, Mod 9, 10, 11, 12			76,959	62,470	36,833
Mk 82, Conical [3]			80,729	65,530	38,367
Mk 82, Mk 15 [3]			88,111	71,522	42,170
Mk 82, BSU-33 [3]			81,043	65,785	38,788
Mk 82, BSU-86 [3]			87,797	71,267	42,020
Mk 83, Conical [3]			—	126,470	74,569
Mk 83, BSU-85 [3]			—	130,805	77,124
Mk 77 Mod 4, 5			—	69,482	40,968
Mk 36, Mk 15 [3]			88,425	71,777	42,321
Mk 36, BSU-86			86,540	70,247	41,419
Mk 40, MAU-91			—	134,502	79,304
GBU-12			—	77,641	45,779
GBU-16			—	139,729	82,386
GBU-32			—	131,060	77,275
GBU-38			—	73,307	43,223
Mk 76 [4]			—	26,390	15,560
BDU-33 [4]			—	26,008	15,335
Mk 106 [4]			—	18,741	11,050
BDU-48 [4]			—	20,271	11,952
LGTR			—	11,474	6,765
LGTR and ITR			—	27,920	16,462
LAU-10D/A (Full w/Fairings)					
WARHEAD	MOTOR	FUZE			
Mk 63	Mk 71	Mk 93	—	87,713	51,717
Mk 24	Mk 71	Mk 188	—	82,614	48,710
LAU-61C/A (Full w/Fairings)					
WARHEAD	MOTOR	FUZE			
M151	Mk 4	M427	—	70,629	41,644
Mk 1	Mk 4	Any	—	63,363	37,359
M151	Mk 66	M427	—	75,474	44,500

Figure 16-1. Asymmetric Stores Calculation (Sheet 1 of 2)

ASYMMETRY (INCH-POUNDS)
VL LIMIT 80,000 INCH-POUNDS

STORE			STATION 1(-) 7(+)	2(-) 6(+)	3(-) 5(+)
LAU-68D/A (Full w/Fairings)					
WARHEAD	MOTOR	FUZE			
M151	Mk 4	M427	—	29,577	17,439
Mk 1	Mk 4	Any	—	29,900	15,861
M151	Mk 66	M427	—	31,363	18,492
LUU-2B/B					
SUU-25 (full)			—	59,665	—
LAU-7A-5 (empty)			14,135	11,474	—
LAU-117A (empty)			—	17,211	10,148
BRU-42/A (ITER) (empty)			—	16,446	9,697
ADU-299A/A			—	3,060	—
SUU-25F/A (empty)			—	33,402	—
LAU-10D/A (empty)			—	17,339	10,223
LAU-61C/A (empty)			—	19,761	11,651
LAU-68D/A (empty)			—	10,837	6,389
300 Gal Tank (empty)			—	25,243	14,884
Fuel (per 100 lbs.)			—	12,700	7,500
			—		
MXU-648 (w/removable tail cone)					
Full			—	50,500	29,800
Empty			—	17,900	10,500
Outboard Pylon (sta. 1 and 7)			15,078	—	—
Intermediate Pylon (sta. 2 and 6)			—	16,701	—
Inboard Pylon (sta. 3 and 5)			—	—	10,749

NOTES:

1. Does not include Launcher LAU-7A-5 or Adapter ADU-299A/A.
2. Does not include Launcher LAU-117A.
3. Asymmetry calculated for thermal protected bombs.
4. Asymmetry calculated for full ITER.
5. Calculated for maximum pod weight.

Figure 16-1. Asymmetric Stores Calculation (Sheet 2)

WING TANK FUEL POUNDS	ASYMMETRY INCH-POUNDS
100	11,500
200	22,200
300	32,200
400	41,000
500	49,200
600	56,500
700	63,100
800	69,100
900	75,000
1,000	80,300
1,100	85,000
1,200	89,500
1,300	93,500
1,400	97,000
1,500	100,300
1,600	103,500
1,700	106,500
1,800	109,400
1,900	112,100
2,000	114,800
2,100	117,100
2,200	119,200
2,300	120,800
2,400	122,100

Figure 16-2. Asymmetric Fuel Calculations

CHAPTER 17

Emergency Egress

17.1 GROUND EGRESS

Rapid egress is essential after forced landing, ditching, runway overrun, or other ground emergencies. The fastest egress method is without the seat survival kit. On land, if the aircraft is burning, the extra time required to egress with the survival kit could cause serious injury or death. After egress, if practical, return to the aircraft and retrieve the survival kit.

If possibility of structural damage exists:

1. Emergency canopy shattering handle — PULL.

Note

- Before pulling the internal emergency canopy shattering handle, pull down the helmet visor (if time permits), close eyes and keep hands and body as far away as possible on the canopy.
- If aircraft is inverted, disconnect lap belt as last step.

To egress without survival kit:

2. Ejection Seat — SAFE.

Note

If unable to pull the ground safety handle to the up (SAFE) position, pulling the emergency restraint release handle will safe the ejection seat.

3. Fittings/connections — RELEASE.
4. EGRESS.

To egress with survival kit:

5. Emergency restraint release handle — PULL.
6. Fittings/connections — RELEASE (except lap restraint).
7. EGRESS.

17.2 DITCHING

Ditching the aircraft should be the pilots last choice. However, if the situation demands ditching, the following procedures should be observed.

17.2.1 Before Impact

1. Make radio distress call.
2. IFF — EMERGENCY.
3. External stores — JETTISON.

4. Landing gear — UP.
5. Flaps — AS REQUIRED.
6. Seat — MID-POSITION.
7. Emergency oxygen actuator — PULL.
8. Oxygen mask — TIGHTEN.
9. NVG — REMOVE (if in use).
10. Helmet visor — DOWN.
11. Shoulder harness — LOCKED AND TIGHT.
12. Lap belt — TIGHTEN.
13. If wingborne, land parallel to swell pattern. If jetborne, land into the wind.
14. Remain braced until shocks stop.

17.2.2 After Impact

1. Parachute riser release fitting — RELEASE.
2. Emergency restraint release handle — SQUEEZE, PULL UP AND AFT.
3. Close eyes and pull internal emergency canopy shattering handle.
4. Abandon aircraft.
5. Inflate life vest.
6. Raft release — PULL.
7. Oxygen mask — REMOVE.
8. Inflate raft and climb in.

WARNING

Do not eject under water.

Note

Canopy will implode at 8 to 12 feet under water.

Underwater egress will be complicated by:

a. Aircraft sink rate under water is 20 to 30 feet per second.

b. Automatic inflation of life preserver unit (LPU) will occur restricting movement.

17.3 EJECTION

Escape from the aircraft inflight and in some instances, from ground level or water should be made with the ejection seat (Figure 17-1). However, under water ejection is not recommended.

Study and analysis of escape techniques by means of the ejection seat reveals that:

1. During ejection seat development and testing the SJU-4/A was qualified for use by male aviators with nude weights from 136 to 213 pounds. Operation of the seat by personnel not within these parameters subjects the occupant to increased risk of injury.
2. Appreciable forces are exerted on the body when ejection is performed at airspeeds of 400 to 600 knots rendering escape more hazardous.
3. At speeds above 600 knots ejection is extremely hazardous because of excessive forces on the body.
4. When circumstances permit, slow the aircraft prior to ejection to reduce the forces exerted on the body.
5. Before AFC-449, because of the nature of the modes of operation of the seat, ejection near the transition area between modes 1 and 2 can result in high ejection forces. Ejection below 7,000 ±750 feet MSL at airspeeds between 180 and 260 KIAS (between 180 and 215 KIAS with IACC 658) increases the risk of injury.

WARNING

- The emergency restraint release handle should never be actuated before an ejection attempt.
- Should severe icing or damage occur causing the airspeed indicator to read either zero or an erroneous value, the ejection seat could function in the low speed (0.10 second) mode. If, at this time, the aircraft is actually above 180 knots and below 7,000 ±750 feet MSL, above 165 KIAS and below 7,000 ±100 feet MSL after AFC-449, the ejection forces on the body could be extreme and severe damage could occur to the main parachute. Thus, below 7,000 ±750 feet MSL, 7,000 ±100 feet MSL after AFC-449, with a faulty airspeed indication caused by icing or pitot systems damage, ejection must be made at airspeeds below 180 knots.
- Ejection near the transition area between modes 1 and 2 can result in high ejection forces. Ejection below 7,000 ±750 feet MSL at airspeeds between 180 and 260 KIAS (between 180 and 215 KIAS with IACC 658) increases the risk of injury.

17.3.1 Low Altitude Ejection

Low altitude ejection depends for its success on the observance of the sink rate, dive angle, bank angle, airspeed and altitude (AGL) limitations. See Figure 17-2 through 17-6 for minimum ejection altitudes for these parameters. The pilot must make the ultimate decision concerning the minimum safe altitude from which an ejection can be made in the prevailing conditions. Every effort must be made to initiate ejection before the aircraft has descended to the minimum safe altitude. Assuming that the aircraft is substantially straight and level, the ejection seat should provide safe escape as follows:

1. At zero and low airspeeds — ground level.
2. At airspeeds above 400 knots — 50 feet minimum AGL.

The optimal controlled ejection conditions before AFC-449, see Figure 17-7:

Mode 1: below 180 KIAS, straight and level, and greater than 2,000 feet AGL.

Mode 2: between 260 (215 AFTER IACC 658) and 400 KIAS, straight and level, and greater than 2,000 feet AGL.

The optimal controlled ejection conditions after AFC-449 are between 150 and 400 KIAS (trade airspeed for altitude).

17.3.1.1 Wingborne Flight

If the aircraft is controllable, and airspeed is not below approximately 150 knots, ejection from low altitude is facilitated by pulling the aircraft nose up and initiating a zoom maneuver before ejecting. This increases the ejection altitude and adds an upward component to seat velocity, thus allowing more time for man/seat separation and main parachute development than in the level flight case. Below approximately 150 knots (e.g., conventional landing approach) the zoom maneuver should not be attempted. If possible, and if time permits, any rate of descent should be reduced or arrested before ejection. Ejection must not be delayed when the aircraft is in a descending attitude from which it cannot be recovered.

17.3.1.2 Jetborne Flight

During low level flight, an engine or control failure demands an immediate ejection since critical sink rate, attitude and altitude conditions may prevent a successful ejection. Following engine/control failures, roll rates and pitch rates will quickly develop leading rapidly to an aircraft attitude from which successful ejection cannot be made; therefore, it is vital that ejection be initiated immediately after such a failure occurs.

WARNING

When circumstances demand an immediate ejection from low level, no attempt should be made to adjust aircraft attitude at the expense of further increase in sink rate and further altitude loss.

17.3.2 Ejection From Surface Level

At surface level, the ejection option exists as long as the seat and parachute harness remain fastened (occupant properly strapped in), the cockpit canopy remains closed and locked, and the aircraft is in a substantially upright attitude. Ejection must not be attempted unless each of these conditions is satisfied. It is stressed that following, say, a crash landing, where it is possible that damage to the canopy frame or front fuselage has occurred and where escape by ejection may be the best course, no attempt should be made to open the canopy. If such an attempt were made and resulted in the canopy jamming in a partially open position, the ejection option would be lost and manual egress from the cockpit might also be lost. On the other hand, manual use of the MDC does not invalidate the ejection option and does not prevent a subsequent manual escape. In such circumstances, the MDC must be used and the canopy must not be opened. Further, the occupant should not unstrap until it is evident that no danger is present which might prevent manual escape from the aircraft. In all circumstances, the pilot must make the ultimate decision as to whether ejection offers the best escape chance in the given conditions. If the seat fails to operate, manual escape is the only option. Refer to ground egress procedures, paragraph 17.1.

WARNING

If the aircraft is ditched (which should only be attempted if the ejection seat fails to provide escape from the airborne aircraft), a manual escape from the cockpit must be made. Refer to ditching procedures, paragraph 17.2. Consideration is given here only to escape by ejection from emergency circumstances during shipborne or water platform type operations.

Escape from circumstances which result, or may result, in the aircraft entering the water should be made by ejecting. Every effort must be made to initiate the ejection before impact with the surface.

17.3.3 High Altitude Ejection

For a high altitude ejection, the basic low level ejection procedure is applicable. Furthermore, the zoom up maneuver is still useful to slow the aircraft to a safer ejection speed or provide more time and glide distance as long as an immediate ejection is not mandatory. If the aircraft is descending uncontrolled as a result of a mid-air collision, control failure, spin, or any other reason, abandon the aircraft at a minimum altitude of 10,000 feet above the terrain if possible. If it is decided to abandon the aircraft while still in controlled flight at altitude, the pilot should abandon the aircraft at a minimum altitude of 2,000 feet above the terrain.

17.4 PARACHUTE DESCENT PROCEDURES

If the emergency oxygen is not activated during ejection, it can be activated by pulling the emergency oxygen actuator on the inside of the left thigh support.

1. Parachute condition — CHECK.
2. I — Inflate (LPU).
3. R — Release (raft).
4. O — Options (time permitting).
   a. Visor.
   b. Oxygen.
   c. Waist lobes.
   d. Gloves.
   e. Four-line release (with ACC-667 PART 2).
5. K — Koch fittings (release upon water entry).

After Water Entry:

6. A — Avoid parachute.
7. D — Disentangle.
8. R — Retrieve raft.

17.5 A/P22P-14(V)3 CHEMICAL, BIOLOGICAL, RADIOLOGICAL PROTECTIVE RESPIRATOR ASSEMBLY EMERGENCY PROCEDURES

The A/P22P-14(V)3 (OBOGS aircraft) respirator assembly (see Figure 17-8) is authorized to be worn by all T/AV-8B aircrew for protection against the elements of CBR warfare. For general information, donning and doffing, and routine usage, refer to Aviation Crew Systems Manual, NAVAIR 13-1-6.10, Special Mission Aircrew Equipment.

17.5.1 Emergency Egress On Land

1. Pusher fan — CONFIRM RUNNING.
2. If pusher fan is not operating hood outlet valve (Figure 17-9) — CLOSE.

Note

If in contaminated environment, CBR protection will be maintained, but the faceplate may fog and prevent wearer from seeing anything.

PREPARATION FOR EJECTION

IMMEDIATE EJECTION

Usually, the pilot will have enough time to accomplish several things to prepare himself for a successful ejection prior to pulling the ejection handle (see controlled ejection). However, when the emergency situation requires, ejection must be made without hesitation, ensure proper body position, grasp the ejection handle and pull until seat ejects.

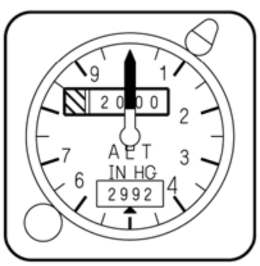
CONTROLLED EJECTION

Time permitting, do the following:

1. Night Vision Goggles - REMOVE FROM HELMET AND STOW
2. Visor - DOWN
3. Oxygen mask - TIGHTEN
4. All loose equipment - STOW
5. Airspeed - Before AFC-449:
   MODE 1: BELOW 180 KIAS, STRAIGHT AND LEVEL
   MODE 2: BETWEEN 260 (215 WITH IACC 658) AND 400 KIAS, STRAIGHT AND LEVEL

   Airspeed - After AFC-449:
   BETWEEN 150 AND 400 KIAS (TRADE AIRSPEED FOR ALTITUDE)

   Altitude - GREATER THAN 2,000 FEET AGL
6. IFF - SELECT EMERGENCY
7. MAYDAY position report - TRANSMIT
8. Shoulder harness lock lever - LOCK



9. Altimeter - CHECK

   NOTE

   Over 14,000 feet, calculate free fall time to automatic parachute opening altitude. (5 seconds per 1,000 feet)
10. Proper ejection body position - ASSUME
11. INITIATE EJECTION

EJECTION POSITION

NOTE

Proper body positioning is a critical factor in preventing ejection injuries.

1. Helmet secured.
2. Lap and shoulder restraints tightened.
3. Head pressed back against headrest.
4. Chin slightly elevated (10 ° up).
5. Back straight.
6. Hips against seat back.
7. Thighs flat on seat survival kit.
8. Feet against rudder pedals, heels in cups.

WARNING

Positioning the legs aft prior to ejection will cause the spine to flex and will increase the possibility of spinal injury.

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Figure 17-1. Ejection Procedures (Sheet 1 of 9)

EJECTION INITIATION

The recommended method for ejection initiation is depicted below.

1. During any combined low altitude/low airspeed situation, continue to fly the aircraft with the right hand, keeping wings level and maintaining altitude or the lowest possible sink rate, while initiating ejection sequence with the left hand.

During an uncontrolled ejection, when maintaining aircraft attitude is impossible, it is recommended that both hands be used to initiate ejection.

METHOD 1

Grip the ejection handle with the thumb and at least two fingers of each hand, palms toward body and elbows close to body.

METHOD 2

Grip handle with strong hand palms inward. Grip wrist of strong hand with other hand, palms toward body and elbows close to body

2. Pull handle sharply up and toward abdomen, keeping elbows in until handle reaches end of travel.

WARNING

Ejection must not be attempted unless the canopy is closed. Any attempt to eject while the canopy is partly or fully open will result in the collision of the seat/occupant and the canopy arch.

After ejection handle is pulled:

a. Canopy detonates.

b. The power retract mechanism on the inertia reel activates, pulling the shoulder restraint system taut.

c. Emergency oxygen and radio beacon set are automatically actuated.

d. One of the four modes of ejection seat operation is automatically selected and actuated.

e. Positive parachute deployment and man/seat separation are automatically provided.

f. Continue holding ejection handle until man/seat separation at which time the handle will remain attached to the seat.

NOTE

See Chapter 2 for details of ejection seat mechanical operation.

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Figure 17-1. Ejection Procedures (Sheet 2)

AUTOMATIC MAN/SEAT SEPARATION

Post ejection automatic sequencing is activated as part of the pitot-static system. The ejection seat is capable of four modes of operation, depending on ejection airspeed and altitude.

MODE 1 – Low Altitude/Low Airspeed
(below 225 knots and below 7,000 feet)
(below 165 knots depending on altitude and below 7,000 feet after AFC-449, see figure 2-26a)

MODE 2 – Low Altitude/High Airspeed
(above 225 knots and below 7,000 feet)
(above 180 knots and below 7,000 feet with IACC 658)
(above 122 knots depending on altitude and below 7,000 feet after AFC-449, see figure 2-26a)

MODE 3 – Intermediate Altitude
(above 7,000 feet and below 14,000 feet)

MODE 4 – High Altitude
(above 14,000 feet)

NOTE

See Ejection Sequences, Chapter 2, for mechanical sequencing of ejection procedure.

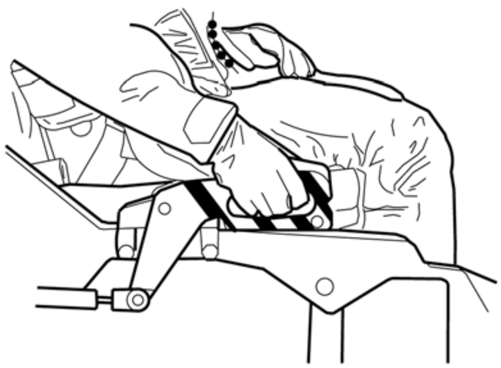
If after ejection from the aircraft and below 14,000 and automatic man/seat separation has not occurred, manual man/seat separation procedures must be performed.

WARNING

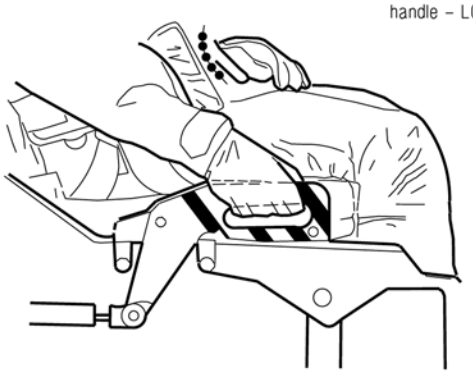
It is recommended that manual seat separation not be utilized at altitudes above 14,000 feet.

MANUAL MAN/SEAT SEPARATION

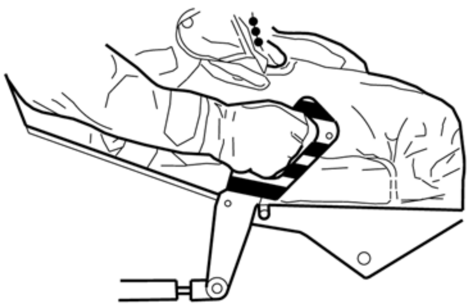
Perform the following procedures to effect man/seat separation:



1. Emergency restraint release handle – LOCATE



2. Emergency restraint release handle trigger – SQUEEZE



3. Emergency restraint release handle – PULL

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Figure 17-1. Ejection Procedures (Sheet 3)

PARACHUTE DESCENT PROCEDURES

*1. Parachute condition – CHECK

*2. I – Inflate (LPU)

*3. R – Release (raft)

*4. O – Options (time permitting)

a. visor

b. oxygen

c. waist lobes

d. gloves

e. four-line release
(with ACC-667 PART 2)

*5. K – Koch fittings
(release upon water entry)

After water entry

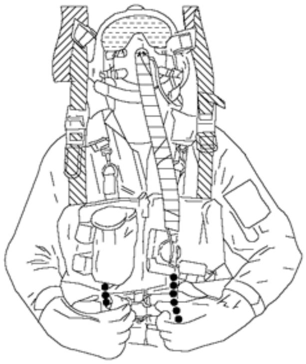
*6. A – Avoid parachute

*7. D – Disentangle

*8. R – Retrieve raft

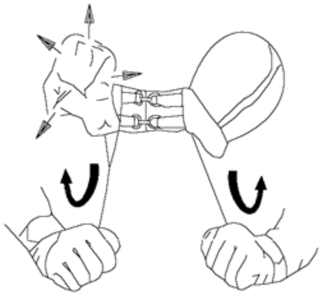
LPU INFLATION

1. Locate and pull LPU beaded handles down and straight out to inflate. If beaded handle inflation fails, use oral inflation tube located on right waist lobe.



WARNING

Although the FLU-8 automatic inflation device is designed to inflate the LPU upon water contact, manual operation 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.



NOTE

The procedures outlined apply to over land or over water ejections. However, inflation of the LPU may be undesirable over land.

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Figure 17-1. Ejection Procedures (Sheet 4)

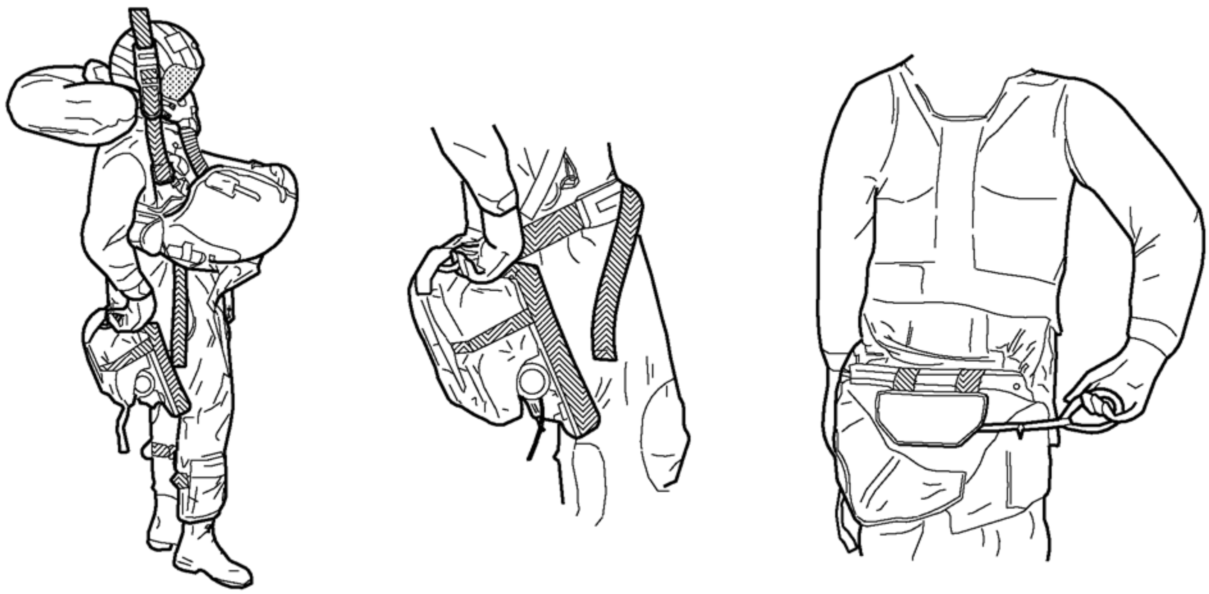
RAFT/SEAT KIT DEPLOYMENT

WARNING

Deploying the seat kit is not recommended over land.

NOTE:

If the seat kit is deployed after water entry, a snatch pull on the dropline near the CO_2 bottle is required to inflate the life raft.



1. After inflating the LPU, prepare to deploy the seat kit.
2. With right hand, locate the raft release handle on the right side of seat kit.
3. Pull outwards on the raft release handle until the seat kit is deployed.

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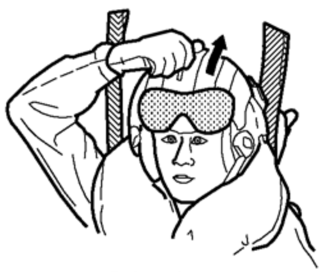
Figure 17-1. Ejection Procedures (Sheet 5)

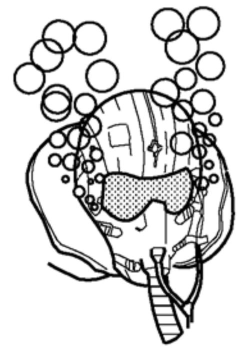
OPTIONS

If time permits, the following options may be accomplished in any order deemed appropriate.



Raise visor.

Remove oxygen mask. Oxygen mask/hose assembly may be disconnected from seat kit and discarded, if desired.



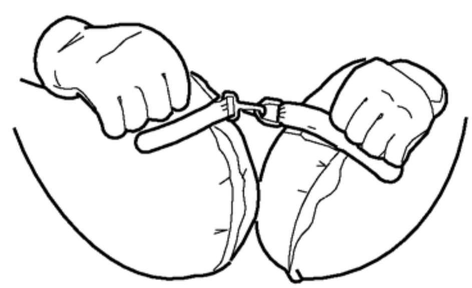
NOTE

The MBU series oxygen mask provides underwater breathing capabilities and should be retained in low level over water ejections.

Remove gloves.

NOTE

- Removal of gloves may facilitate subsequent release of parachute release fittings.
- Stow gloves in a secure place to prevent loss.



Snap lobes.

NOTE

Failure to snap waist lobes before water entry may result in face down floatation.

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Figure 17-1. Ejection Procedures (Sheet 6)

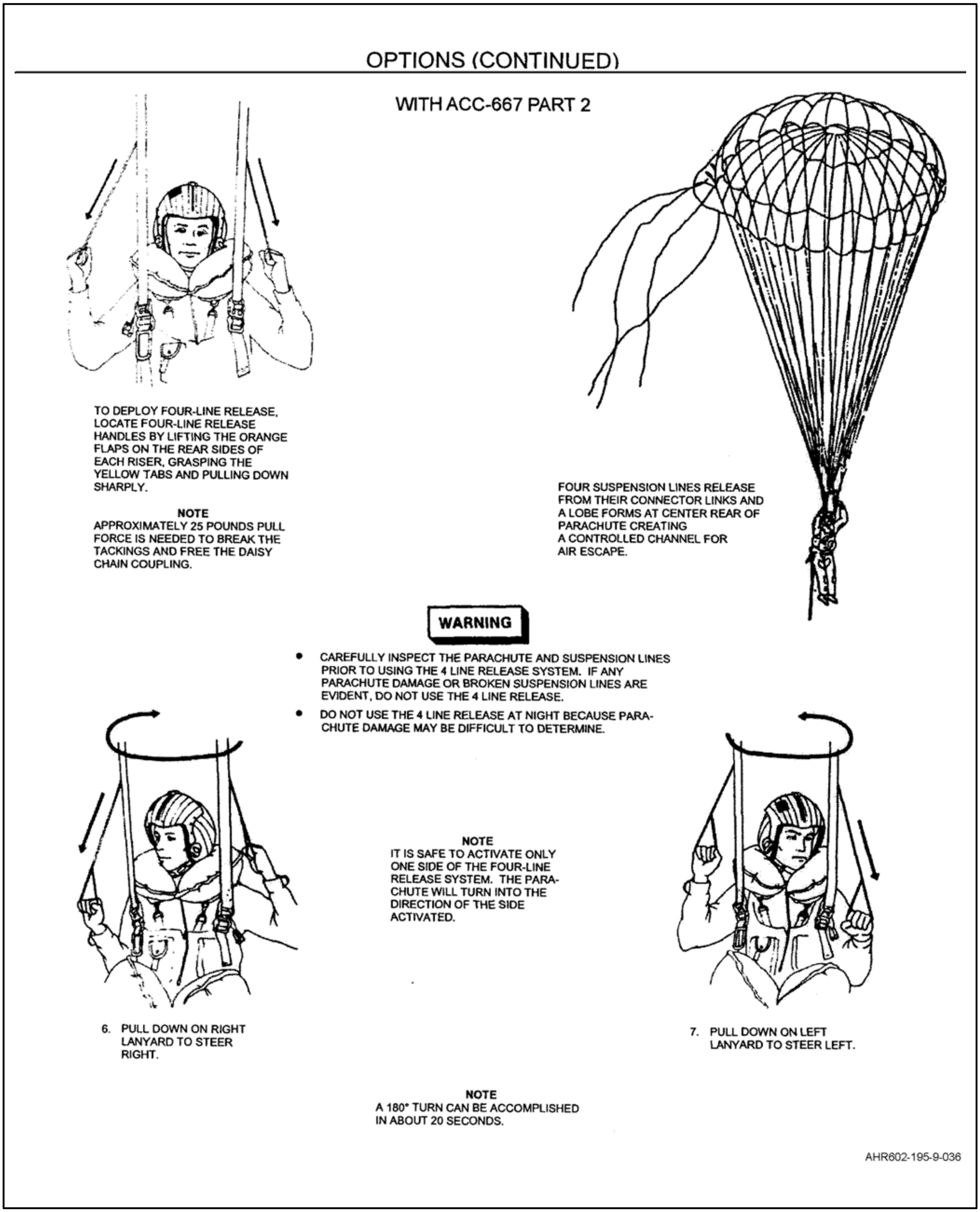

Figure 17-1. Ejection Procedures (Sheet 7)

LANDING PREPARATION

LANDING PROCEDURES

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.

1. Assume proper body position.
   a. Feet and knees together.
   b. Knees slightly bent.
   c. Toes pointed slightly downward.
   d. Eyes on the horizon.
   e. Firmly grasp parachute release fittings
   f. Tuck elbows in prior to water entry.
2. Release Koch fittings –
   Release upon water entry (over water).

WARNING

Do not disconnect Koch fittings until after contact with water.

3. PLF – Perform (over land).

TREE LANDING PROCEDURES

Perform the same procedures as for over water landing, but with the following exceptions:

1. Visor – down.
2. Gloves – on.
3. DO NOT deploy seat kit.

NOTE

- Turning the parachute into the wind counteracts the prevailing wind to some degree and reduces chances of tree landing injury.
- Be prepared to execute a parachute landing fall (PLF) if entanglement does not occur.

4. 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 downward.
   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.

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Figure 17-1. Ejection Procedures (Sheet 8)

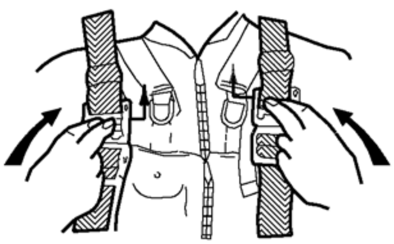
KOCH FITTING RELEASE

NOTE

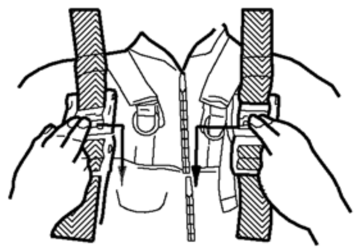
With SEAWARS installed the parachute fittings release automatically upon emersion in salt water.

WARNING

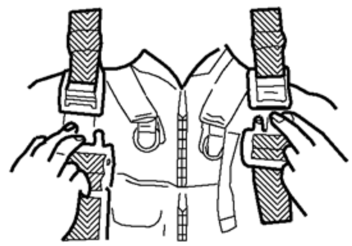
Do not disconnect Koch fittings until after contact with ground or water.



1. Push up on Koch fitting release cover.



2. Pull down on Koch fitting release lever.



3. Parachute released.

A – AVOID PARACHUTE, AFTER WATER ENTRY

1. Immediately look for canopy and face it.
2. Back away, sculling with hands only.
3. Minimize leg movement to reduce possibility of entanglement.

D – DISENTANGLE

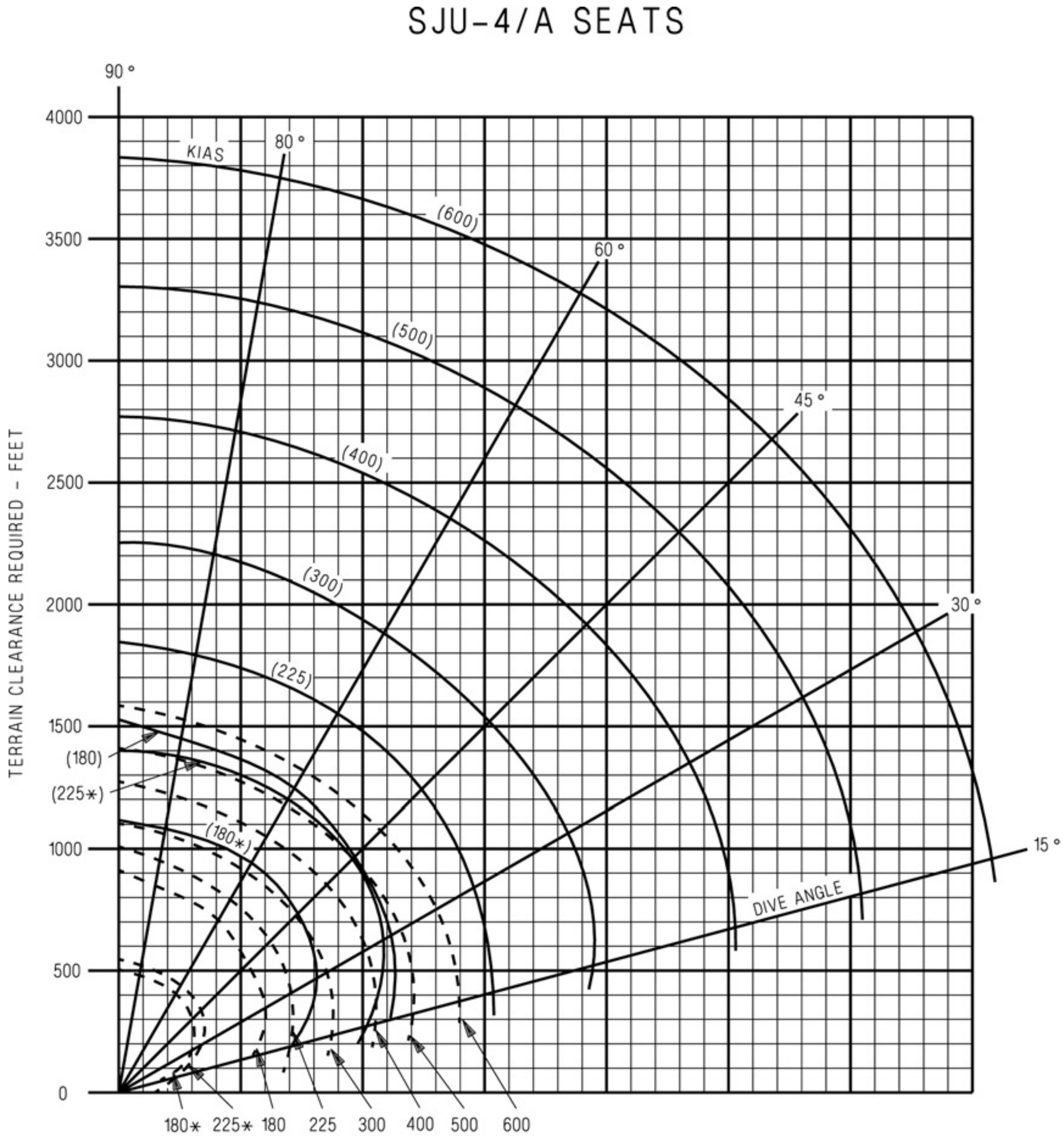
1. Release upper Koch fittings.
2. If the canopy lands on top of you, reach up with both hands, push up and pull the canopy from "back to front". Continue pulling canopy until it is all in front of you.
3. All movements must be slow and deliberate. Do not kick feet. Scull away facing parachute.
4. Back away from chute, keep the chute in front of you, where you can see it.
5. As you back away, free the suspension lines that may be caught on your equipment.

R – RETRIEVE RAFT

1. Inflate life raft if necessary.
2. Locate retaining lanyard and attach it to D-ring.

AV8BB-NFM-00-(195-8)23-51-CATI

Figure 17-1. Ejection Procedures (Sheet 9)



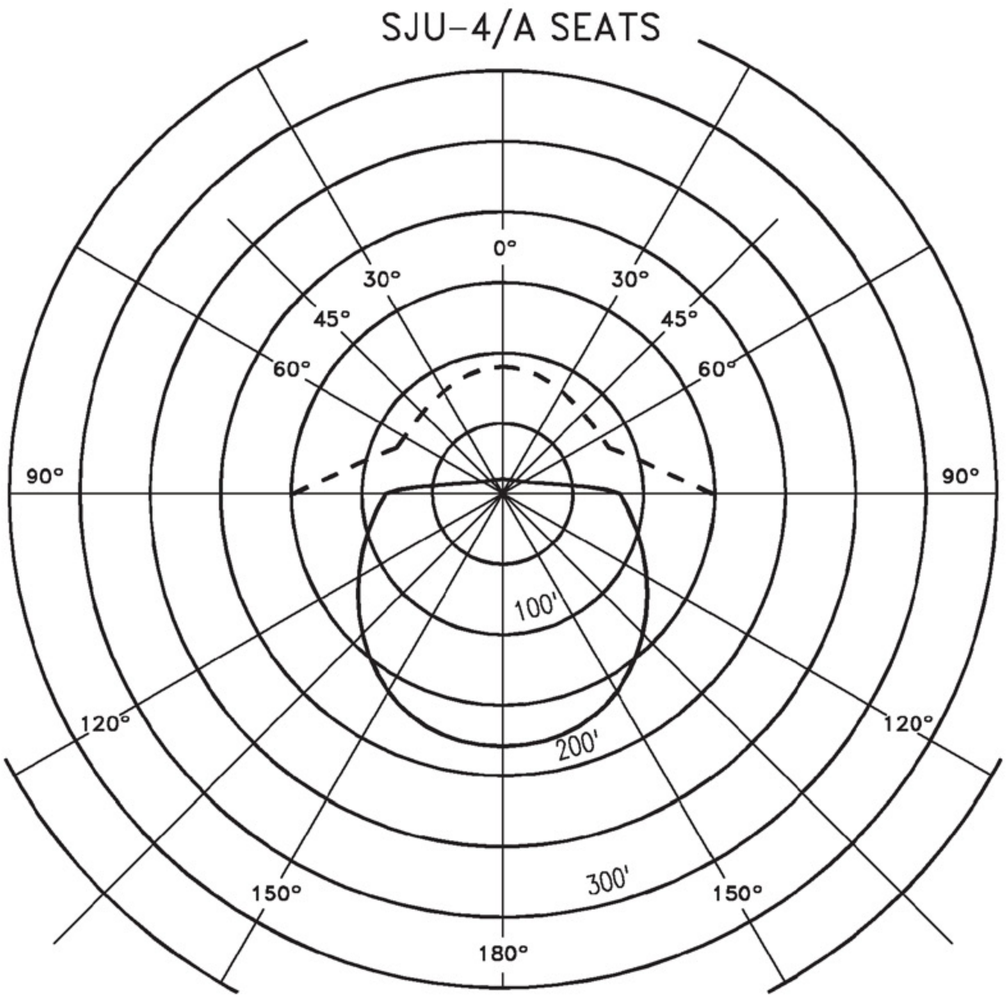
∗ LOW SPEED MODE. TRANSITION POINT IS 225 ±20 KIAS (180 ±20 KIAS WITH IACC 658), (BETWEEN 122 ±5 and 165 ±5 KIAS DEPENDING ON ALTITUDE AFTER AFC-449, SEE FIGURE 2-26A).

NOTES

- The altitudes shown by solid lines allow a pilot reaction time of 2 seconds.
- The altitudes shown by dashed lines are based on ejection seat sequence time only, and are included for reference only.
- Wings level and 0° angle of attack. Terrain clearance required is based on 5000 foot terrain and is conservative for lower terrain.

AHR602-320-1-032

Figure 17-2. Minimum Ejection Altitude vs Airspeed and Dive Angle, AV-8B



NOTES

- Nose level and 0° angle of attack.
- Dashed line represnts minimum altitudes for conditions 1 thru 4 with a 2-second pilot reaction time.
- Solid lines represent minimum altitudes for conditions 1 thru 4 without pilot reaction time, or minimum altitudes for conditions 5 thru 7 with or without pilot reaction time.

CONDITION	ATTITUDE	DESCENT RATE (fpm)	AIRSPEED (KIAS)
1	WINGS AND NOSE LEVEL	2400	100
2	30° BANK AND NOSE LEVEL	2000	50
3	45° BANK AND NOSE LEVEL	2000	100
4	90° BANK AND NOSE LEVEL	2000	100
5	120° BANK AND NOSE LEVEL	0	130
6	150° BANK AND NOSE LEVEL	0	130
7	180° BANK AND NOSE LEVEL	0	130

AV8BB-NFM-00-(321-1)20-CATI

Figure 17-3. Minimum Ejection Altitude (Terrain Clearance) vs Aircraft Attitudes, AV-8B

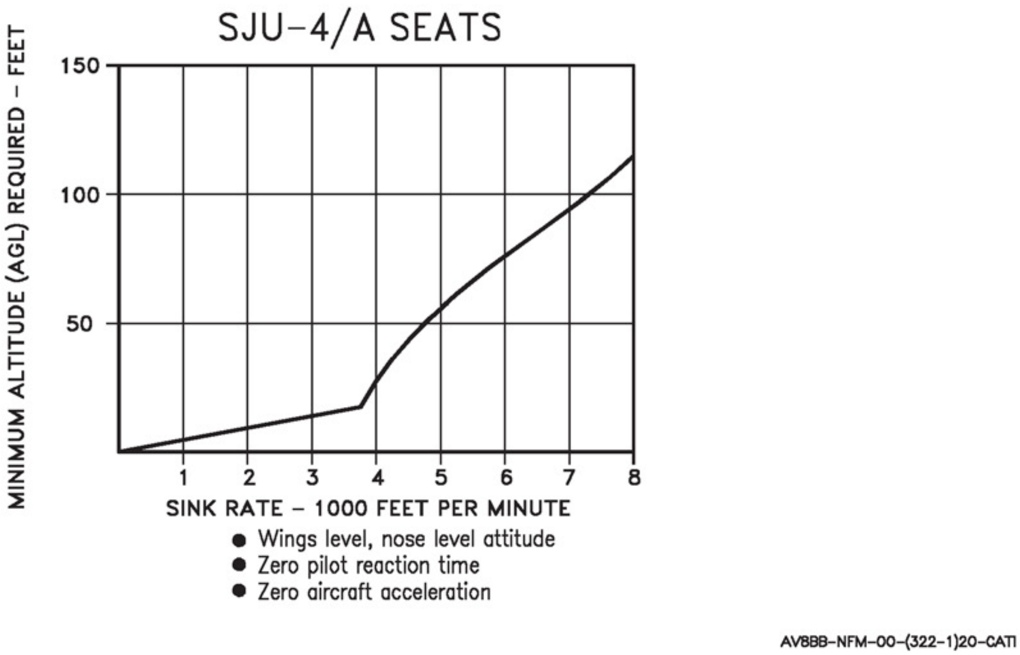


Figure 17-4. Minimum Ejection Altitude vs Sink Rate at Zero Forward Airspeed, AV–8B

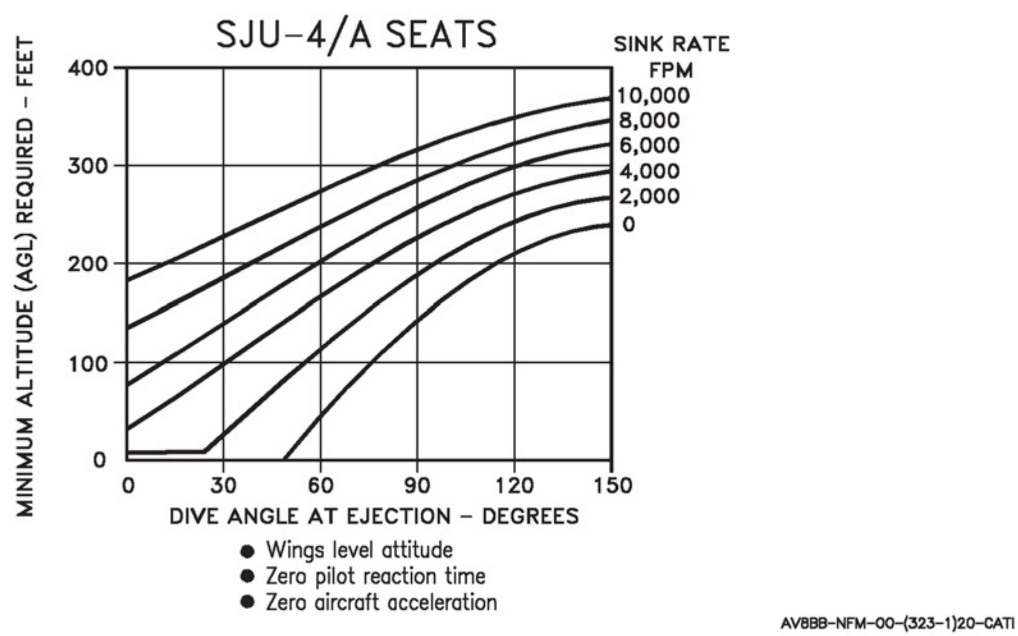


Figure 17-5. Minimum Ejection Altitude vs Dive Angle for Sink Rate at Zero Forward Airspeed, AV–8B

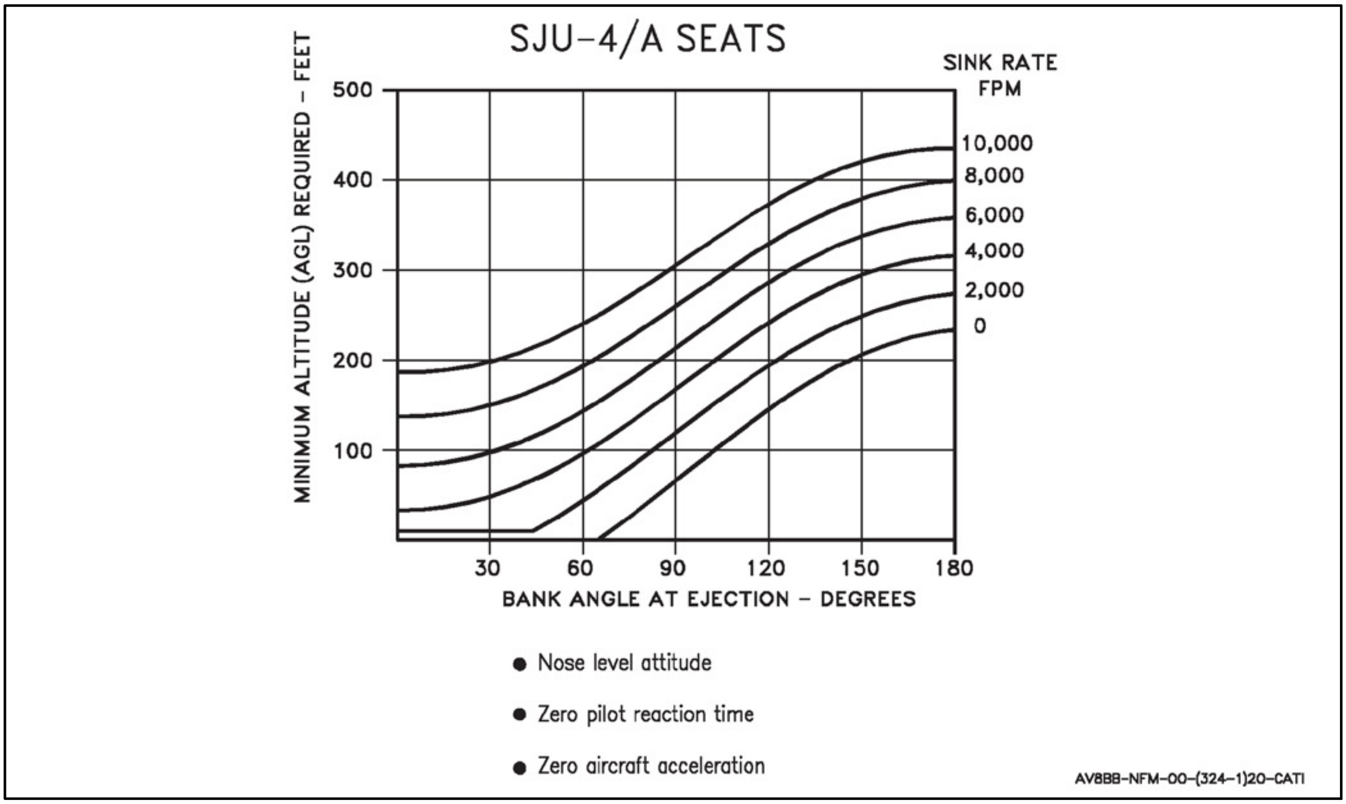


Figure 17-6. Minimum Ejection Altitude vs Bank Angle for Sink Rate at Zero Forward Airspeed, AV-8B

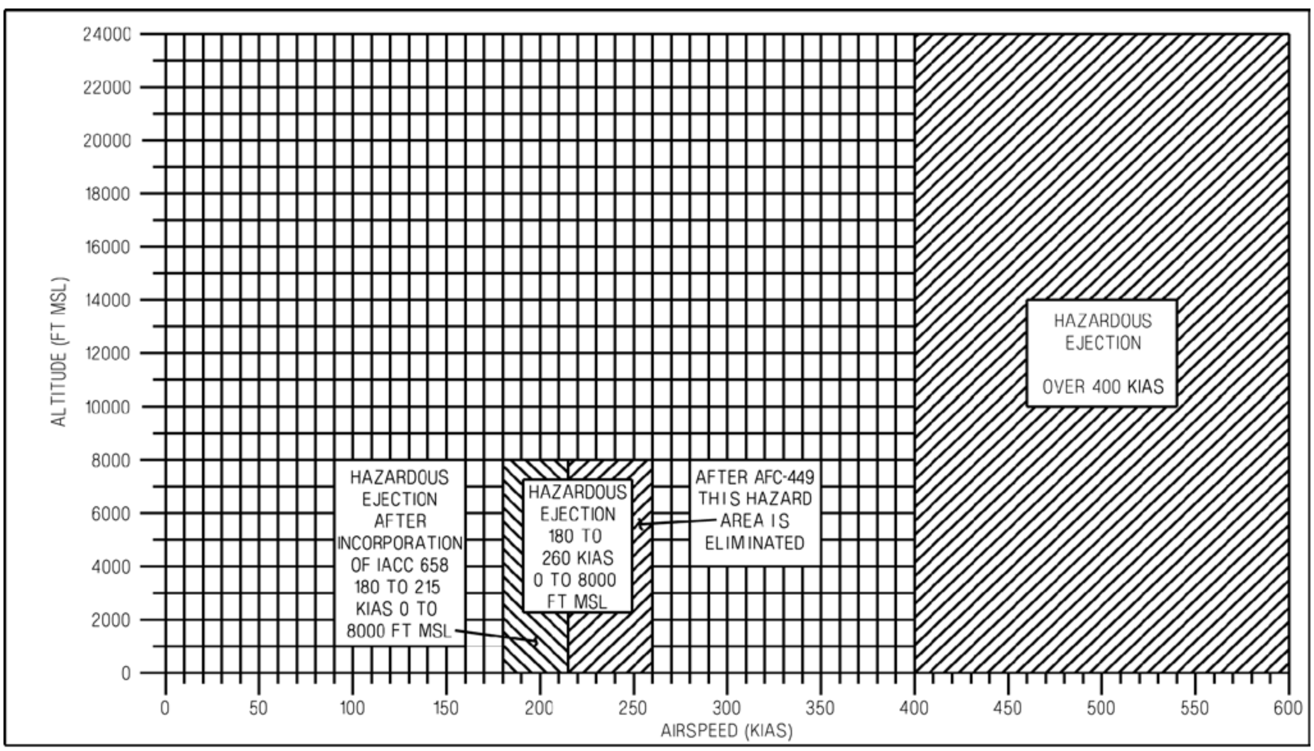


Figure 17-7. Optimal Controlled Ejection Conditions

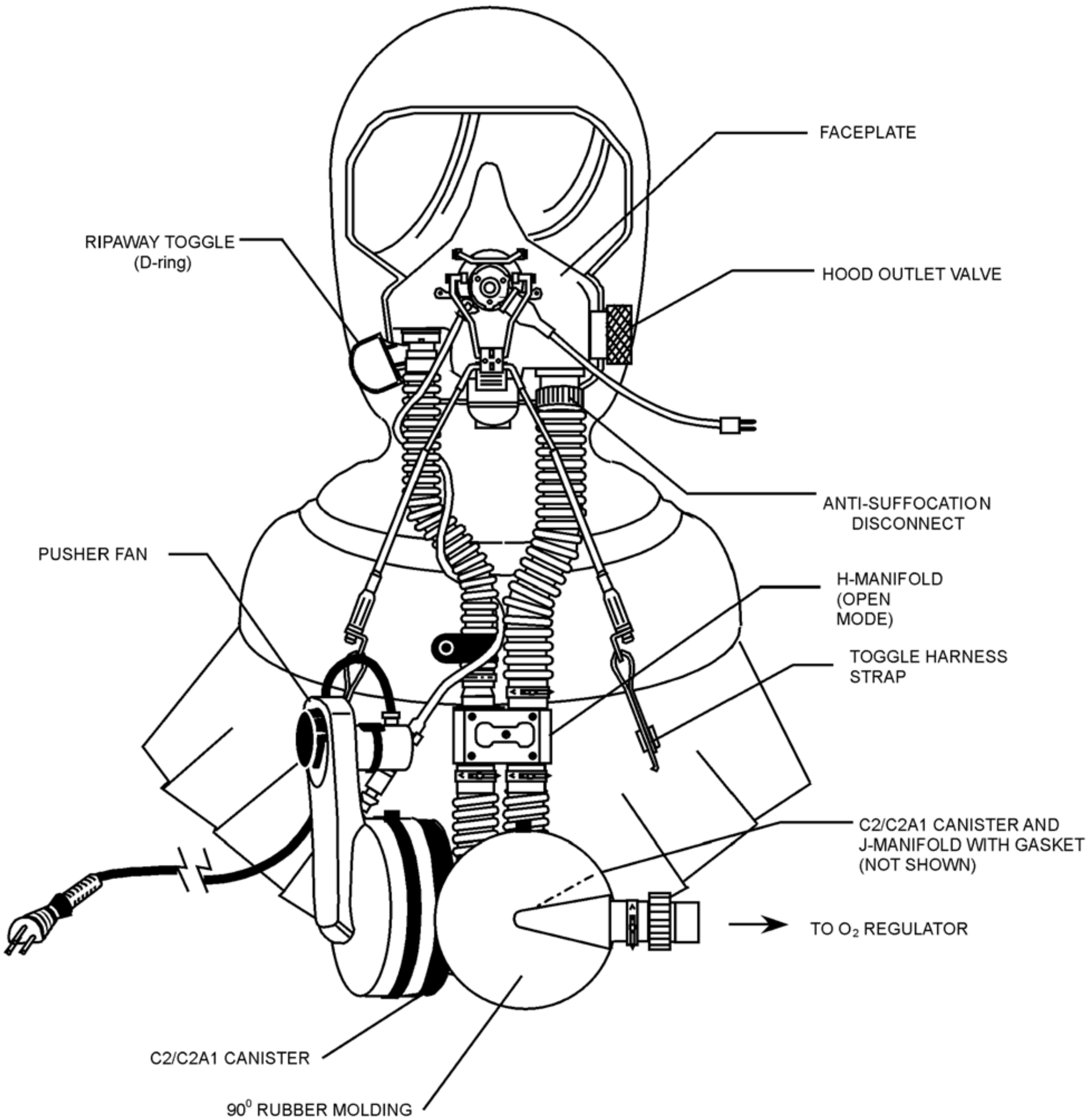


Figure 17-8. A/P22P–14(V)3 Respirator Assembly

17.5.2 Ejection Over Land (In a Non-Contaminated Environment) During the Option Phase of Parachute Descent

1. Helmet visor — RAISE.

Note

If insufficient time to activate ripaway facility proceed to step 3.

2. Mask — RIPAWAY (Figure 17-10).

WARNING

CBR protection will be lost.

a. Locate and grasp ripaway D-ring.

b. Pull D-ring until hood rips and tab ribbon separates from hood.

c. Unsnap right-side toggle harness strap only.

WARNING

Unsnapping both toggle harness straps will allow the faceplate to fall and suspend from the hood and mask hoses resulting in a snag hazard.

d. Rip faceplate away from face.

If Unable To Perform Ripaway:

3. Anti-suffocation disconnect (Figure 17-11) — LOCATE AND DISCONNECT BY TWISTING AND PULLING DOWN.

17.5.3 Ejection Over Land (In a Contaminated Environment) During the Option Phase of Parachute Descent

1. H-Manifold switch (Figure 17-12) — OPEN (Horizontal).
2. Pusher fan — CONFIRM RUNNING.

Note

The pusher fan will provide filtered ventilation and lens de-misting to the respirator assembly hood compartment and filtered air to the orinasal mask.

If pusher fan is not running:

3. Hood outlet valve (Figure 17-9) — CLOSE IMMEDIATELY (Pull out on DISC, twist and release).

Note

CBR protection will be maintained, but the faceplate may fog and prevent wearer from seeing anything.

17.5.4 Ejection Over Water (In Either Contaminated or Non-Contaminated Environment) During Option Phase of Parachute Descent

WARNING

Upon entering water, filter canisters will become blocked and not pass air or water into the mask.

1. Helmet visor — RAISE.
2. Mask — RIPAWAY (Figure 17-10).

WARNING

CBR protection will be lost.

   a. Locate and grasp ripaway D-ring.
   b. Pull D-ring until hood rips and tab ribbon separates from hood.
   c. Unsnap right-side toggle harness strap only.

WARNING

Unsnapping both toggle harness straps will allow the faceplate to fall and suspend from the hood and mask hoses resulting in a snag hazard.

   d. Rip faceplate away from face.

IF Unable to perform ripaway:

3. Anti-suffocation disconnect (Figure 17-11) — LOCATE AND DISCONNECT BY TWISTING AND PULLING DOWN.

After Contact With Water:

WARNING

Contact with water may have forced water through the mask inlet adapter into the orinasal mask.

4. If the anti-suffocation disconnect was activated, before taking a breath, forcibly exhale to blow water out of the mask.

17.5.5 Pusher Fan Malfunction

1. H-Manifold switch — OPEN (Horizontal) (Figure 17-12).

Note

Demand on the OBOGS oxygen supply will be twice the normal amount.

2. Battery switch — CONFIRM ON.
3. Power cord — CONFIRM SECURELY PLUGGED IN.

If pusher fan still not operating:

4. Battery — REPLACE.

If pusher fan operation is restored:

5. H-Manifold switch — CLOSED (Vertical).

17.5.6 Airsickness

If Airsick and Vomiting - Into Mask:

1. Release the helmet chin strap and toggle harness adapter straps.
2. Pull orinasal mask away from face.

Note

CBR protection will still be maintained.

3. Allow the vomit to collect in the respirator assembly neck dam.
4. Reconnect the helmet chin strap and toggle harness adapter straps.

In The Event of Extreme Airsickness:

5. Helmet visor — RAISE.
6. Mask — RIPAWAY (Figure 17-10).

WARNING

CBR protection will be lost.

a. Locate and grasp ripaway D-ring.
b. Pull D-ring until hood rips and tab ribbon separates from hood.
c. Unsnap right-side toggle harness strap only.

WARNING

Unsnapping both toggle harness straps will allow the faceplate to fall and suspend from the hood and mask hose resulting in a snag hazard.

d. Rip faceplate away from face.

17.5.7 OBOGS Failure

1. H-Manifold switch — OPEN (Horizontal) (Figure 17-12).
2. Immediately descend below 10,000 feet cockpit altitude.

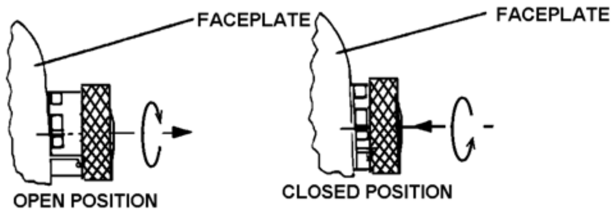


Figure 17-9. Hood Outlet Valve

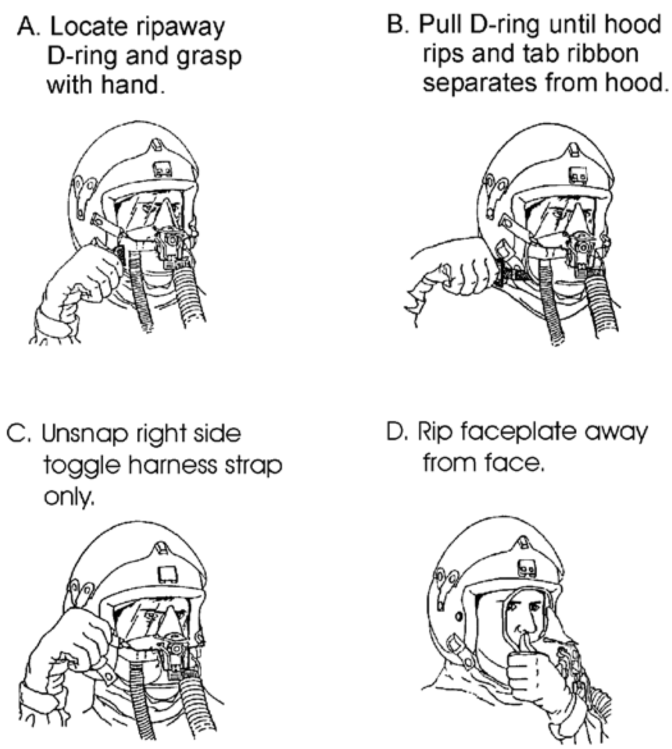


Figure 17-10. Orinasal Mask Ripaway Procedures

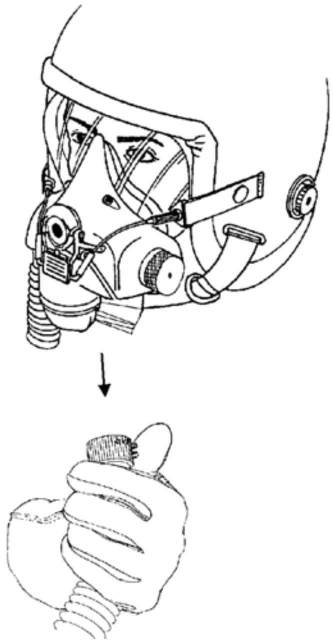


Figure 17-11. Anti-Suffocation Disconnect

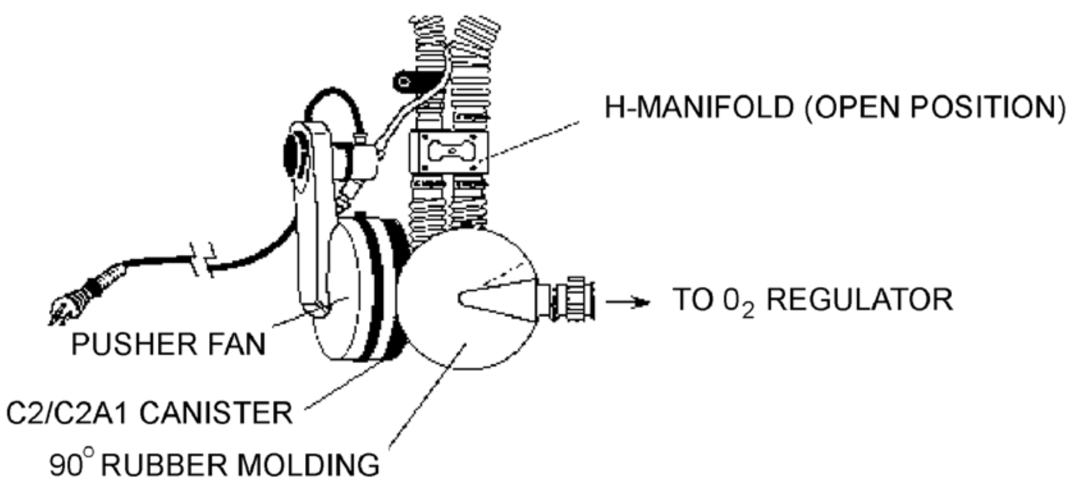


Figure 17-12. H-Manifold Switch

CHAPTER 18

Immediate Action Items

This chapter contains only immediate action items. It is intended for review only and does not contain any steps which are not immediate action nor does it contain notes, cautions, warnings, or explanatory matter associated with particular procedures.

18.1 ABNORMAL START

If the JPT rises rapidly between 350° and 400° (hot start), or if rpm stabilizes below idle (hung start), or if engine does not light off within 10 seconds after selecting idle (wet start):

*1. Throttle — OFF.

If wet start:

*2. Engine start switch — OFF.

18.2 LOSS OF ENGINE CONTROL ON GROUND

If engine RPM-JPT indications on EDP freeze at approximately 22 percent or display an abnormal indication during start, or if the voltmeter drops to zero when the DC test switch is set to STBY during standby TRU check, or during any undemanded engine acceleration:

*1. Throttle — OFF.

*2. Fuel shutoff handle — OFF.

18.3 EMERGENCY SHUTDOWN

*1. Throttle — OFF.

*2. Fuel shutoff handle — OFF.

*3. Engine start switch — OFF.

*4. APU GEN — OFF.

*5. Battery switch — OFF.

18.4 NWS CAUTION LIGHT (AFTER AFC-391)

TAKEOFF/LANDING ROLL OUT:

*1. Attempt to get airborne.

If unable to get airborne:

*2. Engage NWS button at minimum practical groundspeed.

18.5 BRAKE FAILURE/SKID CAUTION LIGHT

On ground:

*1. ANTISKID switch — NWS.

18.6 ABORT

18.6.1 Ashore (CTO or STO)

*1. Throttle — IDLE.

*2. Nozzles — BRAKING STOP.

*3. Throttle — AS REQUIRED.

*4. Brakes — AS REQUIRED.

18.6.2 Afloat

*1. Throttle — OFF.

*2. Brakes — FULL.

18.7 NO LIFTOFF ON STO ASHORE

*1. Nozzles — AFT.

*2. Increase speed 20 knots.

*3. Nozzles — STO STOP.

18.8 OVER ROTATION ON STO

*1. Stick — FULL FORWARD.

*2. Nozzles — REDUCE 20 DEGREES.

*3. Nozzles — STO STOP.

18.9 RPM STAGNATION/LOSS OF THRUST AFLOAT

If decision is made not to abort:

*1. MFS — SELECT.

*2. STO at nozzle rotation line.

*3. Stores — JETTISON (if required).

*4. Water switch — OFF.

18.10 L/R TANK WARNING LIGHT

18.10.1 During Air Refueling

*1. Break away.

18.10.2 During Hot Refueling

*1. Throttle — OFF.

18.11 FIRE

18.11.1 Ground Fire (Engine, GTS/APU, Brake)

*1. Execute Emergency Shutdown.

18.11.2 Takeoff/Landing/Vertical Operation

*1. Abort or land immediately.

*2. Execute Emergency Shutdown.

18.11.3 Inflight

*1. Nozzles — AFT AS SOON AS POSSIBLE.

*2. APU GEN — OFF.

*3. Master arm/gun — OFF.

*4. Throttle — MINIMUM REQUIRED.

If fire persists:

*5. EJECT.

18.12 OIL CAUTION LIGHT

*1. Throttle — MAINTAIN CONSTANT RPM.

a. 75 percent - 85 percent RPM (-406 engine).

b. 80 percent - 85 percent RPM (-408 engine).

18.13 DUAL DECS FAILURE (EFC WARNING LIGHT)

In V/STOL Flight (Takeoff/Approach/Landing) Time Critical:

*1. MFS — SELECT.

*2. Water switch — OFF.

In Conventional Flight:

*1. Throttle — IDLE.

*2. MFS — SELECT.

*3. Throttle — ADVANCE SLOWLY.

If unable to select MFS and sufficient power not available:

*4. EFC switch — CHANGE LANE.

18.14 LOSS OF ENGINE CONTROL INFLIGHT

In Conventional Flight:

*1. Menu - Engine - IGVs — MONITOR.

*2. Throttle — SLOWLY REDUCE TO IDLE.

If IGV failure indicated (stuck IGVs or wandering with constant throttle position):

*3. Execute IGV failure procedures.

If IGV failure not indicated:

*4. MFS — SELECT.

18.15 COMPRESSOR STALL

*1. Throttle — IDLE.

*2. AOA — REDUCE TO LEVEL FLIGHT AOA.

If JPT continues to rise; before 590 °C:

*3. Throttle — OFF.

18.16 AIRSTART

*1. Nozzles — AFT.

*2. Stores — JETTISON (if required).

*3. Throttle — OFF.

*4. Emergency oxygen actuator — PULL.

*5. MFS — AS REQUIRED.

*6. Airstart button — PRESS AND HOLD.

*7. Throttle — ADVANCE SLOWLY TO IDLE.

*8. JPT — MONITOR (475 °C MAX).

18.17 FLIGHT CONTROL MALFUNCTION

*1. Paddle switch — PRESS AND HOLD.

If condition not cleared (possible jammed flight controls):

*2. Transition to conventional flight as soon as possible.

18.18 REACTION CONTROL FAILURE

*1. Transition to conventional flight.

18.19 FLAP WARNING/UNCOMMANDED FLAP MOTION/UNCOMMANDED NOSE DOWN PITCH

*1. Nozzles — 40 DEGREES OR GREATER.

18.20 OUT-OF-CONTROL

18.20.1 Jetborne/Semi-Jetborne Out-of-Control Recovery

*1. Stick — FORWARD.

*2. Throttle — FULL.

*3. Stick — AGAINST ROLL.

*4. Rudder — AGAINST SIDESLIP.

If AOA not recovered and time and altitude permit:

*5. Nozzles — REDUCE 20 DEGREES.

When AOA recovered:

*6. Nozzles — AS REQUIRED.

SEE IC # 37

18.20.2 Out-of-Control/Spin/Falling Leaf Recovery

*1. Controls — NEUTRAL.

*2. Throttle — IDLE/OFF IF COMPRESSOR LOCKED IN STALL.

*3. Nozzles aft.

If spin positively confirmed after 2 turns with neutral controls:

*4. Rudder — FULL OPPOSITE SPIN DIRECTION.

*5. Aileron — FULL WITH SPIN IF UPRIGHT/NEUTRAL IF INVERTED.

If Falling Leaf positively confirmed after 5 seconds with neutral controls (TAV-8B and Radar aircraft only):

*6. Stick — FULL FORWARD.

When recovered:

*7. Initiate Airstart (if required).

*8. Nozzles aft.

If still out of control below 10,000 feet AGL:

*9. EJECT.

18.21 EMERGENCY DC BUS FAILURE

If above 10,000 feet cabin pressure.

*1. Emergency oxygen actuator — PULL.

*2. Descend below 10,000 feet cabin pressure.

With emergency oxygen activated or below 10,000 feet cabin pressure:

*3. DC test switch — SET TO STBY.

If power is not regained:

*4. DC test switch — SET TO MAIN.

18.22 CANOPY EXPLOSION INFLIGHT

*1. Emergency descent — IF REQUIRED.

*2. Lower seat — AS REQUIRED.

*3. Throttle — AVOID ABRUPT THROTTLE MOVEMENTS.

18.23 OXY CAUTION LIGHT

*1. Emergency oxygen actuator — PULL.

*2. Oxygen switch — OFF.

CHAPTER 19

Emergency Procedures Checklist Display

WARNING

Use of the emergency procedure checklist display without TAMMAC installed is not authorized.

In radar and night attack aircraft the emergency procedures checklist (EPC) display is selected by pressing the EMER pushbutton on the MENU display. The primary purpose of this display is to present selected digitized pages of emergency procedures from the NATOPS pocket checklist. The EPC pages are contained on data frames that reside in memory on the TAMMAC digital map computer. The EPC data frames are downloaded with the map theater from the MAP card in the AMU during a theater load.

19.1 EPC SELECTION

At power-up with weight-on-wheels, pressing EMER calls up the EPC menu (Figure 19-1). At any other time, pressing EMER calls up the last selected emergency subject and page. If the selected EPC has additional pages associated with it, as with the asymmetric stores chart (ASYM STR1), CONTINUED is displayed at the bottom of the page. The additional pages are selected by pressing the pushbutton for the next page in the subject sequence (ASYM STR2). Deselecting the emergency subject (boxed legend) recalls the emergency menu display.

If a frame is not available, NO FRAME is displayed in the center of the MPCD. If a frame is available but not yet ready for display, STBY is displayed in the lower left corner of the display while the frame is being called up.

When the EMER page is enabled, the MSC will disable any displayed maps (i.e. MAP is unboxed on the displayed map page's respective (MAPM)/EWM page). When the EMER page is exited, the map is enabled again. If a map is enabled while the EPC is displayed, the EMER page will be exited and the top level MENU page will be displayed.

19.2 UPDATING THE EPC

The date that the EPC was last updated is displayed centered on the EPC menu. The EPC is released during the normal Joint Mission Planning Station (JMPS) block upgrade cycle, and is updated as necessary. The EPC is updated in the TAMMAC DMC during a theater load.

Note

Once the EPC has been updated in JMPS, either through a block upgrade or an interim EPC update, the EPC must be loaded into the TAMMAC DMC by performing a theater load. Otherwise, the update will not display in the cockpit.

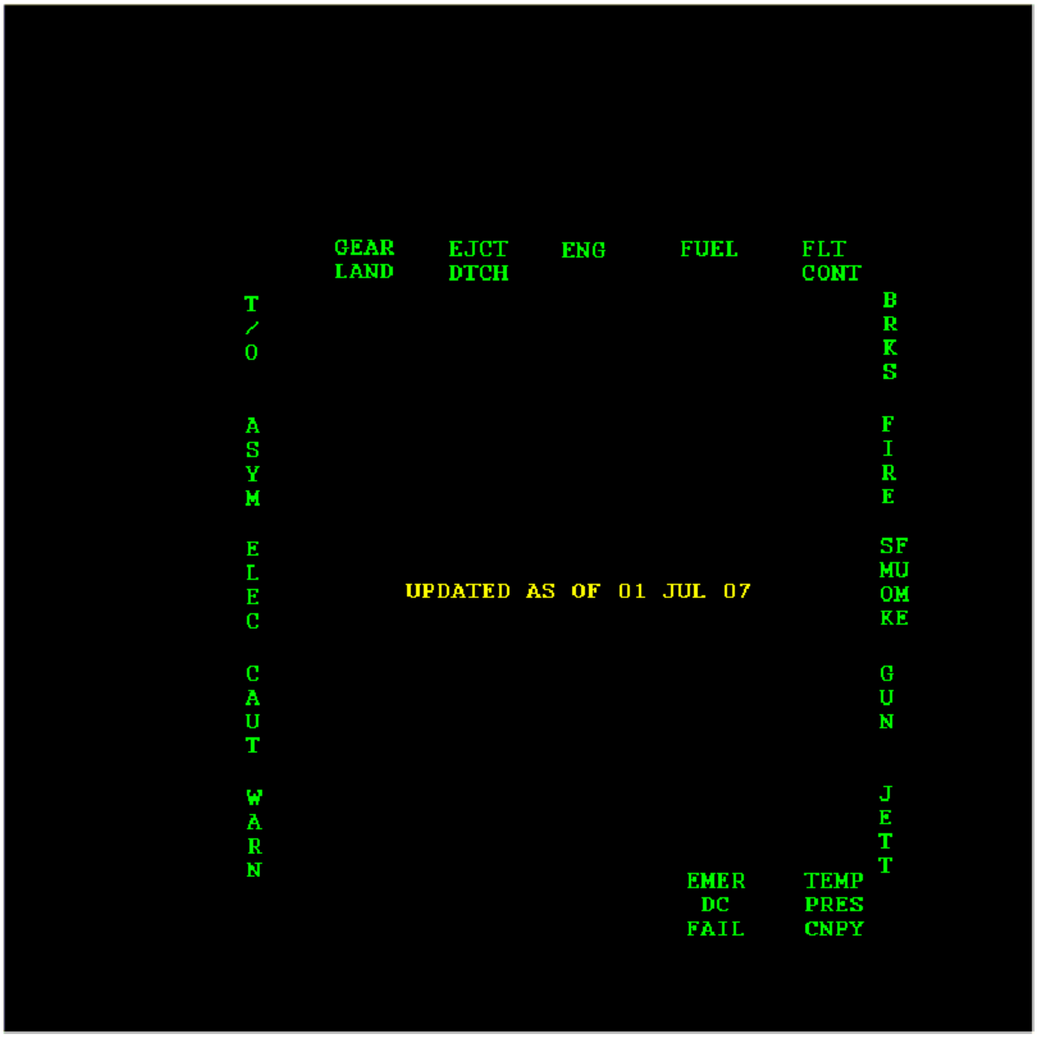


Figure 19-1. Emergency Procedures Checklist Display

PART VI

All–Weather Operation

CHAPTER 20

Instrument Procedures

20.1 SIMULATED INSTRUMENT PROCEDURES

Instrument flight is primarily a problem of time and distance navigation wherein all, or part, of the flight is conducted under instrument conditions. To complete a successful instrument flight, pilots must be properly prepared and have conducted the necessary planning. All pilots will maintain a current instrument rating and be guided by current OPNAV INSTRUCTION 3710.7 (General Flight and Operating Instructions for Naval Aircraft) and Federal Air Regulations.

20.1.1 Chase Plane Procedures

The chase pilot's duties on instrument flights are to act as lookout and to be a flight monitor. The best position for this is a loose tactical wing position where airspeed, attitude, and altitude may be monitored while maintaining a good lookout. During ground controlled approaches (GCA), the chase will fly a position as directed by GCA.

20.2 ACTUAL INSTRUMENT PROCEDURES

20.2.1 Instrument Flight

The ability of the aircraft to fly at slow speeds and to hover dictates some modification of standard instrument procedures.

It is recommended that certain critical operations such as shipboard IMC, restricted site, night, etc., be performed only with a fully functional head-up display. When flying aircraft with an ASN-130 and GPS into or through IMC, the aircraft should be flown with the INS in NAV. Also, the mission computer V/STOL master mode may be used in IMC in order to increase HUD attitude display reliability. Due to the way the INS information is translated for presentation in the HUD, the V/STOL master mode provides a more reliable IMC attitude presentation than the other master modes (NAV, AA, and AG). If INS velocity information begins to degrade, the other modes may present attitude information that is inaccurate. In IMC conditions this inaccurate presentation could result in an unrecognized spatial disorientation. This is a particular concern when operating the ASN-130 in a coupled mode with the GPS. Therefore, the V/STOL master mode should be the presentation of choice when flying in IMC conditions. Use of V/STOL will help to minimize attitude presentation errors when INS velocities are degrading and should provide a relatively stable attitude reference up to the point of INU failure.

20.2.1.1 Instrument Flight Planning

On instrument flights, delays in departure and descent and low climb rates to altitude are often required in high density control areas. These factors make fuel consumption and flight endurance critical. All instrument flights should be carefully planned and consideration given to the additional time and fuel which may be required. A complete weather briefing for all pilots on the flights will be obtained and the appropriate flight plan will be filed. For planning and filing purposes the AV-8B pilot should reference category C minimums (approach speeds of 121-140 knots). The pilot should file as an equipment code I in the equipment code block of the DD-175 (RNAV and transponder with mode C).

20.2.1.2 Before Starting Engine

When practical, an ATC clearance should be obtained before starting the engine.

20.2.1.3 Before Takeoff

It is essential that the instrument and navigation equipment be thoroughly checked prior to takeoff. INS ground speed should be checked when stopped to ensure minimum drift. Head up and head down displays should be cross checked. Selection of APU to ON is recommended.

20.2.1.4 Instrument Takeoff

Same as normal takeoff.

20.2.1.5 Instrument Climb

The simplified climb technique described in Part 4, Section XI of the Performance Chart Manual should be used to optimize fuel consumption and climb rates. Turns should be kept to a minimum during climb. Follow the clearance exactly as given. If unable to comply with the clearance, it is mandatory that ATC be advised immediately.

20.2.1.6 Penetration Procedures

Three to five minutes prior to making a descent, the cabin temperature control should be set at the maximum comfortable level and the cabin air switch should be set to MAX DEFOG to prevent the canopy from fogging up when descending to warmer altitudes. Instrument descent configuration should be based on wingman and aircraft limits. Selection of APU to ON is recommended during IMC. Contact approach control 10 minutes prior to ETA or as directed by ARTC, and conform to the provision of Section 2, Flight Planning Document. Three minutes prior to entering holding, adjust power to arrive at the holding fix with maximum endurance airspeed (230 knots maximum). Prior to descent, the pilot will check missed approach procedures and will obtain the latest weather information at the destination and at the alternate if required. Refer to Descent/Instrument Penetration procedures, Section III. Instrument descent configuration is briefed in consideration of wingmen and aircraft limits (recommend 250 knots, AUTO flaps, speedbrake, 8° to 10° AOA maximum on formation). Selection of APU to ON is recommended during IMC.

20.2.1.7 Radar Controlled Penetration

The approaches are basically the same as previously described with the following additions. The controlling activity will normally ask for turns or specific IFF squawks for positive identification. The controlling activity will advise of turns or headings which will produce the desired flight path. They will also advise as to distance from the destination and direct a descent to lower minimum altitudes as traffic and terrain permit.

20.2.1.7.1 GCA Approaches

Target 250 knots in the GCA pattern. Perform landing checks on base leg or as directed and maintain 8° to 10° AOA. One to two miles prior to intercepting the glide slope, select 25° nozzles and STOL flaps. Maintain 8° to 10° AOA on the glide slope until visual contact with the landing area is established. When visual contact is made, use nozzles as required to decelerate for the desired landing or take separation from wingman.

WARNING

The ability to counter nose down pitch with stick alone during flap programming and aileron droop may be significantly reduced due to decreased RCS pitch authority when the throttle is at minimum power. Abnormally fast approach speeds in combination with low throttle settings could lead to an unrecoverable condition if left unchecked in close proximity to the ground.

Note

- Be aware of flap programming if exceeding 25° nozzles and less than 165 knots while IMC. Flap programming can produce undesirable handling characteristics while IMC; however the added benefits of reduced groundspeeds may make the selection of nozzles greater than 25 and STOL flaps desirable.
- When wingman is a consideration, maintain airspeeds outside of the flap programming/droop transition range to ease wingman workload. AUTO flaps may also be utilized.

20.2.1.7.2 Minimum Fuel GCA

A minimum fuel GCA is flown by delaying gear extension until just prior to the descent point. The controller should notify the pilot when the aircraft is approximately 30 seconds from the glideslope. At this point, the aircraft is configured for landing, the checklist is completed and the remainder of the approach is flown normally.

20.2.2 Turbulent Air and Thunderstorm Operation

Intentional flight through thunderstorms should be avoided, because of the high probability of damage to the airframe by ice, hail, and lightning and possible compressor stall due to negative AOA encountered in turbulence. The aircraft is capable of climbing over the top of small and moderately developed thunderstorms. Thunderstorms have been reported to eject ice and lightning several miles from the buildup. Flight path should be planned accordingly.

20.2.2.1 Penetration

If necessary to penetrate, the basic structure of the aircraft is capable of withstanding the accelerations and gust loadings associated with the largest thunderstorms. The aircraft is stable and comparatively easy to control in the severe turbulence; however, the effects of turbulence becomes noticeably more abrupt and uncomfortable at airspeeds above optimum cruise and below 35,000 feet. The aircraft will not be displaced significantly from the intended flight path and desired heading. Altitude, airspeed, and attitude can be maintained with reasonable accuracy.

20.2.2.1.1 Penetration Airspeeds

The optimum thunderstorm penetration speeds, based on pilot comfort, controllability, and engine considerations are between optimum cruise and 280 knots. Engine rpm should be maintained below 85 percent to reduce compressor stall susceptibility.

20.2.2.2 Approaching the Storm

Adjust power to establish the recommended penetration speed (less than 85 percent). Do not try to top thunderstorms at the sacrifice of maintaining penetration speed. Flight through a thunderstorm at the proper airspeed and attitude is much more advantageous than floundering into the storm at a dangerously slow airspeed while attempting to reach the top. All cockpit lighting should be on at maximum brightness.

20.2.2.3 In the Storm

Maintain a normal instrument scan with added emphasis on the horizon bar. Attempt to maintain a constant pitch attitude and, if necessary, accept moderate altitude and airspeed fluctuations in heavy precipitation, a reduction in engine rpm may be necessary due to the increased thrust resulting from water ingestion. If compressor stalls or engine stagnation develop, attempt to regain normal engine operation by momentarily retarding the throttle to IDLE and then slowly advancing to the normal operating range. If the stall persists, shut down the engine and attempt a relight.

20.2.2.3.1 Angle-of-Attack System Failure

The angle-of-attack system may become temporarily inaccurate due to AOA probe icing with probe heat failure, or it may permanently fail due to structural damage of the probe from ice or hail. Icing of the AOA probe is usually characterized by zero angle of attack indication.

20.2.3 Ice and Rain

The possibility of engine and/or airframe icing is always present when the aircraft is operating under instrument conditions. Icing is most likely to occur when takeoffs must be made into low clouds with temperature at or near freezing. Normal flight operations are carried on above the serious icing levels, and the aircraft high performance capabilities will usually enable the pilot to move out of the dangerous areas quickly. When an icing condition is encountered, immediate action should be taken to avoid further accumulation by changing altitude and/or course and increasing the rate of climb or airspeed.

20.2.4 Hydroplaning

Operations on wet or flooded runways may produce three conditions under which tire traction may be reduced to an insignificant value.

1. Dynamic hydroplaning.
2. Viscous hydroplaning.
3. Reverted rubber skids.

Hydroplaning will not present a significant problem unless a conventional landing must be made. Nozzle braking is effective regardless of runway condition.

20.2.4.1 Dynamic Hydroplaning

As the tire velocity is increased, the hydrodynamic pressure acting on the leading portion of the tire footprint will increase to a value sufficient to support the vertical load acting on the tire. The speed at which this occurs is called total hydroplaning speed. This speed (in knots) can be computed by multiplying 9 times the square root of the tire pressure (105 knots for 135 psi tire pressure). Any increase in ground speed above this critical value lifts the tire completely off the pavement, leaving it supported by the fluid alone. Since the fluid cushion is incapable of sustaining any appreciable shear forces, braking and sideforce coefficients become almost nonexistent.

20.2.4.2 Viscous Hydroplaning

Viscous hydroplaning occurs due to the inability of the tire to penetrate the very thin fluid film found under damp runway conditions. This condition is aggravated when more viscous fluids such as oil, or road dust and water mixed are present, and is improved in the presence of a coarse textured runway surface. Viscous hydroplaning occurs at medium to high speed with rolling or skidding tires, and the speed at which it occurs is not dependent on tire pressure.

20.2.4.3 Reverted Rubber Skids

Reverted rubber skids occur after a locked-wheel skid has started on a wet runway. Enough heat may be produced to turn the entrapped water to steam. The steam in turn melts the rubber. The molten rubber forms a seal preventing the escape of water and steam. Thus the tire rides on a cushion of steam which greatly reduces the friction coefficient and may continue to do so to very low speeds.

20.3 UNUSUAL ATTITUDE RECOVERY

Unusual attitudes are entered due to pilot disorientation, vertigo, excessive task-loading, or unusual maneuvering while IMC. Timely recognition of an unusual attitude situation is paramount for achieving an effective recovery.

1. Altitude — CHECK.
2. Attitude and Airspeed — CHECK.

If nose-high, 200 to 300 KCAS:

3. Throttle — MAINTAIN THROTTLE SETTING.

If nose-high, 100 to 200 KCAS:

4. Throttle — FULL POWER.

Recovery:

5. Attitude — LOWER TO HORIZON.
6. ROLL TO UPRIGHT, WINGS-LEVEL (as required).

If nose-high, less than 100 KCAS:

7. Execute Out-of-Control procedures.

If nose-low:

8. Roll wings level and recover to horizon.

If airspeed exceeds 300 KCAS:

9. Throttle — IDLE.

WARNING

- If an unusual attitude situation occurs at low altitude, a timely ejection decision may be required based on altitude, attitude, airspeed, sink rate, and configuration.
- Ensure an inverted, nose-high attitude is not confused with an inverted, nose-low attitude.

CHAPTER 21

Extreme Weather Operation

Extreme weather operations include hot and cold ambient air temperatures and high altitudes, or combinations of both. Conditions are considered extreme when it becomes necessary to modify the normal shore-based procedures promulgated in Chapter 7. This chapter enumerates many considerations of extreme weather operations. However, the specific operating environment and mission requirements must be carefully assessed before modifying procedures in Chapter 7.

21.1 COLD WEATHER OPERATION

21.1.1 Preflight

Ensure that the aircraft is free of frost, snow, and ice. These accumulations present a major flight hazard resulting in loss of lift and increased stall speeds. Do not allow ice to be chipped or scraped from the aircraft: damage to the airframe may result. Inspect shock struts, actuating cylinders, pitot-static sources, and fuel vents for ice and dirt accumulation.

21.1.2 Interior Check

In temperatures below 0 °F, difficulty may be experienced when connecting the oxygen mask hose to the connector, due to a stiff O-ring in the connector. Application of a small amount of heat to the connector will alleviate this problem. Also, if the oxygen mask is not fastened, keep it well clear of the face to prevent freezing of the inhalation valves.

21.1.3 Engine Start

If any abnormal sounds or noises are present during starting, discontinue starting and apply intake duct preheating for 10 to 15 minutes.

21.1.4 Before Taxi

If the outside ambient air temperature is below freezing and the aircraft has not flown recently, initial movement of controls in the line should be mild and gradual for 3 to 5 minutes to minimize stress on possible frozen hydraulic lines and seals. Place the PROBE HEAT switch to HT prior to taxi to allow sufficient warmup time. Insufficient warmup time may result in erroneous airspeed and altitude displays and cause the system to improperly revert to POS/ADC in flight.

21.1.5 Taxiing

Avoid taxiing in deep or rutted snow; frozen brakes will probably result. Increase the interval between taxiing aircraft to insure a safe stopping distance and to prevent icing of the aircraft surfaces by the snow and ice melted by the jet blast of the preceding aircraft. Trim 4° ND to keep nose puffer duct closed.

21.1.6 Before Takeoff

During the engine runups, an ice-free area should be selected if possible. The engine thrust is noticeably greater at low temperatures and the probability of skidding the aircraft is likely. Engine performance will likely be RPM limited Use of power hex will preclude confusion regarding maximum corrected rpm power margins.

Note

- Certain environmental conditions may require modifications of established takeoff procedures (i.e., ice, snow, FOD, etc.).
- Certain items may not be safely accomplished while stationary due to ice, FOD, etc. (i.e., acceleration checks, duct pressure check, etc). When required these checks should be accomplished during taxi. If these checks cannot be completed, the operational necessity of the flight must be considered.

21.1.7 Landing

Perform an RVL or VL landing, if feasible, to reduce rollout distance.

21.1.8 Before Leaving Aircraft

Weather permitting, leave the canopy partially open to allow for air circulation. This will help prevent canopy cracking from differential cooling and decreases the possibility of windshield and canopy frosting.

21.2 HOT WEATHER OPERATION

Conditions associated with hot weather operations include high ambient temperatures, gusty winds, and blowing sand and dust. In addition to affecting engine performance, high temperatures adversely affect avionics systems, especially during ground operations when temperatures exceed 90 °F (32 °C). Due to decreased effectiveness of the ground cooling fan when temperatures exceed 90 °F (32 °C), minimize prolonged operation of avionics systems to avoid damage.

21.2.1 Ground Procedures

Avoid applying power to avionics systems until absolutely necessary based on mission requirements, airfield procedures (i.e. arming and dearming), and/or ground crew coordination. The TPOD, RADAR, IFF, TACAN and NAVFLIR should not be on for more than 10 minutes when the temperature exceeds 90 °F (32 °C) to prevent system damage and ensure proper airborne operation. Specifically, radar installation is divided between the forward and aft avionics bays. All radar components in the aft bay are mounted on the avionics shelf. With aircraft weight on wheels, the cooling air for the aft bay is ambient air drawn from the ram air inlet at the base of the vertical stabilizer by the aft avionics auxiliary cooling fan. Components in the forward bay are cooled by conditioned air from the forward ECS except the transmitter, which is cooled by liquid coolant. The radar liquid coolant is in turn cooled by conditioned air from the aft ECS in a heat exchanger located in the aft bay. At high ambient air temperature, cooling airflow to the aft equipment rack with weight on wheels may be insufficient to properly cool the RTDP and CPS. In this case, the radar may not successfully complete the ORT.

When the outside air temperature is reported to be greater than 90 °F, secure power to avionics equipment until ready for taxi. If verification of the avionics system(s) is required for the mission, apply power, allow the system to warm-up, execute the applicable BIT, and then secure power if a significant ground delay is expected.

21.2.2 Engine Start

Do not operate the engine in a sand or dust storm if avoidable. To initially increase the amount of cool air flow during engine start, allow rpm to build to 6 to 8 percent prior to selecting idle. Maintain JPT during engine start. With JP-4, high ambient temperature, and hot engine, an intermittent beat similar to the chuffing noise of a helicopter rotor may be emitted by the engine below about 50 percent rpm. Avoid prolonged operation in this condition.

21.2.3 Takeoff

The required takeoff distances and ground speed increases as air temperature increases. Acceleration checks may not have a valid time due to high idle rpm at high altitudes. Ensure takeoff does not exceed 180 knots ground speed to maintain tire limits (consider wet takeoffs). Note IGV band for appropriate temp range.

21.2.4 Landing

At high density altitudes, there will be high airspeeds associated with normal KCAS and AOA. Landing speed must remain below 180 knots ground speed. Reduce gross weight to maximum extent practical. At high density altitudes a compromise must be achieved between power committed to the total lift vector and maintaining an adequate margin for wave-off. Therefore, to reduce landing speeds and maintain wave-off capability, execute a STOL flap, VNSL landing, water armed. No later than the 180 position, select 50° nozzles and throttle to 104 percent. Gradually increase nozzle angle until 8 to 10 AOA achieved (this may be 50° to 70° depending upon conditions). At 50 feet, go to throttle and complete the landing.

21.2.5 Post Landing

Once the post-landing checks are complete and the aircraft is safely taxiing back for shutdown, initiate an AUTO BIT as soon as practical. As avionics components complete their BIT sequence, record any failure indications, and secure power to each component. Consider securing power to the following components as soon as practical: RADAR, NAVFLIR, IFF, TACAN, RWR, RADALT, and AWLS.

PART VII

Communications – Navigation Equipment and Procedures

CHAPTER 22

Communications

This chapter promulgates standards and procedures associated with administrative flight operations and the communications systems of the AV-8B. For information on the description, components, controls, displays, and modes of operations of communication systems, refer to NTRP 3-22.4-AV8B.

22.1 STANDARDS

22.1.1 Communication Brevity

Utilize communication brevity terms in accordance with MCRP 3-25B Multi-service Air-Air, Air-Surface, Surface-Air Brevity Codes published by the Air, Land, and Sea Application (ALSA) Center. Although brevity is preferable, do not sacrifice accuracy and/or clarity. If there is a possibility of misunderstanding, use plain language. Clear, concise, situational awareness enhancing communications is always the objective.

22.1.2 Priority Communications

The flight member with priority communication is the flight lead or the tactical lead. All other flight members will limit communications to that specific to safety-of-flight, mission accomplishment, or as directed. The division lead and/or section lead have priority communication.

22.1.3 Cockpit Management

With two operative radios, R/T 1 should be used for communications external to the flight and R/T 2 should be used for intra-flight communications and/or safety of flight frequencies.

22.1.4 Nomenclature

For directing actions referable to the aircraft radios (i.e. direct a frequency change) proper nomenclature is “Comm 1” and “Comm 2” respectively vice “#1/#2”, “front/back” or “left/right”.

22.1.5 Callsigns

All tactical radio transmissions will be initiated and acknowledged with full tactical callsigns. Do not abbreviate callsigns on the radio by using only the numbered portion, “Razor 11” vice “11.” Callsigns may be abbreviated using the flight callsign (“Razor”). Be diligent to ensure you do not clip your transmission. Key the Mike, pause, and then talk. Administrative transmissions (frequency changes/check ins) will be acknowledged with flight position number (“Razor 1, check”, “2, 3, 4”) on the same radio as the check-out/check in is initiated.

22.1.6 Directive and Descriptive Communications

Descriptive calls are started with your own callsign (“Razor 01, Joker”). Directive calls are started with the unit or aircraft addressed (“Razor 02, Break Right!”).

22.2 PROCEDURES

22.2.1 Communication Checks

If there are no alibis, the comm procedures will start when the flight lead initiates the Comm-Checks as depicted in Figure 22-1.

COMM-1	COMM-2
VMA TAC Freq (Single Channel Clear 21) **[2 mins prior to taxi]** **(Get Well Freq)** “Razor 51 – check Comm 1” "… 2, … 3, … 4" "Razor 51, push SECURE" **VMA TAC Freq (Single Channel Secure 21)** "Razor 51 - check" "Razor 52" “Razor 53" “Razor 54” Flight lead deselects Cipher on Channel 21 and states All other flight members deselect Cipher on Channel 21 and push Channel 25 **(VMA TAC Freq – Active Clear).** **VMA TAC Freq (Active Clear Channel 25)** "Razor 51 - check" "2, … 3, … 4" "Razor 51, PUSH 21 clear, Comm 1” "Razor 51 - check" "2, … 3, … 4" “Swap Radios” Flight selects 20 on Comm 1 and 21 on Comm 2	**Monitor Base / VMA Common Channel 20**
	VMA TAC Freq (Single Channel Clear 21) **(Get Well Freq)** “Razor 51 – check Comm 2” "… 2, … 3, … 4" "Razor 51, push SECURE" **VMA TAC Freq (Single Channel Secure 21)** "Razor 51 - check" "Razor 52" “Razor 53" “Razor 54” Flight lead deselects Cipher on Channel 21 and states "Razor 51, PUSH 25 Comm 2" All other flight members deselect Cipher on Channel 21 and push Channel 25 **(VMA TAC Freq – Active Clear).** **VMA TAC Freq (Active Clear Channel 25)** "Razor 51 - check" "2, … 3, … 4" The flight remains on Channel 25 for the remainder of the flight.
"Base Razor 51 flight is outbound, any words?" “Negative words, Good Flight” “Razor 51 push button 3 Comm 1” **Ground Control Channel 3** "Ground … Razor 51 flight of four taxi with information Alpha"	

Note: (1) If no communications within 15 seconds during comm checks, flight members POGO to Get Well.
(2) This example uses preset channels 21 and 25. If those are used by another flight, use secondary or tertiary VMA Tac frequencies.

Figure 22-1. Communication Checks

22.2.2 Frequency Changes

The standard format for a changing frequencies is: Callsign, Action, COMSEC status, Channel/Frequency/NET, RT assigned. Frequency changes are signaled by the term "PUSH" or "GO".

- "PUSH" – Indicates positive check in only.
- "GO" – Positive check out and check in. If a wingman is known single radio, the standard is to use "GO" in order to confirm acknowledgement.
- "Clear" – Unencrypted, or un–secure.
- "Single–channel" – Singular frequency, non–hopping.
- "ACTIVE" – Anti–jam frequency hopping.
- "SECURE" – Encrypted, or secure.
- "Channel" – Implies a pre–set.
- "NET" – SINGARS, HQ I or II NET ID.

Example 1: "Razor 11, PUSH ACTIVE, clear, Channel 2, Comm–1" means the entire flight will meet on pre–set channel 2 anti–jam, clear.

Example 2: "Razor 11, PUSH 318.925, Comm–2" means the entire flight will meet on a manual inputted UHF frequency on comm.–2. Single–channel, un–secure is implied unless otherwise stated.

Example 3: "Razor 11, PUSH 318.925 SECURE, Comm–2" means the entire flight will meet on a manual inputted UHF frequency on comm.–2. The frequency will be encrypted.

22.2.3 Degraded Communications

22.2.3.1 Single Radio

If single radio, tune it to the R/T 1 planned frequencies unless otherwise briefed or directed.

22.2.3.2 Get Well

The frequency used whenever the flight becomes "lost lead on the radios." If no transmission is received within 30 seconds after a frequency change, or during single radio operation, switch to the briefed "get well" frequency.

22.2.3.3 Microphone Failure

In the event of microphone failure, key the transmit button to communicate as follows:

- 1 click – "NO"
- 2 clicks – "YES"
- 3 clicks – "SAY AGAIN"

22.2.3.4 NORDO

References governing two–way radio failure procedures for a single aircraft are provided in Federal Aviation Regulations part 91 and the DOD Flight Information Handbook. These procedures do not alleviate a pilot to remain predictable in recovering NORDO (No radio) aircraft.

22.2.3.4.1 V/STOL Considerations

NORDO aircraft will attempt to execute recovery to the last known duty runway, or the primary runway for which an instrument approach is designated, in order to predictably enter the landing pattern. If unable to determine the duty runway, select MENU–DATA–AC to attempt to estimate wind velocity. Additionally, conduct a search for other aircraft, blowing smoke or other physical signs of wind velocity. If the crosswind component for a rolling landing cannot be reasonably ascertained, then execute a vertical landing.

22.2.3.4.2 Formation NORDO Recovery

In formation, a NORDO aircraft will normally fly a wingman position unless other conditions dictate that the NORDO aircraft assume or retain the lead. If the flight was larger than a section, the remainder of the flight will separate and execute the mission or return to base as briefed.

22.2.3.4.3 NORDO as Wingman

In the event the wingman loses the capability to communicate, the NORDO aircraft will join on the flight lead, collapse into parade formation, and use hand and arm signals to communicate the aircraft status. Or if separated, proceed to the briefed Lost Communication/Lost Lead rendezvous point and hold as briefed. If join-up does not occur, return-to-base as a single aircraft once JOKER fuel is reached.

Once joined, point at the mask and ear independently with a follow on thumbs-up or thumbs-down to indicate the capability to transmit and/or receive respectively. No HEFOP signal will indicate that the only problem is with the radios. The NORDO aircraft will remain as the wingman during recovery.

If an emergency occurs, utilize standard HEFOP hand or light signals (see Figure 22-2). During the day, the NORDO aircraft will give a weeping signal and then indicate with number of fingers associated with the affected system. At night, the NORDO aircraft will use the flashlight. Holding the flashlight close to the top of the canopy and pointed toward the wingman, the NORDO aircraft will signal his wingman the affected system with 1 to 5 dashes as appropriate.

22.2.3.4.4 NORDO as Lead

If the NORDO aircraft is the flight lead, then the lead pilot will rock his wings to “knock-off” the training and maneuver his aircraft to collapse the flight into a parade formation. Or if separated, proceed to the briefed Lost Communication/Lost Lead rendezvous point and hold as briefed. If join-up does not occur, return-to-base as a single aircraft once JOKER fuel is reached. Once joined, the lead pilot will communicate his status via hand and arm signals, pass the lead, and remain as the wingman during recovery.

22.2.3.4.5 Recovery Procedures

The standard recovery is a straight-in section approach to an appropriate roll-on landing. If a vertical landing is needed, the NORDO pilot will signal the lead this requirement with an open hand, palm down, up and down motion. For dual runway airfields, lead shall position the NORDO aircraft on the left or right wing to correspond to the left or right runway in use. The lead will, at a minimum, clear the flight to land on the duty runway and all available pads.

To change configurations during the day, use the hand and arm signals as depicted in Figure 22-2. In all cases, the NORDO aircraft should attempt to match the escort’s configuration for approach to landing. If an IMC approach is anticipated and situation permits, configure the flight for landing before encountering IMC.

When the flight is cleared to land, the lead will indicate clearance to land via passing the lead to the NORDO aircraft. The NORDO aircraft will consider the landing clearance is valid unless the escort flies past the NORDO aircraft with his landing gear retracted and anti-collision light off. In this event, the NORDO aircraft will initiate a wave-off and rejoin the escort as wingman.

22.2.3.4.6 Night Considerations

The NORDO aircraft signals lost communications by cycling the exterior lights master switch and collapses the flight. Once the flight is joined, the NORDO aircraft keeps the anti-collision light on and slides aft into parade position. The non-NORDO aircraft assumes the lead and extinguishes the anti-collision light to signal taking the lead.

Light signals to configure the aircraft to land are depicted in Figure 22-2. With clearance to land, the lead aircraft will illuminate the anti-collision light signaling the NORDO aircraft is cleared to land and has the lead. The escort aircraft will then detach to monitor the NORDO aircraft's landing. If clearance for landing is revoked, the escort flies by the NORDO aircraft with landing gear retracted and the NORDO aircraft should execute a wave-off and rejoin on lead. The NORDO aircraft should attempt to match the escort's configuration during the wave-off.

22.2.4 Loading GPS time for HAVEQUICK and SINGCARS

1. 1. Ensure both C1 and C2 are in FF or MX channelization mode.

Note

MX channelization is only valid if the mixed list frequencies are mapped to the fixed frequency list.

2. Select MENU-COMM on the MPCD.
3. Select HQ (PB14) on the COMM card page.
4. Select GPS (ODU option 4) to set GPS time in both radios.
5. Set both C1 and C2 to AJ channelization mode and a valid AJ preset.
6. Verify that TIME, DAY and FILL indication is blank on HQ TIME page.
7. Deselect HQ (PB 14) and verify GPS time is displayed under the upper COMM 1 and COMM 2 label of the FF, AJ or MX COMM Card.

Note

GPS must be on-line and GPS time valid.

22.2.5 Time of Day Operations for HAVEQUICK

1. Select MENU-COMM on the MPCD.
2. Select HQ (PB14) on the COMM card page.
3. Select TIME (PB6) on the MPCD (if not already boxed).
4. ODU Selection:
   a. Select XMT (ODU option1) then C1 or C2 (ODU option 4 and 5) to transmit the time of day using the desired radio (COMM1 or COMM 2).
   b. Select RCV (ODU option 2) to receive the time of day.
   c. Select TRST (ODU option 3) then ACPT (ODU option 4) to reset the time or REJ (ODU option 5) to cancel TRST.

Note

Prior to XMT or RCV operations, the radio(s) must be set to the proper FF or MX preset (user defined or pointed to FF preset).

22.2.6 Time of Day Operations for SINGCARS

1. Ensure both C1 and C2 are set to AJ channelization mode and the preset is set to a SINGCARS Net.
2. Select MENU-COMM on the MPCD.

3. Select SG (PB13) on the FF, AJ or MX COMM Cards.
4. Select TIME (ODU option 3) if not already colonized.
5. Enter the desired day and time to the minute.

Note

A two digit entry changes the minutes, a four digit entry changes the hour and minutes, and a six digit entry changes the day, hour, and minutes.

22.2.7 HAVEQUICK MWOD Operations

1. Select MENU-COMM from the MPCD.
2. Select HQ (PB14) from the FF, AJ or MX COMM Card.
3. Select MWOD (PB7) on the MPCD (if not already boxed).
4. Program:

To program MWOD:

a. Select MWOD (ODU option 1).
b. Program all segments (20-15) and the Day (segment 14) and select LOAD (PB11).

To load Day into the radios:

c. Select LDAY (ODU option 2).
d. Enter the date to be loaded (0-31).

Note

A 1000 Hz tone is heard in the headset indicating that the day had been loaded and accepted in the radios.

To verify that a radio has an MWOD loaded for a specific day:

e. Select VDAY (ODU option 3).
f. Enter the date to be checked (0-31).
g. Select C1 or C2 (for COMM 1 or COMM 2 in ODU windows 4 and 5).

Note

- A 1000 Hz tone is heard in the headset indicating that the current radio has a valid MWOD loaded.
- Tones must be enabled to hear the associated 1000 Hz tones. From the AJ or MX COMM Cards, COMM 1 (PB20) and COMM 2 (PB17) must be unboxed.

22.2.8 Electronic Remote Fill (Cold Start)

1. Select CS (Coldstart frequency) using the channel select knob.
2. Colonize CS (ODU option 5).

3. Select HSET (ODU option 3) or LSET (ODU option 4), whichever is to be received or transmitted.

4. Receive/Send:

To receive ERF data:

a. Enter the AJ preset where the ERF data is to be stored and select RCV.

Note

A 1000 Hz tone indicates successful storage of the ERF data.

To send ERF data:

b. Enter the preset of the data to be transmitted in the UFC.

c. Select HSET or LSET the select XMIT.

Note

XMIT is briefly cued and the transmission is heard in the headset.

5. Repeat step 4 as necessary.

22.2.9 Mixed Mode Editing

1. Press the desired radio knob to activate the UFCs.
2. Cycle ODU option 5 to MX.
3. Select MENU — COMM on the MPCD.
4. Select MX (PB9) on the COMM page.
5. Select the preset to be changed using the channel select knob or direct access entry.
6. Select EDIT (PB15) or re-enter the selected channel to activate the ODU for channel editing.
7. Select FF, AJ or UD on the ODU as desired.
8. Enter the desired Channel, Net ID, or frequency.
9. Repeat steps 4-7 as necessary.

22.2.10 Comm Alert Mode Procedures

The following are the procedures for comm. alert mode:

1. Battery switch — ALERT.
2. ACNIP controls — SET.

a. Successively actuate the code/mode switch to MODE until PL is displayed in KY 1 or 2 windows.

b. Baseband/diphase switches 1 and 2 — BB.

c. Ground and auxiliary volume control knobs — AS DESIRED.

d. Microphone switch — COLD or HOT.

e. MODE switch — MAN.

3. V/UHF RSC — SET.

   a. Squelch switch — SQL.

   b. UHF mode selector switch — AS REQUIRED.

   c. Brightness control knob — AS DESIRED.

   d. Frequency mode selector knob — MAN.

   e. Mode selector knob — T/R OT T/R + G.

4. UFC comm. 1 and 2 volume control knobs — AS DESIRED.

5. RSC frequency slew switches — SET DESIRED FREQUENCY.

6. PRGM switch — 1 or 2.

7. RSC mode selector knob — OFF (to conserve power); T/R OR T/R + G (to change frequency then OFF).

For KY-58 operations:

8. Successively actuate ACNIP code/mode switches to MODE until CY is displayed in KY 1-2 window.

9. Successively actuate ACNIP code/mode switches to CODE until desired code is displayed in KY 1 or 2.

22.2.11 Built-In-Test

BIT should be initiated anytime the FREQ/(CHAN) display blanks or indicates an erroneous readout. BIT is performed as follows:

Note

BIT will fail if radio transmissions received during test.

1. To avoid reception, insert the frequency of an unused channel and key both comm. 1 and comm. 2.

2. MODE selector switch — TEST.

3. PRGM switch — 1.

4. BIT requires approximately 5 to 8 seconds, observe FREQ/(CHAN) display. No fault is indicated by 888.888.

5. MODE selector switch — T/R.

6. PRGM switch — 1.

Steady tone in headset stops.

7. Repeat the procedure for position 2 on the PRGM switch.

22.2.12 KY-58 Operation

With control-monitor set:

1. ACNIP controls — SET.

   a. Baseband/diphase switch — BB.

   b. MODE switch — UFC.

2. ODU — SET.

   a. Option 4 pushbutton — PRESS TO CIPH (tone heard).

      On some aircraft, the tone is momentary and is automatically cleared. On other aircraft, the tone must be cleared by pressing the comm. switch.

   b. Option 5 pushbutton — PRESS (code displayed on scratch pad).

3. Comm switch — PRESS (tone stops).

With ACNIP controls:

4. ACNIP controls — SET.

   a. MODE switch — MAN.

   b. Successively actuate the code/mode switches to MODE until CY is displayed in KY-1/KY-2 window.

   c. Successively actuate the code/mode switches to CODE until desired code is displayed.

22.3 VISUAL COMMUNICATIONS

Communications between aircraft are visual whenever practical. Flight leaders shall ensure that all pilots in the formation receive and acknowledge signals when given. The visual communications chapters of NAVAIR 00-80T-113 should be reviewed and practiced by all pilots. Common visual signals applicable to flight operations are listed in Figure 22-2.

22.3.1 Deck/Ground Handling Signals

Communications between aircraft and ground personnel are visual whenever practical, operations permitting. The visual communications chapters of Aircraft Signals NATOPS Manual (NAVAIR 00-80T-113) should be reviewed and practiced by all flightcrew and groundcrew personnel. For ease of reference, visual signals applicable to deck/ground handling are listed in Figure 22-3. During night operations, wands shall be substituted for hand and finger movements.

GENERAL SIGNALS

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Thumbs up, or nod of head. Thumbs down, or turn of head from side to side.	Flashlight moved vertically up-and-down repeatedly. Flashlight moved horizontally back-and-forth repeatedly.	Affirmative. (“Yes,” or “I understand.”) Negative. (“No,” or, “I do not understand.”)	
Hand cupped behind ear as if listening.		Question. Used in conjunction with another signal, this gesture indicates that the signal is interrogatory.	As appropriate.
Hand held up, with palm outward.		Wait.	
Employ fingers held vertically to indicate desired numerals 1 through 5. With fingers horizontal, indicate number which added to 5 gives desired number from 6 to 9. A clenched fist indicates 0. (Hold hand near canopy when signaling).		Numerals as indicated.	A nod of the head (“I understand”). To verify numerals, addressee repeats. If originator nods, interrogation is correct. If originator repeats numerals, addressee should continue to verify them until they are understood.
Make hand into cupshape, then make repeated pouring motions.		I am going to dump fuel.	
Slashing motion of index finger across throat.		I have stopped dumping fuel.	
Raised fist with thumb extended in drinking position.		How much fuel have you?	Indicate remaining fuel in hundreds of pounds by finger numbers.

Figure 22-2. Visual Communications (Sheet 1 of 11)

CONFIGURATION CHANGES

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Rotary movement of clenched fist in cockpit as if cranking wheels, followed by head nod.	Rotary motion of flashlight.	Lower or raise landing gear and flaps to STOL/AUTO, as appropriate.	Execute when leader changes configuration.
Forearm held vertically while nodding, clenched fist followed by extending number of fingers for each 10° of nozzle rotation.	Horizontal movement of flashlight followed by number of flashes for each 10° of nozzle.	Rotate nozzles.	Execute when leader changes configuration.
Open and close four fingers and thumb.		Extend or retract flaps, as appropriate.	Execute upon head nod from leader or when leader’s flaps extends/retract.
Rapid opening and closing four fingers and thumb.		Extend or retract speed brake as appropriate.	Execute upon head nod from leader or when leader’s speedbrake extends/retracts.

Figure 22-2. Visual Communications (Sheet 2)

ARMAMENT

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
1. Pistol-cocking motion with either hand. 2. Followed by question-signal. 3. Followed by thumbs-down signal.		1. Ready or safety guns. 2. How much ammo do you have? 3. I am unable to fire.	Repeat signal, and execute. Thumbs up-"over half"; thumbs down-"less than half." Nod head ("I understand").
1. Shaking fist. 2. Followed by question-signal. 3. Followed by thumbs-down signal.		1. Arm or safety bombs, as applicable. 2. How many bombs do I have? 3. I am unable to drop.	1. Repeat signal and execute. 2. Indicate with appropriate finger-numerals. 3. Nod head ("I understand").
1. Shaking hand, with fingers extended downward. 2. Followed by question-signal. 3. Followed by thumbs-down signal.		1. Arm or safety missile/rockets as applicable. 2. How many missiles/rockets do I have? 3. I am unable to fire.	1. Repeat signal and execute. 2. Indicate with appropriate finger-numerals. 3. Nod head ("I understand").
Pistol-cocking motion with either hand, followed by fore and aft pulling motion with a clenched fist.	1. Rotating beacon ON and OFF by lead aircraft. 2. Rotating beacon turned ON for second time (allow time for setting up switches).	Jettison external stores: 1. Set up your switches for jettison. 2. Your are cleared to drop.	Repeat signal and execute: 1. Set up jettison ordnance switches. 2. Execute.
Pistol-cocking motion followed by head nod.		Expendable check. First head nod for flares, second head nod for chaff.	Wingman replies with thumbs up or down for each head nod.

Figure 22-2. Visual Communications (Sheet 3)

MALFUNCTIONING EQUIPMENT (HEFOP CODE)

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Weeping signal and then indicating by finger-numbers 1 to 5 the affected system.	Flashlight held close to top of canopy, pointed toward wingman, followed by 1 to 5 dashes to indicate system affected.	Number of fingers or dashes means: 1. Hydraulic system. 2. Electric system. 3. Fuel system. 4. Oxygen system. 5. Power.	Day; not, or thumbs up ("I understand"). Night; Vertical movement of flashlight. Pass lead to disable plane or assume lead, if indicated.

Figure 22-2. Visual Communications (Sheet 4)

ELECTRONIC COMMUNICATIONS AND NAVIGATION

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Tap earphones, followed by patting of head, and point to other aircraft.		Take over communications.	Repeat signals, pointing to self, and assume communications lead.
Tap earphones, followed by patting of head.		I have taken over communications.	Nod ("I understand").
Tap earphones and indicate by finger-numerals, number of channel to which shifting.		Shift to radio frequency indicated by numerals.	Repeat signal and execute.
Tap earphones, followed by question signal.		What channel (or frequency) are you on?	Indicate channel (or frequency) by finger-numerals.
Vertical hand, with fingers pointed ahead and moved in a horizontal sweeping motion, with four fingers extended and separated.		What is bearing and distance to the tacan station?	Wait signal, or give magnetic bearing and distance with finger-numerals. The first three numerals indicate magnetic bearing and the last two or three, distance.

Figure 22-2. Visual Communications (Sheet 5)

FORMATION

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Open hand held vertically and moved forward or backward, palm in direction of movement.		Adjust wing position forward or aft.	Wingman moves in direction indicated.
Open hand held horizontally and moved slowly up or down, palm in direction of movement.		Adjust wing position up or down.	Wingman moves up or down as indicated.
Open hand used as if beckoning inboard or pushing outboard.		Adjust wing position laterally toward or away from leader.	Wingman moves in direction indicated.
Hand opened flat and palm down, simulating dive or climb.		I am going to dive or climb.	Prepare to execute.
Hand moved horizontally above glareshield, palm down.		Leveling off.	Prepare to execute.
Head moved backward.		Slow down.	Execute.
Head moved forward.		Speed up.	Execute.
Head nodded right or left.		I am turning right or left.	Prepare to execute.
Thumbs waved backward over shoulder.		Take cruising formation or open up.	Execute.
1. Holds up right (or left) forearm vertically, with clenched fist or single wing-dip. 2. Same as above, except with pumping motion or double wing-dip.		1. Wingman cross under to right (or left) echelon or in direction of wing-dips. 2. Section cross under to right (or left) echelon or in direction of wing-dips.	1. Execute. 2. Execute.

Figure 22-2. Visual Communications (Sheet 6)

FORMATION (CONT)

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Triple wing-dip.		Division cross under. Form a Vee or balanced formation.	Execute. Execute.
Porpoising of aircraft.		Close up or join up; join up on me.	Execute.
Lead patting shoulder.		Airborne: Join in parade Ground: Section taxi.	Execute.
Rocking of wings by leader.		Prepare to attack.	Execute preparation to attack.

Figure 22-2. Visual Communications (Sheet 7)

TAKEOFF, CHANGING LEAD, LEAVING FORMATION, BREAKUP, LANDING

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
1. Flight leader or wingman signal one finger. 2. Flight leader or wingman signal thumbs up. 3. Flight leader or wingman signal two finger. 4. Flight leader nods head.	1. Flight leader/wingman turn approach light on. 2. Flight leader/wingman turn approach light off. 3. Flight leader or wingman turn approach light on. 4. Flight leader turns exterior master switch off and back on.	1. I have completed my takeoff checklist and I am ready for takeoff. 2. I am in position for takeoff. 3. I have completed my two finger checks. 4. When head touches headrest, I will begin takeoff roll.	1. Return signal to flight leader/wingman when ready for takeoff. 2. Return signal to flight leader/wingman when in position for takeoff. 3. Return signal to flight leader/wingman when two finger checks are complete. 4. Execute.
1. Leader pats self on the head, points to wing.	1. Lead aircraft cycles rotating beacon ON/OFF. 2. If external lights are inoperative, leader shines flashlight on hard-hat, then shines light on wingman.	Leader shifting lead to wingman.	1. Wingman pats head and assumes lead. 2. Wingman turns rotating beacon OFF and assumes lead. 3. If external lights are inoperative, wingman shines flashlight at leader, then on his hard-hat and assumes lead.
Leader pats self on head and holds up two or more fingers.		Leader shifting lead to division designated by numerals.	Wingman relays signal; division leader designated assumes lead.
Pilot blows kiss to leader.		I am leaving formation.	Leader nods (“I understand”) or waves good-bye.
Leader blows kiss and points to aircraft.		Aircraft pointed out leave formation.	Wingman indicated blows kiss and executes.

Figure 22-2. Visual Communications (Sheet 8)

TAKEOFF, CHANGING LEAD, LEAVING FORMATION, BREAKUP, LANDING (CONT)

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
Leader points to wingman, then points to eye, then to vessel or object.		Directs plane to investigate object or vessel.	Wingman indicated blows kiss and executes.
Division leader holds up and rotates two fingers in horizontal circle, preparatory to breaking off.		Section break off.	Wingman relays signal to section leader. Section leaders nods ("I understand") or waves good-bye and executes.
Leader describes horizontal circle with forefinger.	Series of I's in code, given by external lights.	Breakup (and rendezvous).	Wingman take lead pass signal after leader breaks, and follows.
Landing motion with open hand: 1. Followed by patting head. 2. Followed by pointing to another aircraft. **Note** Landing motion with open hand can be modified to signal a roll-on landing or vertical landing.	Lower landing gear: 1. Followed by selection of approach light ON. 2. Selection of approach light ON.	Refers to landing of aircraft, generally used in conjunction with another signal. 1. I am landing. 2. Directs indicated aircraft to land.	1. Nods. ("I understand") or waves goodbye. 2. Aircraft indicated repeats signal, blows a kiss and executes.

Figure 22-2. Visual Communications (Sheet 9)

ARMING

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
1. Arming supervisor: Hands over head.	Same.	Pilot: Check all armament switches OFF and SAFE.	Pilot: Execute. Raise both hands to view of arming supervisor after checking switch position. (Hands remain in view during check and hook-up.)
2. Arming supervisor points at crew member (used if applicable).	Same.	Crew: Perform stray voltage checks.	Arming crew: Execute. Give arming supervisor THUMBS UP if no stray voltage exists.
3. Arming supervisor; raises fist, thumb extended upward, to meet horizontal palm of other hand.	Same.	Arming crew: (as applicable). Hook up rocket pigtails and/or arm 20 MMs.	Arming crew: Execute. Give arming supervisor THUMBS UP when arming completed and clear immediate area.
4. Arming supervisor gives pilot: a. Thumbs up. b. Thumbs down.	Same.	a. Aircraft is armed and all personnel and equipment clear of area. b. Aircraft is down.	a. Hold until arming crew clear of arming. b. Return to line.
5. Arming supervisor gives pilot: Rotating hand with index finger and pinkey extended.	Arming supervisor gives pilot: Rotating horizonal wand.	Apply/secure generator power.	Repeat signal. Turn on/off generator.

Figure 22-2. Visual Communications (Sheet 10)

DEARMING

SIGNAL		MEANING	RESPONSE
DAY	NIGHT		
1. Dearming supervisor: Hands over head.	Same.	Pilot: Check all armament switches OFF or SAFE.	Pilot: Execute. Raise both hands to view of dearming supervisor after (checking switch positions). (Hands remain in view during dearming.)
2. Dearming supervisor points at crew member.	Same.	Crew: Disconnect rocket pigtail and/or disconnect feed mech air supply hose, clear rounds from feed mech throat. (If jammed, also disconnect electrical lead to feed mech to disable firing circuit). Comply with appropriate local and technical instructions for the type armament concerned.	Crew: Execute.
3. Dearming supervisor give pilot: Thumbs-up.	Same.	Pilot: Aircraft is dearmed and crew and equipment clear of aircraft.	Pilot: Hold until arming crew clear of arming area - then return to line.

Figure 22-2. Visual Communications (Sheet 11)

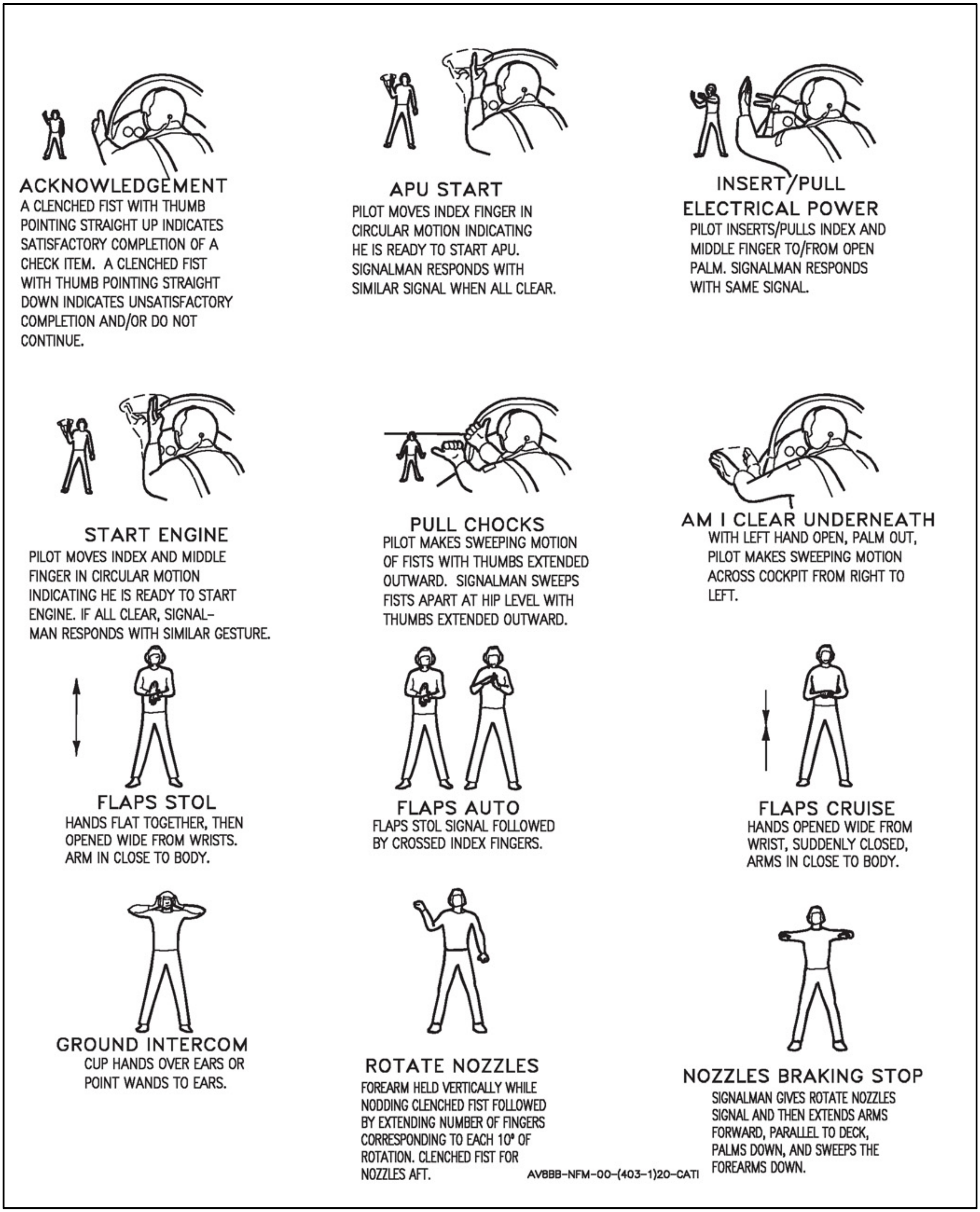


Figure 22-3. Deck/Ground Handling Signals (Sheet 1 of 3)

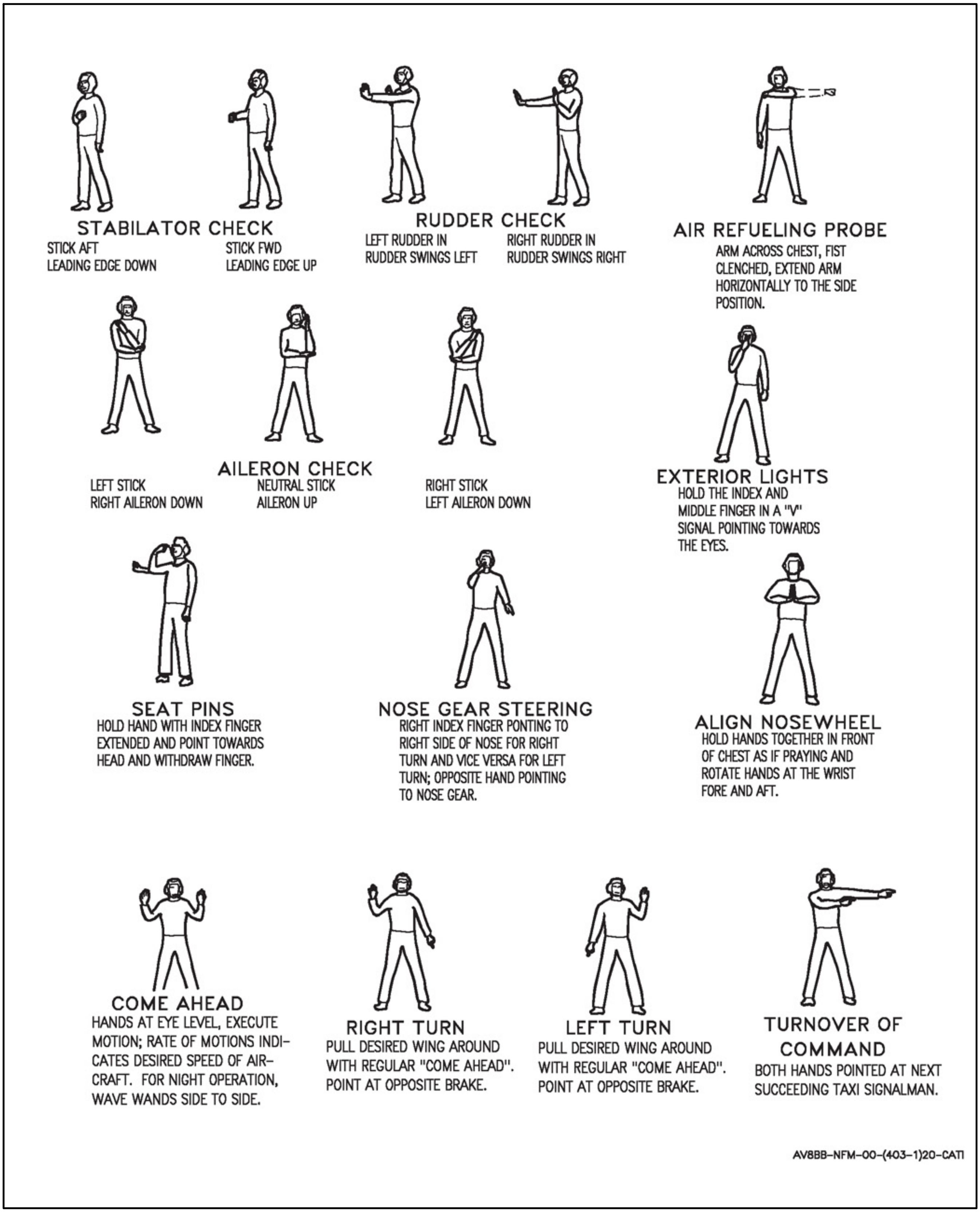


Figure 22-3. Deck/Ground Handling Signals (Sheet 2)

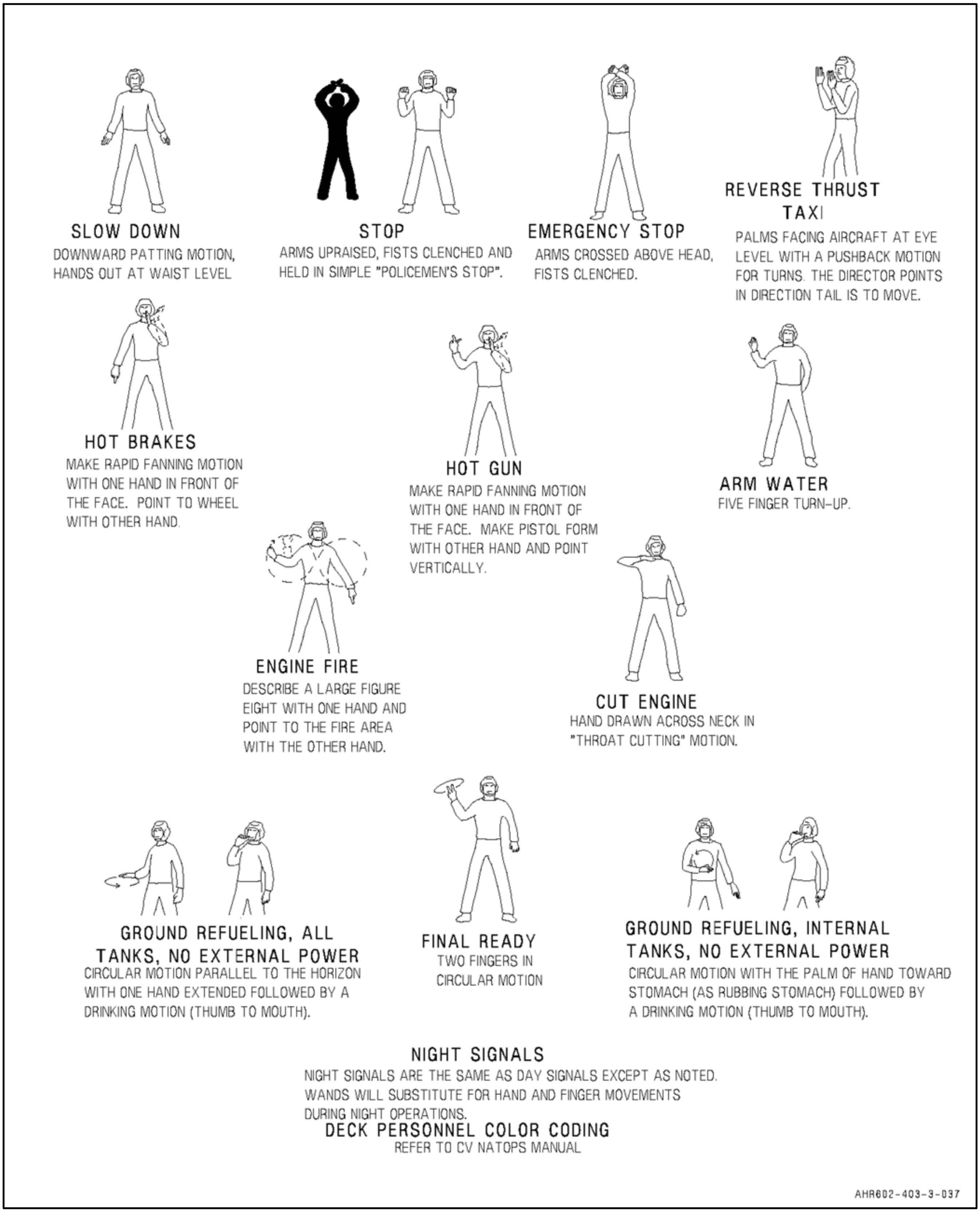


Figure 22-3. Deck/Ground Handling Signals (Sheet 3)

CHAPTER 23

Navigation

This chapter promulgates procedures associated with navigation systems of the AV-8B. For information on the description, components, controls, displays, and modes of operations of communication systems, refer to NTRP 3-22.4-AV8B.

23.1 INERTIAL NAVIGATION SYSTEMS PROCEDURES

23.1.1 Ground Alignment Procedures

The following are the procedures for performing an Inertial Navigation Systems (INS) Ground Alignment:

1. Select MENU-EHSD-DATA-A/C on the MPCD.
2. Enter the correct current latitude (N-S) of the aircraft on the UFC and press ENTER.
3. Enter the correct current longitude (E-W) of the aircraft on the UFC and press ENTER.
4. Place the INS mode selector knob to GND position without pausing in the SEA position.

Note

During the first 1 to 2 minutes of alignment the indicator has ATT NOT OK displayed to the right of QUAL.

5. Place the INS mode selector knob to NAV anytime after the alignment quality (QUAL) number drops below 3.0.

Note

- If maximum accuracy is desired, wait until OK is displayed and then select NAV or IFA.
- With AN/ASN-139, the time required to achieve an OK can be less than 4 minutes and temperature has no effect.
- If the parking brake is released during alignment the INS switches to align hold and the time digits on the MPCD display will flash on and off.
- The INS caution light will illuminate if the INS present position and the GPS Navigation data are both valid and the INS mode selector knob is set to NAV. This is to indicate that the system should be in IFA.

23.1.2 SINS Sea Alignment Procedures

The following are the procedures for a SINS alignment aboard the ship:

Note

Entering current aircraft position prior to initiating a SINS alignment will greatly enhance alignment accuracy and decrease its duration.

With SINS cable connected:

1. Select MENU-EHSD-DATA-A/C on the MPCD.
2. Enter the correct current latitude (N-S) of the aircraft on the UFC and press ENTER.
3. Enter the correct current longitude (E-W) of the aircraft on the UFC and press ENTER.
4. Place the INS mode selector knob to SEA position.
5. Place the INS mode selector knob to NAV anytime after the alignment quality (QUAL) number drops below 3.0.

RF SINS alignment with no SINS cable:

1. Select MENU-EHSD-DATA-A/C on the MPCD.
2. Enter the correct current latitude (N-S) of the aircraft on the UFC and press ENTER.
3. Enter the correct current longitude (E-W) of the aircraft on the UFC and press ENTER.
4. Enter the SINS radio frequency in COMM 1 or COMM 2 as desired.
5. Place the INS mode selector knob to SEA position.
6. Colonize COM1 or COM2 on the ODU as appropriate.

Note

The ODU will be enabled for selection of SINS data source when the INS mode selector knob is initially placed to the SEA position or whenever the SINS option is re-boxed on the EHSD. The ODU defaults to DECK with a SINS data cable connected and to COM2 if the avionics system does not detect a cable. For RF SINS alignments with H4.0, due to a software anomaly, colonize DECK prior to colonizing COM1 or re-colonizing COM2.

7. Place the INS mode selector knob to NAV anytime after the alignment quality (QUAL) number drops below 3.0.

Note

- If maximum accuracy is desired, wait until OK is displayed and then select NAV or IFA.
- With AN/ASN-139, the time required to achieve an OK can be less than 4 minutes and temperature has no effect.
- If the parking brake is released during alignment the INS switches to align hold and the time digits on the MPCD display will flash on and off.
- The INS caution light will illuminate if the INS present position and the GPS Navigation data are both valid and the INS mode selector knob is set to NAV. This is to indicate that the system should be in IFA.

23.1.3 Manual Sea Alignment Procedures

The following are the procedures for a Manual Sea Alignment:

1. Select MENU-EHSD-DATA-A/C on the MPCD.
2. Enter the correct current latitude (N-S) of the aircraft on the UFC and press ENTER.

3. Enter the correct current longitude (E–W) of the aircraft on the UFC and press ENTER.
4. Press the SHIP option on the ODU. Enter the ships heading and speed in the UFC.
5. Press the THDG option on the ODU. Enter the aircraft true heading in the UFC.
6. Place the INS selector knob to the SEA position.
7. Select EHSD display and box the MAN legend at the top of the MPCD.

Note

- During the first 1 to 2 minutes of alignment the indicator has ATT NOT OK displayed to the right of QUAL. The INS caution light will illuminate until ATT NOT OK is replaced by a QUAL number.
- With AN/ASN–139 when the INS alignment is completed, the QUAL number will be less than 1.0 and the time should be less than 10 minutes and an OK is displayed.

8. Place the INS mode selector knob to NAV or IFA.

23.1.4 GPS Carrier Alignment

The following are the procedures to initiate a GPS carrier alignment:

1. Place the INS mode selector knob to IFA.

Note

- During the GPS carrier alignment, the MC must provide valid GPS data from the MAGR. The magnetic heading input is not required since the INS performs a wide angle alignment.
- If GPS velocity become invalid before wide angle alignment complete (HDG displayed in the MPCD), the alignment will restart. This is due to the Kalman filter extrapolations which require valid reference velocities without interruption before high order AHRS.

23.1.5 Ground Stored Heading Alignment Procedures

This procedure can be performed if the aircraft is parked and an INS complete ground alignment has been done; if the aircraft has not been moved since the alignment, and if NAV has not been selected on the miscellaneous control panel. A stored heading alignment is indicated by SHDG option displayed on the upper left corner of the ground align display. The procedures are as follow:

Note

The SHDG pushbutton should be selected as quickly as possible after selecting a ground alignment. A recently operated system would be warm and the SHDG option is displayed only as long as its use would assist in the alignment. When the alignment progresses past the point that its use would assist, the option is removed from the display.

1. Place the INS mode selector knob to GND. The MPCD will display INS ground alignment.
2. Press the SHDG pushbutton on the MPCD.
3. Observe the MPCD for ground alignment indications.

Note

During the first portion of alignment the indicator may have ATT NOT OK displayed to the right of QUAL. QUAL digits start counting down and TIME digits start counting up. When INS heading is valid, HDG will be displayed after the quality digits. When the INS alignment is completed, OK will be displayed next to QUAL with less than 5 minutes.

4. Place the INS mode selector knob to NAV.

Note

Stored Heading Alignment is only available in C1+ aircraft.

23.1.6 INS Gyro Alignment Procedure

The following are procedures for INS gyro alignment:

1. Select MENU-EHSD-DATA-A/C on the MPCD.
2. Enter the correct current latitude (N-S) of the aircraft on the UFC and press ENTER.
3. Enter the correct current longitude (E-W) of the aircraft on the UFC and press ENTER.
4. Place the INS mode selector knob to GYRO.

Note

On the MPCD, after approximately 15 seconds HDG/COMP is replaced by HDG/SLV. These options will disappear from the MPCD within 33 seconds.

5. Press the SYNC pushbutton on the MPCD to slave the magnetic heading from the magnetic azimuth detector (MAD) to the platform heading.
6. Press the ERECT pushbutton to fast level the platform.

23.1.7 RADAR In-Flight Align

The procedures for a radar in-flight alignment (RIFA) are as follows:

Note

A complete RIFA may be initiated after a total INS shutdown and may take up to 20 minutes to complete. During the RIFA the ADC must be available to provide magnetic heading information and the radar must be capable of providing continuous position velocity updates.

1. Ensure NAV master mode is selected.
2. Place the INS mode selector knob to IFA.
3. Select RIFA on the GPS Data page for C1+ aircraft and A/C Data page for H4.0 aircraft.
4. Observe that time begins to increment during the first 1 to 2 minutes of the alignment.

When RIFA displays an OK after the QUAL number:

5. Place the INS mode select switch to the NAV position.

23.1.8 Post Evaluation Procedure

The post evaluation procedures are:

Note

To prevent erroneous results this procedure should only be performed ashore.

1. On MPCD select — MENU, BIT, MAINT, INS, POST.

POST 1 data display appears for flight 1.

2. Record — ALN TIME, AQ (align quality), and PER (positional error rate).

3. Select — POST 1.

POST 2 data display appears for flight 1.

4. Record — UPDATE.

5. Select — POST 2.

POST 1 data display appears for flight 2.

6. Repeat steps 1 through 5 to record all stored flights.

23.2 POSITION UPDATE PROCEDURES

23.2.1 TACAN Position Update

There are two types of TACAN Position updates: 1) Single TACAN update; and 2) Two TACAN update. A single TACAN update uses the range and bearing to the TACAN and its known position to calculate the aircraft's position. A two TACAN update uses the range and bearing from two TACANs to triangulate aircraft position. A TACAN Position update will update the aircraft position and the INS position.

Note

- TACAN Position updates can only be performed using TACANs that are entered on the EHSD-DATA-TCN page. The current aircraft TACAN channel and mode (X/Y) must match a TACAN channel and mode entered on the EHSD-DATA-TCN page. In the case where more than one TACAN entry has the same channel and mode combination, the system will pick the first match (TCN 0 - TCN 4).
- A TACAN Position update cannot be performed while AWLS Steering or EMCON is enabled.
- The range and bearing to the selected TACAN/TACANs must be valid.

23.2.1.1 Single TACAN Position Update

1. Place the INS mode selector knob to NAV. Select DGD/INS or DGD/ADC.

2. Turn on TACAN power and select the desired TACAN channel and X/Y mode.

3. Select UPDT on the EHSD, FLIR, A/G RDR, or DMT page.

4. Select TCN in ODU window 1.

5. The TACAN bearing and range error is displayed in the scratchpad.

6. Select ACPT to accept the displayed bearing and range adjustments. Select REJ or unbox UPDT to cancel the update.

23.2.1.2 Two TACAN Position Update

1. Perform steps 1 through 5 of the Single TACAN Position update.

2. Select TCN2 in ODU window 2. The scratchpad will display the TACAN number (as entered in the EHSD-DATA-TCN page) and the TACAN's channel number. Select TCN2 again to cycle to the next TACAN station.

3. If the range and bearing to the second TACAN is valid, the ERR2 option will appear in option window 3 after approximately 5 seconds.

4. Select ERR2 to display the two TACAN Position update bearing and range error in the scratchpad. Select ERR1 in ODU window 1 to display the single TACAN Position update bearing and range error.

5. Select ACPT to accept the displayed bearing and range adjustments. Select REJ or unbox UPDT to cancel the update.

23.2.2 Designate Position Update

There are two types of Designation Position updates: 1) WYPT Designate update; and 2) MAP Designate update. A WYPT designation update uses the designation's known location and its slewed position in the HUD to calculate the aircraft's position. A MAP designation update uses the slant range and bearing of a HUD designation and its slewed position on the map to calculate the aircraft's position. A Designate Position update will update the aircraft position and the INS position.

Note

A designation is required before the Designate Position update can calculate the error in the aircraft's position. Although, a designation can be made after a Designation Update is initiated, a known software anomaly will sometimes cause the system to automatically reject the update. Therefore, best practice would be to make a designation before selecting DESG on the ODU.

23.2.2.1 WYPT Designate Update

1. Place the INS mode selector knob to NAV. Select DGD/INS or DGD/ADC.

2. Designate a waypoint, markpoint, or targetpoint.

3. Select UPDT on the EHSD, FLIR, A/G RDR, or DMT page.

4. Select DESG in ODU window 2.

5. Slew the diamond in the HUD over the designation.

6. The WYPT Designate bearing and range error is displayed in the scratchpad.

Select ACPT to accept the displayed bearing and range adjustments. Select REJ, unbox UPDT, or undesignate to cancel the update.

23.2.2.2 MAP Designate Update

1. Place the INS mode selector knob to NAV. Select DGD/INS or DGD/ADC.
2. Designate a landmark on the HUD.
3. Select UPDT on the EHSD center or decenter page.

Note

An update can be initiated from the EHSD, FLIR, A/G RDR, or the DMT page, but the EHSD center or decenter page must be displayed before MAP appears on the ODU in window 2. Additionally a map set must be installed in the aircraft and EMCON must be disabled.

4. Select DESG in ODU window 2.
5. Select MAP in ODU window 2. A crosshair is displayed in the center of the map. The center of the map is moved to the designation's location.
6. Slew the crosshair on the map until it is over the landmark that is designated in the HUD.
7. The MAP Designate bearing and range error is displayed in the scratchpad.
8. Select ACPT to accept the displayed bearing and range adjustments. Select REJ, unbox UPDT, or undesignate to cancel the update.

Note

A MAP Designate will be cancelled if the EHSD page is exited, if the decenter compass rose is selected, or if the type of map (CHRT, DTED, or CIB) is changed after MAP has been cued on the ODU. WYPT Designation update can be reselected by uncolonizing MAP.

23.2.3 Overfly Position Update

There are three types of Overfly Position update: 1) WYPT Overfly update; 2) MAP Overfly update; and 3) Navigation Fix Overfly update. A WYPT overfly update is used to update the aircraft's position to the steer-to point's known location. It is also used to update the aircraft's altitude. A MAP overfly update uses the map to select the aircraft's position. A navigation fix update allows the pilot to enter the aircraft's latitude and longitude or 10-digit UTM. An Overfly Position update will update the aircraft position and the INS position. If the radar altimeter is valid, a WYPT overfly update can also be used to update the aircraft's altitude.

23.2.3.1 WYPT Overfly Update

1. Place the INS mode selector knob to NAV. Select DGD/INS or DGD/ADC.
2. Select UPDT on the EHSD, FLIR, A/G RDR, or DMT page.
3. Select OVFY in ODU window 3 when the current waypoint, markpoint, or targetpoint is overflown.
4. The WYPT Overfly bearing and range error is displayed in the scratchpad.
5. Select ACPT to accept the displayed bearing and range adjustments. Select REJ to not accept the displayed bearing and range adjustments.
6. The WYPT Overfly altitude error is displayed in the scratchpad if the radar altitude is valid.
7. Select ACPT to accept the altitude adjustments. Select REJ or unbox UPDT to cancel the update.

23.2.3.2 MAP Overfly Update

1. Place the INS mode selector knob to NAV. Select DGD/INS or DGD/ADC.
2. Select UPDT on the EHSD center or decenter page.

Note

An update can be initiated from the EHSD, FLIR, A/G RDR, or the DMT page, but the EHSD center or decenter page must be displayed before MAP appears on the ODU in window 2. Additionally a map set must be installed in the aircraft.

3. Select OVFY in ODU window 3 when the desired map location is overflown.
4. Select MAP in ODU window 2. A crosshair is displayed in the center of the map. The center of the map remains at the aircraft location.
5. Slew the crosshair on the map until it is over the landmark that was overflown.
6. The MAP Overfly bearing and range error is displayed in the scratchpad.
7. Select ACPT to accept the displayed bearing and range adjustments. Select REJ or unbox UPDT to cancel the update.

Note

A MAP Overfly will be cancelled if the EHSD page is exited, if the decenter compass rose is selected, or if the type of map (CHRT, DTED, or CIB) is changed after MAP has been cued on the ODU.

23.2.4 Manual GPS Update

A GPS update is used to update the aircraft's position and the INS position if the position keeping mode/source is DGD/INS or DGD/ADC. If the position keeping mode source is DGD/GPS, only the INS position is updated.

1. Place the INS mode selector knob to NAV. Select DGD/INS, DGD/GPS, or DGD/ADC.
2. Select UPDT on the EHSD, FLIR, A/G RDR, or DMT page.
3. Select GPS in ODU window 4.
4. The GPS bearing and range error is displayed in the scratchpad.
5. Select ACPT to accept the displayed bearing and range adjustments. Select REJ or unbox UPDT to cancel the update.

23.3 ALL WEATHER LANDING SYSTEM PROCEDURE

1. UFC – AWLS. Defaults to ON.
2. Cycle ON or OFF via UFC.
3. ODU option 1 – enter channel (1–20) via UFC.
4. ODU option 2 – enter glideslope (2.0 –6.0 in 0.1° increments) via UFC.
5. ODU option 3 – enter azimuth offset option (+/– 310 feet) via UFC.
6. ODU option 4 – enter TACAN channel (1–126; alternate depressions of "TCN" option on ODU cycle between X and Y) via UFC.

7. ODU option 5 – enter elevation offset option (0–31 feet) via UFC.
8. EHSD box AWLS option to select AWLS steering.

23.4 BUILT-IN-TEST PROCEDURES

23.4.1 TACAN Built-In-Test

1. Press BIT button on the MPCD menu.
2. Press the CNI pushbutton.
3. Observe TEST next to TCN (test takes 25 seconds).
4. If 1 next to TCN (TCN 1) — TACAN failed BIT check.
5. If space next TCN remains blank — TACAN passed BIT check.

23.4.2 AWLS BIT Check

1. Press BIT button on the MPCD menu.
2. Press the CNI pushbutton.
3. Observe TEST next to AWLS (test takes approximately 15 seconds).
4. If any number next to AWLS — AWLS failed BIT check.
5. If space next to AWLS remains blank — AWLS passed BIT check.

23.5 GLOBAL POSITIONING SYSTEM

The Global Positioning System (GPS) is a space–based radio positioning system which provides accurate position, velocity, and time data to various targeting, navigation, and communication systems aboard the aircraft. See NATIP NTRP 3–22.4 for in–depth theory and system operation.

23.5.1 Component Description

The aircraft components of the GPS system are the GPS antenna and the Miniaturized Airborne GPS Receiver (MAGR).

23.5.1.1 GPS Antenna

The GPS antenna is a fixed radiation pattern low profile antenna mounted on door 51 next to the water fill tank door. The antenna provides omnidirectional coverage above 10° elevation from its surface.

23.5.1.2 MAGR

The MAGR receives ranging codes and a navigation data message from the NAVSTAR satellites through the GPS antenna. The MAGR can track five GPS satellites and calculate the aircraft exact position from the four best satellites being tracked. The MAGR provides UTC time, aircraft position, aircraft velocity, and altitude data to the MC. The MAGR contains a battery to provide power for a clock and to maintain memory when aircraft power is not supplied. The MAGR has a built–in–test used for determining the status of the receiver and the battery.

23.5.2 GPS Controls and Indicators

The controls and indicators for the GPS include the upfront control, option display unit, multipurpose color display, INS mode select switch, and GPS caution light.

23.5.2.1 Upfront Control

The scratch pad display on this control is used for displaying the position error when a GPS navigation update is performed. The display is also used to display GPS time, in UTC, when REAL is selected in the ODU.

23.5.2.2 Option Display Unit

This control/indicator provides a way of displaying and selecting the various options available for a GPS navigation update and provides the option (REAL) for selecting the GPS time display on the UFC.

23.5.2.3 Multipurpose Color Display

The EHSD display, BIT display, and GPS waypoint and data displays are presented on the MPCD. The 20 pushbutton switches surrounding the crt provide display selection and control

23.5.2.4 INS Mode Select Switch

Selecting IFA initiates the in-flight alignment and enables a tightly-coupled navigation mode. Selecting NAV enables a loosely coupled, degraded, navigation mode.

23.5.2.5 GPS Caution Light

When enabled, indicates aggressive maneuvering, GPS data is not valid or has stopped updating, or GPS horizontal and vertical position error is not within the tolerance required for GPS navigation steering modes, normal (NORM) and approach (APPR). The GPS light on the CAUTION/ADVISORY panel is illuminated along with the MASTER CAUTION light if a GPS failure has been detected or if the GPS horizontal error exceeds a specified tolerance. If the GPS is being used as the position keeping source and normal mode is selected, the GPS caution light is illuminated when the horizontal position error exceeds 333 meters for greater than 5 seconds. If the GPS is being used as the position keeping source, approach mode is selected, true airspeed is valid and less than 300 knots, the GPS caution light is illuminated when the horizontal position error exceeds 33 meters for greater than 5 seconds. With MAGR not installed the system disables the GPS caution light, however it lights up with DC backup running.

Note

The GPS caution light will also illuminate if the INS present position and the GPS navigation data are both valid and the INS mode selector knob is set to NAV. This is to indicate that the system should be in IFA.

23.5.3 EHSD Display Format

The EHSD display format shows the aircraft position keeping source, navigation system coupling mode, and additional information when utilizing the in-flight alignment mode or courseline feature.

23.5.4 GPS Flight Mode Selection

The GPS flight mode selections, APPR or NORM are available on the aircraft data display (POS/GPS or DGD/GPS, DATA, A/C, NORM, or APPR). See Figure 23-1. These options specify a corridor (navigation tolerance) about the desired aircraft course. If GPS position keeping is selected and the estimated error of the GPS exceeds the selected mode tolerance, a cockpit warning is provided by a GPS advisory and MASTER CAUTION light. The default flight mode selection at aircraft power-up with weight-on-wheels is normal mode. The flight mode selection option is only available in POS/GPS and DGD/GPS position keeping modes. Currently GPS in USN aircraft is for tactical use only and does not meet FAA standards for enroute or the terminal phase of flight. GPS is not used as the primary means of navigation to file or fly in the National Airspace System. Reference CNO/N88/021214Z Aug 94.

23.5.5 GPS Data

The GPS data display format is enabled by selecting the GPS option from the EHSD-DATA display format with OMNI 7.1 and C1+. The GPS data display format is enabled by selecting the GPS option from the SDAT-TFER display format in H4.0. See Figure 23-2. The GPS data display format contains GPS and tactical waypoint/markpoint information, including the identifier, latitude, longitude, datum, elevation, and magnetic variation. The GPS data display format is used to:

1. Upload waypoints into the MAGR from the data storage unit (DSU) or AMU mission card.
2. Transfer waypoint data stored in the MAGR into a tactical waypoint/markpoint/targetpoint.

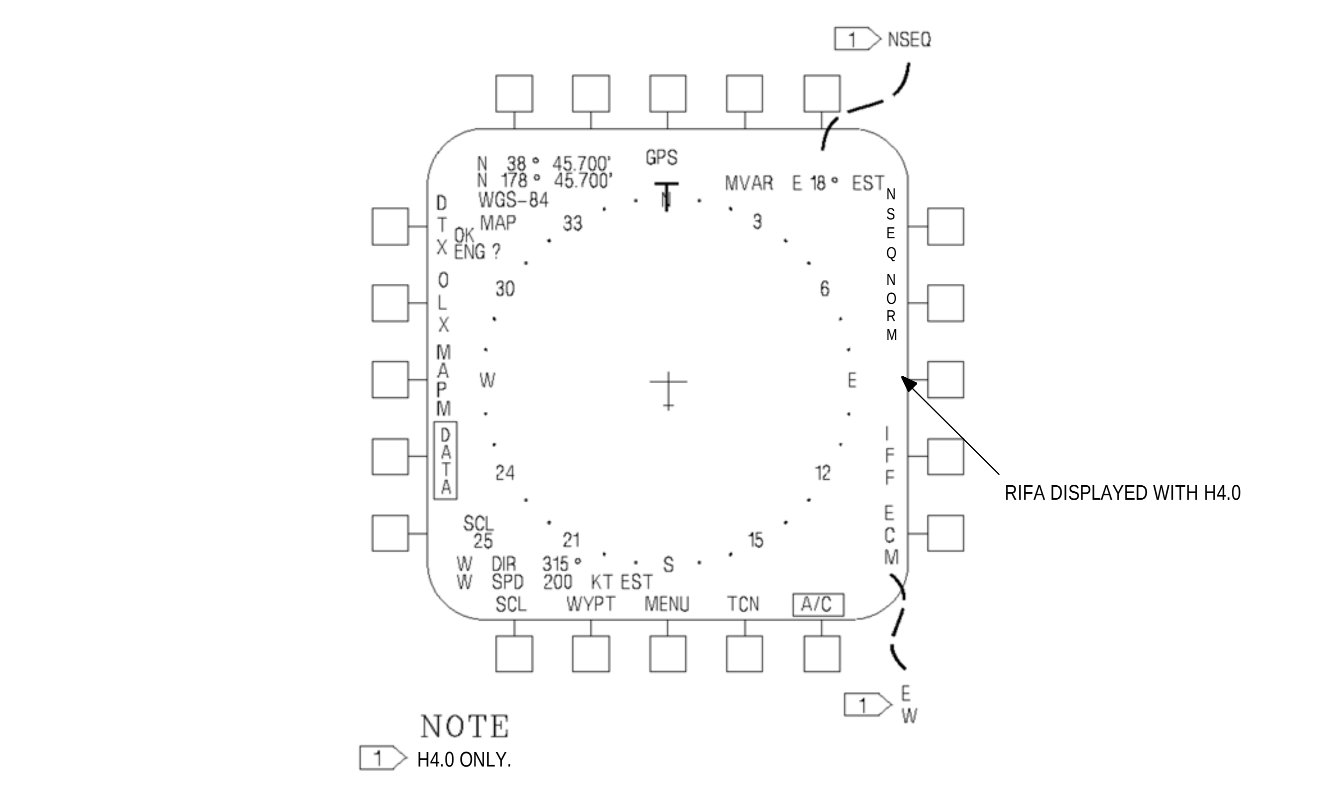


Figure 23-1. Aircraft Data Display

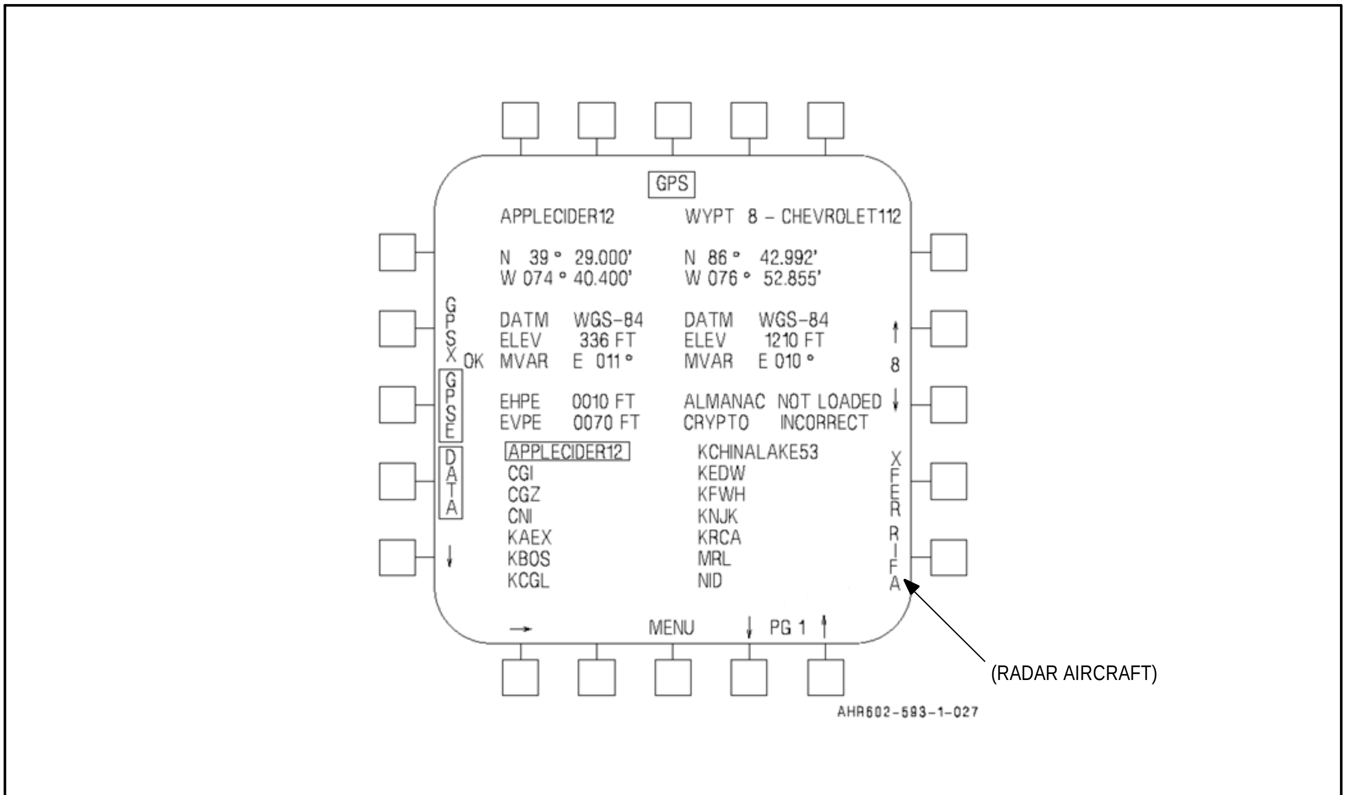


Figure 23-2. GPS Data Display (OMNI 7.1 and C1+)

3. Examine the GPS almanac and crypto-key status (OMNI 7.1 and C1+ only).
4. Inspect the current estimated GPS position errors (OMNI 7.1 and C1+ only).

Note

With H4.0, the estimated GPS position errors are displayed on the EHSD page and the GPS almanac and crypto-key status lines are displayed on BIT page 2.

23.5.5.1 GPS Waypoint Data Upload

Selection of the GPSX option transfers the GPS waypoint database from the DSU or the AMU mission card to the GPS. To get to the GPSX option select EHSD-DATA-GPS with OMNI 7.1 or C1+, or select SDAT-TFER-GPS with H4.0. OK indicates the transfer was successful. ?? indicates an error occurred during transfer. OK or ?? is displayed until another pushbutton is pressed. With H4.0, GPS waypoints that are corrupted on the DSU/AMU mission card or were corrupted when read from the DSU/AMU mission card are displayed with the waypoint ID ????????????. These corrupted GPS points are moved to the end of the list. Corrupted GPS waypoints cannot be transferred into waypoints, markpoints, or targetpoints.

23.5.5.2 GPS Waypoint Data Transfer (OMNI 7.1 and C1+)

To transfer waypoint data from over 200 waypoints stored in the MAGR into one of the tactical waypoints/markpoints (0 through 24, MK1, MK2, MK3) do the following:

1. Select a tactical waypoint/markpoint.
2. Select a GPS waypoint.
3. Select XFER option.

The tactical waypoints/markpoints are selected by scrolling to the desired waypoint/markpoint number using the increment or decrement arrow option on the right side of the display format. The GPS waypoint is selected by scrolling to the desired page using the page up or page down arrow option and then by using the down and/or right arrow option, the selection box is placed around the desired GPS waypoint. The transfer of the GPS waypoint data into the tactical waypoint/markpoint is accomplished by selecting the XFER option. When the XFER option is pressed, if the GPS waypoint is stored in the DSU, the MC transfers the waypoint and any associated offset data into the tactical waypoint/markpoint. However, if the MC is forced to retrieve the GPS waypoint data from the MAGR, only the waypoint data without any associated offset is transferred to the tactical waypoint/markpoint. The MAGR does not store offset data.

23.5.5.3 GPS Almanac and Crypto-Key Status

After aircraft power-up with OMNI 7.1 or C1+, the GPS-Data page display format should be selected to examine the almanac and crypto-key loading status. With H4.0, the GPS almanac and crypto-key status is located on the BIT page.

1. Almanac Status. If the almanac data is not loaded in the MAGR, the NOT LOADED legend is displayed adjacent to the ALMANAC legend. When the almanac data is loaded into the MAGR, LOADED is displayed adjacent to ALMANAC . If no almanac is loaded, the MSC will attempt to transfer the almanac file from the DSU or AMU mission card to the MAGR. Regardless of whether the almanac is LOADED or not, the MAGR will strip a complete almanac from the satellite signal once it finds any satellite. This takes approximately 14 minutes after a satellite is located. Once an almanac is loaded , the MAGR will retain it even after shutdown. Whenever the MAGR is changed or batteries in the MAGR are changed, the MAGR should be run on ground power until a fix is obtained. There is no power switch or ON/OFF switch for the MAGR. The MAGR functions any time APU or main generator power is available.
2. Crypto-Key Status. After communication with a satellite is established, the MAGR reports whether the crypo-keys are correct. If the crypto keys are not loaded in the MAGR, NOT LOADED is displayed adjacent to the CRYPTO legend. When the crypto keys are loaded into the MAGR and the MAGR has not verified whether the keys are correct, LOADED is displayed adjacent to the CRYPTO legend. INCORRECT is

displayed adjacent to the CRYPTO legend if the MAGR determines that the loaded keys are incorrect. OK legend is displayed adjacent to the CRYPTO legend after the MAGR has determined that the loaded keys are correct. Crypto–key verification may take up to 12 minutes.

23.5.5.4 GPS Estimated Position Error Status

To inspect the current estimated horizontal and vertical position errors of the GPS with OMNI 7.1 or C1+, the GPSE option on the GPS data page can be selected. With H4.0, the estimated Horizontal Position Errors (abbreviated as H) and Estimated Vertical Position Errors (abbreviated as V) are continuously displayed on the EHSD center, decenter, and EW pages (see Figure 23-11). Leading zeroes are not depicted on the EHSD and EW pages.

Note

It is especially important to monitor GPS position errors when using the GPS (POS/GPS or DGD/GPS) for low–level night navigation.

If a GPS failure exists an asterisk (*) is displayed adjacent to the position errors, almanac, and crypto–key status. The GPSX option is removed if a DSU, AMU, or AMU mission card failure exists or the DSU/AMU mission card does not contain GPS waypoints. The XFER option, the cursor arrow options, and the GPS waypoint data are not displayed until valid GPS waypoints have been uploaded from the DSU or the AMU mission card. An asterisk is displayed next to the GPS waypoint data when there are no GPS waypoints. See Figure 23-3.

23.5.6 Built–In–Test Format

The GPS BIT reporting status can be inspected by selecting the BIT display format. In Radar and Night Attack Aircraft the BIT display format is split into two displays, see Figure 23-4. The BIT1 format contains the weapon and sensor subsystem BIT reporting and the BIT2 format contains the communication, identification, and navigation subsystem BIT information. The default BIT display format at power–up with weight–on–wheels is the BIT2 display format. The GPS BIT reporting information, found on the BIT2 format, includes receiver, battery, velocity, and communication status. With H4.0, the BIT format also reports GPS antenna status. The GPS can only be placed into initiated BIT with weight–on–wheels by selecting the GPS pushbutton option. The GPS option is not available with weight–off–wheels.

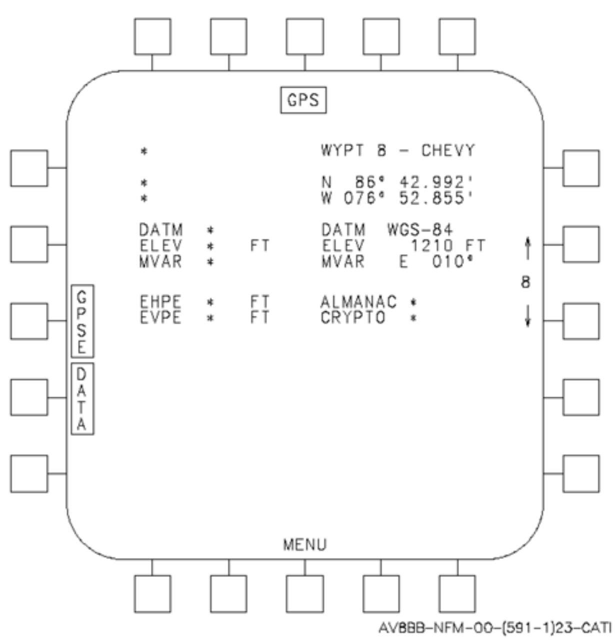


Figure 23-3. GPS Failure and GPS Waypoints Not Present (OMNI 7.1 and C1+ page shown)

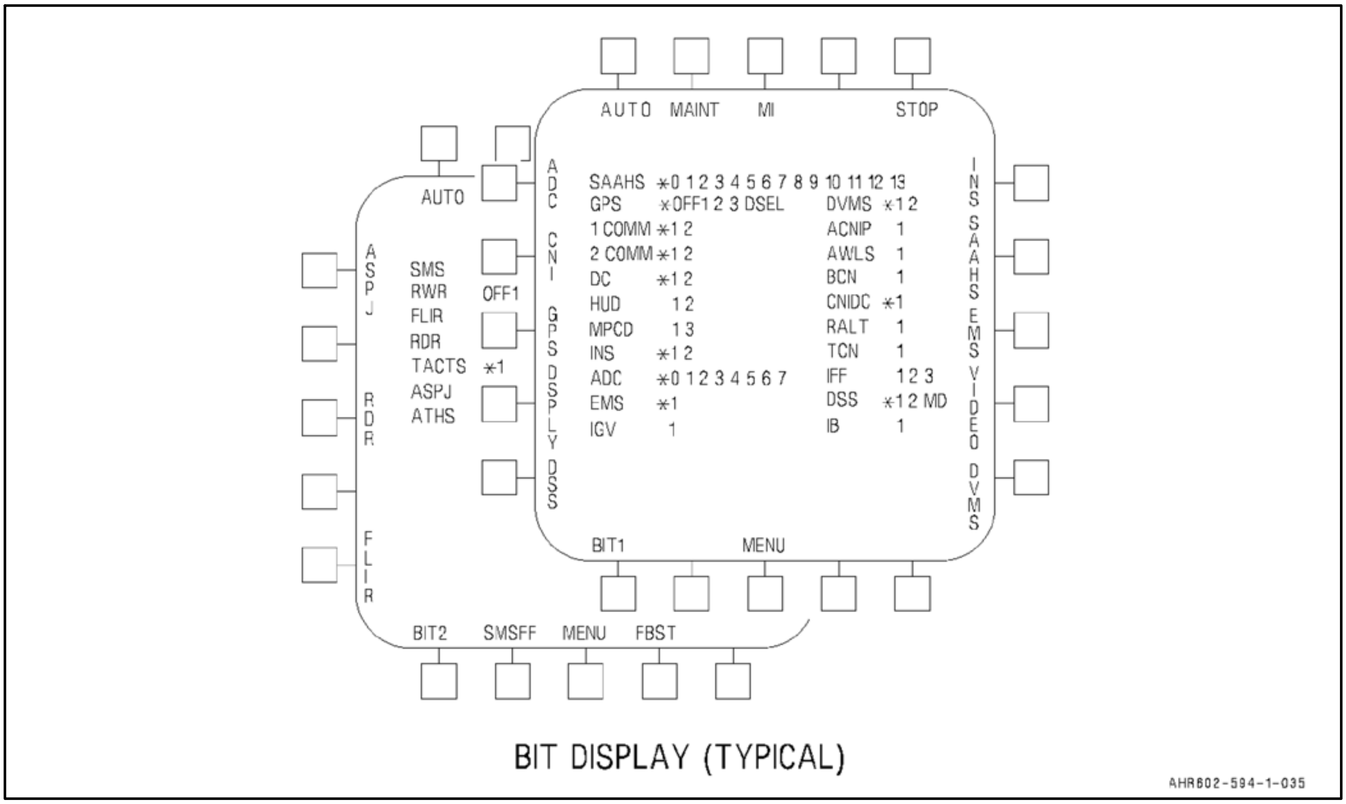


Figure 23-4. GPS Bit (C1+ BIT page shown)

23.5.6.1 GPS BIT Reporting Status

GPS Asterisk (*) – GPS MAGR present but not communicating.

GPS Off – GPS MAGR not present or power off to it.

GPS 1 – GPS Receiver Fail.

GPS 2 – GPS Battery Fail.

GPS 3 – Velocity Reasonableness Test Failure.

GPS 4 – GPS Antenna Fail (H4.0 only).

GPS DSEL – GPS was deselected as the position keeping source during the last flight because GPS data did not meet quality/sanity checks.

23.6 POSITION KEEPING

23.6.1 Aircraft Without GPS

There are two methods of maintaining aircraft present position. INS, which is the primary mode, uses inertial velocities and true heading to maintain present position. ADC position keeping uses true airspeed, magnetic heading, attitude, angle of attack, and pilot entered wind data to keep track of present position. The system automatically initializes to INS position keeping. This is indicated by the DGD/INS nomenclature above the lower right pushbutton on the EHSI/EHSD display. If ADC position keeping is desired, the pushbutton should be pressed to deselect the INS. Also, if the INS velocities are not valid while in INS position keeping, the system automatically reverts to the ADC position keeping mode. When DGD/ADC is selected or reverted to filtered values of ADC true airspeed (TAS) and ADC AOA are used to determine all velocities, and therefore the velocity vector position on the HUD. On radar aircraft INS velocities can be updated using the precision velocity update mode (PVU) of the radar. Refer to A1–AV8BB–TAC–000.

23.6.2 Aircraft With GPS

There are three sources for maintaining aircraft present position. The three sources in order of priority are: INS, GPS, and ADC. The position keeping mode legend on the EHSD (i.e., POS/INS) identifies the navigation sensor that is used to determine aircraft present position. The aircraft position keeping source is pilot selectable by scrolling the pushbutton option on the bottom right of the EHSD display (and also on the EW, STRS, FLIR, DMT and Maverick display formats when in A/G master mode only). At power-up, the aircraft will initialize to ADC position keeping. When the GPS completes initialization, the position keeping mode will automatically upgrade from ADC to GPS. When the INS present position becomes valid, the position keeping mode will automatically upgrade from either ADC or GPS to INS. The MC will automatically upgrade to the best available position keeping mode when the better mode becomes available for the first time following aircraft power-up with weight-on-wheels. The MC also degrades to the next best available position keeping source in the event the current source is deemed erroneous or unavailable. The position keeping mode is selectable independent of the navigation system coupling mode (tightly-coupled or loosely-coupled), with one exception that ADC position keeping is not allowed in a tightly-coupled mode (INS and GPS valid). The navigation system coupling mode, which controls the interface between the GPS and INS, is pilot selectable using the INS mode select switch.

23.6.2.1 Navigation System Coupling Modes

Selecting IFA on the INS mode select switch causes the navigation system to enter into tightly-coupled mode. Whenever the navigation system is in tightly-coupled mode, the POS legend will appear as part of the position keeping mode legend (i.e., POS/INS or POS/GPS).

Tightly-coupled refers to a navigation system in which the GPS is aided by ADC and INS data and continually returns corrections to the INS platform. The aiding data permits the GPS to keep satellite lock and to stabilize the internal Kalman filter. The platform correction data provides the INS with data it can use to better estimate its internal platform errors. A tightly-coupled mode is accessible when: (1) an INS with GPS compatible software is installed in the aircraft, (2) GPS navigation data is valid, and (3) the INS is in either in-flight align mode or aided navigation mode.

Loosely-coupled refers to a navigation system in which the GPS is aided by an external source, but the GPS does not continually provide corrections to the INS platform. Selection of free inertial navigation mode, NAV on the INS mode select knob, causes the navigation system to enter into loosely-coupled mode. In loosely-coupled mode, the INS is not aided by the GPS. Whenever the navigation system is in loosely-coupled or uncoupled mode the DGD (degraded) legend will appear as part of the position keeping mode legend (i.e., DGD/INS, DGD/GPS or DGD/ADC). An uncoupled mode is not selectable by the pilot and is only entered when the INS and ADC, and/or GPS are not providing valid data.

A complete list of definitions of the combinations of navigation system coupling and position keeping modes is given below:

1. POS/INS - Indicates a tightly-coupled navigation system in which the INS is being used as the position keeping source.

2. POS/GPS - Indicates a tightly-coupled navigation system in which the GPS is being used as the position keeping source.

3. POS/ADC - Not a possible configuration.

   IFA
4. POS/INS - Indicates a tightly-coupled navigation system in which the INS is being used as the position keeping source. The INS is currently being aligned inflight using GPS data. (This legend will appear in the final stages of an INS in-flight alignment.)

   IFA
5. POS/GPS - Indicates a tightly-coupled navigation system in which the GPS is being used as the position keeping source. The INS is currently being aligned in-flight using GPS data. (This legend will appear in the initial stages of an INS in-flight alignment.)

IFA

6. POS/ADC – Not a possible configuration.

7. DGD/INS – Indicates a loosely–coupled/uncoupled navigation system in which the INS is being used as the position keeping source.

8. DGD/GPS – Indicates a loosely–coupled/uncoupled navigation system in which the GPS is being used as the position keeping source.

9. DGD/ADC – Indicates a loosely–coupled/uncoupled navigation system in which the ADC is being used as the position keeping source.

10. DGD/blank – Indicates that the navigation system does not have a valid position keeping source. (This mode is not pilot selectable).

In summary:

1. POS – Indicates the INS is automatically updated by GPS data. No manual updates are required.

2. DGD – Indicates the INS is not automatically updated by the GPS. Manual updates are required to limit navigation system errors and INS drift.

23.6.3 Velocity Reasonableness Test

Like the position keeping source, the aircraft velocity source (used for navigation and weapon delivery calculations) is automatically selected by the MC and is based on the best available velocity source. The three sources of aircraft velocity data are, in order of priority, INS, GPS, and ADC. The MC automatically upgrades to the best available velocity source when the better source becomes available. The MC also degrades to the next best available velocity source in the event the current source is unavailable or deemed erroneous by the velocity reasonableness tests. Delta terms are added to aircraft velocity to provide a smooth transition during degradation from using INS to GPS as the velocity source. The choice of velocity source is independent of the navigation system coupling and position keeping mode, with the exception of ADC position keeping mode. When ADC position keeping is selected and the navigation system is loosely–coupled, the ADC is used as the velocity source.

There are three different velocity reasonableness tests: INS vs GPS, INS vs ADC, and GPS vs ADC. For the INS vs GPS velocity reasonableness test to pass, the difference between the INS velocity and the GPS velocity must be 20 ft/s or less. For the INS vs ADC or GPS vs ADC tests to pass the difference between the INS or GPS velocity and ADC true airspeed must be less than a threshold value for wind magnitude. The threshold value value for wind magnitude is altitude dependent. The INS vs GPS velocity reasonableness test must not pass for 5 seconds to be considered failed, and likewise; it must pass for 5 seconds to be considered passed. Both the INS vs ADC and the GPS vs ADC velocity reasonableness tests must not pass for 3 seconds to be considered failed, and likewise; they must pass for 3 seconds to be considered passed.

The best velocity source is indeterminate or unresolved if: 1) all three velocity reasonableness tests fail; 2) the INS velocity is invalid and the GPS vs ADC velocity reasonableness test fails; 3) the GPS velocity is invalid and the INS vs ADC velocity reasonableness test fails; or 4) the ADC velocity is invalid and the INS vs GPS velocity reasonableness tests failed. In the event the best velocity source is indeterminate, the velocity source is tied to the aircraft position keeping source selected by the pilot and VEL? appears above the current position keeping source selected by the pilot. The system automatically degrades to DGD/ADC position keeping source if DGD/ADC is a valid position keeping source.

The pilot is notified as to which velocity sources failed the velocity reasonableness tests on the BIT page. Whenever the INS fails both of its velocity reasonableness tests, a code of 2 is displayed in the INS BIT codes on the BIT page. In addition, the INS caution light on the caution/advisory light panel is lit. The INS caution light is also lit whenever the INS experiences BIT failures or the horizontal velocity from the INS is invalid. A code of 3 is displayed in the GPS BIT codes whenever the GPS fails both of its velocity reasonableness tests. A code of 7 is displayed in the ADC BIT codes whenever the ADC fails both of its corresponding velocity reasonableness tests. These BIT codes are for pilot information only and are not maintenance issues.

Note

While weight-on-wheels, all velocity reasonableness tests are automatically passed, therefore the BIT failures and VEL? are never displayed while weight-on-wheels.

23.7 TACAN SYSTEM

The TACAN system gives precise bearing and/or slant range distance to a TACAN ground station or suitably equipped aircraft. The TACAN system is limited to line of sight range which depends upon aircraft altitude. The maximum operating range is 390 nautical miles when the selected TACAN station is a surface beacon and 200 nautical miles when the selected TACAN beacon is airborne beacon. The aircraft receives a three letter audio station signal to identify the beacon being received. When operating in conjunction with aircraft having air-to-air capability the A/A T/R mode provides the same as A/A REC mode. Additionally, it indicates line of sight distance to the nearest complementary aircraft and transponds up to five complementary aircraft interrogations. A/A REC mode indicates bearing to a suitable equipped aircraft (AWACS, KC 10, etc.).

23.7.1 TACAN Controls and Indicators

The controls and indicators for TACAN operation are on the UFC, ODU, DDI, ACNIP, and on TAV-8B and Day Attack aircraft the HSI. See Figure 23-5.

23.7.1.1 Upfront Control

The pushbuttons and indicators on this control that are used for TACAN operation and display are the TACAN function selector pushbutton (labeled TCN), the ON/OFF selector pushbutton, the EMCON pushbutton, the pushbutton keyboard, and scratch pad.

23.7.1.1.1 TACAN Function Selector Pushbutton

Pressing the TCN pushbutton enables TACAN options to be displayed on the option display windows, enables the TACAN status window on the scratch pad to ON, if TACAN is enabled, and allows the TACAN channel number to be displayed on the scratch pad when entered on the keyboard.

23.7.1.1.2 On/Off Selector Pushbutton

Pressing this pushbutton turns the TACAN system on or off after first pressing the function selector pushbutton.

23.7.1.1.3 Emission Control

Selecting EMCON puts the TACAN in a non-transmitting mode by switching the system to a receive mode if it is in the transmit/receive mode. At the same time, option displays 1 through 5 on the ODU are first blanked when EMCON is selected, then option 1 displays :EMCN. A colon appears to the left of the option to indicate selection. When the pushbutton is pressed again, deselecting EMCON returns the TACAN to its previous operating mode.

23.7.1.2 Option Display Unit

The pushbuttons and indicators on the ODU used for TACAN operation and display are the option select pushbuttons and the option display windows.

23.7.1.2.1 Option Select Pushbuttons

The option select pushbuttons are numbered downward 1, 2, and 3 on the right side, and 4 and 5 on the left side. These pushbuttons select the TACAN mode of operation. When TACAN is enabled, a colon appears to the left of the option display windows to indicate the last mode and channel selection.

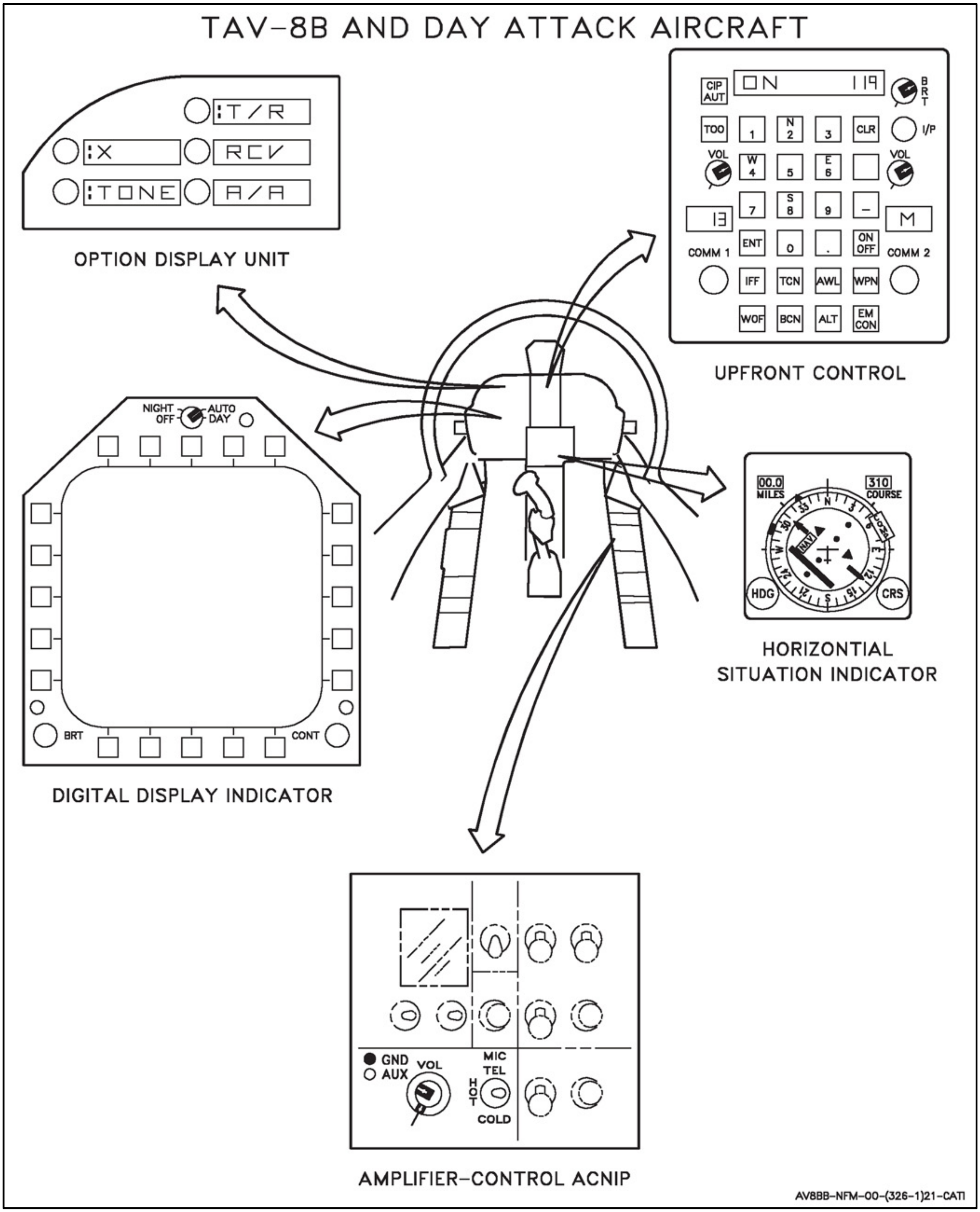


Figure 23-5. TACAN Controls and Indicators (Sheet 1 of 2)

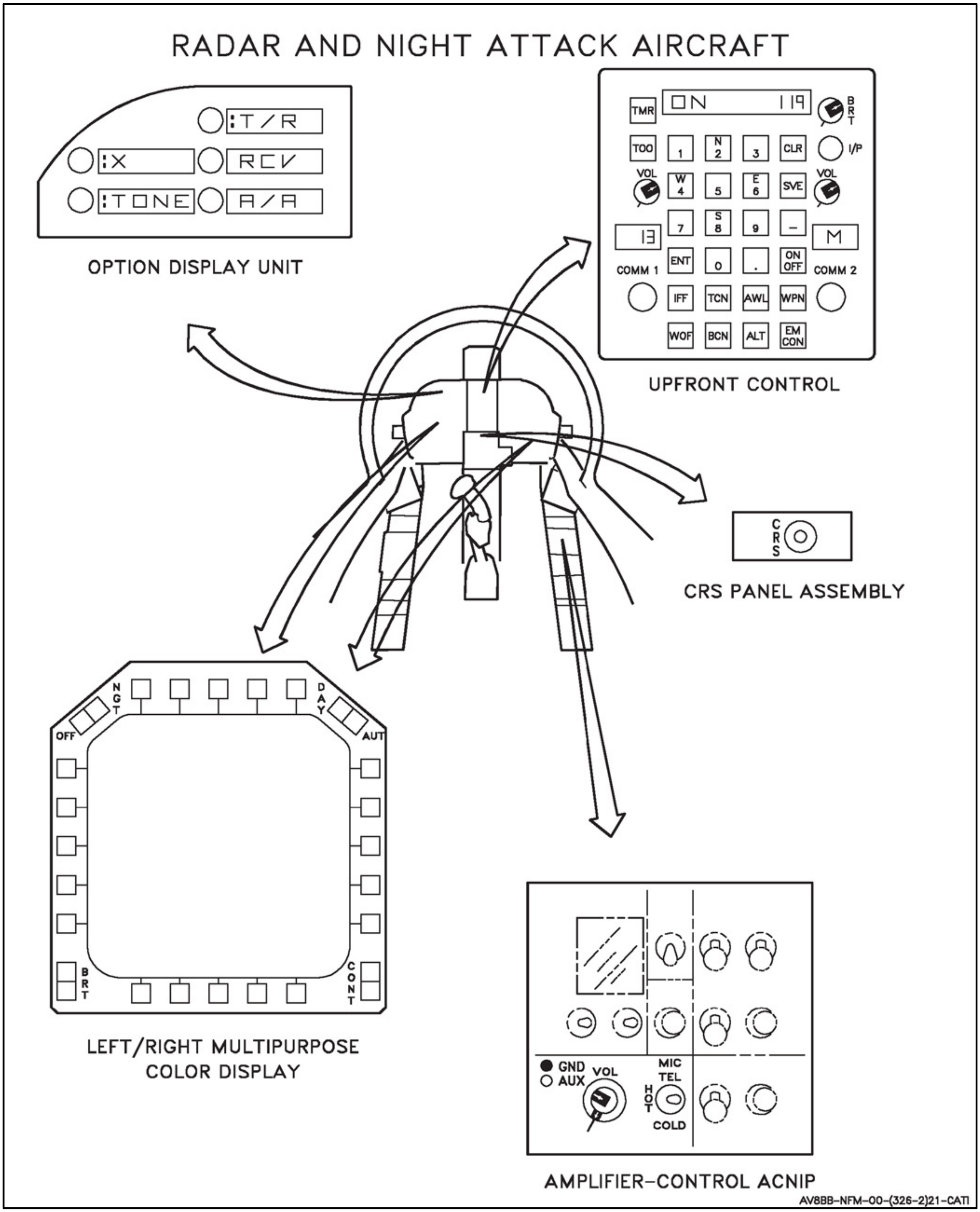


Figure 23-5. TACAN Controls and Indicators (Sheet 2)

1. Option 1. Selecting the :T/R option commands the TACAN Receiver-Transmitter (R/T) to operate in that mode. Air-to-ground range and bearing information is provided by the R/T for display on the DDI (EHSI/EHSD display), the HUD, and on TAV-8B and Day Attack aircraft the HSI. When :T/R is selected range and bearing information is provided by a ground station, when :A/A is selected range and bearing is provided by another aircraft.

2. Option 2. Selecting the :RCV option commands the TACAN R/T to operate in the air-to-ground receive mode. Bearing information is provided by the receiver for display on the DDI (EHSI/EHSD display), the HUD and on TAV-8B and Day Attack aircraft the HSI. The T/R and RCV options are mutually exclusive. In RCV mode only bearing (not range) is provided by the ground station.

3. Option 3. Selecting the :A/A option commands the TACAN R/T to operate in the air-to-air mode. In A/A T/R mode distance information is provided for display on the DDI (EHSI/EHSD display), and on TAV-8B and Day Attack aircraft the HSI. Bearing to a suitably equipped cooperating aircraft (AWACS, KC-10, etc.) is also displayed on the EHSI/EHSD display and on TAV-8B and Day Attack aircraft the HSI. In A/A T/R mode the TACAN R/T transmits a distance replay to an interrogating aircraft. Selecting :A/A again displays :PROX in window 3 and enables A/A TACAN proximity warning. To disable A/A TACAN select :PROX in window 3. Deselecting A/A causes the TACAN to operate in the air-to-ground mode.

4. Option 4. Pressing this pushbutton selects either X or Y channel for R/T operation. The channel number may be entered on the keyboard. Successive pressing of the pushbutton alternates between the X and Y channels.

5. Option 5. Pressing the TONE pushbutton allows the TACAN identification tone to be turned on or off. A colon appears on the left side of the option display window when the tone is enabled.

23.7.1.3 DDI

For TACAN operation, pressing the TCN pushbutton on the DDI turns the TACAN on, if not on, and enables steering data from the digital computer to be displayed on the EHSI/EHSD display on the DDI and the HUD. The symbols, pointers and displays which appear on the DDI are the aircraft symbol, TACAN station symbol, TACAN bearing pointer, TACAN course pointer and various digital TACAN displays. See Figure 23-6. The aircraft symbol represents the aircraft position and the TACAN symbol represents the TACAN station position. The TACAN bearing pointer indicates the bearing to the selected TACAN station. The TACAN course pointer indicates the course to/from the selected TACAN station. The digital TACAN displays which appear on the DDI are the range, bearing, and time-to-go to the station.

23.7.1.4 TACAN Volume Control

The volume control for the TACAN identification tone (when tone is enabled) is on the ACNIP. The control used for TACAN volume is the outer knob (AUX).

23.7.1.5 Course Set Control (TAV-8B and Day Attack)

The course set knob on the HSI on the main instrument panel is used to set a course for steering to or from the TACAN station.

CAUTION

The course line displayed on the EHSI/EHSD and the course in the course selector window of the HSI is not necessarily the same. The bearing displayed in the course line data block in the lower right corner of the EHSI/EHSD and the course line displayed on the EHSI/EHSD should be used instead of the bearing in the course selector window of the HSI. See Figure 23-6.

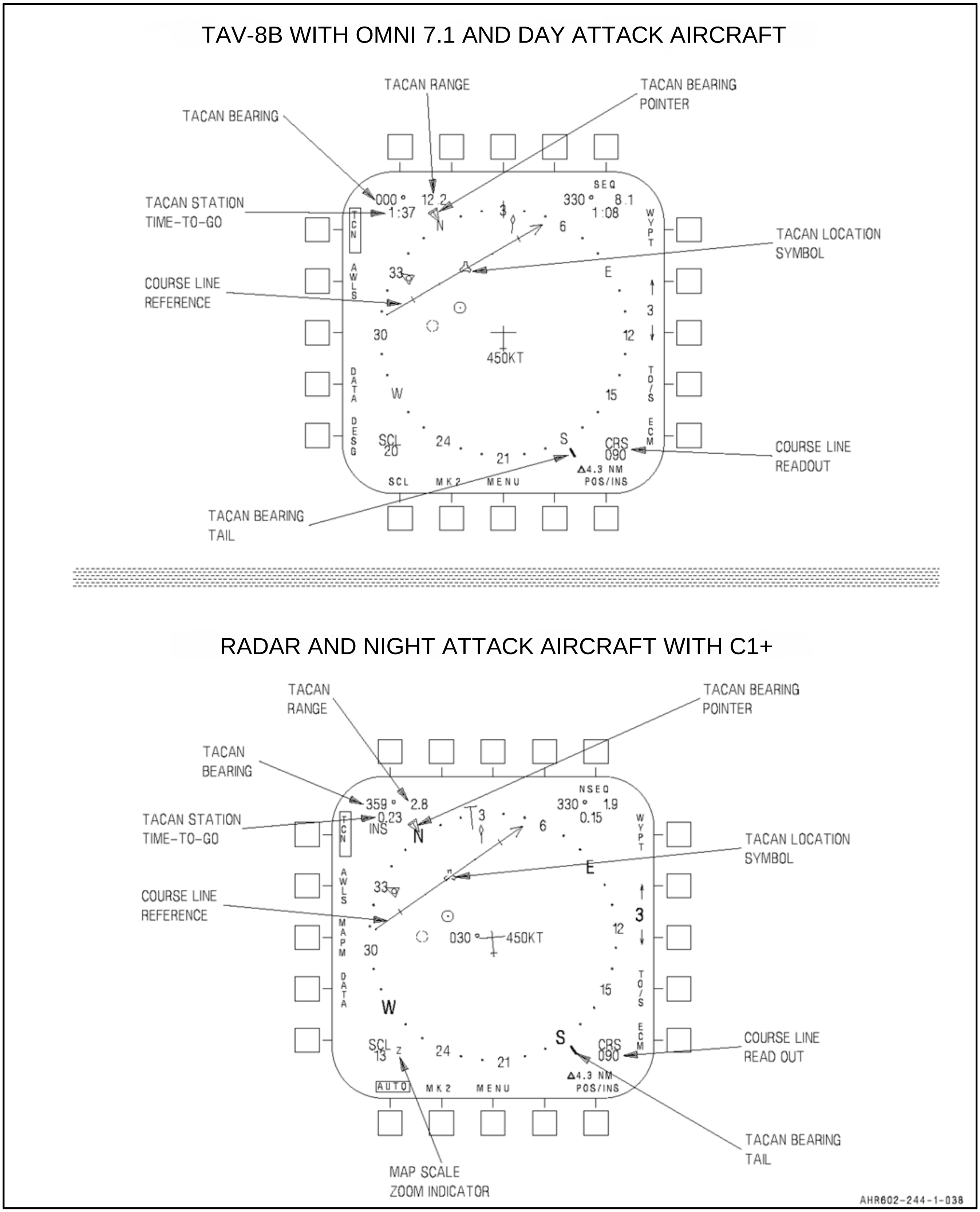


Figure 23-6. TACAN Display

23.7.1.6 Course Set Switch (Radar and Night Attack Aircraft)

The course set switch is on the CRS panel assembly on the main instrument panel (see Figure 23-5). This switch is used to set a course for steering to or from the TACAN station when TACAN steering is selected. Holding the switch to the right slews the course arrow in a cw rotation, to the left a ccw rotation.

23.7.2 TACAN BIT Checks

To perform an initiated TACAN BIT check, press the BIT pushbutton on the DDI menu display to initiate a BIT display. Press the CNI pushbutton and the word TEST appears next to TCN. After about 25 seconds the word TEST disappears. If a number one then appears next to TCN the TACAN has failed the BIT check. If the space next to TCN remains blank the TACAN has checked good.

23.7.3 TACAN and TACAN Offset Data

The pilot has the option of programming an offset for the selected TACAN station. TACAN offsets can be utilized for area navigation on cross country flights. This allows the aircraft to fly a great circle route between two distant points when the appropriate TACAN stations are not geographically located along the direct line of flight.

23.7.4 TACAN Data Entry

TACAN station data is stored for five TACAN stations. TACAN channel, position, elevation, and magnetic variation are stored in the mission computer for use in updating the INS. Navigation can not be performed using the stored TACAN information. On the DDI, press the EHSI/EHSD and then the DATA pushbutton. The WYPT data is displayed. Press the TCN pushbutton and the DDI shows the TACAN data display. Pressing the down arrow or up arrow pushbutton changes the TACAN station number (0 through 4). The option display unit and the upfront control are used to manually enter TACAN data, as follows:

1. On the option display unit, press the CH X or CH Y (channel) option pushbutton.

   A colon appears to the left of the option display window. If X is displayed, press CH X pushbutton again and Y is displayed.

2. Type desired new channel on keyboard, then press ENT. Channel number appears on scratch pad.

3. Press POS (position) option pushbutton.

   A colon appears to the left of the option display window. Stored latitude of selected TACAN channel is displayed.

4. Type N or S on keyboard, then type desired new latitude and press ENT.

   If N093105 is typed, the scratch pad blanks momentarily and then displays N 09°31’05’’. Six numerics must be entered for a degrees-minutes-seconds entry. The TACAN latitude may be entered to the thousandth of a minute. If N0931.083 is typed, the scratch pad blanks momentarily and then displays N 09°31.083’. A minimum of four numerics must be entered before the system will accept the entry.

5. Press POS option pushbutton.

   A colon appears to the left of the option display window. Stored longitude of selected TACAN channel is displayed.

6. Type E or W on keyboard, then type desired longitude and press ENT.

   Scratch pad blanks momentarily and then displays new longitude. Seven numerics must be entered for a degrees-minutes-seconds entry. The TACAN longitude may be entered to the thousandth of a minute. A minimum of five numerics must be entered before the system will accept the entry.

7. Press ELEV option pushbutton.

   A colon appears to the left of the option display window. Stored elevation of the selected TACAN channel is displayed.

8. Type elevation in feet, then press ENT.

   Elevation display blanks momentarily on scratch pad and then new elevation is displayed.

9. Press MVAR option pushbutton.

   A colon appears to the left of the option display window. Stored magnetic variation of the selected TACAN channel is displayed. If there is no stored magnetic variation for the selected TACAN then the scratch pad will be blank.

10. Type E or W and two digits, then ENT.

    Magnetic variation display blanks momentarily on scratch pad, then new magnetic variation is displayed. The magnetic variation must always be typed as 2 digits. For 9° east type E 09. With H4.0, it is possible to enter the magnetic variation to the nearest tenth of a degree.

23.7.5 TACAN Offset Data Entry

The selected TACAN has an associated offset capability. TACAN selection on the DDI EHSI/EHSD display changes the waypoint offset (WO/S) option legend to the TACAN offset (TO/S) option legend. Selecting the TO/S option boxes the legend and displays the currently selected TACAN offset on the DDI within the compass rose, changes the waypoint data block to reflect current TACAN offset data, and displays the TACAN offset bearing and range options on the ODU. The BRG (bearing) option initializes selected (cued) and the last entered value is displayed on the scratch pad. The TO/S options are mutually exclusive with respect to UFC usage. Selecting an option on the ODU automatically deselects the current option. The new selection is cued and the last entered data is displayed on the scratch pad. The pilot enters TACAN offset data in terms of bearing and range from the associated TACAN. TACAN offset data entry is as follows:

1. On the option display unit, press the BRG (bearing) option pushbutton.

   A colon appears to the left of the option display window.

2. Type bearing in degrees magnetic, then press ENT.

   Enter bearing in increments of 0.01°. Entry of leading zeroes is not required.

3. On the option display unit, press the RNG (range) option pushbutton.

   A colon appears to the left of the option display window.

4. Type range in nautical miles , then press ENT.

   Entries up to 999.999 nautical miles with 0.001 precision may be entered.

23.7.6 TACAN Steering

In TACAN steering, the pilot’s display shows the aircraft’s situation relative to the TACAN station. TACAN steering is selected by pressing the TCN pushbutton on the EHSI/EHSD display. When TACAN steering is selected, the TACAN option is boxed (see Figure 23-7) and the commanded heading marker (bug) on the HUD heading scale shows relative bearing. The heading bug is corrected for drift. DME slant range is shown on the bottom right of the HUD display. The bearing to the station is indicated by the pointer outside the compass rose. A digital readout of bearing and distance to the station is provided in the upper left corner of the EHSI/EHSD display. Time to go to the station in minutes and seconds is provided under the bearing and distance. Once the heading bug is positioned straight ahead, heading is maintained to fly directly to the TACAN station.

The mission computer uses the elevation and magnetic variation from the stored TACAN information to calculate the position of the TACAN station on the EHSI/EHSD page and the steering information on the EHSI/EHSD page and HUD. If the information for the selected TACAN is not stored in the mission computer, a default elevation of 0 FT MSL and the aircraft's current magnetic variation are used instead.

CAUTION

The mission computer uses the TACAN channel to search for the stored information, instead of the unique three letter station ID. It is possible that the system can mistakenly use the elevation and magnetic variation belonging to a different TACAN station that happens to use the same channel number as the currently selected TACAN. An incorrect stored magnetic variation will result in erroneous TACAN steering information.

To fly a selected course to or from a TACAN station, the course is set in with the course set knob on the HSI (TAV-8B and Day Attack aircraft) or course set switch (Radar and Night Attack aircraft). The course appears on the bottom right of the EHSI/EHSD display. A course line also appears on the display. The course line's rate of movement is used to anticipate when to turn to intercept the course.

CAUTION

In the TAV-8B and Day Attack aircraft, the course line displayed on the EHSI/EHSD and the course in the course selector window of the HSI is not necessarily the same. The bearing displayed in the course line data block in the lower right corner of the EHSI/EHSD and the course line displayed on the EHSI/EHSD should be used instead of the bearing in the course selector window of the HSI. See Figure 23-6.

23.7.7 TACAN Offset Steering

TACAN offset steering (see Figure 23-7) may be used to steer to or away from an offset selected from any TACAN station. The associated TACAN must be in the T/R mode and the aircraft operating in the NAV or V/STOL master mode. TACAN offset steering is selected in the same manner as TACAN steering except that TO/S option must be selected after selecting TCN. After selecting TO/S, enter the bearing and range of the offset from the TACAN station selected. When TO/S is boxed, the TACAN bearing pointer stays on the bearing of the selected TACAN station, the offset bearing pointer rotates around the inside of the compass rose to the bearing of the TO/S from the aircraft. The waypoint data in the upper right corner of the EHSI/EHSD display changes to reflect TO/S data for the TACAN station selected. A course to the TACAN offset may be selected in the same manner as described for TACAN steering. When TACAN offset steering is selected a bearing bug is displayed on the HUD. Ground range to the offset in nautical miles is indicated next to the TO/S legend on the HUD. If EMCON is selected, TACAN offset data is removed from the HUD and EHSI/EHSD display.

23.7.8 TACAN Cone of Confusion (H4.0 Only)

The TACAN steering data on the EHSD page is displayed using green symbology during the initial power up BIT and anytime the aircraft calculates that it is within a 60 degree half angle cone (from the vertical) positioned at the calculated TACAN position. A green CC legend also appears next to the TACAN range in the TACAN steering block.

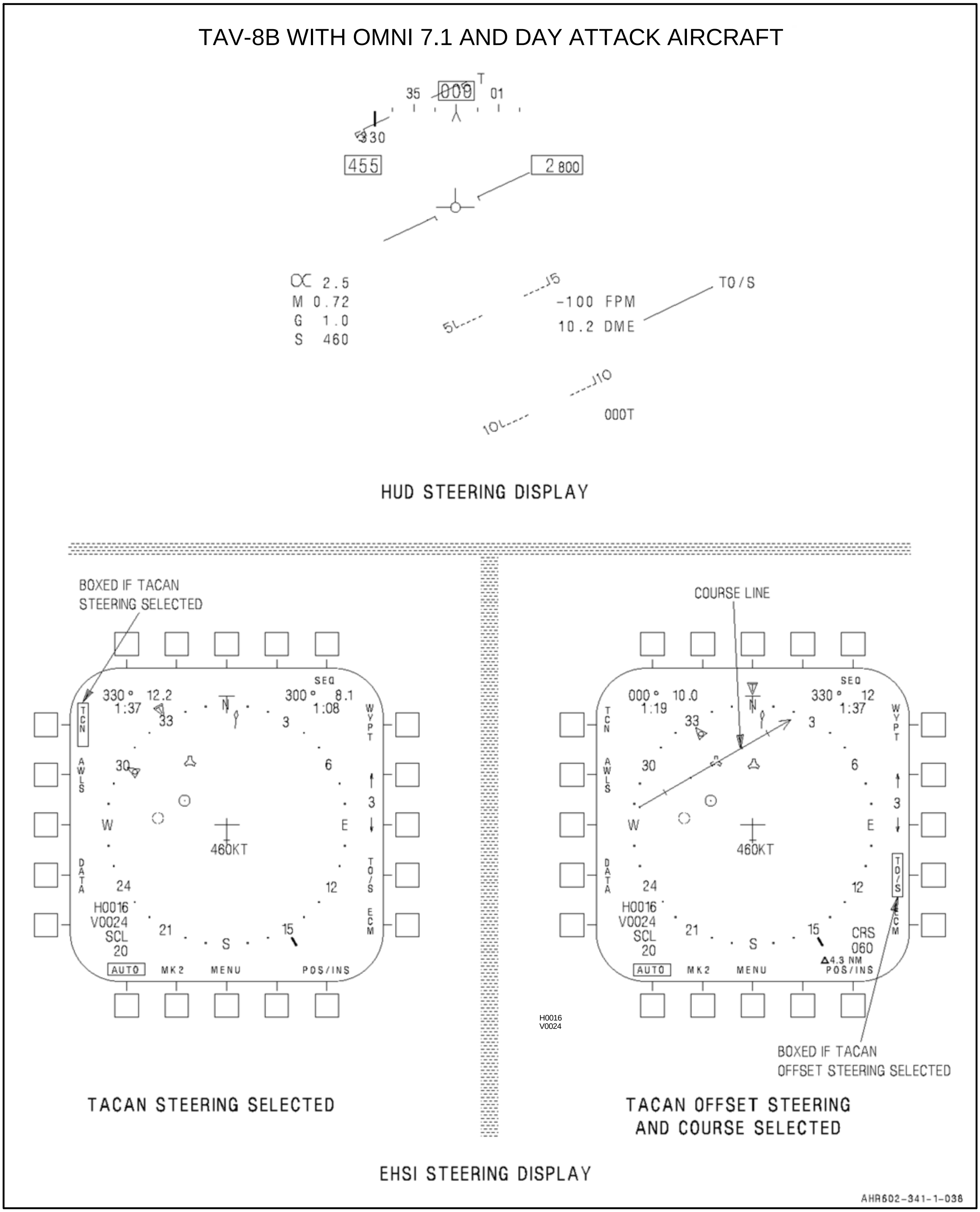


Figure 23-7. TACAN or TACAN Offset Steering (Sheet 1 of 3)

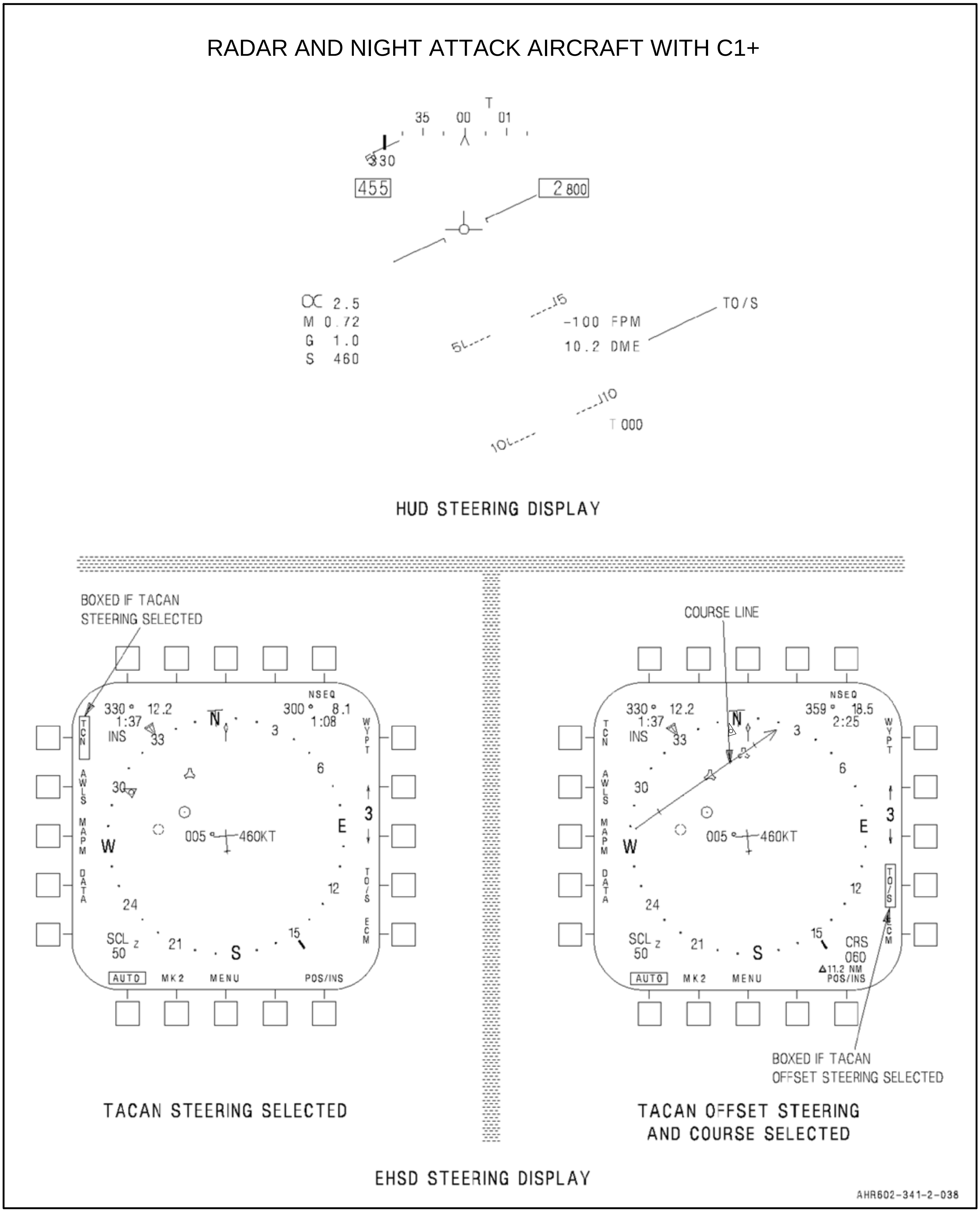


Figure 23-7. TACAN or TACAN Offset Steering (Sheet 2)

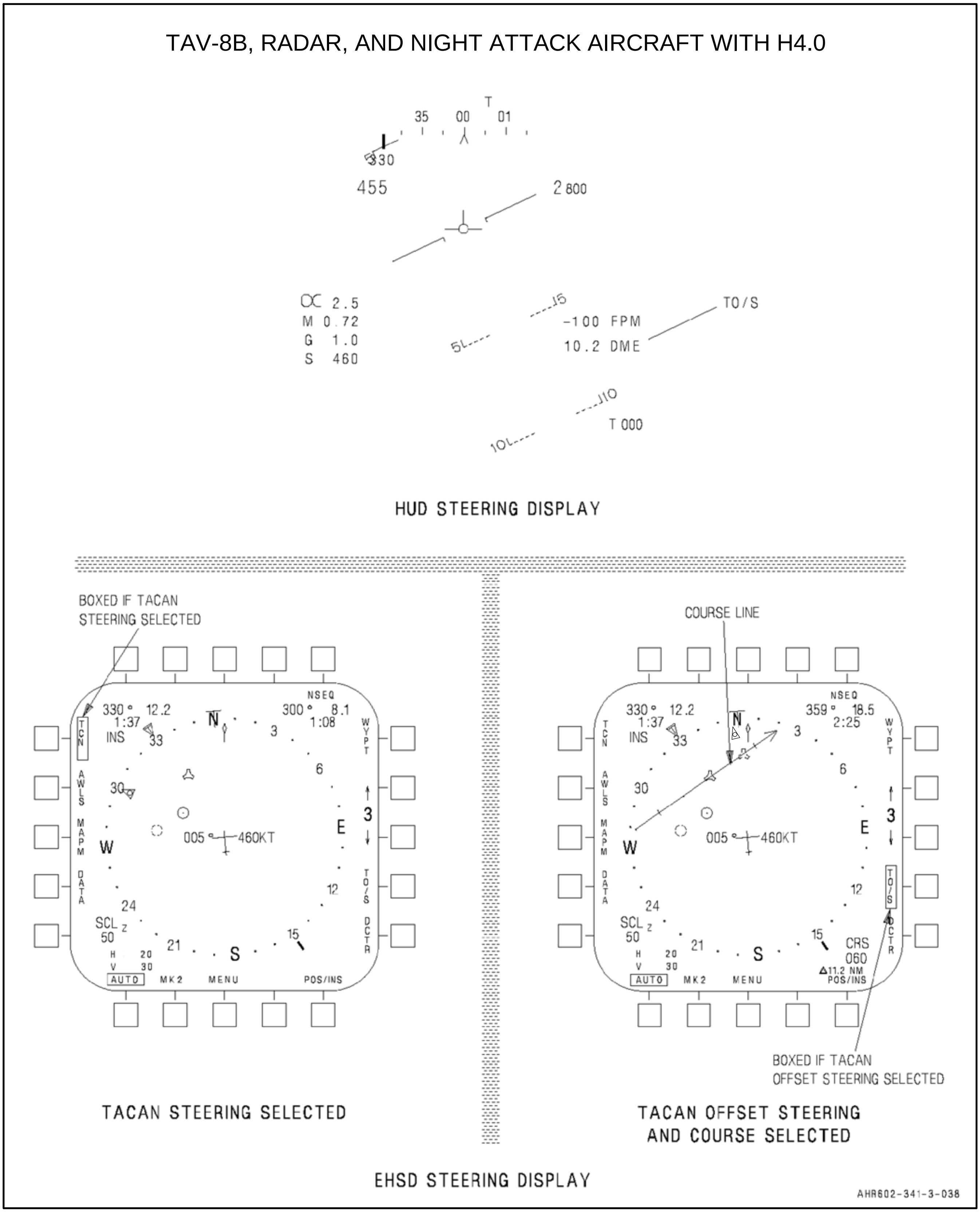


Figure 23-7. TACAN or TACAN Offset Steering (Sheet 3)

23.8 ALL WEATHER LANDING SYSTEM

The all weather landing system (AWLS) provides the aircraft with steering information to fly a selected glideslope and localizer. The AWLS operates in conjunction with a ground system which provides azimuth and elevation angle information along with range derived from TACAN DME. AWLS steering provides situation steering displays on the HUD, representing aircraft position to maintain the localizer and selected glideslope. The azimuth steering bar is displayed when the azimuth signal is valid. The elevation steering bar is displayed only when both elevation and azimuth signals are valid. DME range is displayed when valid TACAN signals are present. Azimuth and elevation offsets can be entered by the pilot if required to offset the steering signals to a station offset.

An obstacle clearance warning is provided when the aircraft descends below a predetermined elevation angle set on the ground station. When the AWLS senses it is at or below the obstacle clearance angle, the elevation bar on the HUD flashes at a 2 Hz rate. On AV-8B 161573 through 163518, TAV-8B 162747 through 163207, in addition, when the obstacle clearance region is first entered a warning tone is generated for 3 seconds. The warning consists of a 1000 Hz tone pulsed at a 1 Hz rate (same as radar altimeter LAW tone). On AV-8B 163519 and up, TAV-8B 163856 and up, an OBSTACLE, OBSTACLE voice warning is provided in conjunction with the flashing elevation bar on the HUD.

23.8.1 Controls and Indicators

Controls and indicators for the AWLS include the upfront control, the option display unit, the DDI, and the HUD (see Figure 23-8).

23.8.1.1 Upfront Control

The pushbuttons and indicators on this control that are used for AWLS operation and display are the AWLS function selector pushbutton (labeled AWL), the on/off selector pushbutton, the pushbutton keyboard, and the scratch pad.

23.8.1.1.1 AWLS Function Selector Pushbutton

Pressing the AWL pushbutton enables AWLS and displays the options associated with the AWLS system on the ODU. The AWLS system will initialize on an AWLS channel and display the previously entered channel on the scratch pad.

23.8.1.1.2 On/Off Selector Pushbutton

Pressing this pushbutton turns AWLS on or off after first pressing the AWLS function selector pushbutton. When AWLS is first turned ON, the system goes through a 10 second warm-up and is commanded by the MC to perform an AWLS BIT (15 seconds). Selection of AWLS on the DDIs EHSI/EHSD display also turns on the system.

23.8.1.2 Option Display Unit

The pushbuttons and indicators on this panel are the option select pushbuttons and the option display windows.

23.8.1.2.1 Option Select Pushbuttons

The option select pushbuttons are numbered downward 1, 2, and 3 on the right side, and 4 and 5 on the left side. A colon displayed on the left side of an option display window indicates that option has been selected on the pushbutton.

1. Option 1. Displays the current AWLS ground station channel (CH 1 through 20). When the option is enabled, the channel number appears on the scratch pad and the keyboard can be used to change channel number.

2. Option 2. Displays the letters GS. When the option is enabled, the scratch pad also displays the current glideslope and allows the keyboard to be used to change glideslope (2° to 6° with resolution to 0.1°).

3. Option 3. Displays the letters AZ (Azimuth). When the AZ option is selected, the scratch pad displays the current azimuth offset and the keyboard can be used to change the value. Azimuth offsets up to ±310 feet in 1 foot increments can be entered. Minus numbers mean centerline of runway is left of AWLS station and positive numbers mean centerline of runway is right of the AWLS station. Zero is a valid azimuth offset entry.

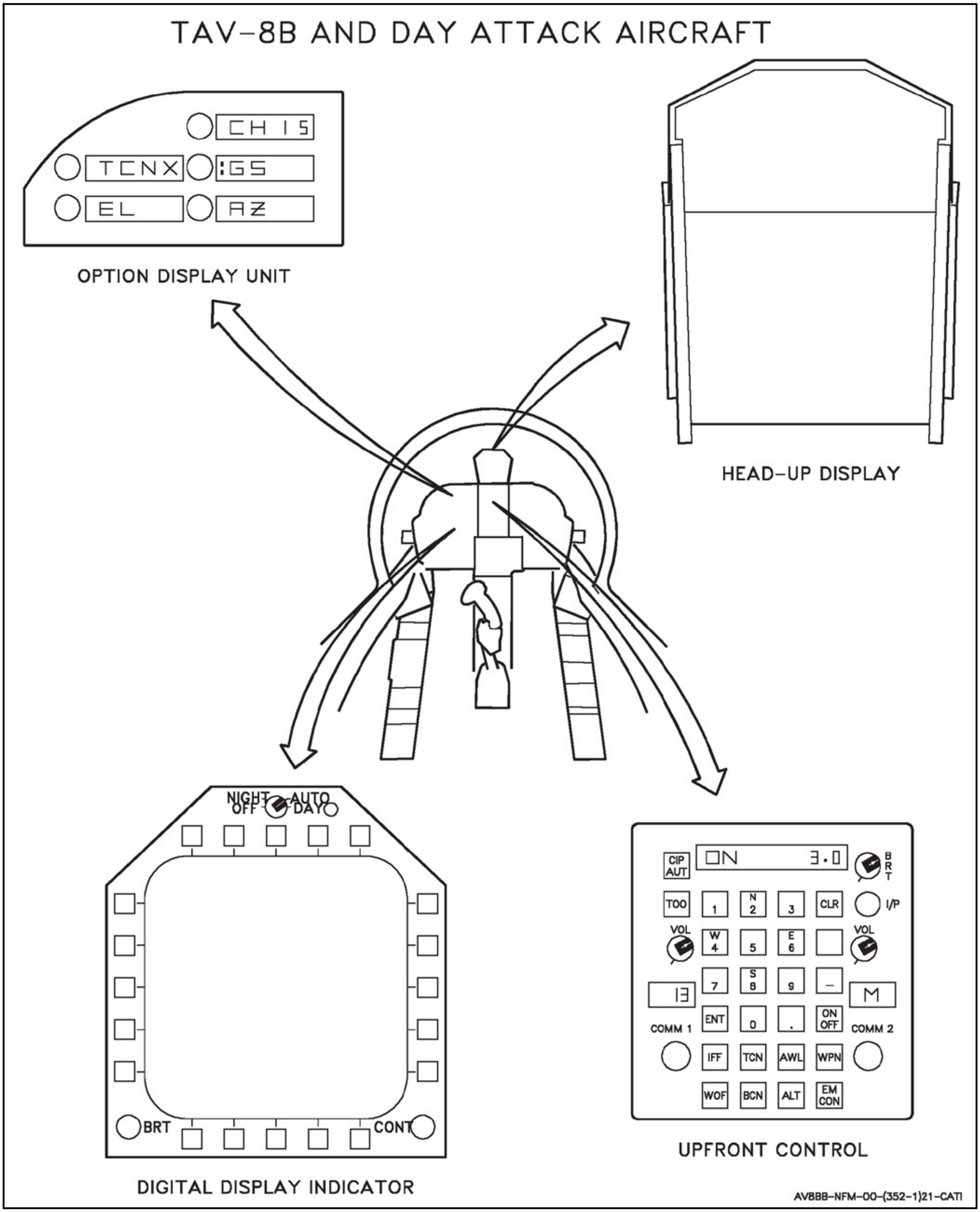


Figure 23-8. AWLS Controls and Indicators (Sheet 1 of 2)

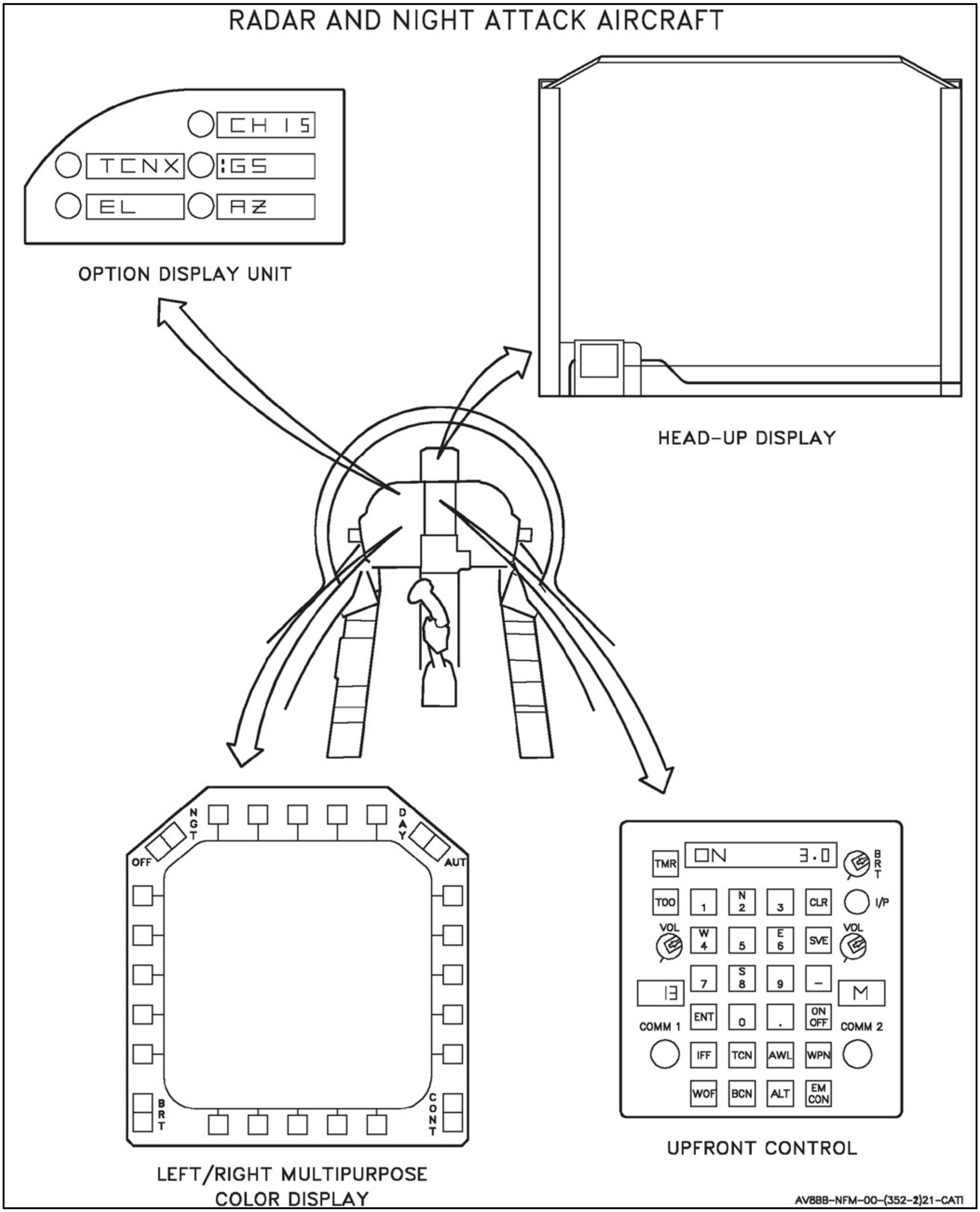


Figure 23-8. AWLS Controls and Indicators (Sheet 2)

4. Option 4. Displays the letters :TCNX or :TCNY. Successive pressing of the option 4 pushbutton alternates X and Y and displays the TACAN channel number on the scratch pad and current X and Y selection in window 4.

5. Option 5. Displays the letters EL (Elevation). When the EL option is selected, the scratch pad displays the current elevation offset and the keyboard can be used to change the value. Elevation offsets up to 31 feet in 1-foot increments can be entered. Zero is a valid azimuth or elevation offset entry. Offsets are automatically zeroed upon changing AWLS stations.

23.8.1.3 DDI

If the DDI does not have a menu displayed, press the menu pushbutton. Then press the EHSI/EHSD pushbutton to obtain an EHSI/EHSD display. On the display, press the AWLS pushbutton and AWLS is displayed in a box (see Figure 23-9). AWLS steering mode is now selected and the AWLS display is seen on the HUD if in the guidance beam. Selection of the AWLS steering mode activates the AWLS and the TACAN, and tunes the TACAN to the preselected channel. Selection of AWLS also deselects any other steering mode.

To prevent the TACAN from remaining in the channel associated with AWLS steering after AWLS steering deselection, the TACAN channel prior to selecting AWLS steering is automatically saved. This TACAN channel is restored when AWLS steering is deselected.

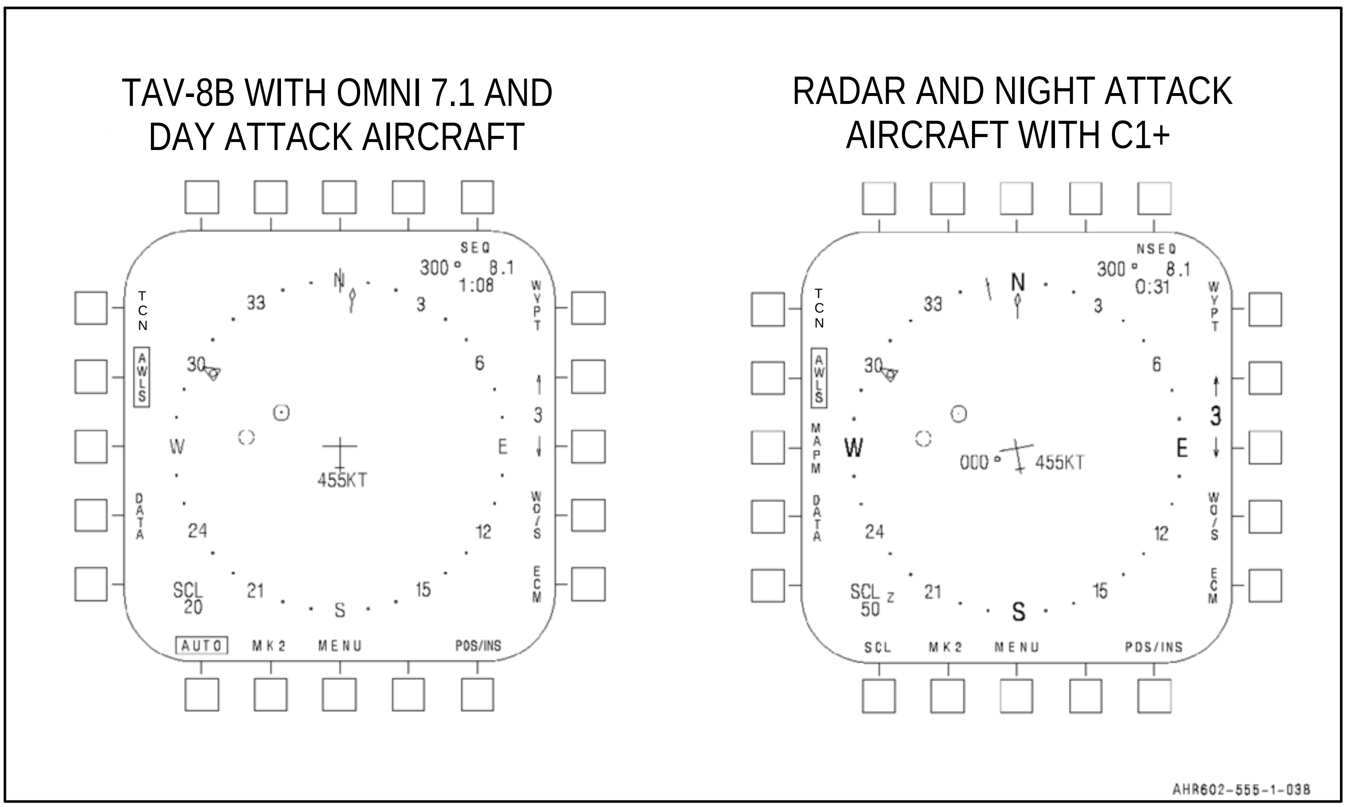


Figure 23-9. AWLS DDI Steering Displays

23.8.1.4 HUD

TACAN or waypoint steering can be initially selected by the pilot until the 40° wide and 20° high guidance beam is intercepted, at which time the pilot can select AWLS steering. When the beam is acquired, a vertical azimuth steering bar and a horizontal elevation steering bar are displayed (see Figure 23-10). Both bars are referenced to the velocity vector in the NAV mode and to the vertical flightpath symbol in the VSTOL mode. The azimuth bar represents aircraft azimuth angle from the localizer and the horizontal bar represents elevation angle from glideslope. Full deflection of the steering bars on the HUD represents ±2° for elevation and ±6° for azimuth. Azimuth steering reference marks are provided adjacent to the velocity vector/vertical flightpath symbol when the AWLS steering mode is selected. The reference markers denote 3° and 6° steering deviation (left and right).

The OFST (offset) legend appears when the azimuth and elevation steering bars are referenced to a station offset. If the TACAN DME or offset data becomes invalid, the OFST legend is removed and steering reverts to beam centerline.

Glideslope angles of less than 2° or in excess of 6° should not be used. The pilot must keep the elevation bar centered on the velocity vector to fly the selected glideslope.

23.8.2 AWLS BIT Check

To perform an initiated AWLS BIT check, press the BIT pushbutton on the DDI menu display to initiate a BIT display. Press the CNI pushbutton and the word TEST appears next to AWLS. After approximately 15 seconds the word TEST disappears. If a number then appears next to AWLS the system has failed the BIT check. If the space next to AWLS remains blank the system has checked good. AWLS initiated BIT is commanded automatically when AWLS power is turned on.

23.9 NAVIGATION CONTROLS AND INDICATORS

The symbols and digital readouts that normally appear on the DDI display (see Figure 23-11 through Figure 23-14) are discussed below. Targetpoints and the EW page are only available with H4.0.

23.9.1 Aircraft Symbol

The aircraft symbol represents the position of the aircraft.

23.9.2 Bearing Pointer

The bearing pointer indicates bearing to the selected waypoint, markpoint, targetpoint, waypoint/markpoint offset or TACAN offset. With C1+, the bearing pointer does not indicate bearing to the TACAN offset.

23.9.3 Waypoint, Markpoint or Targetpoint Location Symbol

A circle represents the location of the selected waypoint or markpoint. With H4.0, triangles represent the location of all targetpoints (except T0) currently within the compass rose, not just the selected targetpoint. Small numbers next to each triangle identify the targetpoints.

23.9.4 Bearing (Upper Right Digital Readout)

This readout indicates the bearing to the selected waypoint, markpoint, targetpoint, waypoint/markpoint offset, TACAN offset, or designated point. With C1+, the bearing does not indicate bearing to the TACAN offset.

23.9.5 Range (Upper Right Digital Readout)

This readout indicates the ground range to the selected waypoint, markpoint, targetpoint, waypoint/markpoint offset, TACAN offset, or designated point. With C1+, the range does not indicate ground range to the TACAN offset.

23.9.6 Time-to-Go (Upper Right Digital Readout)

This readout indicates the time-to-go to the selected waypoint, markpoint, targetpoint, waypoint/markpoint offset, TACAN offset, or designated point. With C1+, the time-to-go does not indicate time-to-go to the TACAN offset.

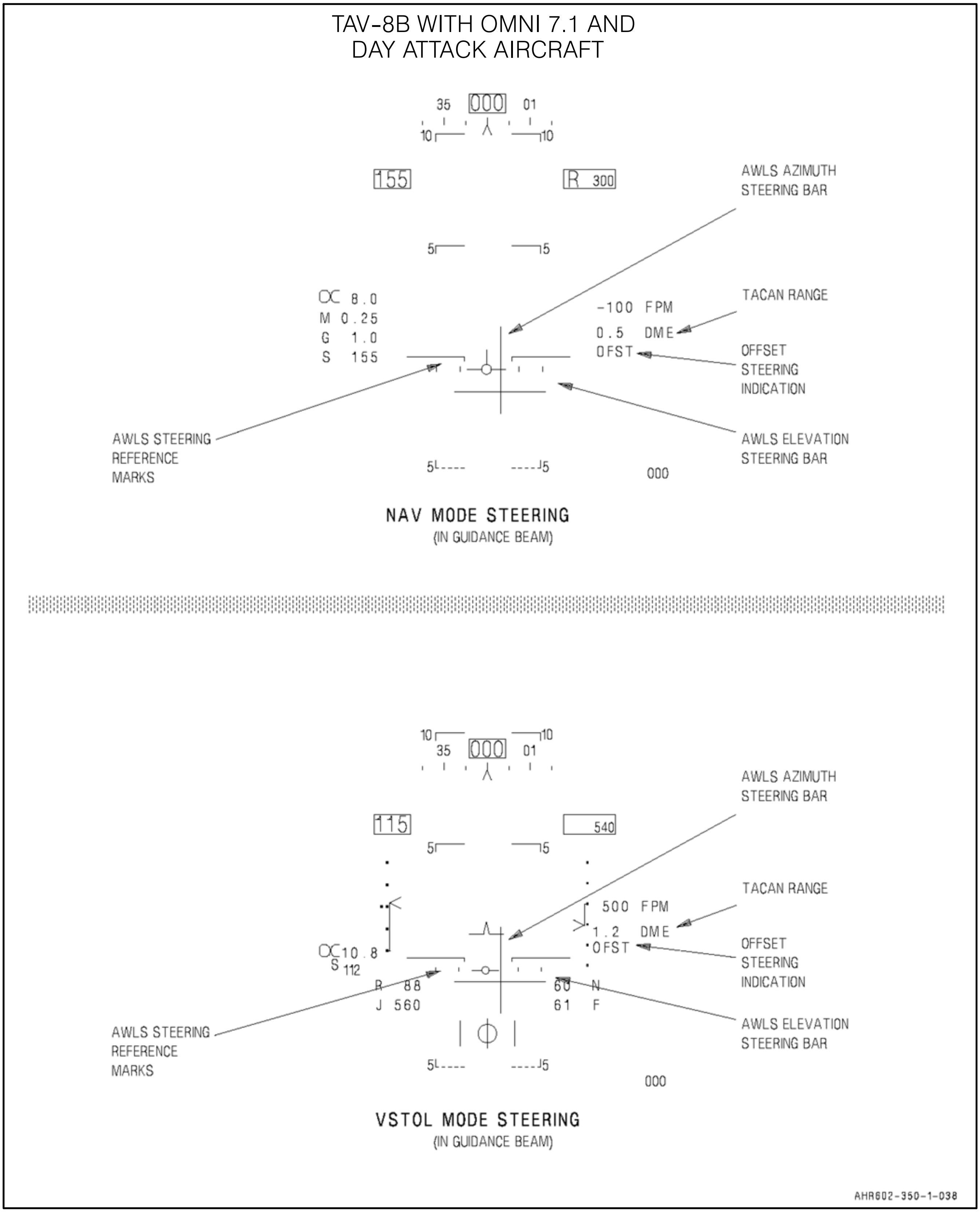


Figure 23-10. AWLS HUD Steering Displays (Sheet 1 of 2)

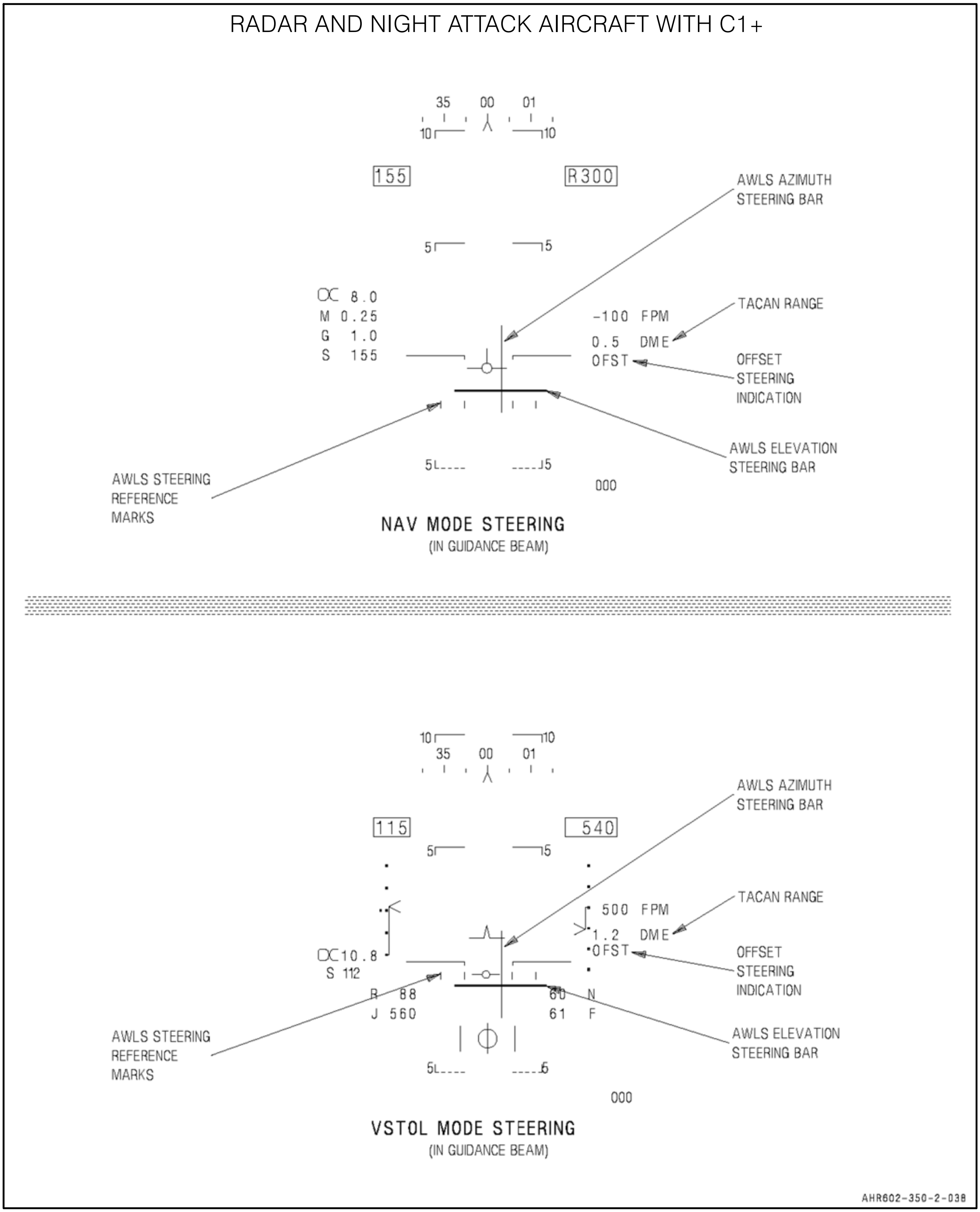


Figure 23-10. AWLS HUD Steering Displays (Sheet 2)

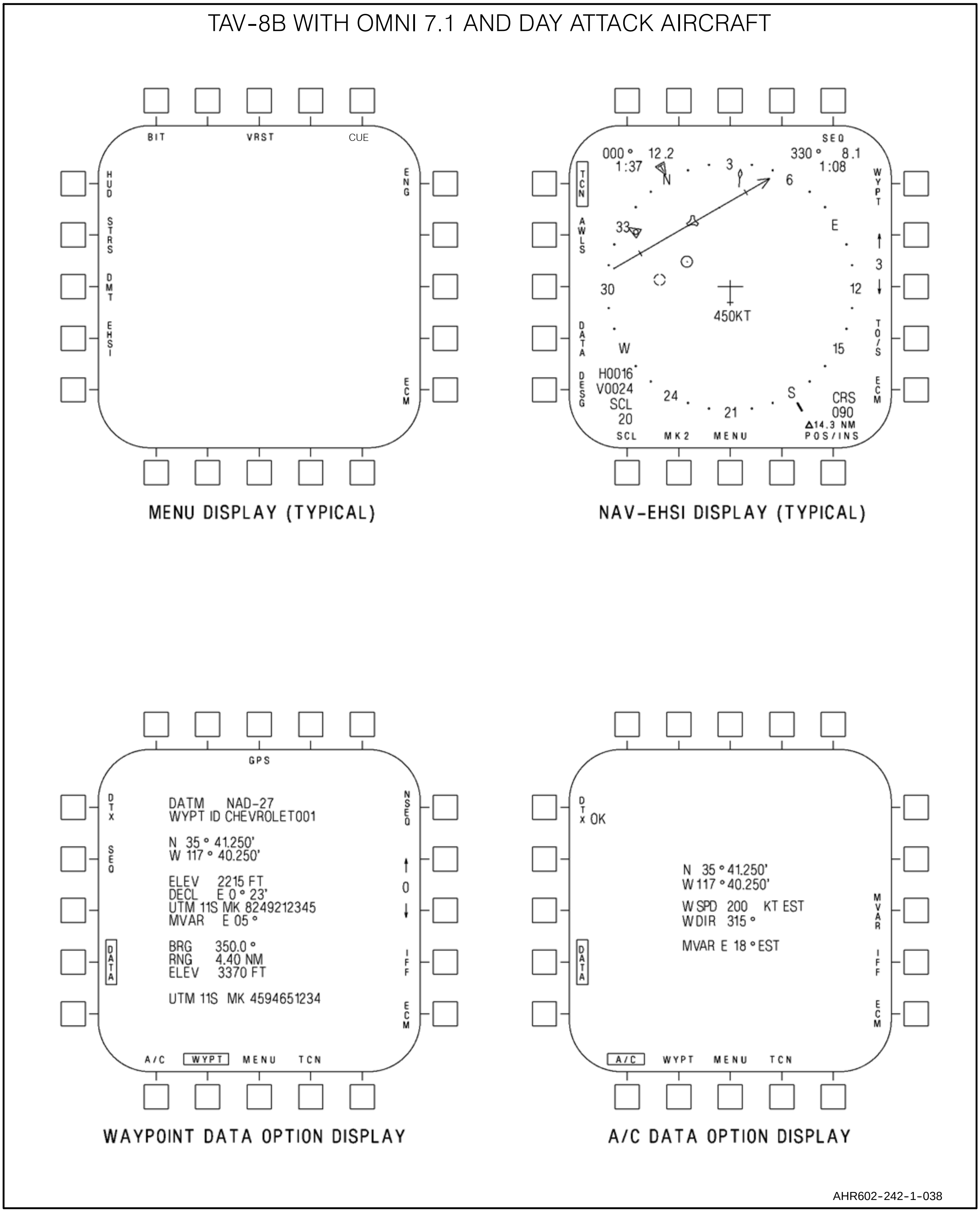


Figure 23-11. Navigation Controls and Indicators (Sheet 1 of 5)

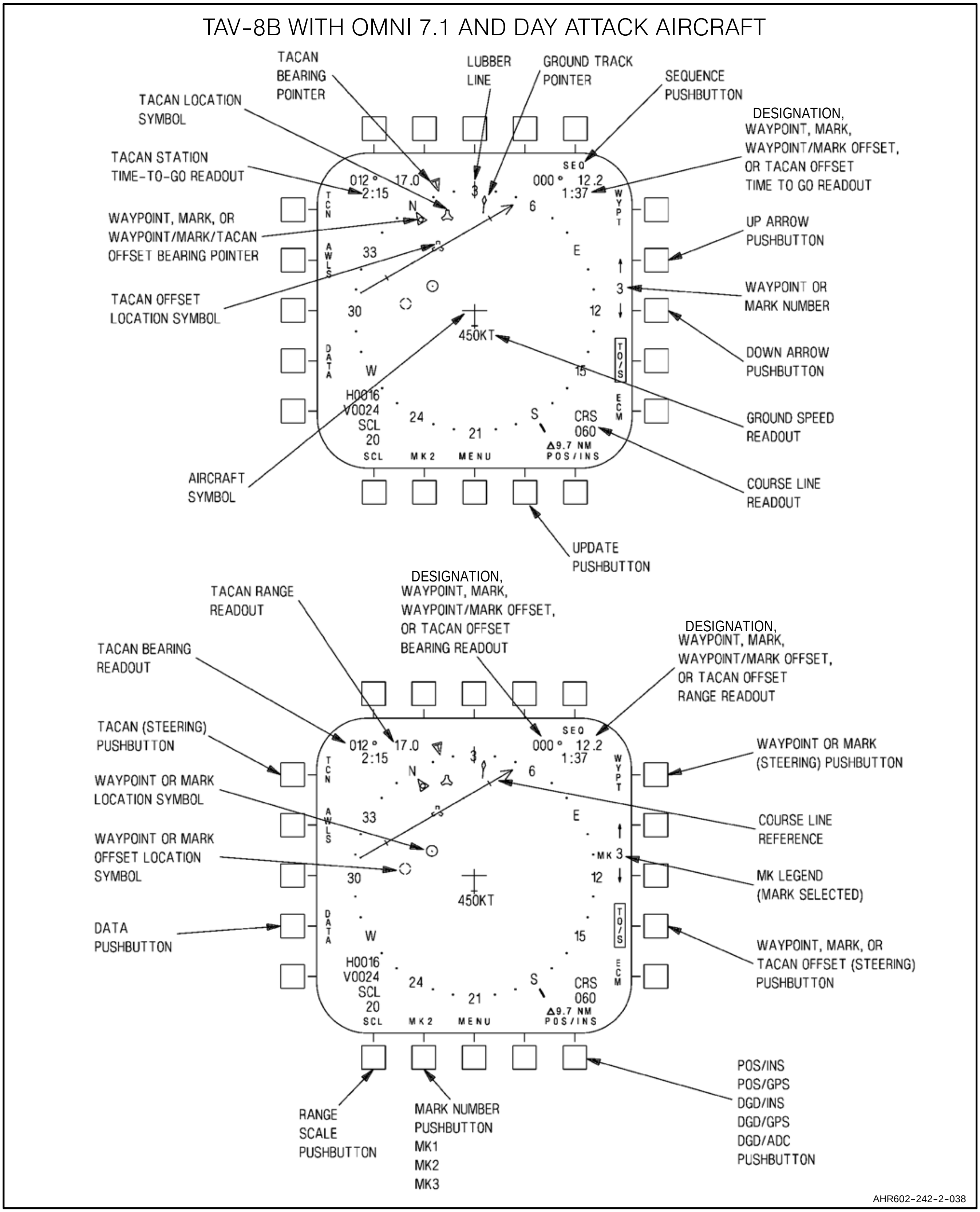


Figure 23-11. Navigation Controls and Indicators (Sheet 2)

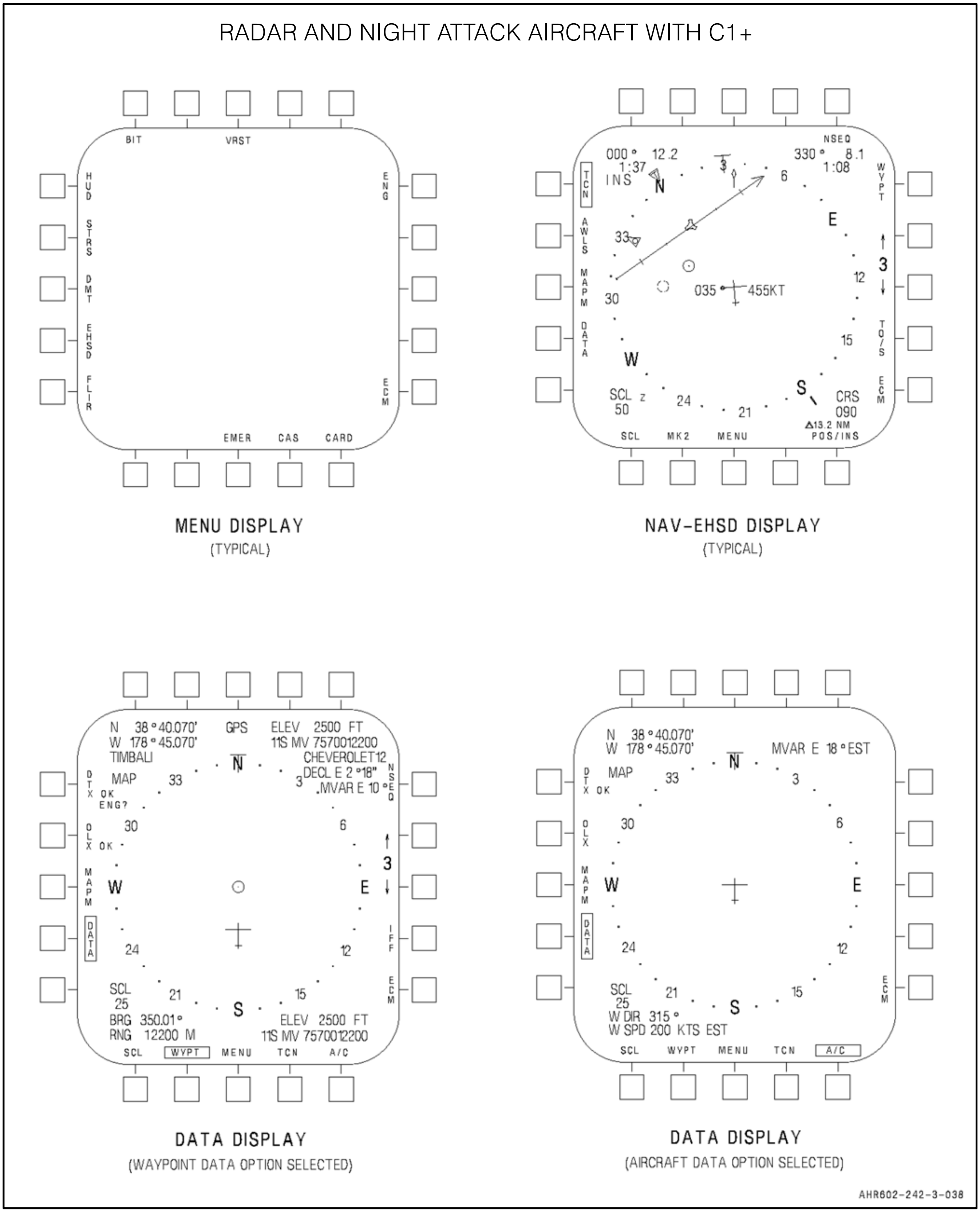


Figure 23-11. Navigation Controls and Indicators (Sheet 3)

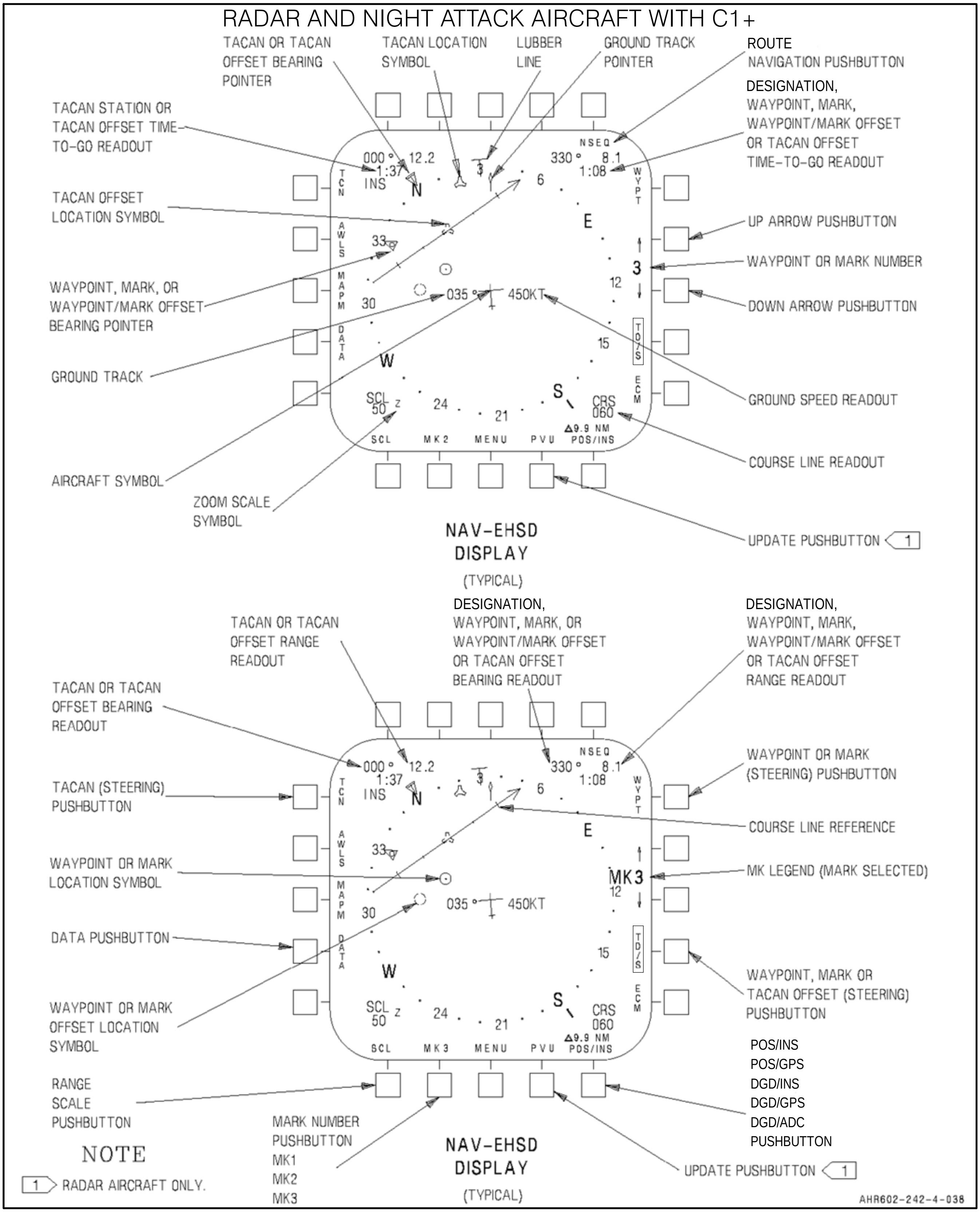
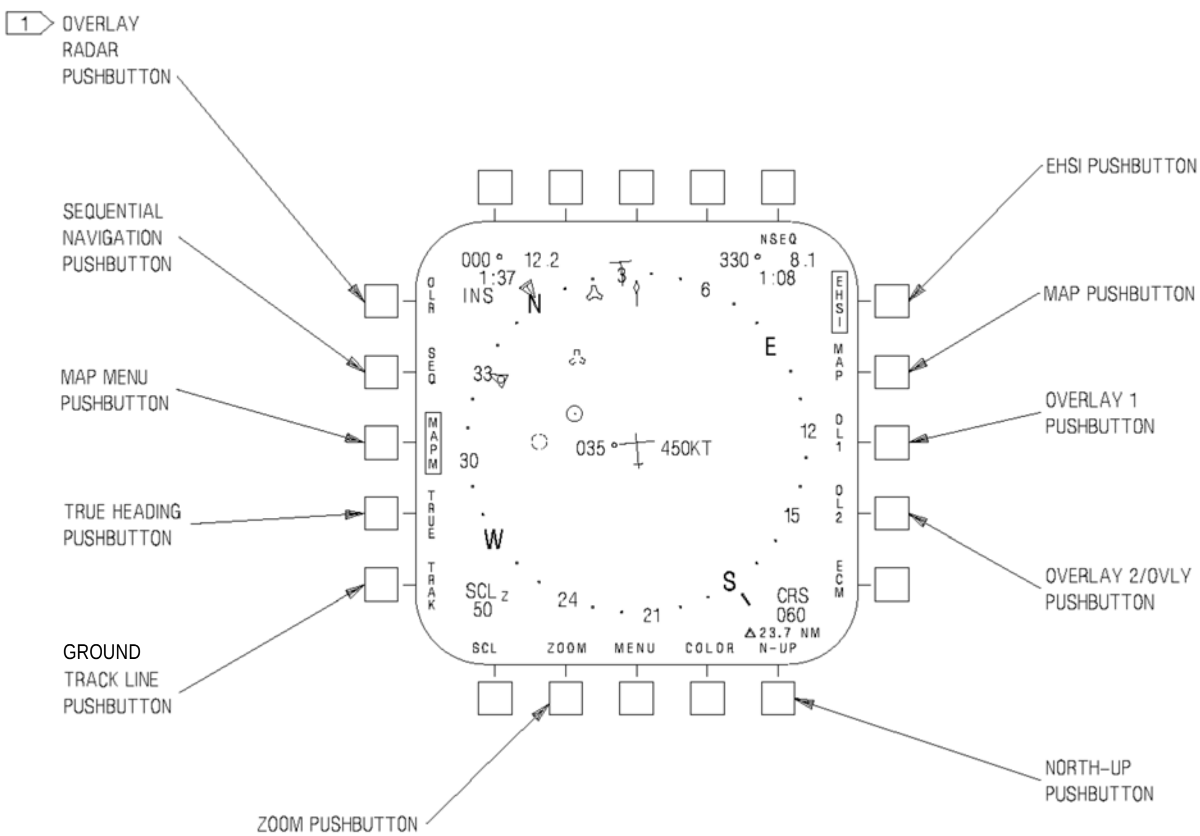


Figure 23-11. Navigation Controls and Indicators (Sheet 4)

RADAR AND NIGHT ATTACK AIRCRAFT WITH C1+



NAV-EHSD DISPLAY

(MAP MENU SELECTED)

NOTE

1 RADAR AIRCRAFT

AHR602-242-5-038

Figure 23-11. Navigation Controls and Indicators (Sheet 5)

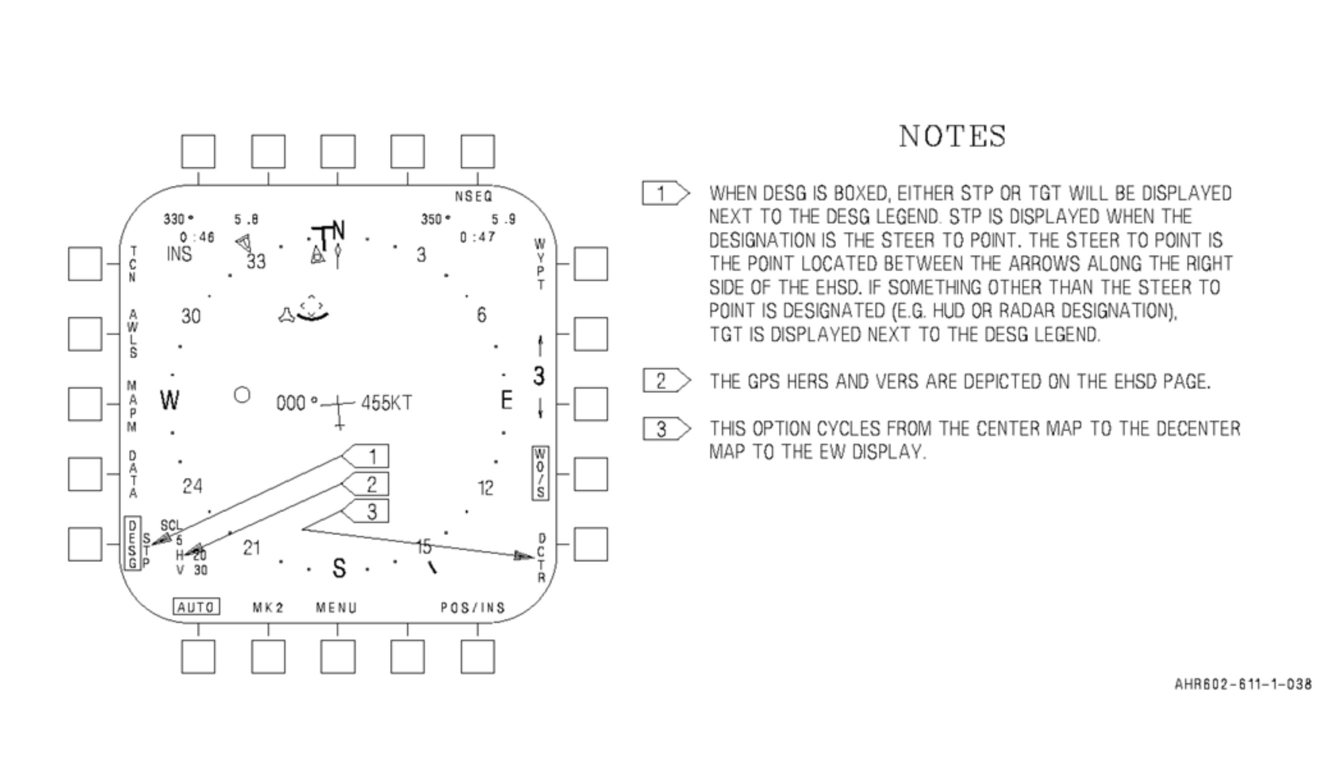


Figure 23-12. EHSD with Steer to Point Designation (H4.0)

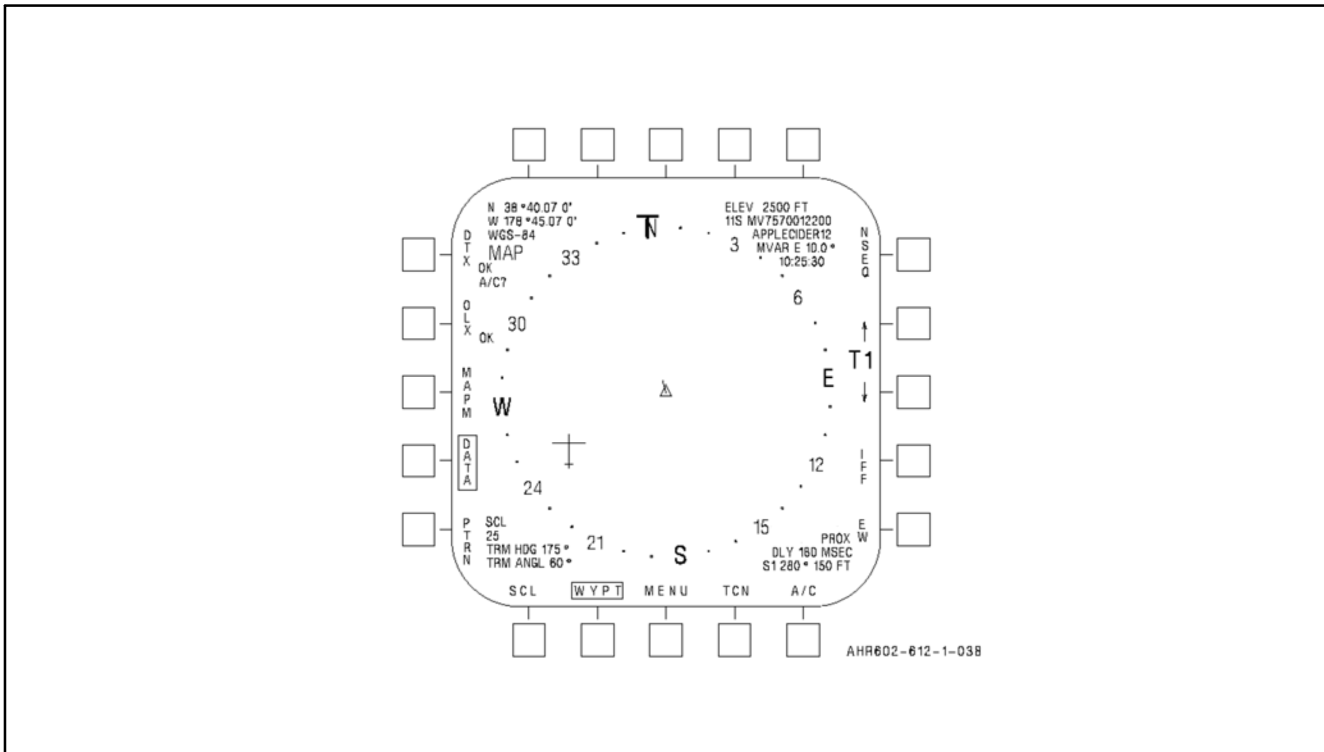


Figure 23-13. Waypoint Data Page with Targetpoint Selected (H4.0)

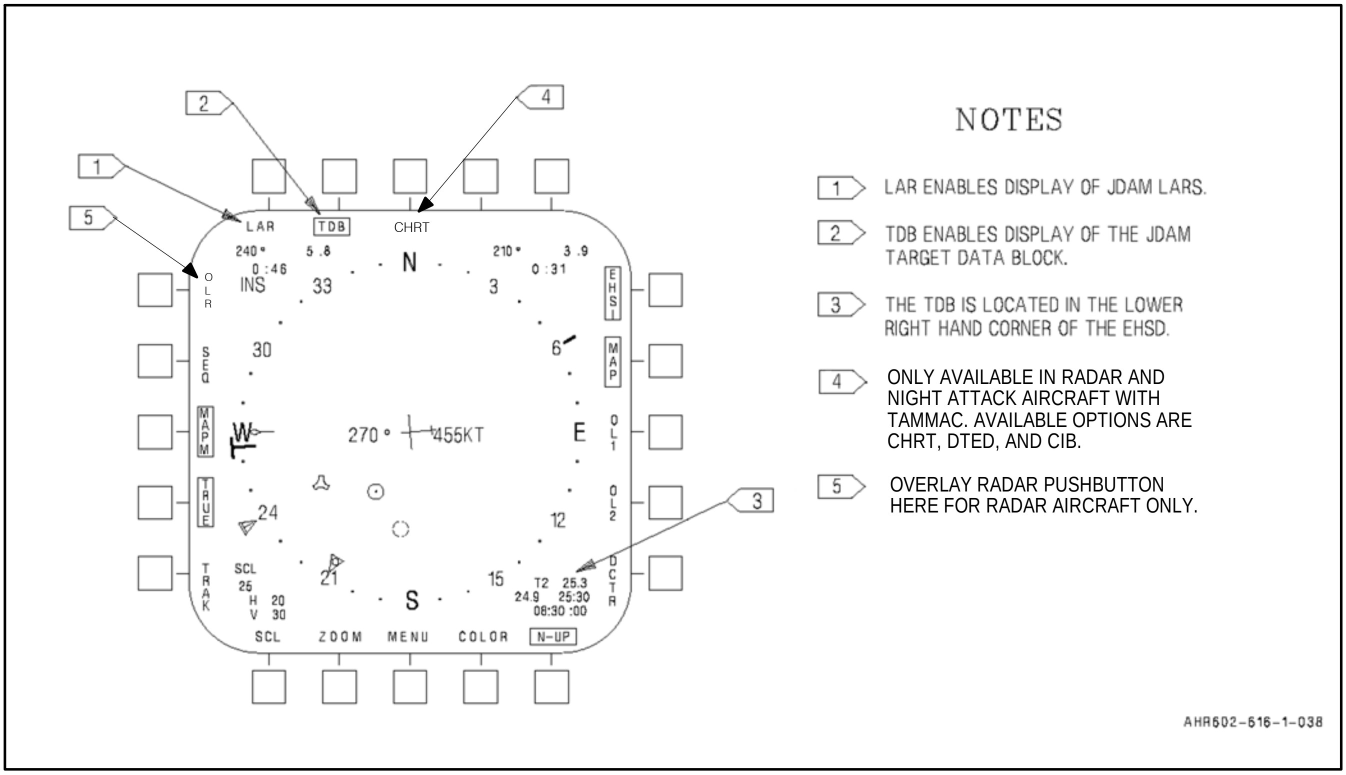


Figure 23-14. EHSD MAPM Option (H4.0)

23.9.7 Ground Track (Digital Readout) and Ground Track Pointer

This pointer indicates the aircraft true ground track. On Radar and Night Attack aircraft ground track is also a digital readout. Trainer aircraft with H4.0 have a digital readout of ground track as well.

23.9.8 Ground Speed (Digital Readout)

This readout indicates ground speed.

23.9.9 Waypoint, Markpoint or Targetpoint Steering Pushbutton

This pushbutton selects waypoint (WYPT), markpoint (MK), or targetpoint steering for display on the HUD and on TAV-8B and Day Attack aircraft, the HSI. When a targetpoint (other than T0) is selected, it is automatically designated. It may be manually undesignated.

23.9.10 Up Arrow Pushbutton

This pushbutton, when depressed, selects the next waypoint, markpoint, or targetpoint as the steer-to-point for display on the HUD. When this pushbutton is selected the WYPT option will box if not already boxed. With OMNI 7.1 and C1+ when waypoint 24 is reached, pressing this pushbutton selects markpoint 1. Likewise, when markpoint 3 is reached, pressing this pushbutton selects waypoint 0. With H4.0, the list of available waypoints, markpoints, and targetpoints are limited to points that are not null. Therefore, when the last non-null waypoint is reached, pressing this pushbutton selects waypoint 0, when the last non-null markpoint is reached, pressing this pushbutton selects markpoint 0, and when the last non-null targetpoint is reached, pressing this pushbutton selects targetpoint 0. If route steering is enabled, pressing this pushbutton selects the next point in the route or the first point in the route if the last point was displayed. With H4.0, depressing this pushbutton for greater than 0.8 seconds causes the system to enter the quick access mode. See paragraph 23.9.40 for a description of quick access.

23.9.11 # (Number)

This digital readout indicates the waypoint, markpoint, or targetpoint selected. Waypoints are represented by only numbers. Markpoints are represented by numbers preceded by MK (OMNI 7.1 and C1+) or M (H4.0). Targetpoints are represented by numbers preceded by T.

23.9.12 Down Arrow Pushbutton

This pushbutton, when depressed, selects the previous waypoint, markpoint, or targetpoint as the steer-to-point for display on the HUD. When this pushbutton is selected the WYPT option will box if not already boxed. With OMNI 7.1 and C1+ when waypoint 0 is reached, pressing this pushbutton selects markpoint 3. Likewise, when markpoint 1 is reached, pressing this pushbutton selects waypoint 24. With H4.0, the list of available waypoints, markpoints, and targetpoints are limited to points that are not null. Therefore, when waypoint 0 is reached, pressing this pushbutton selects the last non-null waypoint, when markpoint 0 is reached, pressing this pushbutton selects the last non-null markpoint, and when targetpoint 0 is reached, pressing this pushbutton selects the last non-null targetpoint. If route steering is enabled, pressing this pushbutton selects the previous point in the route or the last point in the route if the first point was displayed. With H4.0, pressing this pushbutton for greater than 0.8 seconds causes the system to enter the quick access mode. See paragraph 23.9.40 for a description of quick access.

23.9.13 WO/S or TO/S Pushbutton

Pressing the offset pushbutton commands the mission computer system to provide steering information to an offset point from the selected waypoint, markpoint, or TACAN.

23.9.14 POS/ or DGD/ Pushbutton

This pushbutton indicates the data source that the mission computer system is using to compute the aircraft position latitude and longitude. When pressed it scrolls the POS/ option or DGD/ option pushbutton legend. IFA appears above this legend when the INS is being aligned inflight.

23.9.15 UPDT/PVU Pushbutton

Pressing this pushbutton provides an update (UPDT) option display on the coordinate data monitor, or a PVU. UPDT is available only when the navigation system is not tightly-coupled, while PVU is only available on Radar aircraft when the navigation system is tightly-coupled.

23.9.16 Data Pushbutton

Pressing this pushbutton provides the DATA option display.

23.9.17 TRUE Heading Pushbutton (TAV-8B with OMNI 7.1 and Day Attack Aircraft)

The TRUE pushbutton is located on the WYPT Data page. See Figure 23-16. Pressing this pushbutton selects true heading for display. T legend appears in place of lubber line on EHSI display and a T appears above heading display on HUD to indicate true heading displayed.

23.9.18 SCL Pushbutton (TAV-8B with OMNI 7.1 and Day Attack Aircraft)

Pressing this pushbutton decreases the scale once each time it is pressed. The scales displayed are 160, 80, 40, 20, or 10. Numbers indicate nautical miles from the top to the bottom of the display. Symbology representing waypoints, markpoints, waypoint/markpoint offsets, TACAN stations and TACAN offsets must be within selected scale range to appear on display. There is an AUTO scaling option which appears after the 10 mile scale. When AUTO is selected the EHSI scale changes based on sensor mode, steering selection, and TACAN, waypoint, mark, and waypoint, mark, or TACAN offset ranges.

23.9.19 SCL Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

Pressing this pushbutton decreases the scale once each time it is pressed. The scales displayed for the CHRT and DTED (only available in aircraft with TAMMAC installed) map types are 100, 25, 13, or 5 unless ZOOM is selected. With ZOOM selected the displayed scales are 50, 13, 6, or 3. The scales displayed for the CIB (only available in aircraft with TAMMAC installed) map type are 3 or 1 unless ZOOM is selected. With ZOOM selected the displayed scales are 1 or 1. Numbers indicate the nautical miles from the top to the bottom of the display. Symbology representing waypoints, markpoint, targetpoints, waypoint/markpoint offsets, TACAN stations and TACAN offsets must be within selected scale range to appear on display. There is an AUTO scaling option which appears after the

5 (or zoomed to 3) mile scale. When AUTO is selected the EHSD scale changes based on sensor mode, steering selection, and TACAN, waypoint, markpoint, and waypoint, markpoint, or TACAN offset ranges. See Figure 23-15. The AUTO option is not available on the DATA page or when the CIB map type is selected in aircraft with TAMMAC installed. With TAMMAC installed, the SCL pushbutton works differently on the DATA page. The scales displayed are 100, 25, 13, 5, 3, or 1 (or 50, 13, 6, 3, 1 or 1 if ZOOM is enabled) unless DTED is the selected map type. When the map scale transitions from 5 to 3 (or 3 to 1 when ZOOM is enabled) the map type changes from CHRT to CIB. When the map scale transitions from 1 to 100 (or 1 to 50 when ZOOM is enabled) the map type changes from CIB to CHRT. This provides the pilot a way to quickly access the CIB map display while on the DATA page. If the map type is DTED, the displayed scales on the DATA page are 100, 25, 13, or 5 (or 50, 13, 6, or 3 with ZOOM enabled).

DISPLAY SCALE	ZOOM	CENTERED		DECENTERED		EW (H4.0 ONLY)	
		SCALE DOWN	SCALE UP	SCALE DOWN	SCALE UP	SCALE DOWN	SCALE UP
100		8.0	NA	16.0	NA	6.0	NA
25		4.0	9.0	8.0	18.0	3.0	6.75
13		1.6	4.5	3.2	9.0	1.2	3.38
5		NA	1.8	NA	3.6	NA	1.35
50	Yes	4.0	NA	8.0	NA	3.0	NA
13	Yes	2.0	4.5	4.0	9.0	1.5	3.38
6	Yes	0.8	2.25	1.6	4.5	0.6	1.69
3	Yes	NA	0.9	NA	1.8	NA	0.68

Figure 23-15. Auto Scaling

23.9.20 Mark Number Pushbutton

If no designation exists, pressing the MK pushbutton stores aircraft present position as a markpoint. The source of the altitude stored in the markpoint is dependent upon sensor validity at the time MK is depressed. With OMNI 7.1 and C1+ if RALT is valid, aircraft barometric altitude minus RALT is used. With H4.0 if RALT is valid, GPS altitude minus RALT altitude is used if GPS is cued, otherwise aircraft barometric altitude minus RALT altitude is used. In the absence of valid RALT, the altitude of the current steer to point is used. If a system designation exists with C1+ and H4.0, the calculated designation position is stored in the markpoint when the MK pushbutton is pressed. Only 3 markpoints (1–3) are available with OMNI 7.1 and C1+. With H4.0, 10 markpoints (0–9) are available. With OMNI 7.1 and C1+, the system initializes the MK pushbutton to MK1 during initial power–up. With H4.0, the system initializes the MK pushbutton to the markpoint number displayed during during the previous shut down (assuming the MSC has not been reloaded, in which case the system initializes to MK0). Each time MK is depressed, position and altitude data is written to the markpoint number displayed above the MK pushbutton, and the markpoint number is incremented. If data exists in the markpoint displayed on the MK pushbutton, and the pushbutton is subsequently depressed, the previously stored data is overwritten with current data.

23.9.21 Waypoint or Mark Offset Location Symbol

The symbol indicates relative location of the selected waypoint or mark offset.

23.9.22 TACAN Offset Location Symbol

The symbol indicates the relative location of the selected TACAN offset.

23.9.23 SEQ Pushbutton (TAV-8B with OMNI 7.1 and Day Attack Aircraft)

The SEQ pushbutton is located on the WYPT and TCN Data pages. Pressing the pushbutton provides display of up to five above and two below the currently selected waypoint if in the selected range scale (see Figures 23-16 and 23-17). The number next to the small waypoint circle indicates their associated waypoint number. Only the waypoint offset to the selected waypoint is displayed. If waypoint steering is selected, the steering and data block displayed are to the selected waypoint. If one of the markpoints is currently selected, waypoints 23, 24, 0, 1, 2, 3, and 4 are displayed if in the selected range scale. SEQ waypoint circles are not available on the DATA page format or in A/G master mode.

23.9.24 NSEQ Pushbutton

(Located on the EHSI/EHSD page). Pressing this pushbutton enables nonsequential or sequential waypoint navigation (see Figure 23-17). Refer to NTRP 3-22.4-AV8B to learn how to choose between sequential and nonsequential routes. A programmed subset of waypoints are selected for navigation. Pressing the waypoint step button or the waypoint increment button steps through each waypoint and offset in the sequential string, or steps through each waypoint and offset in the ingress sequence and then step through each waypoint in the egress sequence. With H4.0 only the offset to the terminal point in the sequential string or the terminal point of the ingress string of a nonsequential route shall be included in a route. The button is not displayed, but the function is present in A/G master mode. Waypoints, markpoints, and targetpoints are available for use in the NSEQ string with H4.0. A targetpoint can be placed at the end of a sequential string with H4.0.

23.9.25 MAPM/EWM Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

Pressing this pushbutton enables map menu pushbutton options. Options differ with different modes (CENTER, DECENTER, EW (H4.0 only) and DATA). The legends EHSI, MAP, OL1/OL2, OVLY, N-UP, COLOR, ZOOM, SCL/AUTO, TRAK, TRUE, and SEQ (also OLR on radar aircraft, LAR and TDB on aircraft with H4.0, and CHRT/DTED/CIB in aircraft with TAMMAC installed) are displayed for 10 seconds and then return to the previous display if no other pushbutton is pressed. Selecting or deselecting one of these functions restarts the 10 second timer and enables display of these legends for another 10 seconds. A box displayed around the legend indicates the function is enabled.

23.9.26 EHSI Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

Selecting map menu (MAPM) on the centered or decentered EHSD display, any DATA display, or the EWM (with H4.0) display enables the EHSI pushbutton legend. Selection of EHSI is independent for each MAPM. Pressing this pushbutton on the Center, Decenter, or EW MAPM enables display of the compass rose, lubber line and T legend, ground track pointer, waypoint and waypoint offset, TACAN and TACAN offset and target (with H4.0) bearing pointers on the Center, Decenter and EW page. Pressing this pushbutton on the WYPT or TCN Data MAPM enables display of the compass rose, lubber line and T legend, and aircraft symbol on the WYPT and TCN Data pages. Pressing this pushbutton on the A/C Data MAPM enables display of the compass rose, and lubber line and T legend on the A/C Data pages. When enabled the EHSI legend is boxed.

23.9.27 MAP Pushbutton (Radar and Night Attack Aircraft)

Pressing this pushbutton enables display of map video if location is covered by map and if map scene is ready for display. When enabled MAP legend is boxed. Selection of MAP is independent for each MAPM. Although this option is available in TAV-8B with H4.0 it is non-functional without a DMS.

23.9.28 OL1 Pushbutton (Radar and Night Attack Aircraft)

Pressing this pushbutton enables display of overlay 1. Selection of OL1 is independent for each MAPM. When enabled OL1 legend is boxed. Although this option is available in TAV-8B with H4.0 it is nonfunctional without a DMS.

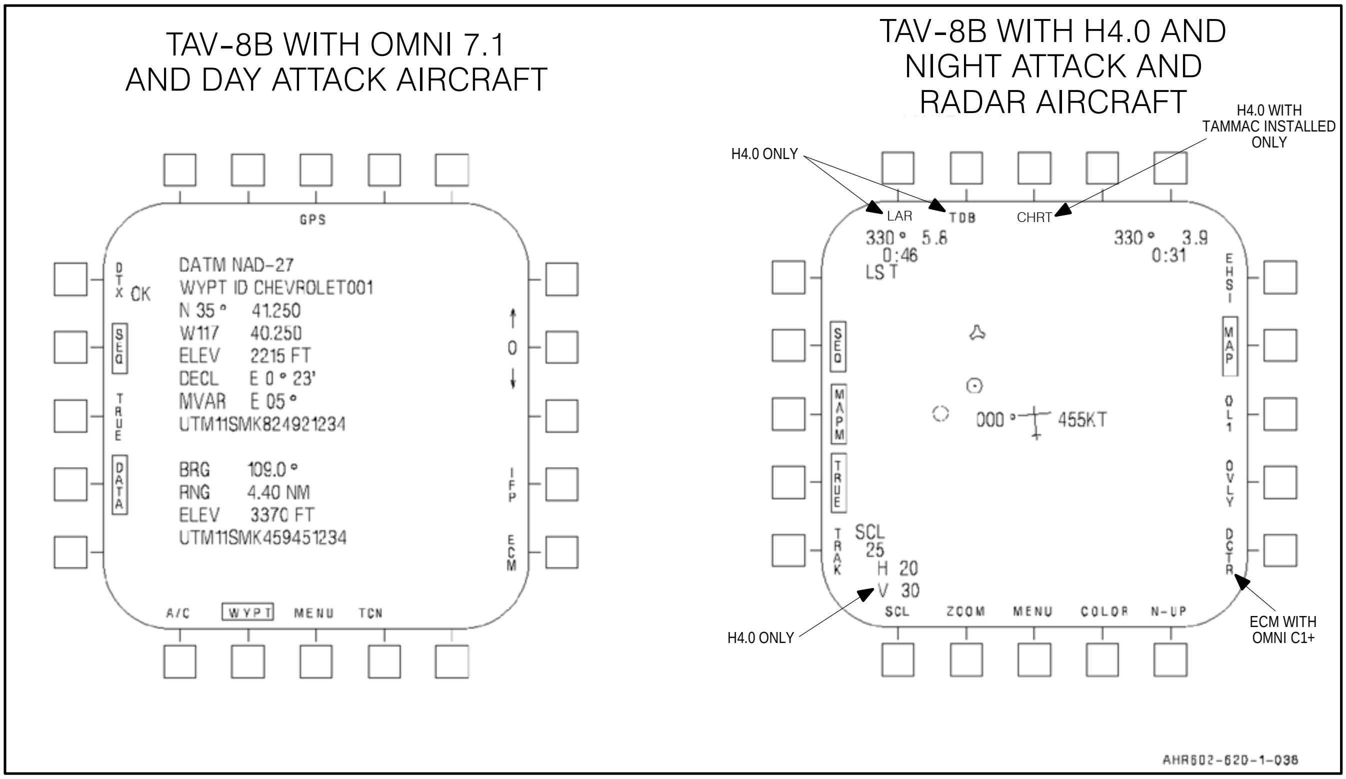


Figure 23-16. SEQ and TRUE Navigation Display

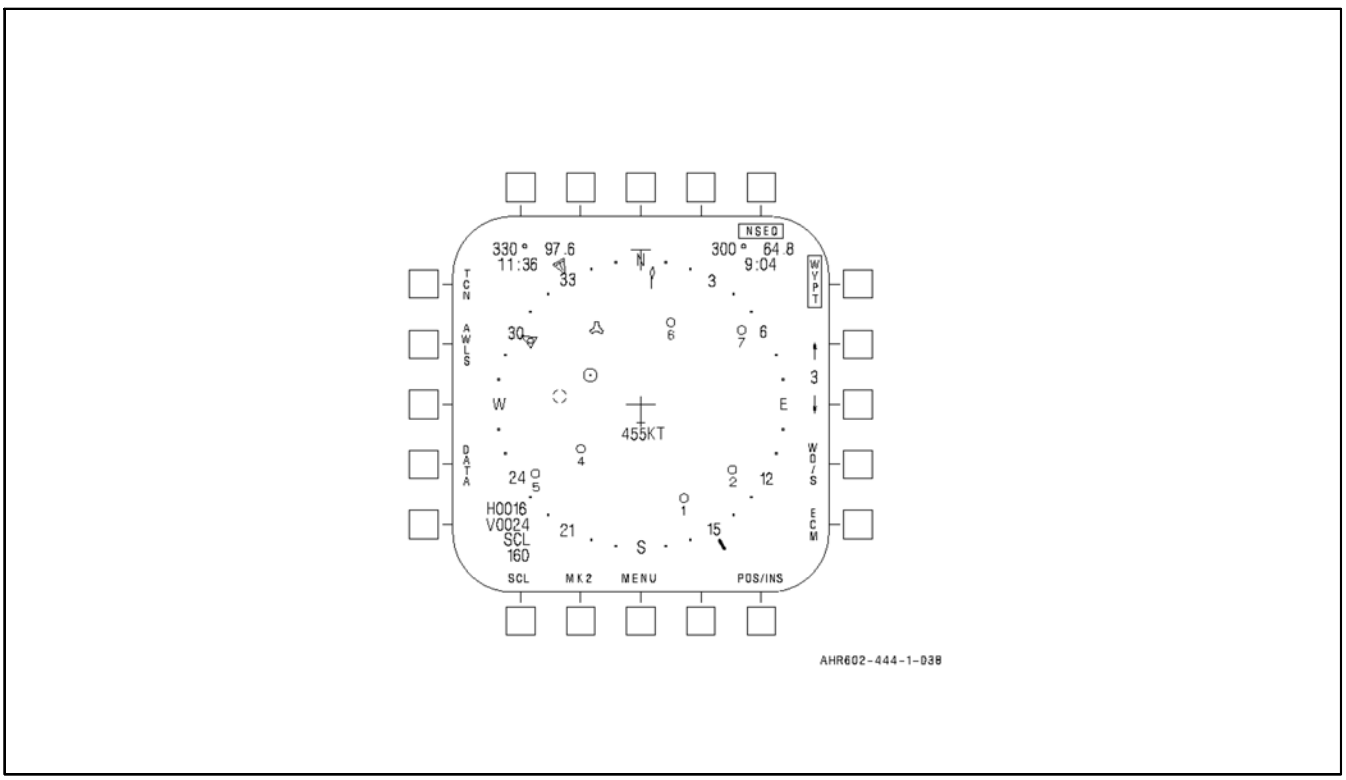


Figure 23-17. SEQ and NSEQ Navigation Display

23.9.29 OL2/OVLY Pushbutton (Radar and Night Attack Aircraft)

OL2 or OVLY is dependent on NSEQ selection. Pressing OL2 (NSEQ not boxed) pushbutton enables display of overlay 2. When enabled OL2 legend is boxed. Pressing OVLY (NSEQ boxed) pushbutton enables the nonsequential programmed ingress/egress route lines or the sequential route lines. When enabled OVLY is boxed. Selection of OL2/OVLY is independent for each MAPM. Although this option is available in TAV-8B with H4.0 it is non-functional without a DMS.

23.9.30 N-UP Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

Pressing this pushbutton selects north-up or track-up mode. When N-UP legend is boxed north-up mode is enabled, else track-up mode is enabled. Selection of N-UP is independent for each MAPM. N-UP legend is not displayed in decenter mode or on the EW page.

23.9.31 ZOOM Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

Magnifies map display by two. When selected ZOOM legend is boxed and Z legend is displayed next to SCL legend. Selection of ZOOM is independent for each MAPM.

23.9.32 SCL Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

Pressing this pushbutton selects the default map scale for the top-level page (CENTER, DECENTER, EW (with H4.0) and DATA). The default map scale is the map scale that will be selected when first entering the corresponding top-level page. Selection of SCL is independent for each MAPM. Pressing this pushbutton decreases the scale once each time it is pressed. The scales displayed are 100, 25, 13, 5, and AUTO unless ZOOM is selected or the map type is CIB. The scales displayed for the CIB map type (only available in aircraft with TAMMAC installed) are 3 and 1 unless ZOOM is selected. With ZOOM selected the displayed scales are 50, 13, 6, 3, and AUTO. The scales displayed for the CIB map type with ZOOM enabled are 1 and 1. The AUTO option is not available on the DATA MAPM page. With TAMMAC installed, the SCL pushbutton works differently on the DATA MAPM page. The scales displayed are 100, 25, 13, 5, 3, and 1 (or 50, 13, 6, 3, 1 and 1 if ZOOM is enabled) unless the selected map type is DTED. When the map scale transitions from 5 to 3 (or 3 to 1 when ZOOM is enabled) the map type changes from CHRT to CIB. When the map scale transitions from 1 to 100 (or 1 to 50 when ZOOM is enabled) the map type changes from CIB to CHRT. If the map type is DTED, the displayed scales on the DATA MAPM page are 100, 25, 13, and 5 (or 50, 13, 6, and 3 with ZOOM enabled).

23.9.33 TRAK Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

Pressing this pushbutton enables display of ground track line. When selected TRAK legend is boxed. TRAK legend not displayed in DATA mode. Selection of TRAK is independent for each MAPM.

23.9.34 TRUE Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

When selected the system uses true heading to compute the orientation of the compass rose, aircraft symbol, ground track pointer, map heading and bearing to waypoint, offset or TACAN station. The selection of true or magnetic also affects the display of TACAN, waypoint, and markpoint offset bearing, targetpoint terminal heading and pattern heading, and radar BRAA (bearing, range, altitude, aspect) and cursor data block displays. A T legend appears in place of lubber line and also a T appears above heading display on HUD to indicate true heading display. When TRUE legend is boxed true heading is enabled, else magnetic heading is enabled. Selection of TRUE is NOT independent for each MAPM. Selecting TRUE on any MAPM affects all displays.

23.9.35 SEQ Pushbutton (TAV-8B with H4.0 and Radar and Night Attack Aircraft)

Pressing the pushbutton provides display of up to five above and two below the currently selected waypoint if in the selected range scale (see Figures 23-24 and 23-25). The number next to the small waypoint circle indicates their associated waypoint number. Only the waypoint offset to the selected waypoint is displayed. If waypoint steering is selected, the steering and data block displayed are to the selected waypoint. With C1+, if one of the markpoints is currently selected, waypoints 23, 24, 0, 1, 2, 3, and 4 are displayed if in the selected range scale. With H4.0, if a markpoint or targetpoint is currently selected, the four waypoints above and the two waypoints below the last selected waypoint and the last selected waypoint itself are displayed if in the selected range scale. SEQ waypoint circles are not available on the Data page format or in A/G master mode. Selection of SEQ is NOT independent for each MAPM. Selecting SEQ on any MAPM affects all displays.

23.9.36 OLR Pushbutton (Radar Aircraft with H4.0)

Pressing this pushbutton will display a corral on the EHSD which corresponds to the radar display corral when using an EXPAND MODE. This feature aids the pilot in accurately placing expand corrals on the radar display by allowing comparison between map and radar. The OLR legend is not displayed in DATA mode. Selection of OLR is NOT independent for each MAPM. Selecting OLR on any MAPM affects all non–DATA displays.

23.9.37 LAR Pushbutton (with H4.0)

Selecting this option enables the display of the Launch Acceptable Region (LAR) for the Joint Direct Attack Munitions (JDAM) on the EHSD. When selected LAR legend is boxed. The LAR legend is not displayed in DATA mode. Selection of LAR is independent for each MAPM.

23.9.38 TDB Pushbutton (with H4.0)

Selection of the option enables the display of the targetpoint data block in the lower right hand corner of the EHSD display. See Figure 23-18. The targetpoint data block is displayed after TDB has been boxed and a targetpoint has been selected as a target contributor. This requires that at least one JDAM is loaded on the aircraft or training mode is selected with a JDAM stores code loaded. When selected TDB legend is boxed. The TDB legend is not displayed in DATA mode. Selection of TDB is independent for each MAPM.

23.9.39 CHRT/DTED/CIB Pushbutton (Radar and Night Attack Aircraft with TAMMAC Installed)

Selection of this option will scroll through the available map imagery formats. The pushbutton legend will scroll from CHRT (chart) to DTED to CIB and back to CHRT. Selection of map format is independent for each MAPM. The CIB map format is not available on the EWM page, instead the legend scrolls from CHRT to DTED and back to CHRT. The map format legend is removed when the TAMMAC is not communicating with the MSC or is not installed. CHRT is the default map format on all map pages after a fresh MSC load. See Figure 23-18.

23.9.40 Quick Access (with H4.0)

Pressing an up arrow, a down arrow, or the WINC button for greater than 0.8 seconds will cause entry into the Quick Access (QA) mode. There are two types of quick access sessions. Steer–to–point (STP) quick access can be initiated using the WINC button or the up and down arrows on the EHSD and the EW pages. Point–of–Interest (POI) quick access can be initiated by using the up and down arrows on the WYPT Data page, NSEQ Data page, Radar Data page, TFER page, or any of the six different VREST pages. STP QA is used to change the steer to point on the EHSD page and therefore the steering cues presented in the HUD. POI QA is used to change the point on the page that is used to initiate the QA session (i.e. WYPT Data page, NSEQ Data page, TFER Data page, Radar Data page, or any of the six different VREST pages). The ODU displays WYPT in window 1, MKPT in window 2, TGPT in window 3, NSEQ in window 4 (NSEQ is displayed only during a STP QA session), and TOT in window 5 (TOT is displayed only if the current point is targetpoint 1–4 or the terminal point in a sequential, ingress, or egress string). Selecting the NSEQ option toggles NSEQ on the EHSD page. Selecting the TOT option enables the scratch pad for programming a time–on–target for the selected point. If a system designation exists (radar designation, waypoint designation, etc.) TGPT defaults to colonized and 0 is presented in the scratchpad when a STP QA session is initialized. If a system designation does not exist, the current point displayed on the current page (or the EHSD page if QA was initiated using the WINC option) is the initial default selection on the ODU and scratchpad. Quick accessing a point that is not in the NSEQ string when NSEQ steering is selected causes NSEQ to become deselected. A QA session will time out after 15 seconds of inactivity, or a QA session can be manually exited by pressing ENT on the UFCS when there is no pending entry flashing on the scratch pad.

23.9.41 Null Points (with H4.0)

A Nullpoint is a point (waypoint, markpoint, or targetpoint) that has its null flag set true. The null flag is set in mission planning and is meant to indicate a point that cannot be used as a STP or as a point of interest on the VREST and Radar Data pages. WYPT 0, MKPT 0 and TGPT 0 cannot be null points. When stepping through points on the EHSD page, null points are skipped. A null point can be converted to a non–null point by accessing the point on the EHSD DATA page or the TFER DATA page.

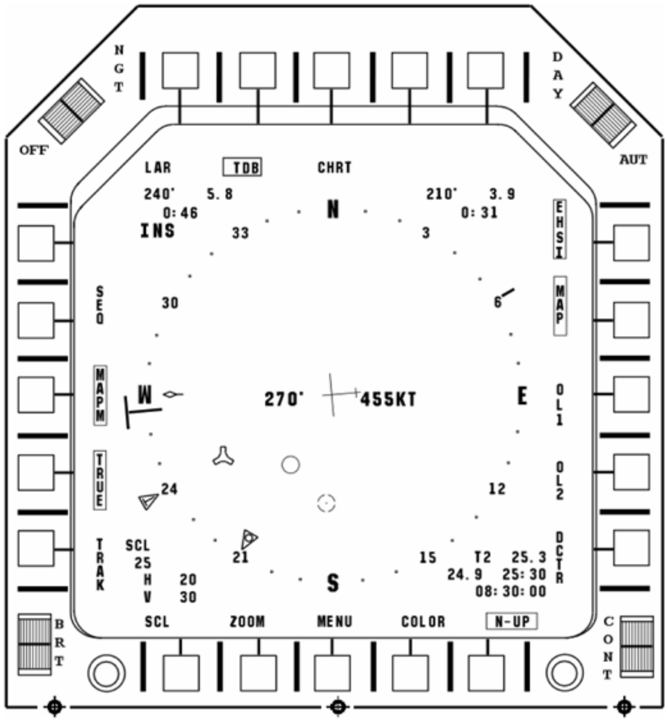


Figure 23-18. Center EHSD Map Menu Page with TAMMAC Installed

23.9.42 Electronic Warfare Page (with H4.0)

The EW page is intended to help increase defensive situational awareness. The EW page can be selected by pressing pushbutton 15 from the Basic Menu page, or it can be selected via Sensor Select Switch Left when not in Air Combat Maneuvering (ACM) sensor mode or TPOD sensor mode. The EW page is the third page in the EHSD display sequence (Center, De–Center, then EW).

23.9.42.1 EW Page Unique PB Options (with H4.0)

Depression of the EWM pushbutton (PB) selects the EW Menu page that provides the capability to control map, waypoint, RWR and Radar footprint (radar aircraft only) symbology displayed on the EW page. See Figure 23-19. A 10 second timeout applies to the EWM, similar to the MAPM selections, while the page is presented.

Pressing the RWR PB selects the RWR Page. Note that the Expendables information has been moved from the RWR page to the CMDS page.

Pressing the CMDS PB selects the Countermeasures Dispensing System page.

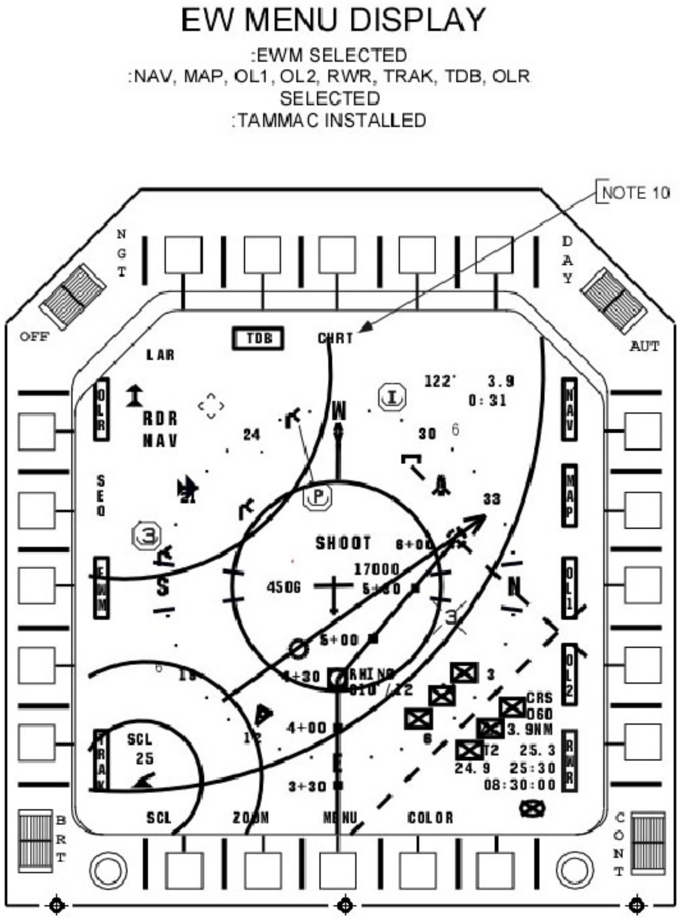
23.9.42.1.1 EWM Page Unique Options (with H4.0)

Nav Option.

Selecting the NAV option displays the waypoint or waypoint offset steering information, waypoint or waypoint offset data block, waypoint or waypoint offset symbols, course line and course line data block, and the GPS HERS and VERS in the lower left corner.

RWR Option.

Selecting the RWR option displays the RWR threat symbols (maximum of six), critical ring and beam Cues. RWR symbols are drawn in a brighter intensity of the color selected for the rest of the legends using the COLOR option on the EW menu page.



NOTES:

1. THE EMW PAGE ALLOWS SELECTION OF SYMBOLOGY/INFORMATION TO BE DISPLAYED ON THE EW PAGE. FIRST SELECTION OF THIS PAGE AFTER FRESH MSC LOAD WILL DEFAULT TO SCALE 25, COLOR YELLOW AND THE FOLLOWING OPTIONS BOXED: NAV. MAP, OL1, OL2, RWR, TRAK, AND LAR. THE ZOOM, AND SEQ OPTIONS DEFAULT UNBOXED. SUBSEQUENT SELECTIONS OF THIS PAGE WILL DISPLAY SETTINGS AS LAST SELECTED ON THE EW OR EWM PAGE.
2. SELECTION OF NAV WILL ENABLE THE FOLLOWING SYMBOLOGY: WAYPOINT OR WAYPOINT O/S STEERING INFORMATION, WAYPOINT OR WAYPOINT O/S DATA BLOCK, WAYPOINT OR WAYPOINT O/S SYMBOL, COURSE LINE, COURSE LINE DATA DISPLAY. UNBOXING NAV WILL DECLUTTER THE DISPLAY BY REMOVING THE ABOVE INFORMATION.
3. SELECTION OF MAP ENABLES DISPLAY OF THE MAP UNDER THE COMPASS ROSE.
4. SELECTION OF TRAK ENABLES DISPLAY OF THE TRACK LINE.
5. THE RADAR TRACK FILES AS MECHANIZED ON THE EHSD ARE ALWAYS DISPLAYED ON THE EW MENU PAGE.
6. SELECTION OF RWR ENABLES DISPLAY OF RWR THREAT SYMBOLS, CRITICAL RING, CRITICAL TAILS AND BEAM CUES. ORIENTATION OF RWR THREATS IS LETHALITY IN.
7. OL1, OL2, COLOR, ZOOM, SCL, SEQ, AND OLR PROVIDE THE SAME FUNCTIONALITY AS CURRENT AV-8B EHSD FOR THE TOP LEVEL EW PAGE.
8. LAR (P/B #6) IS DISPLAYED WHEN JDAMS ARE INVENTORIED ON THE AIRCRAFT. BOXING IT DISPLAYS THE JDAM LARS.
9. TDB (P/B #7) CONTROLS DISPLAY OF THE JDAM DATA BLOCK IN THE LOWER RIGHT HAND CORNER OF THE EW PAGES. BOXING IT DISPLAYS THE TARGET DATA BLOCK IN THE LOWER RIGHT HAND CORNER OF THE EW PAGES.
10. LEGEND ONLY AVAILABLE WHEN TAMMAC SYSTEM IS INSTALLED. PUSHBUTTON ALLOWS SELECTION OF MAP IMAGERY. ROTARY PUSHBUTTON DISPLAYS CHART (CHART), DTED BACK TO CHRT DEFAULTS TO CHRT, SCALE 25 WITH NEW MSC LOAD, CAN BE MISSION PLANNED AFTER THAT.

Figure 23-19. Electronic Warfare Menu Page

23.9.42.2 Threat Symbols

With the RWR option selected on the EWM page, the RWR Threat Information is displayed on the EW page based on lethality using the same symbology as the RWR page. Critical and missile launch RWR threats are positioned along the inside circumference of the critical ring and have a tail extending from the critical ring to the compass rose. Lethal RWR threats are positioned along the outside circumference of the critical ring. Nonlethal RWR threats are positioned along the outside circumference of the compass rose.

23.9.42.3 Beam Cues

With the RWR option selected on the EWM page, the beam cues are displayed. The beam cues are broken X centered about the aircraft symbol and extending out slightly over the compass rose. The beam cues are referenced to the ground track of the aircraft and are fixed relative to the three/nine o'clock position on the compass rose. The cues are offset from the beam by ±7.5 degrees (15 degrees total between tic marks).

23.9.42.4 SHOOT Cue

The avionics system displays a SHOOT cue in the center of the EW pages above the aircraft symbol only in A/A master mode concurrent with the SHOOT cue on the HUD.

23.10 WAYPOINT, MARKPOINT, TARGETPOINT, AND OFFSET DATA ENTRY

With OMNI 7.1 and C1+, the mission computer can store 25 waypoints, numbered 0 through 24, and 3 mark points, numbered 1 through 3. Scrolling past the end of the waypoints accesses the markpoints. Markpoints are denoted by the MK legend.

With H4.0, the mission systems computer can store 60 waypoints, numbered 0 through 59, 10 markpoints, numbered 0 through 9, and 5 targetpoints, numbered 0 through 4. Markpoints are denoted by the M legend and Targetpoints by the T legend. Quick Access must be used to change between point types (waypoint, markpoint, or targetpoint). See paragraph 23.9.40 for a description of Quick Access. The waypoint, markpoint, or targetpoint currently selected for navigation is indicated by the number located between the up and down arrows on the right side of the EHSI/EHSD and EW display (see Figure 23-21). The point between the arrows is also called the steer to point.

23.10.1 Waypoint Data Display

The waypoint data display allows for viewing and/or inputting the data required for each waypoint, markpoint, targetpoint, and their associated offsets. The display is enabled by selecting the DATA pushbutton on the EHSI/EHSD display. The display is also available for selection on the DMT display when DMT video is not available in the Day Attack and TAV-8B with OMNI 7.1. The display is also available for selection on the EW display with H4.0. The display initializes with waypoint data selected, indicated by the boxed DATA and WYPT legends. The waypoint, markpoint, or targetpoint position and elevation as well as the associated offset range, bearing and elevation are displayed for the waypoint, markpoint, or targetpoint last selected on the EHSI/EHSD and EW displays. Cycling the waypoint/markpoint/targetpoint number to inspect the other waypoints, markpoints, or targetpoints does not affect the waypoint or markpoint, or targetpoint selected for navigation on the EHSI/EHSD and EW display. This allows for data change in flight without effecting the steering information on the HUD. Deselecting DATA brings up the last selected display, EHSI, EHSD, EW, or DMT. Data is entered into the system automatically by way of the data storage set or manually by way of the UFC keyboard and ODU options.

23.10.2 Manual Data Entry

Manual data entry utilizes the UFC keyboard and scratch pad, and the ODU options. When entering data on the UFC keyboard the scratch pad blanks with the first key depression. The last digit of a sequence being entered will flash to indicate the entry is not complete. When the ENT key is pressed the scratch pad will blank momentarily and then display the new entry, if the entry is valid. If the entry is not valid, incorrect number of keystrokes etc., the scratch pad will flash until cleared. Valid entries are also displayed on the DDI.

23.10.2.1 Entering Waypoint or Markpoint, or Targetpoint Data

Selecting the waypoint data display enables the UFC and ODU for waypoint data entry. This is indicated by the colon next to the WYPT (or TGPT) and POS options on the ODU, and the stored latitude of the selected waypoint, markpoint, or targetpoint on the scratch pad.

If a valid offset is stored for the selected waypoint or markpoint, the system initializes with the WO/S options selected on the ODU. The WYPT and WO/S options are mutually exclusive, and successive depression of the associated option pushbutton provides alternate displays of WYPT and WO/S in the first window on the ODU (with OMNI 7.1 and C1+). With H4.0, the first window of the ODU cycles from WYPT to WO/S to TGPT. If a number is entered into the UFC after ODU window 1 cycles to TGPT and the enter button is pressed, the waypoint offset for the current waypoint transfers into the targetpoint number that was entered.

To re-energize the DATA page ODU options, simply select the desired data entry pushbutton on the DATA page (i.e. WYPT, TCN, or A/C). The data entry pushbuttons are boxed as an indication of what DATA page is currently active. Selecting the data entry pushbuttons on the DATA page has the effect of energizing or de-energizing the ODU options, so selecting a boxed data entry pushbutton will not deselect the DATA page.

23.10.2.1.1 Targetpoint Data Programming (with H4.0)

Targetpoints have additional data referred to as JDAM target data (terminal parameters and fuzing data) associated with them that is primarily pertinent to JDAM deliveries. The TDB PB on the EHSD MAPM page controls whether this information is displayed on the EHSD when a targetpoint is selected.

The initial ODU options displayed when the DATA page is active for a targetpoint are similar to those for a typical waypoint except that TGPT is displayed in ODU window 1. Pressing PB 1 causes the ODU to cycle through the display shown in Figure 23-20. Selection of the TGPT option changes the ODU to the terminal parameter options ODU (TERM for terminal parameters options, HDG for heading, ANG for angle, and INV for invalidate in ODU windows 1-3, and 5). HDG specifies the final heading that the JDAM tries to obtain at impact with the targetpoint. ANG specifies the final angle (measured from the horizontal) that the JDAM tries to obtain at impact with the targetpoint. INV is used to invalidate the HDG or ANG entries, whichever one is cued when INV is pressed. If the HDG is invalid, the JDAM will proceed directly from the aircraft position at weapon release to the target. The type of heading entered reflects the aircraft system mode (true or magnetic). If the ANG is invalid, the JDAM will try to obtain a default value of 65 degrees. Changing the location or elevation of a targetpoint does not change the terminal parameters associated with that targetpoint.

Pressing the TERM option changes the ODU to the pattern options ODU (PTRN for pattern options, SYM for symmetric or AREA for area or LINE for line, PHDG for pattern heading, and INT for interval in ODU windows 1-4). SYM represents the currently selected pattern that is used if pattern is enabled on the EHSD. Pressing the SYM ODU button cycles the pattern option through the three types of defined patterns (SYM, AREA, and LINE). Refer to NATIP, NTRP 3-22.4-AV8B for a detailed description of the patterns available. The PTRN (for pattern) PB must be selected on the EHSD DATA page for the pattern options to be enabled. The PTRN PB is not displayed unless JDAMs are inventoried on the aircraft. Pressing PHDG enables the UFC scratchpad for entry of the heading on which the pattern is based. Pressing INT enables the UFC scratchpad for entry of the interval (in feet) used in the pattern calculations.

Pressing the PTRN option changes the ODU to the fuze options ODU (FUZE for fuze options, MSEC for milliseconds of delay, MIN for minutes of delay, HRS for hours of delay, and PROX for the proximity option in ODU windows 1-5). Refer to NATIP, NTRP 3-22.4-AV8B for additional fuze option details.

Pressing the FUZE option changes the ODU to the time on target (TOT) option ODU that displays TOT in ODU window 1. This enables the UFC scratchpad for TOT entry.

Pressing the TOT option returns the ODU to the TGPT options display.

23.10.2.1.2 Elevation

To enter the ELEV option on the ODU. A colon appears next to the ELEV option indicating selection and the scratch pad displays the stored elevation for the selected waypoint, mark point, or targetpoint. The elevation range is -2,000 feet to 25,000 feet. Enter new elevation by selecting a negative sign and 1 to 4 digits if the elevation is below sea level, or 1 to 5 digits if above sea level.

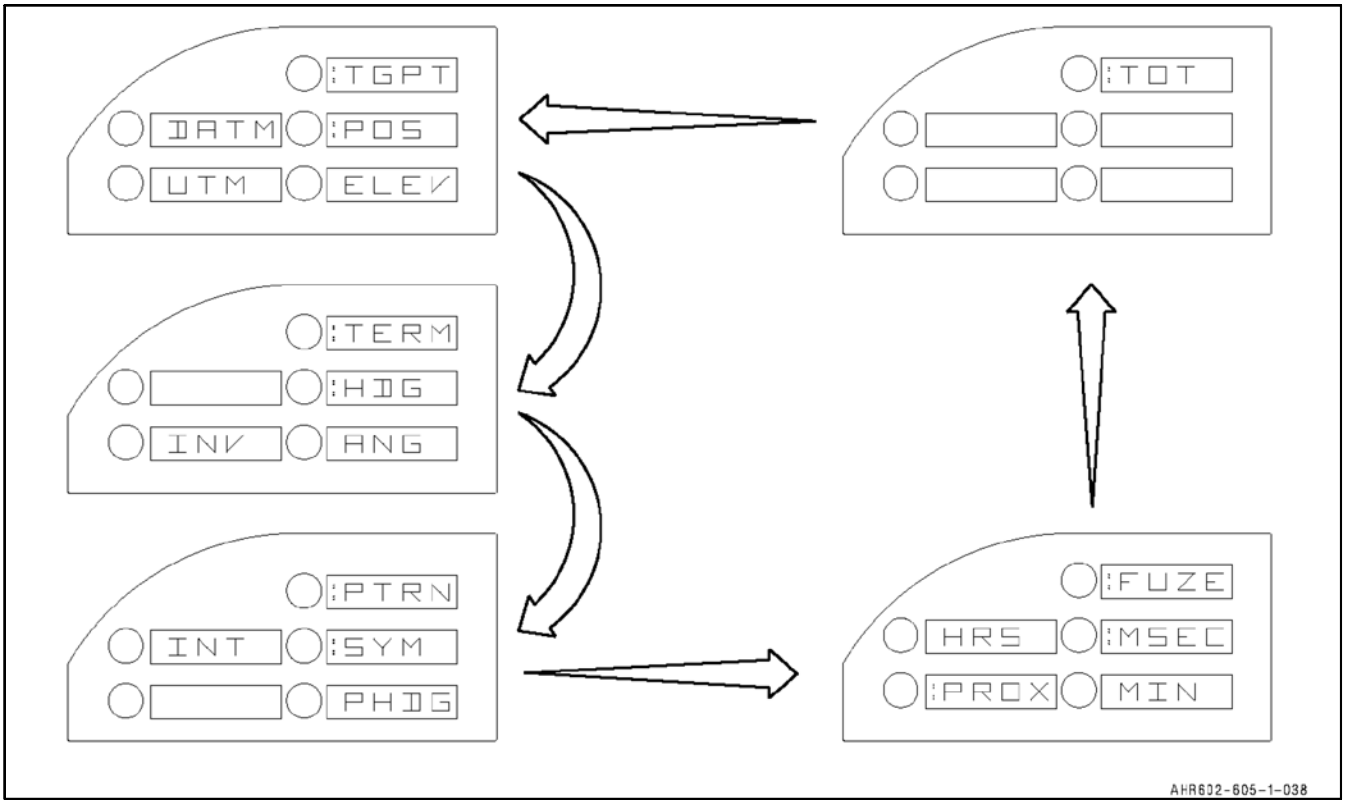


Figure 23-20. Programming Targetpoints (with H4.0)

23.10.2.1.3 Magnetic Variation

To enter magnetic variation select the ELEV option twice. This option toggles between ELEV and MVAR. A colon appears next to the MVAR option indicating selection, while the scratch pad displays the stored magnetic variation for the selected waypoint. Magnetic variation can be entered to the nearest degree from W 90 degrees to E 90 degrees. With H4.0 magnetic variation can be entered to the nearest tenth of a degree.

23.10.2.1.4 Datum

To enter a datum select the DATM option on the ODU. A colon appears next to the DATM option indicating selection and the ODU displays last entered datum. Initial default shall be 47. If the DATM is invalid a blank scratchpad will be displayed. Entries of 1 through 47 will be allowed for the appropriate datums. If an invalid DATM is entered the invalid entry will flash.

23.10.2.1.5 Bearing

To enter bearing select the BRG option on the ODU. A colon appears next to the BRG option indicating selection and the scratch pad displays the stored bearing for the selected offset. On the UFC keyboard, enter the new bearing by sequentially entering values from 0 to 360° in 0.1° increments with OMNI 7.1 and 0.01° increments with C1+ and H4.0. Entry of leading zeros is not required. If TRUE is boxed on the MAPM/EWM page, then the entered bearing is true. If TRUE is not boxed on the MAPM/EWM page, then the entered bearing is magnetic.

23.10.2.1.6 Offset Elevation

To enter offset elevation select the ELEV option on the ODU. A colon appears next to the ELEV option indicating selection and the scratch pad displays the stored elevation for the selected waypoint offset or markpoint offset. The elevation range is −2,000 feet to 25,000. Enter new elevation by selecting a negative sign and 1 to 4 digits if the elevation is below sea level, or 1 to 5 digits if above sea level.

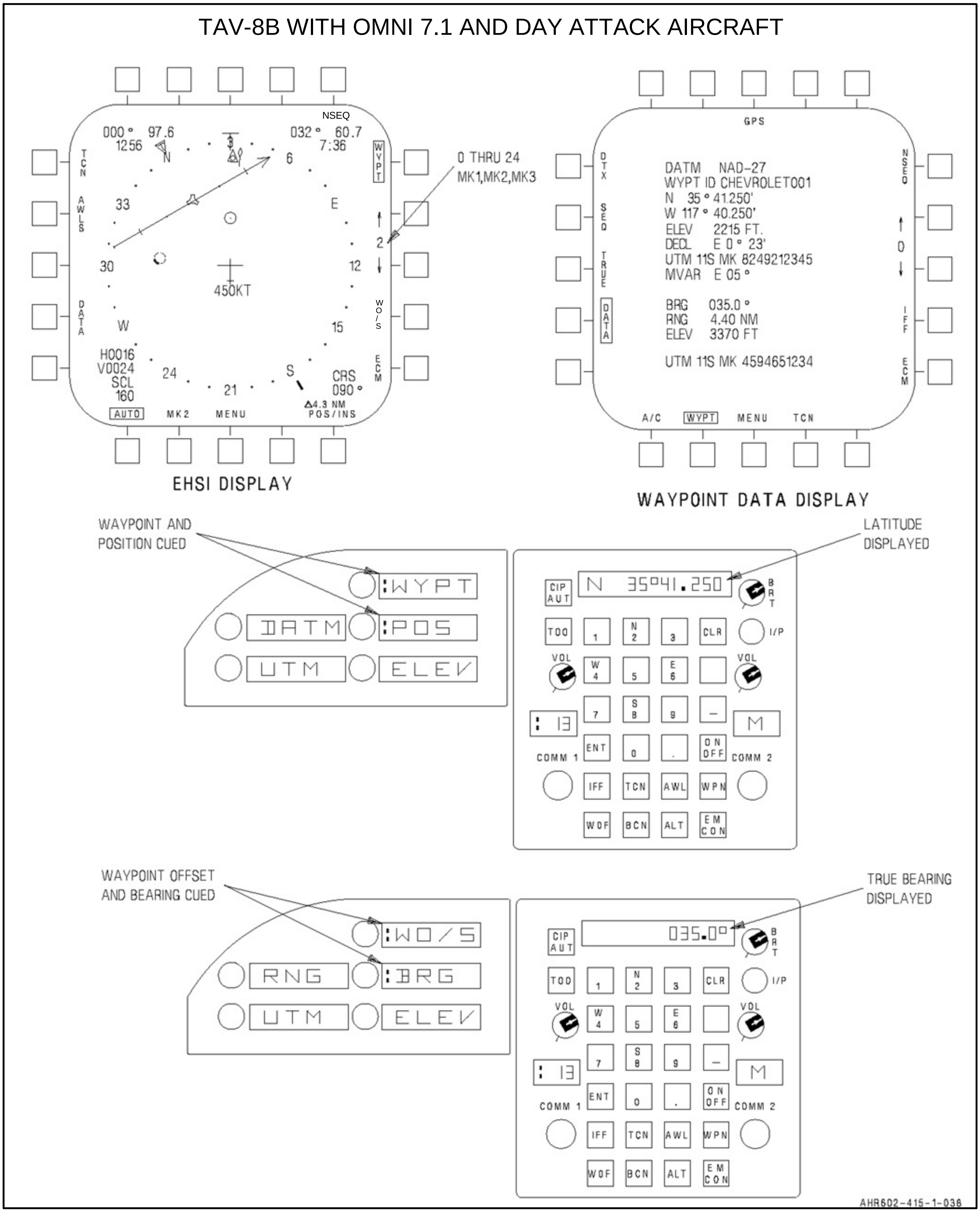


Figure 23-21. Waypoint, Mark, or Waypoint/Mark Offset Data Entry (Sheet 1 of 4)

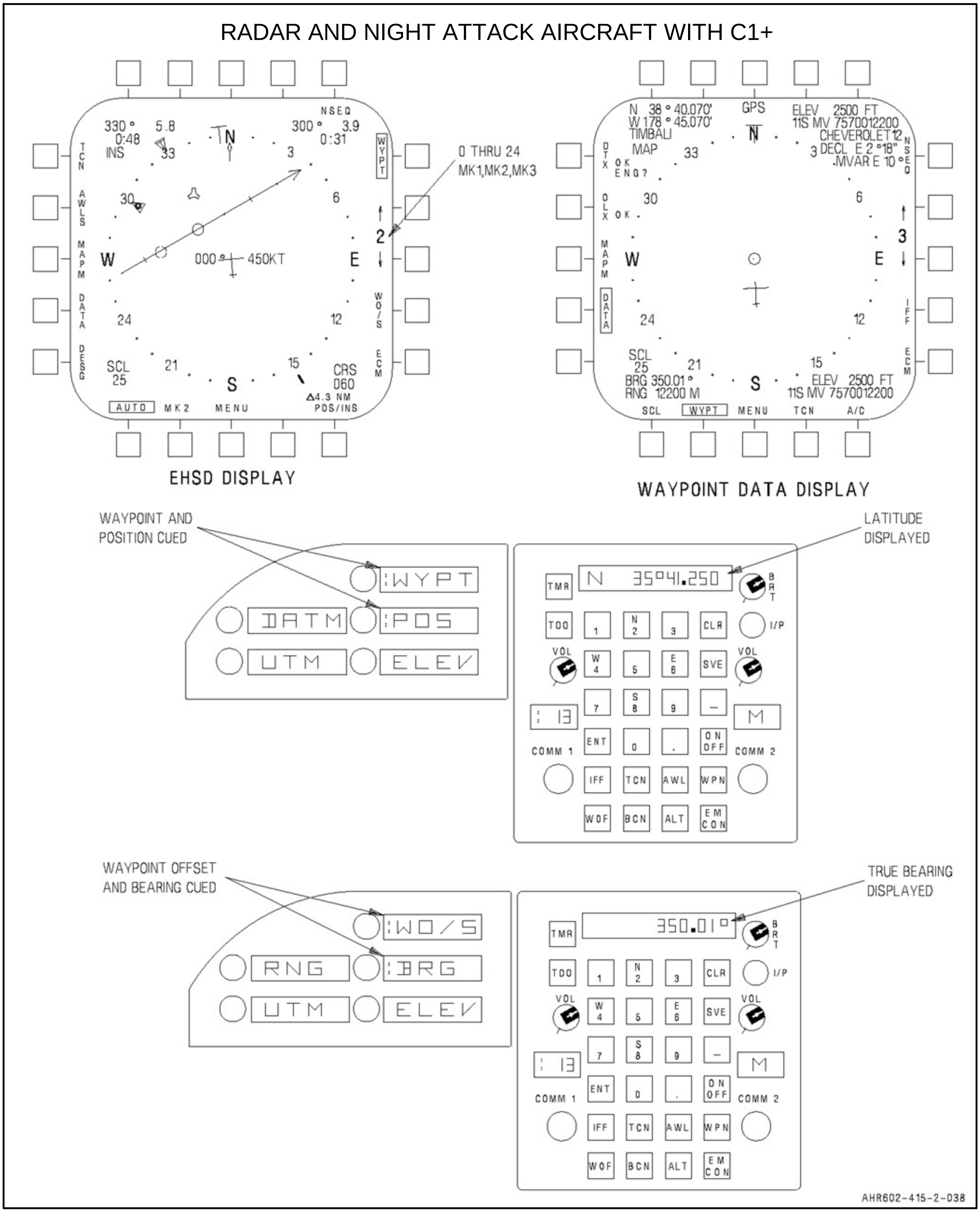


Figure 23-21. Waypoint, Mark, or Waypoint/Mark Offset Data Entry (Sheet 2)

TAV-8B WITH H4.0 AND RADAR AND NIGHT ATTACK AIRCRAFT

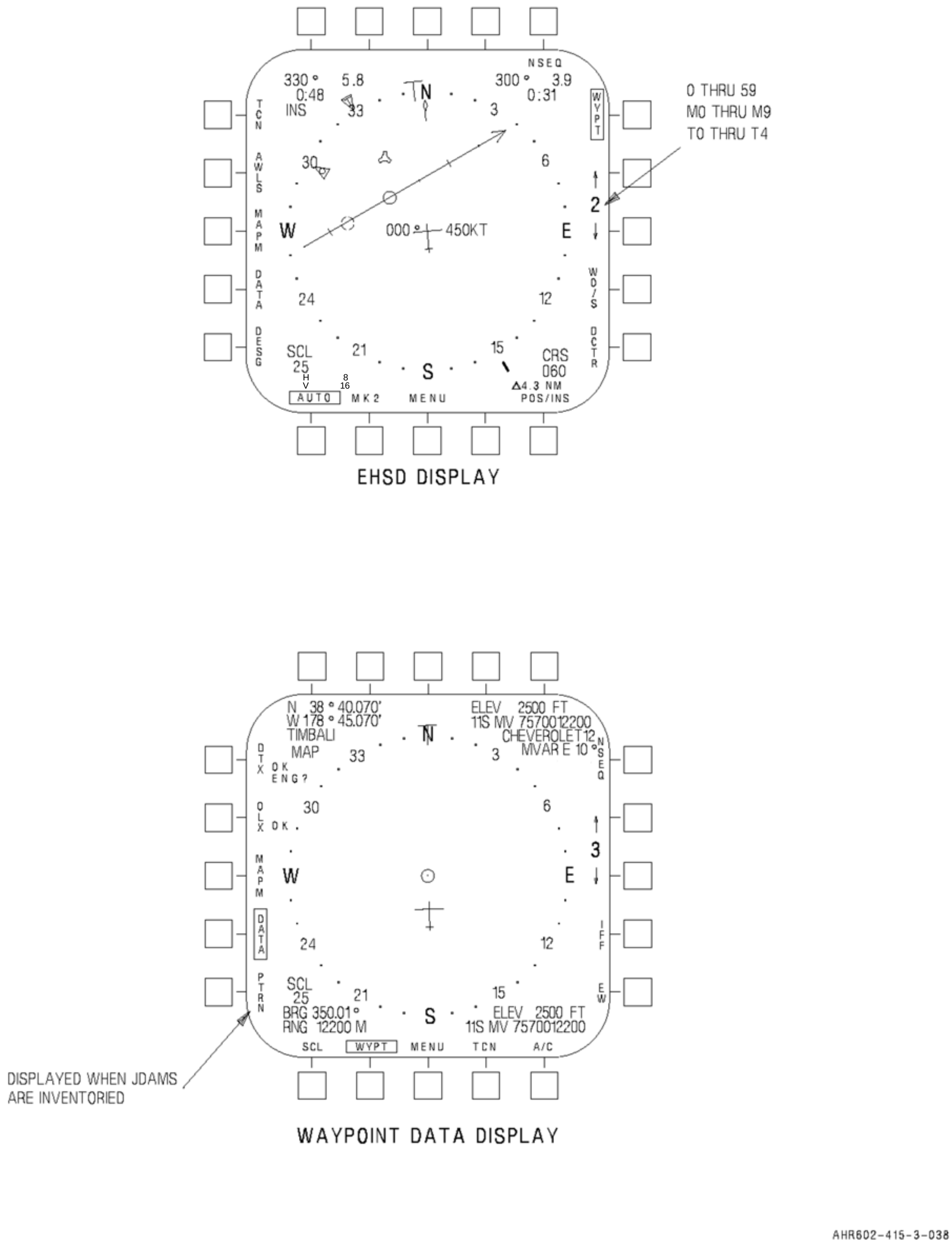


Figure 23-21. Waypoint, Mark, or Waypoint/Mark Offset Data Entry (Sheet 3)

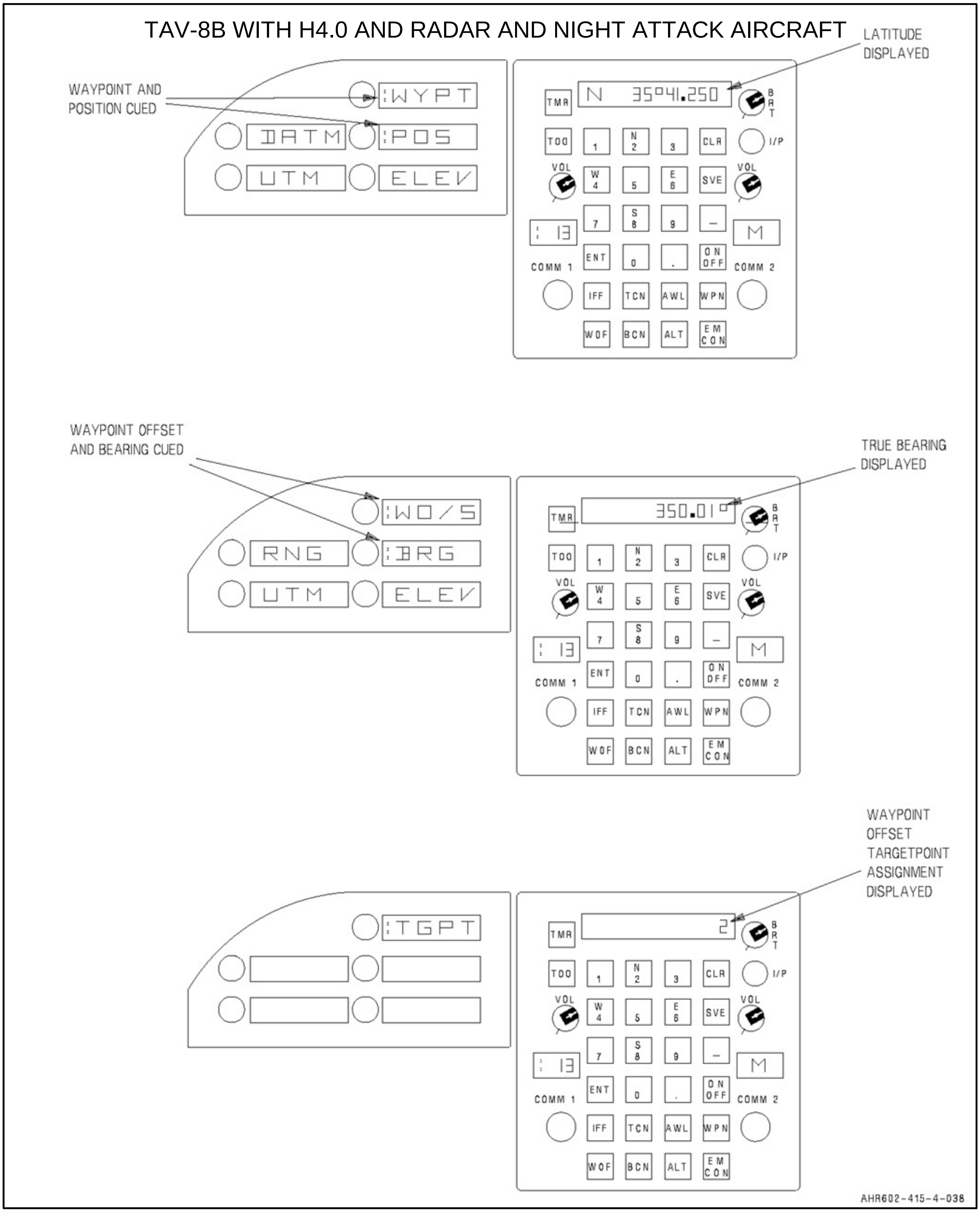


Figure 23-21. Waypoint, Mark, or Waypoint/Mark Offset Data Entry (Sheet 4)

23.10.2.1.7 Range

To enter range select the RNG option on the ODU. A colon appears next to the RNG option indicating selection and the scratch pad displays the stored range for the selected offset. Range is displayed in nautical miles or meters. Successive depression of the cued RNG option provides alternate displays of range in nautical miles or meters. On the UFC keyboard enter the new range. Entries of 100.000 or less are interpreted as nautical miles. Entries greater than 100 are interpreted as meters. Nautical mile entries can be to the hundredths of a mile with OMNI 7.1 or to the thousandths of mile with C1+ and H4.0 if a decimal is entered. Meter entries must be an integer from 101 to 185,200. A range entry of zero forces the bearing entry to zero and sets the elevation equal to the waypoint or markpoint and blanks the offset data on the DDI. With H4.0, it is possible to create an offset with 0 range, by entering an elevation that is different than the waypoint's elevation. Entering a range of 0 still removes the offset from the waypoint.

23.10.3 Transfer Data Page (with H4.0)

Selection of the TFER option on the SDAT page, displays the data point transfer page. See Figure 23-22. This page provides the ability to transfer waypoints, GPS waypoints, markpoints, and targetpoints (current, pre-planned, and another aircraft's flight position) that have been located on the DSU or the AMU mission card, into a selected waypoint, markpoint, or targetpoint. The aircrew must select both the point to be transferred (the transfer-from point on the left side of the MPCD) and the point into which the data will be transferred (the transfer-to point on the right side of the MPCD). The point data for both points is displayed at the top of each column.

23.10.3.1 Transfer-from Point

Waypoints, markpoints, targetpoints, and stored GPS points can be selected using PB 2-5. They are listed in alphabetical order with the waypoint, markpoint, or targetpoint number displayed to the right of the point's name. The arrows at PB 1, 16, 17, and 20 can then be used to select the actual point number to be transferred. Since there are only 10 markpoints, PB 16, 17 and 20 are not displayed if the transfer-from point is a markpoint. There are up to three pages of targetpoint data available for selection. The first page contains T0-T4. The second page contains the first twenty of the pre-planned targetpoints. The third page contains the last twelve pre-planned targetpoints.

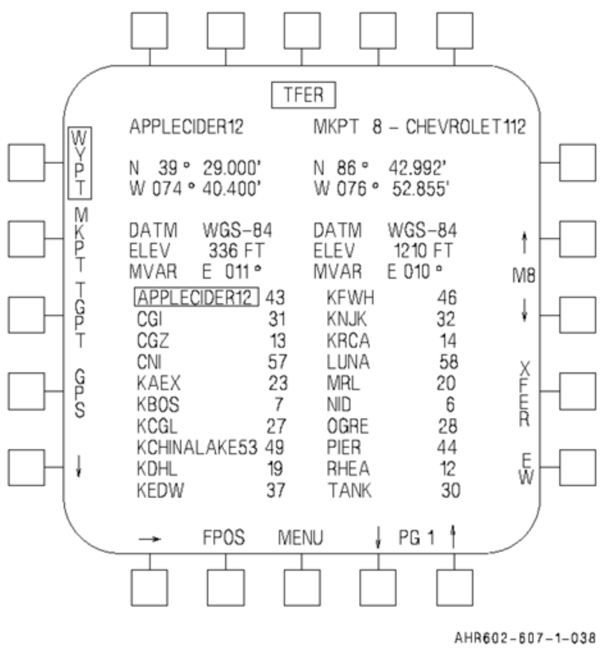


Figure 23-22. Transfer Data (TFER) Page

23.10.3.2 Transfer-to Point

Quick access must be used to switch between point types. The arrows at PB 12 and 13 can then be used to select the actual point number to be overwritten.

23.10.3.3 Flight Position Transfer Page

Depression of the FPOS option (PB 19) displays the first page of the flight position data. See Figure 23-23. The arrows at PB 1, 16, 17, and 20 are used to select the desired targetpoint set for transfer. Selection of the FPOS transfer option moves all targetpoints (T1-T4) and the associated targetpoint data (terminal heading, impact angle, TOT, etc.) from that FPOS into the current aircraft targetpoints. If less than four targetpoints are transferred, the aircraft will reset the remainder to default values and set them null.

23.10.3.4 XFER

Depressing the XFER option (PB 14) transfers data into the selected point. Offsets are only transferred between waypoints, markpoints, and stored GPS points that are not read from the MAGR. Targetpoint data (terminal parameters, pattern data, TOT, and fuze data) is transferred with the rest of the targetpoint data when transferred into another targetpoint. If a waypoint, markpoint, or stored GPS point is transferred into a targetpoint, the targetpoint remains the terminal parameters, pattern data, TOT, and fuze data.

23.11 UTM DATA ENTRY (OMNI 7.1 AND C1+)

Data may be entered in universal transverse mercator (UTM) coordinates for all 25 waypoints and 3 marks. The UTM system subdivides 6° by 8° earth zones into a 300 km by 300 km segment (see Figure 23-24). This segment is subdivided into nine 100 km by 100 km segments which are each further subdivided into 10 km by 10 km segments. The UTM coordinates of a selected waypoint and offset are entered into the MC as 10 digit numbers if they are both located within the same 100 km by 100 km grid segment. If the offset is located in an adjacent grid segment it must have a 11 digit UTM number. Using the single waypoint entry method, only one waypoint or markpoint needs to be in the same or adjacent grid segment for each offset. In this method accuracy is a function of latitude, offset range, and declination angle. To use UTM data, the selected waypoint (within a 100 km by 100 km segment) must be entered into the system in both earth and UTM coordinates. To manually enter UTM data, perform the following:

1. On the upfront control the latitude and longitude of the selected waypoint has been initially selected.

2. Press UTM pushbutton.

   A colon appears to the left of the option display window. Stored UTM coordinates are displayed on the scratch pad.

3. Type in ten-digit UTM numbers representing Eastings and Northings taken from a standard UTM grid map, then press ENT.

   The new UTM coordinates for the selected waypoint are displayed on the scratch pad and on the DDI.

4. Select UTM again, which brings up declination (DECL). UTM toggles between UTM and DECL.

   A colon appears to the left of the option display window.

5. Type declination angle (difference between true north and UTM grid north), then press ENT.

   The scratch pad and DDI display declination angle. The declination angle is a four key entry, E or W plus X° XX’, and is limited to 9° 59’ East or West.

6. Press WYPT pushbutton on the ODU.

   The ODU displays offset options in the display windows.

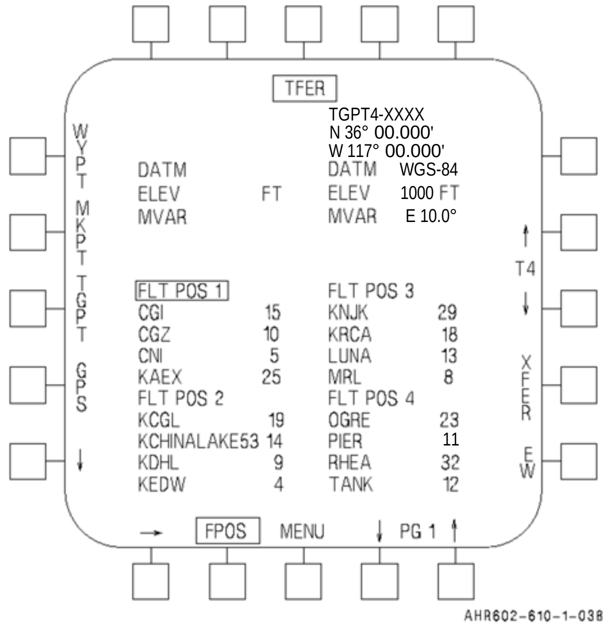


Figure 23-23. Flight Position Data Page

7. Type in 10 or 11 digit UTM of the offset or target, then press ENT.

   The UTM coordinates for the selected offset or target are displayed on the scratch pad and on the DDI. The UTM will only be 10 digits if it lies within the same grid segment as the waypoint. If the offset range extends to an adjacent grid segment, the first digit entered is the number of the adjacent grid segment in which the offset is located. For ease of entry, the adjacent grid segments correspond to the numbered buttons on the upfront control and their position in relation to one another. The next 10 digits represent the offset Eastings and Northings.

   When the entries are completed, the range and bearing to the offset (target) from the waypoint is displayed on the DDI. If required, these steps may be repeated to enter offsets for all the waypoints and markpoints.

On TAV-8B and Day Attack aircraft, there are two different ways to enter UTM coordinates as follows:

1. If UTM data has been transferred from the data storage set the ODU will initialize with the first of four selections of two-letter alpha identifiers of the UTM coordinates for the waypoint/mark point selected and the adjacent grid segments (see Figure 23-25). Pressing the UTM option scrolls through the four quadrants of selection. The two-letter alpha identifier corresponds to the applicable segment on the mercator chart. The numeric preceding the alpha (e.g., 3-QM) corresponds to the same numeric on the UFC keyboard. Each grid segment corresponds to a keyboard number. To enter the UTM coordinates select the desired alphas on the ODU. The scratchpad displays the corresponding grid segment alpha identifier and related keyboard number. Enter the ten-digit Northing and Easting on the keyboard. Entering a Northing or Easting, or selecting a new alpha grid segment will recalculate the UTM bearing and range. If waypoint data for segment five is altered the alphas on the ODU will be blanked.

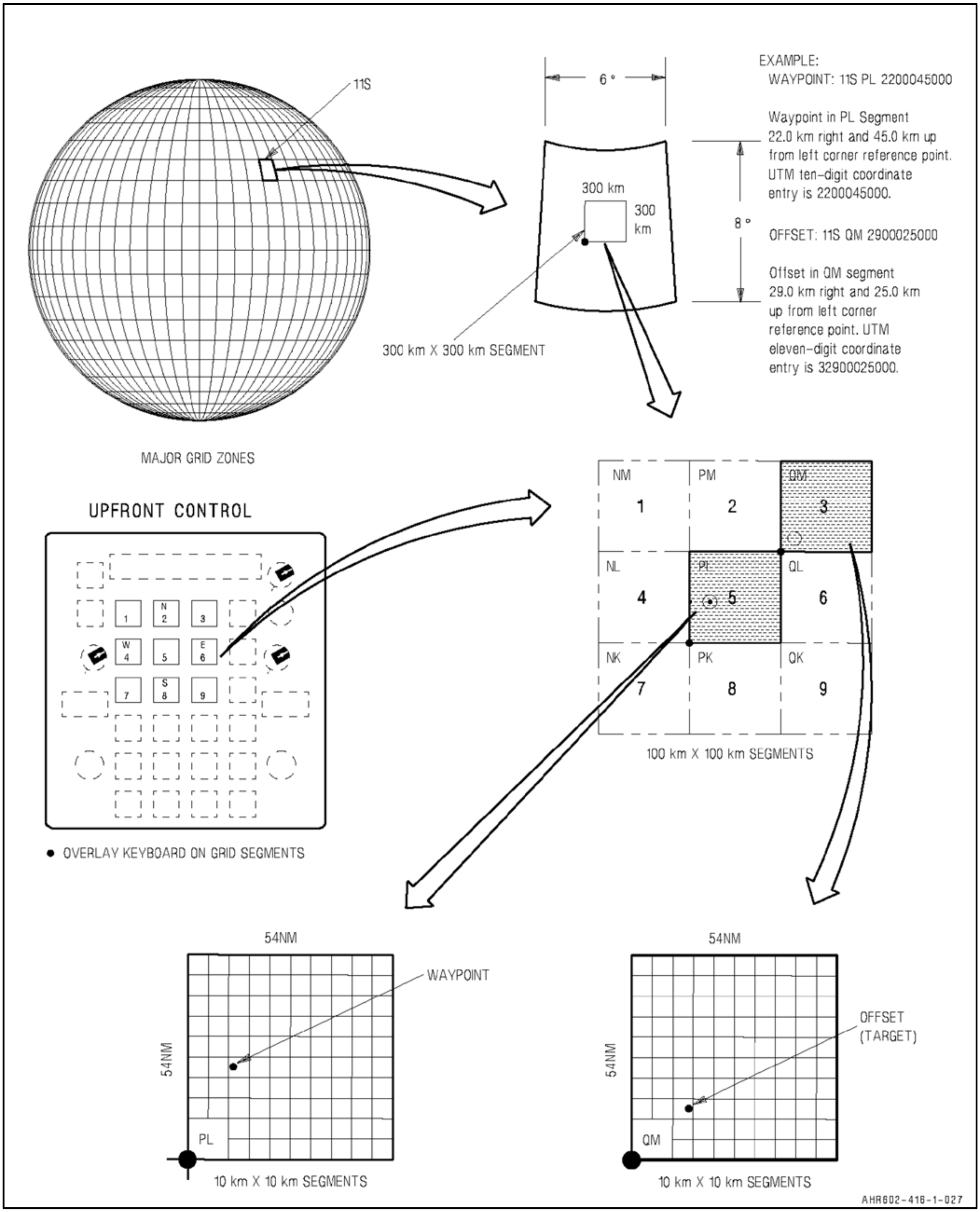


Figure 23-24. UTM Grid System

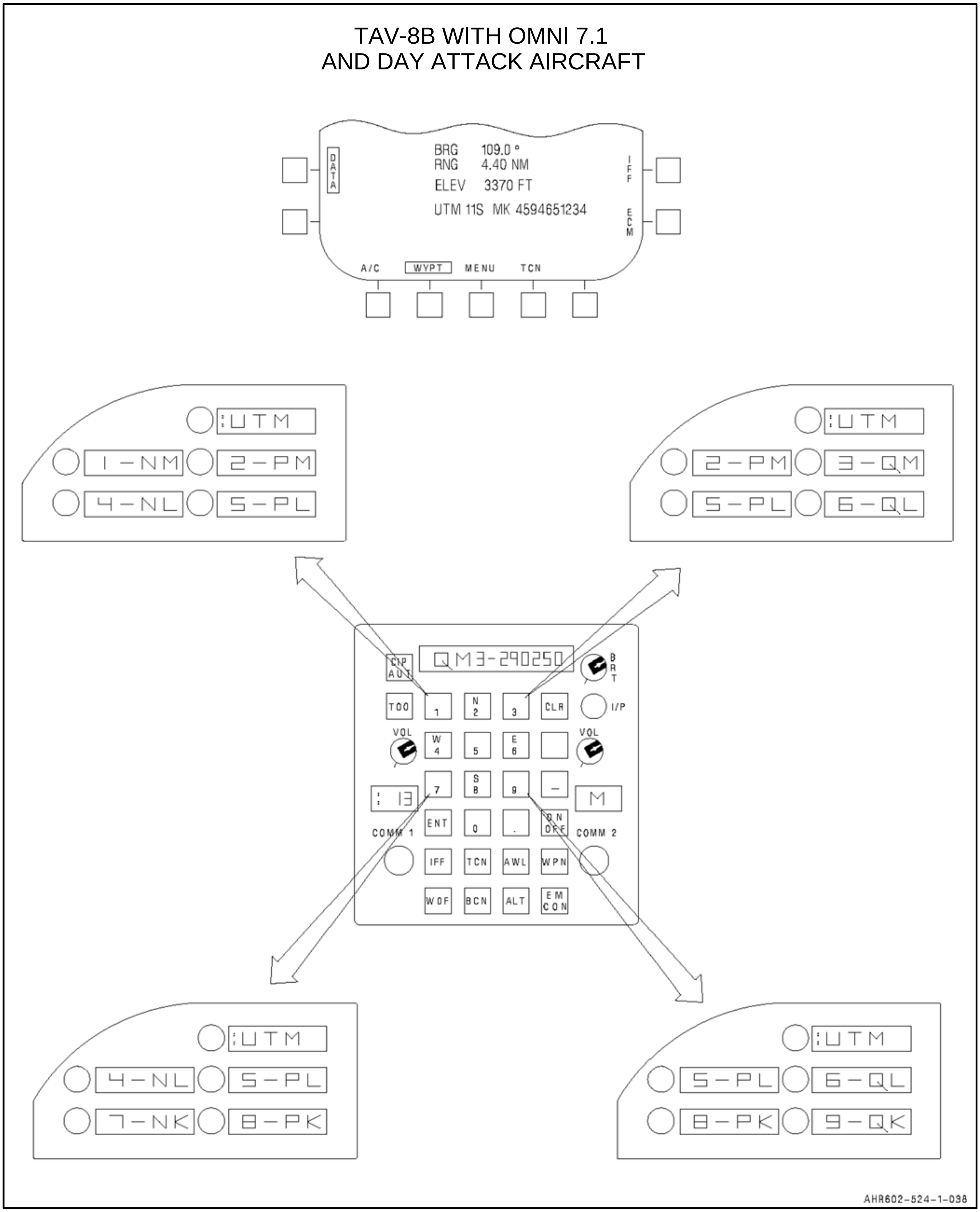


Figure 23-25. UTM Alpha Identifiers

2. If UTM alpha segment identifiers are not available the offset UTM segment must be selected using the UFC keyboard. As with the alpha segment identifier method, the waypoint or mark point is always the center key, number five. The adjacent keys correspond to the eight surrounding UTM grid segments. To enter the UTM coordinates select the desired segment on the keyboard and enter the ten-digit offset Easting and Northing. If the UTM offset lies within the same grid segment as the waypoint or mark point only the offset Easting and Northing needs to be entered.

On Radar and Night Attack aircraft, alpha segment identifiers are not available for waypoint or markpoint offset data entry. The UTM segment is selected and the Northings and Eastings are entered using the UFC keyboard as stated in the previous paragraph.

23.11.1 UTM Error vs Range (OMNI 7.1 and C1+)

When using the UTM to define offset, the system derives true bearing and range using declination data and a comparison of the waypoint/markpoint UTM coordinates. Since this calculation makes a flat plate earth assumption, the accuracy of the derived target location suffers as range from the waypoint/markpoint and the offset increase. See Figure 23-26.

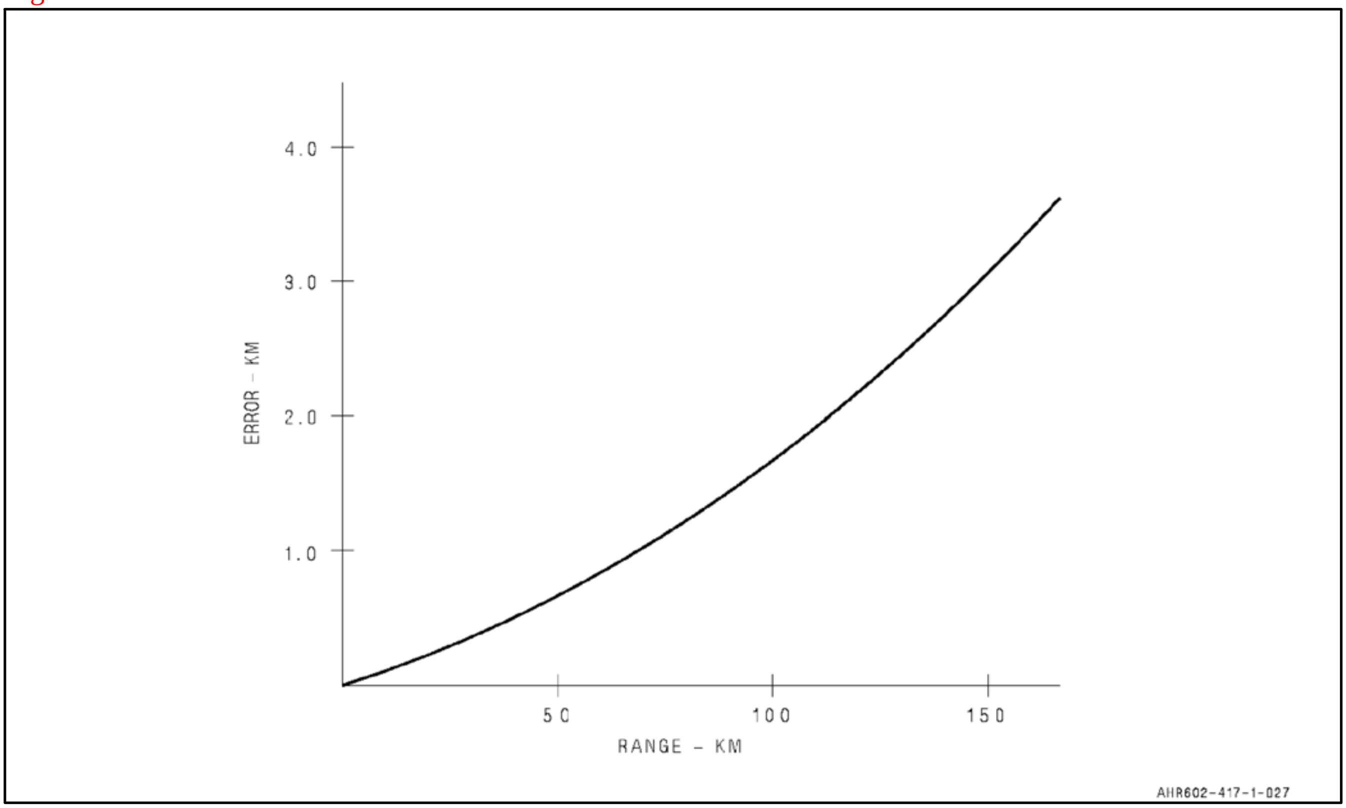


Figure 23-26. UTM Error vs. Range

23.12 UTM DATA ENTRY (WITH H4.0)

Positional data may be entered in universal transverse mercator (UTM) coordinates for all 60 waypoints and their offsets, for all 10 markpoints and their offsets, and for all 5 targetpoints. The UTM system subdivides 6 degree by 8 degree earth zones into a 300 km segment (see Figure 23-24). This segment is subdivided into nine 100 km by 100 km segments segments which are each further subdivided into 10 km by 10 km segments. The UTM coordinates of a selected waypoint and offset are entered into the MC as 10 digit numbers if they are both located in the same 100 km by 100 km grid segment. If the new point location or offset is located in an adjacent grid segment it must have an odd digit UTM number (7, 9, or 11). The first digit entered is the number of the adjacent grid segment in which the offset is located. For ease of entry, the adjacent grid segments correspond to the numbered buttons on the upfront control and their position in relation to one another. The next 10 digits represent the offset Easting and Northing. The system does not allow the selection of an adjacent grid segment if that segment lies in another major grid zone (see Figure 23-24). In other words, if the current row alpha is A then none of the segments south of the current segment can be selected; if the current row alpha is V then none of the segments north of the current segment can be selected; if the current column alpha is A then none of the segments west of the current segment can be selected; and if the current column alpha is Z then none of the segments east of the current segment can be selected.

1. Press UTM pushbutton on the WYPT or TGPT ODU. A colon appears to the left of the option display window. The stored 10–digit UTM coordinates of the point are displayed on the scratch pad preceded by an asterisk.

2. Type in 6 to 11 digit UTM numbers representing Easting and Northing, and then press ENT. The new UTM coordinates for the selected point are displayed on the scratch pad and on the DDI. The point's latitude and longitude are updated to correspond to the entered UTM position. The UTM displayed on the scratch is 10 digits preceded by the segment number (1–9). If an even number of digits were entered then the segment number is 5. The UTM displayed in the upper right data block on the DDI is the complete 15–digit UTM.

The position of a waypoint or markpoint offset can be moved within a grid segment or to an adjacent grid segment by entering a UTM. After the UTM is entered, the MC recalculates and displays the new latitude and longitude. The UTM will retain its 15 digit format. To manually enter UTM data for an offset from a point, perform the following:

1. Press WYPT pushbutton on the ODU. The ODU displays offset options in the display windows with a colon next to UTM. The stored 10–digit UTM coordinates of the offset are displayed on the scratch pad preceded by an asterisk.

2. Type in 6 to 11 digit UTM numbers representing Easting and Northing, and then press ENT. The new UTM coordinates for the offset are displayed on the scratch pad and on the DDI. The range and bearing from the point to the offset are updated to correspond to the entered UTM position. The UTM displayed on the scratch pad is 10 digits preceded by the segment number (1–9). If an even number of digits were entered then the segment number is 5. The UTM displayed in the lower right data block on the DDI is the complete 15–digit UTM.

If required, these steps may be repeated to enter offsets for all the waypoints and markpoints.

23.13 POSITION MARKING

With OMNI 7.1 and C1+, the mission computer has the capability to store three mark locations, MK1, MK2, MK3. With H4.0, 10 markpoints numbered 0 through 9 are available for use. This is done by pressing the MK pushbutton at the bottom of the EHSI/EHSD display on the DDI or by pressing the TOO pushbutton on the UFC. If MK1 is displayed above the pushbutton, that is the storage location that is used when the pushbutton is pressed. Press the pushbutton and the latitude and longitude of the ground point beneath the aircraft is stored in the mark 1 location. MK2 is then displayed above the pushbutton in preparation for the next mark. With OMNI 7.1 and C1+, after the second and third marks are stored, the system recycles and stores the next mark in the mark 1 location. With H4.0, after the tenth mark is stored, the system recycles and stores the next mark in the mark 0 location. A mark location can be used like a waypoint, including entry of offsets. With OMNI 7.1 and C1+, the three marks are stored at the end of the 25 waypoints.

On night attack and radar aircraft and all aircraft with H4.0 position marking has been enhanced to allow marking all designated points regardless of mode of designation. This allows the pilot to slew and designate the desired ground point using the HUD, map, or radar sensors. Pressing the MK option on the EHSD will store the designation as a markpoint.

With OMNI 7.1 and C1+, pressing the TOO pushbutton on the UFC stores the latitude and longitude of the ground point beneath the aircraft in the mark location represented by the MK pushbutton at the bottom of the EHSI/EHSD page regardless of whether a designation exists or not. With H4.0, pressing the TOO pushbutton on the UFC stores the latitude and longitude of the ground point beneath the aircraft in the mark location represented by the MK pushbutton at the bottom of the EHSI/EHSD only if a designation does not exist. If a designation exists, then pressing the TOO pushbutton on the UFC stores the designation as a markpoint.

With H4.0, the system also allows the pilot to enter the TOO position into a targetpoint (1 through 4). The default targetpoint number is displayed on the scratch pad. Press ENT to accept the default targetpoint or enter a different targetpoint number on the UFC. An entry of 0 on the UFC will cancel the targetpoint assignment portion of the TOO. The default targetpoint is the first null targetpoint or targetpoint 1 if none of the targetpoints are null. A targetpoint position can be sweetened by designating the targetpoint, slewing the position, and then selecting TOO on the UFC. The updated position is put into the targetpoint. The targetpoint retains its previous identifier. If a targetpoint is updated in this way, the MC replaces T0 in the JDAM priority list and the target data block (if displayed) with the slewed targetpoint's number.

23.14 POSITION UPDATE

There are four methods of correcting or updating the present position of the aircraft and one method (radar aircraft only) of correcting the velocity of the aircraft. TACAN, overfly, designate, GPS, or VEL (Radar only). When the update pushbutton is pressed on the EHSI/EHSD, FLIR, Radar, or DMT display, available only when the navigation system is in a loosely coupled position keeping mode, the four (or five) update options are displayed on the option display unit. In trainer aircraft with OMNI 7.1 and Day Attack aircraft, the reject option is also displayed in case it is desired to cancel the update.

On radar aircraft, position updating using the radar display can be performed by comparing the map or previously entered waypoint coordinates to a point on the radar map. Refer to NATIP, NTRP 3-22.4 AV8B.

23.14.1 TACAN Position Update

The system stores five TACAN stations and coordinates. A TACAN update can be performed anytime one of the five stored stations is selected and is within operating range. After selection of the TACAN option, the position of the aircraft is calculated using the range and bearing to the TACAN station. The computed position is then compared to the aircraft position derived from either INS or air data. The error in degrees and nautical miles is displayed on the scratch pad. Pressing the ACPT or REJ option select pushbutton on the option display unit either updates present position or rejects the update as desired.

A two TACAN station update can be performed to improve TACAN ranging accuracy. If this is desired, the TCN2 option is selected to initialize the TACAN to the next stored channel of the five station sequence. If this is not the desired station, successive pressing of the TCN2 pushbutton scrolls through the remaining stations excluding the station used in the first update. After lockon, the second station is displayed on the EHSI/EHSD display. Pressing the ERR2 pushbutton on the ODU displays bearing and range error on the scratch pad based on both TACAN stations. Pressing the ERR1 pushbutton on the ODU displays bearing and range error on the scratch pad based on the first TACAN station. Pressing the ACPT or REJ option select pushbutton on the ODU either updates present position or rejects the update as desired.

23.14.2 Overfly Position Update

This method is the same as waypoint designate position update, except the aircraft is flown directly over the waypoint and the OVFY option select pushbutton on the option display unit is pressed. The system then computes the position error in degrees and nautical miles using the position derived by the onboard system compared with the stored waypoint position. The error is displayed on the scratch pad. The update can then be accepted or rejected or, another overfly position update may be made. If a second overfly position update is made without accepting or rejecting the first update, the first update is automatically rejected.

23.14.2.1 Navigation Fix Update

A navigation fix update provides the capability to quickly update the navigation system on an unplanned navigation point. To perform a FIX update, the aircraft is flown directly over the navigation point and the OVFY option select pushbutton on the option display unit is pressed followed by the FIX option on the ODU. The fix (FIX) option on the ODU enables position entry or UTM entry as a source for an update. With the position (POS) option pressed and enabled, the latitude and longitude are entered and displayed on the scratch pad. When entry is completed the ERR option is displayed and the UTM option blanks. Pressing the error (ERR) pushbutton displays the navigation error on the scratch pad. The update can then be accepted or rejected.

To make a UTM entry as an update source, the UTM option pushbutton is pressed and the overfly UTM coordinates relative to the selected waypoint are entered. When entry is completed the ERR option is displayed and the POS option blanks. Pressing the error pushbutton displays the navigation error which can then be accepted or rejected.

23.14.3 Designate Position Update

This method allows the aircraft to update its position by designating one of the stored waypoints, markpoints, or targetpoints using the HUD or the dual mode tracker. A waypoint is selected and the designate (DESG) option is then selected on the option display unit. The waypoint is visually acquired and then designated using either the HUD or the dual mode tracker. The system then computes the position error by comparing the derived position from the designated point with the existing present position and displays it on the upfront control scratch pad. The update can then be accepted or rejected as desired.

23.14.4 MAP Position Update (Night Attack and Radar only)

A map position update is available when a map page is displayed. There are two types of map updates: overfly (OVFY) and designate (DESG). In an overfly map update the aircraft position can be updated by over flying a landmark that is on the digital map. Crosshairs are slewed over the location on the map. The navigation errors are displayed in the scratchpad. The update can then be accepted or rejected.

The designation map update method allows the aircraft to update its position by slewing the position of a HUD designation on the digital map. The system then computes the position error by comparing the derived position from the designated point with the existing present position and displays it on the upfront control scratch pad. The update can then be accepted or rejected as desired.

In aircraft with TAMMAC installed, map updates cannot be performed if the map type format is CIB. Map updates are cancelled if the map type format changes (CHRT to DTED or DTED to CIB) during the update.

23.14.5 Manual GPS Update

This method allows the aircraft to update its position by using current GPS position as the source for the update. The update displays current position errors as range and bearing errors. The update can then be accepted or rejected as desired.

23.15 WAYPOINT, MARKPOINT, TARGETPOINT OR WAYPOINT/MARKPOINT OFFSET STEERING

Waypoint, markpoint, targetpoint, or waypoint/markpoint offset steering is provided to any of the waypoints, the markpoints, the targetpoints, or their associated offsets. Waypoint, markpoint, or targetpoint steering is selected by selecting the desired waypoint, markpoint, or targetpoint and pressing the WYPT pushbutton on the DDI. The WYPT option is boxed (see Figure 23-27) and the bug (heading marker) on the heading scale indicates relative bearing to the waypoint or mark. The bug is wind corrected. The waypoint, markpoint, or targetpoint range and number are shown at the bottom right on the HUD. A digital readout of bearing and distance to the waypoint, markpoint, or targetpoint is provided in the upper right corner of the EHSI/EHSD display. Time to go to the waypoint, markpoint, or targetpoint in minutes and seconds is displayed under the bearing and distance.

To fly a selected course to a waypoint or mark, set in the course with the course knob on the HSI (TAV-8B and Day Attack aircraft) or course set switch on the CRS panel (Radar and Night Attack aircraft). The course appears on the bottom right of the EHSI/EHSD display and the course line is also displayed to indicate the position of the aircraft relative to the course. The course line rate of movement is used to anticipate when to turn to intercept the course. Steering to an offset from a waypoint or markpoint is also available by selecting the WO/S pushbutton to transfer the steering to the offset point. In this case the HUD range nomenclature would change from WYPT to WO/S.

CAUTION

In the TAV-8B and Day Attack aircraft, the course line displayed on the EHSI/EHSD and the course in the course selector window of the HSI are not necessarily the same. The bearing displayed in the course line data block in the lower right corner of the EHSI/EHSD and the course line displayed on the EHSI/EHSD should not be used instead of the bearing in the course selector window of the HSI. See Figure 23-27.

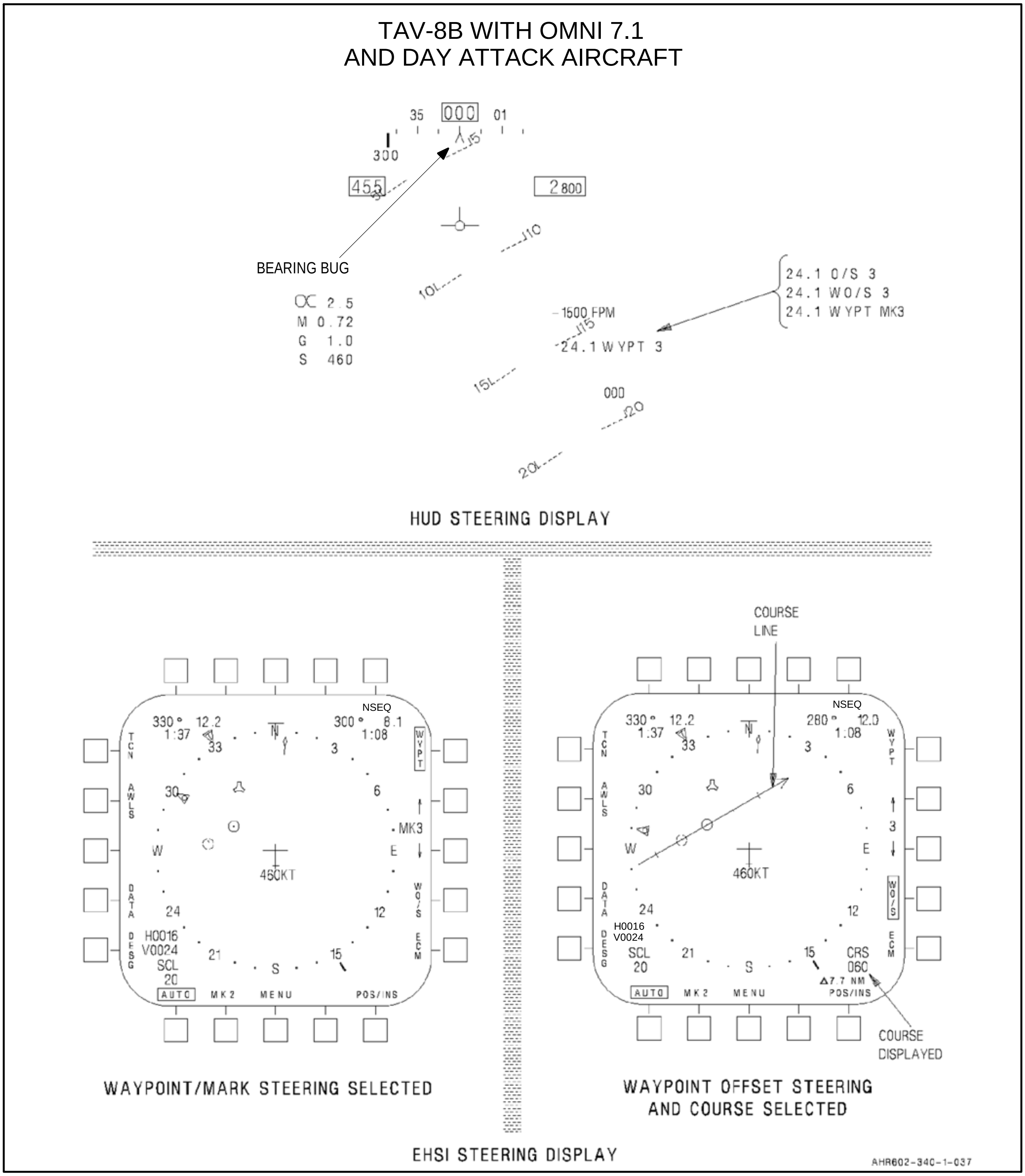


Figure 23-27. Waypoint, Mark, or Waypoint/Mark Offset Steering (OMNI 7.1) (Sheet 1 of 2)

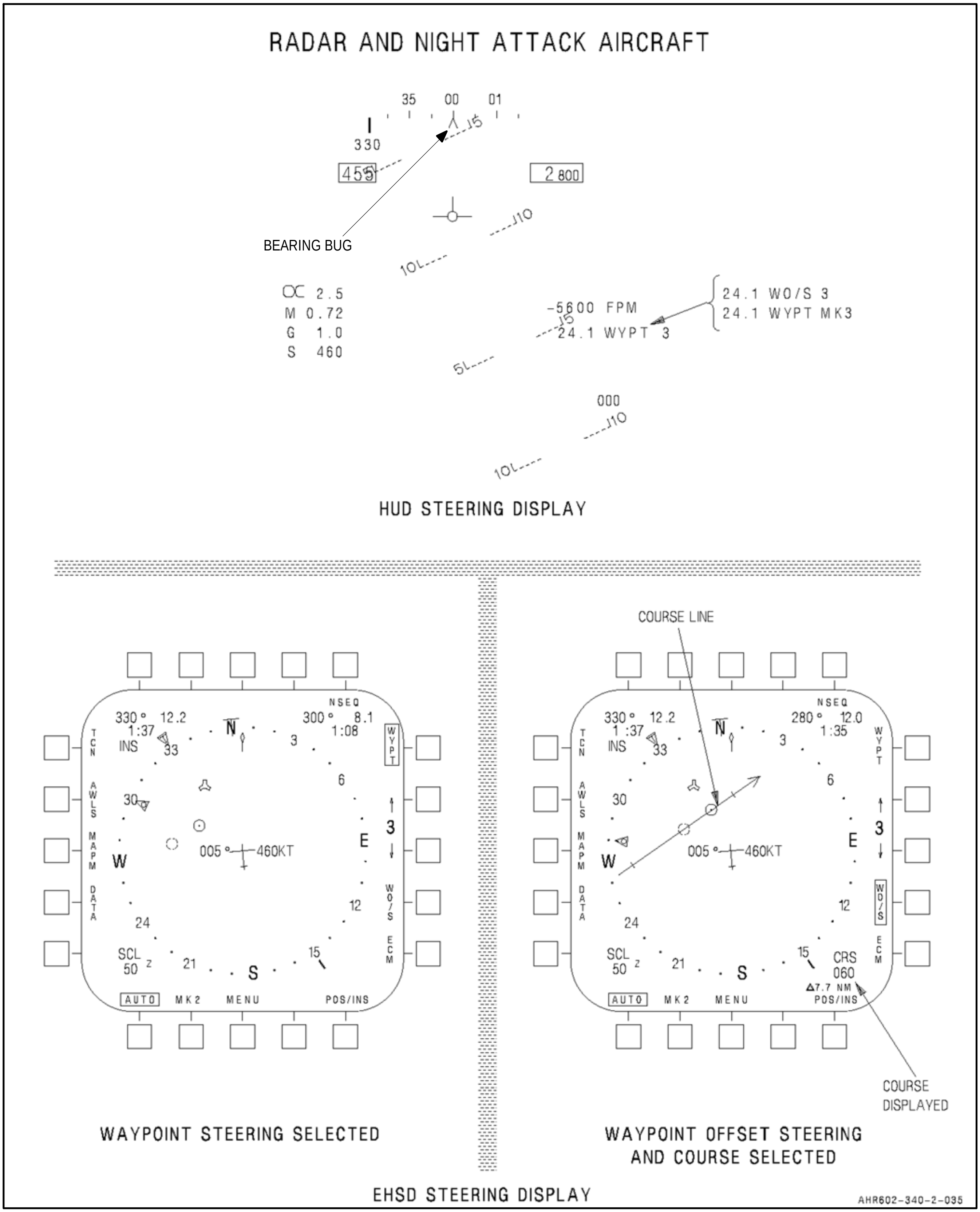


Figure 23-27. Waypoint, Mark, or Waypoint/Mark Offset Steering (OMNI C1+) (Sheet 2)

23.16 NAVIGATION MASTER MODE

Navigation master mode is selected by pressing the NAV mode pushbutton on the main instrument panel. In the navigation mode, primary flight information is presented on the HUD and aircraft horizontal situation is provided on the EHSI/EHSD display on the DDI. Three navigation steering modes are provided and selectable from the EHSI display: (1) waypoint, markpoint, targetpoint, or waypoint/markpoint offset steering, (2) TACAN or TACAN offset steering, and (3) AWLS steering. Waypoint steering provides great circle steering to a selected waypoint, markpoint, targetpoint, or waypoint/markpoint offset. TACAN steering provides the same capability to the selected TACAN station or TACAN offset. AWLS steering provides localizer and glideslope steering to the AWLS ground station. The basic flight data presented on the HUD (see Figure 23-28) is described in the following paragraphs:

23.16.1 Heading

The aircraft true heading is indicated by the moving 360° scale. True heading is the initial heading with OMNI 7.1 and C1+ and T appears on the HUD display. If magnetic heading is desired the TRUE pushbutton on the DDI is pressed and the box is removed from around the TRUE legend and the T is removed from the HUD display. Magnetic heading is the initial heading and no T appears on the HUD display with H4.0. If true heading is desired the TRUE pushbutton on the MAPM page is pressed and the box is displayed around the TRUE legend and the T appears on the HUD display. The actual aircraft heading is directly above the caret. The moving heading scale provides trend information during turns. As the aircraft turns right, the scale moves from right to left.

23.16.2 Airspeed

Calibrated airspeed from the air data computer is provided in the box on the left side of the HUD. With H4.0, the box is no longer displayed around the calibrated airspeed.

23.16.3 Altitude

The altitude presented in the box on the right side of the HUD may be either barometric altitude or radar altitude depending on the setting of the altitude switch on the HUD control panel. When the altitude switch is in the BARO position, barometric altitude is displayed. When the altitude switch is in the RDR position, radar altitude is displayed and is identified by an R next to the altitude. If the radar altitude becomes invalid, barometric altitude will be displayed and a flashing B is displayed to the right of the box indicating barometric altitude. The flashing B remains until either radar altitude becomes valid again or the altitude switch is placed in BARO. With H4.0, the box is no longer displayed around the altitude.

23.16.4 Barometric Setting

The barometric setting used by the air data computer (ADC) is the value set in the standby altimeter. When the barometric setting is changed on the standby altimeter by at least .02 inches of mercury, the ADC barometric setting is presented below the altitude on the HUD to provide a head-up baroset capability. The display remains for 5 seconds after the change is made.

23.16.5 Angle of Attack

Angle of attack in degrees is displayed at the left center of the HUD.

23.16.6 Mach Number

The aircraft mach number (M) is displayed immediately below the angle of attack.

23.16.7 Aircraft G

Normal acceleration (G) is displayed immediately below the mach number.

23.16.8 Ground Speed

Ground speed (S) is displayed immediately below the aircraft G.

TAV-8B WITH OMNI 7.1 AND DAY ATTACK AIRCRAFT

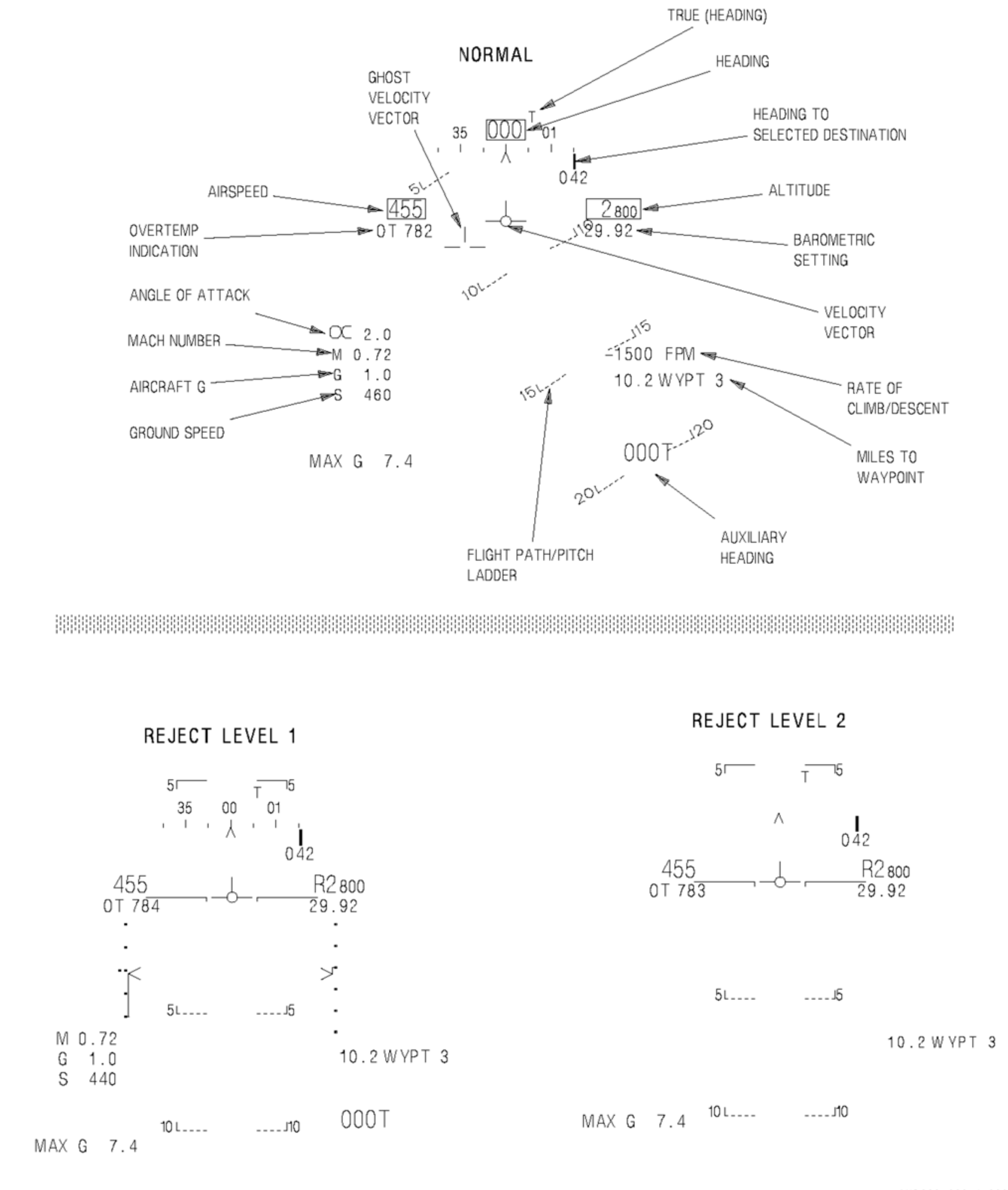


Figure 23-28. Nav Mode HUD Symbology (Sheet 1 of 2)

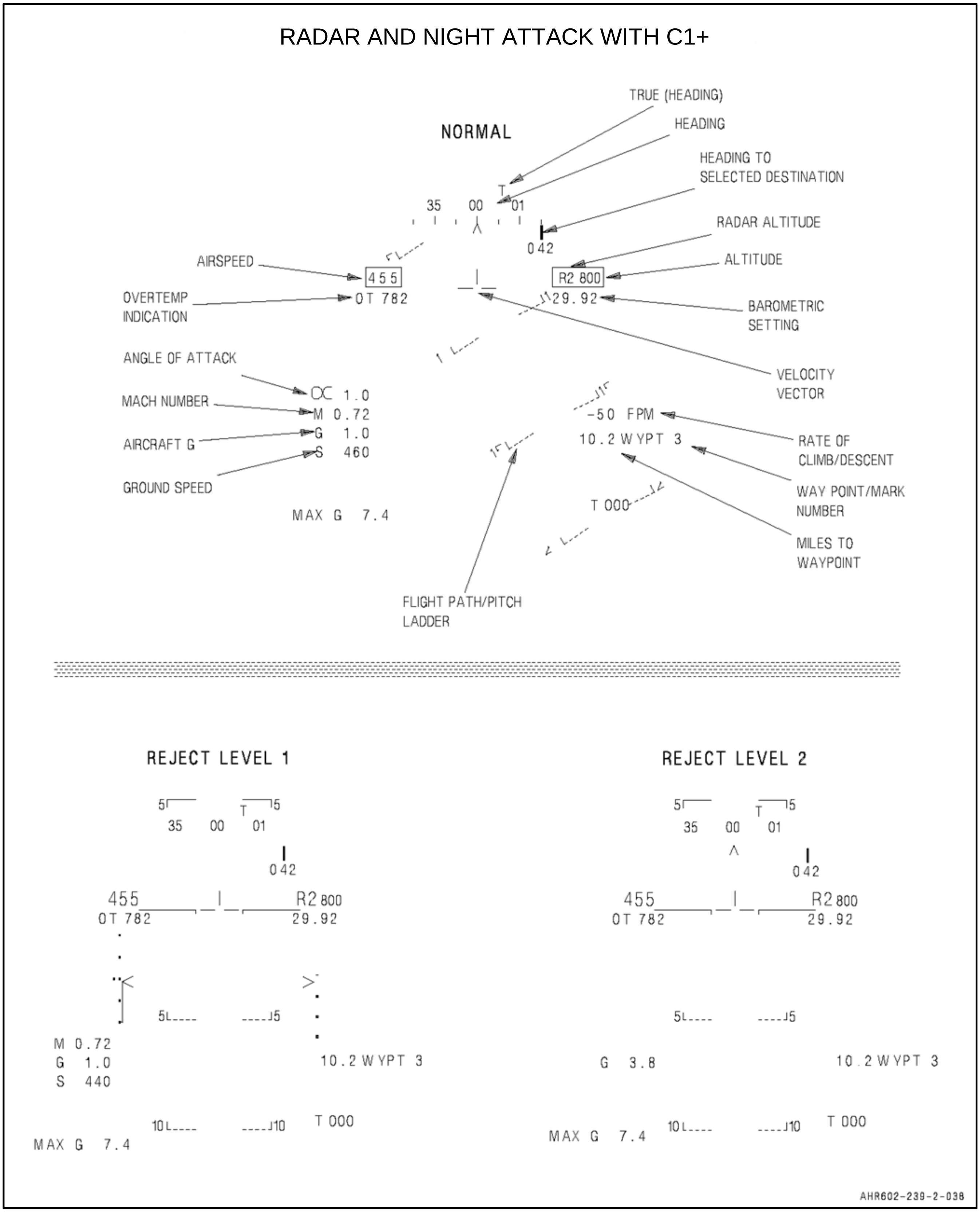


Figure 23-28. Nav Mode HUD Symbology (Sheet 2)

23.16.9 Maximum G

Maximum normal acceleration (MAX G) attained since it was last reset is displayed below the ground speed providing the maximum g exceeded 4.5g's.

Note

It should be noted that, at gross weights above 20,000 pounds or with lateral stick, the aircraft g–limit can be exceeded without exceeding 8g's on either the HUD or FLC.

23.16.10 Velocity Vector

The velocity vector provides the pilot with an outside world reference with regard to actual aircraft flight path. The velocity vector represents the point towards which the aircraft is flying (aircraft flight path). In the NAV master mode, the velocity vector is always caged to the vertical center line of the HUD. A ghost velocity vector is displayed at the true velocity vector position if that position is more than 2° from the caged position. The flight path/pitch ladder and steering information are referenced to the caged position. The ghost velocity vector will flash when limited. The velocity vector is normally positioned by inertial velocities, derived from either INS or GPS velocities. When these are invalid, filtered values of ADC TAS and ADC AOA are used to determine all velocities and therefore position of the velocity vector.

23.16.11 Flight Path/Pitch Ladder

The vertical flight path angle of the aircraft is indicated by the position of the velocity vector on the flight path/pitch ladder. The horizon and flight path/pitch angle lines represent the horizon and each 5° angle between plus and minus 30° and each 10° between 30° and 90°. Positive pitch lines are solid and are above the horizon line. Negative pitch lines are dashed and are below the horizon line. The outer segments of the lines point toward the horizon. Each line is numbered and the numbers rotate with the lines so that inverted flight can easily be determined. To aid in determining flight path angle when it is changing rapidly, the pitch lines are angled toward the horizon at an angle half that of the flight path angle. For example, in a 50° climb, the pitch lines are angled 25° toward the horizon. In level flight, pitch lines are not angled. The zenith is indicated by a circle and the nadir is indicated by a circle with an X in it. However, since the flight path/pitch ladder normally rotates about the velocity vector, determination of pitch angle may be difficult at high roll angles.

23.16.12 Waypoint/Markpoint or Targetpoint Number

This number indicates the number of the waypoint, markpoint, targetpoint, or offset selected. With OMNI 7.1 and C1+, MK precedes the number when a markpoint is selected. With H4.0, M precedes the number when a markpoint is selected, and T precedes the number when a targetpoint is selected.

23.16.13 True Heading

The letter T is displayed when true heading is selected on the DDI. If there is no T displayed, magnetic heading is being displayed.

23.16.14 Rate of Climb/Descent

This number indicates the feet per minute that the aircraft is climbing or descending. A minus sign indicates the aircraft is descending.

23.16.15 Range

The range to the selected waypoint, markpoint, targetpoint, waypoint/markpoint offset, TACAN station or TACAN offset is displayed in nautical miles.

23.16.16 Heading Marker

The heading marker (bug) indicates relative bearing to the selected waypoint, markpoint, targetpoint, waypoint/markpoint offset, TACAN, TACAN offset, or designated point. The heading marker position varies along the heading scale and will peg at scale limit. When pegged, the bearing numerals are displayed below the heading marker.

23.16.17 Overtemp Indication

If the JPT exceeds the engine threshold value, the maximum JPT recorded is displayed on the HUD beneath the air speed box adjacent to the OT legend. The OT indication is removed when the HUD reject level is changed if the overtemp condition no longer exists. If another overtemp condition occurs, the current JPT at that time is displayed.

23.16.18 Auxiliary Heading

The auxiliary heading is displayed in all master modes and is a repeat of the HUD aircraft heading. The auxiliary heading provides a way to view aircraft heading during video playback. A T is displayed if true heading is being displayed. Auxiliary heading is not displayed in reject level 2 in the TAV-8B with OMNI 7.1 and the Day Attack aircraft.

23.17 VSTOL MASTER MODE

The VSTOL mode is selected by pressing the VSTOL mode pushbutton on the main instrument panel. With VSTOL selected while weight-on-wheels, two options are displayed on the option display unit. They are NRAS (nozzle rotation airspeed) and PC (pitch carets). The basic flight data of heading, airspeed, altitude, barometric setting, angle of attack, waypoint number, T, waypoint, markpoint, targetpoint, waypoint/markpoint offset, DME, or TACAN offset range, and heading marker are displayed and function the same as described in the navigation master mode. Additional and different functions in the VSTOL mode are described in the following paragraphs. See Figure 23-29.

23.17.1 Vertical Speed Analog Scale

The vertical speed analog scale provides trend information during climbs and dives. The scale range is +1,500 to -2,000 feet per minute with graduations at +1,000, +500, 0, -500, -1,000 and -1,500 feet per minute. The moving caret is displayed on the inboard side of the scale and when displaced from zero has a reference line connecting the caret to the zero graduation.

23.17.2 FPM

Digital vertical velocity is displayed in feet per minute (FPM) with a limit of ±9,950 fpm and a resolution of 50 fpm. Plus or minus signs are not displayed on the FPM display. Below 60 knots, the vertical speed analog scale and FPM digital vertical velocity are not corrected for pitot static source error. Therefore, these displays should not be used for sink rate information when the displayed vertical velocity is greater than 500 feet per minute.

23.17.3 N (Nozzle)

Digital nozzle position is displayed in degrees.

23.17.4 F (Flap)

Digital flap position is displayed in degrees.

23.17.5 Auxiliary Heading

The auxiliary heading is displayed in all master modes and is a repeat of the HUD aircraft heading. The auxiliary heading provides a way to view aircraft heading during video playback. A T is displayed if true heading is being used. Auxiliary heading is not displayed in reject level 2 in the TAV-8B with OMNI 7.1 and the Day Attack aircraft.

23.17.6 Vertical Flight Path Symbol

The vertical flight path symbol is caged laterally and above 60 knots provides climb and dive angle information and is referenced to the flight path/pitch ladder. Below 60 knots, the vertical flight path symbol indicates vertical speed in feet per minute. When referenced against the flight path/pitch ladder, 1° of displacement from the horizon line equals 100 fpm vertical speed.

23.17.7 Sideslip Indicator

Sideslip is indicated by horizontal movement of the sideslip ball in relation to three vertical lines. Full movement of the ball to either side is equal to 0.09g and is represented by the ball being bisected by an outer vertical line.

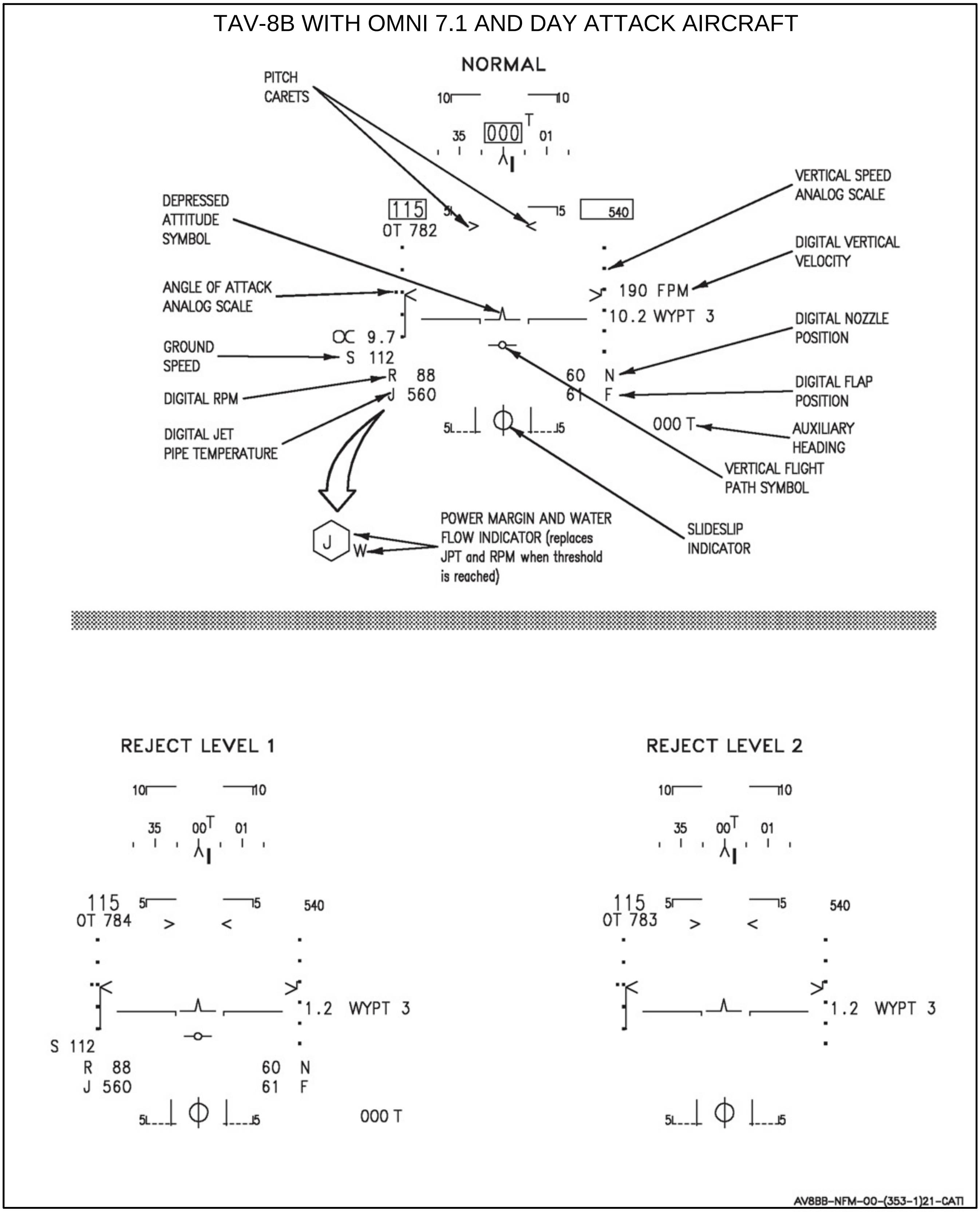


Figure 23-29. VSTOL Mode HUD Symbology (Sheet 1 of 2)

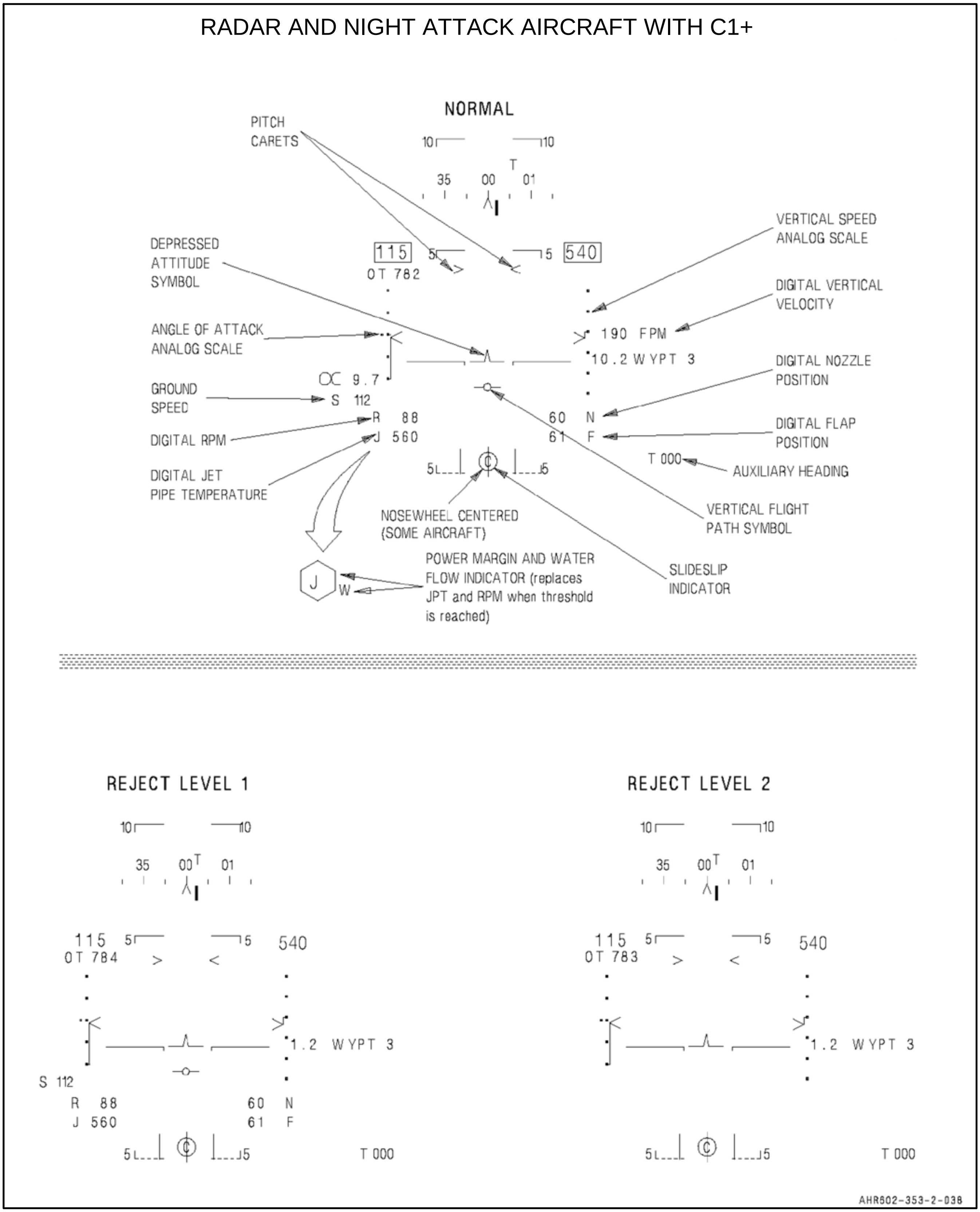


Figure 23-29. VSTOL Mode HUD Symbology (Sheet 2)

23.17.8 Nosewheel Steering Mode (Aircraft After AFC-391)

Steering modes are displayed in V/STOL master mode in all reject levels with landing gear extended. The four modes are displayed to the right of the sideslip indicator. CAST, CTR, NWS, or NWS HI is displayed depending on which steering mode is selected. Aircraft will also display a C inside the sideslip ball when the nosewheel is within 3° of neutral steering angle.

23.17.9 Power Margin Display and W

The power margin display (see Figure 23-30) replaces the JPT and rpm display when JPT is approximately 60° below maximum JPT or when rpm is approximately 6 percent below maximum rpm. The display is a growing hexagon around the letter J or R with each completed side representing 10 °C JPT or 1 percent rpm. The W is displayed when water injection is selected (SLW) and water is flowing.

With the -406 engine the power margin threshold for JPT starts at 640 °C dry or 665 °C wet; the threshold for indicated rpm starts at 96.5 percent dry or 100.0 percent wet, and corrected rpm starts at 100.5 percent. See Figure 23-30.

With the -408 engine the power margin threshold for JPT starts at 715 °C dry or 735 °C wet; the threshold for indicated rpm starts at 107.0 percent dry or 113.5.0 percent wet, and corrected rpm starts at 110.3 percent. See Figure 23-30.

406 ENGINE

JPT - °C				RPM - %		
DRY	WET	DISPLAY		DRY	WET	*
640	665	J	R	96.5	100.0	100.5
650	675	J	R	97.5	101.0	101.5
660	685	J	R	98.5	102.0	102.5
670	695	J	R	99.5	103.0	103.5
680	705	J	R	100.5	104.0	104.5
690	715	J	R	101.5	105.0	105.5
700	725	J	R	102.5	106.0	106.5
703	727	J	R	103.5	107.0	107.5

408 ENGINE

JPT - °C				RPM - %		
DRY	WET	DISPLAY		DRY	WET	*
715	735	J	R	107.0	113.5	110.3
725	745	J	R	108.0	114.5	111.3
735	755	J	R	109.0	115.5	112.3
745	765	J	R	110.0	116.5	113.3
755	775	J	R	111.0	117.5	114.3
765	785	J	R	112.0	118.5	115.3
775	795	J	R	113.0	119.5	116.3
780	800	J	R	113.5	120.0	116.8

* Corrected rpm wet or dry.

Figure 23-30. Power Margin Displays Series Engine

There is no pilot indication that rpm threshold is reached by indicated or corrected rpm. The threshold reached first determines whether J or R power margin is displayed. If JPT or rpm is still increasing after the hexagon is complete, the last leg of the hexagon continues in a straight line. The length of this line is proportional to the increase in JPT or rpm.

23.17.10 J (Jet Pipe Temperature)

Digital jet pipe temperature (JPT) is displayed in degrees Celsius with a resolution of 10 °C.

23.17.11 R (Rpm)

Digital engine rpm is displayed in percent with a resolution of 1 percent.

23.17.12 S (Ground Speed)

Digital ground speed is displayed in knots. Ground speed is removed in reject level 2.

23.17.13 Angle of Attack Analog Scale

The angle of attack analog scale has a range of +25° to –5° AOA with graduations at +20°, +15°, +10° (double dot), +5° and 0°. The moving caret is displayed on the inboard side of the scale and when displaced from zero has a reference line connecting the caret to the zero graduation.

23.17.14 Depressed Attitude Symbol

The depressed attitude symbol is fixed at 8° below the waterline. When the horizon bar of the flight path/pitch ladder is aligned with the depressed attitude symbol, the aircraft is at the proper hover attitude. GS angle (2.0° through 6°) entered through the upfront control will be maintained.

23.17.15 Pitch Carets Cue

The pitch carets (PC) initialize at 14° and provide a cue for pitch. The carets are adjustable from 0° to 30° in 1° increments. When VSTOL mode is selected the PC option is displayed on the ODU. The carets are set by pressing the PC option, typing the desired degrees of pitch (0° through 30°) on the UFC, then pressing ENT. The pitch carets are referenced to the depressed attitude symbol and move with the pitch ladder.

23.17.16 Nozzle Rotation Airspeed Cue

With VSTOL mode selected while weight–on–wheels, the nozzle rotation airspeed (NRAS) cue is set by pressing the NRAS option on the ODU, typing the desired airspeed (up to 160 knots) on the UFC, then pressing ENT. With OMNI 7.1 and C1+ and with normal or reject 1 selected, the airspeed display is boxed when the set airspeed is reached. With reject 2 selected, the airspeed box is removed when the set airspeed is reached. With H4.0 in all master modes, the airspeed box is displayed when the set airspeed is reached and then removed when 160 knots indicated airspeed is reached.

Note

With H4.0, if the NRAS airspeed is set close to or at the maximum (160 knots), the cue may appear only momentarily or not at all.

23.18 HUD SYMBOLOGY CHANGES (WITH H4.0)

With the additional HUD symbology, the time required to write all of the HUD symbology exceeded the time available. This resulted in flickering HUD symbology. Changes in HUD symbology were made to decrease the occurrence of flickering HUD symbology. The following actions were taken (see Figure 23-31):

1. Some symbology is written at a lower intensity in the A/G and A/A master modes with the HUD in the Day mode. Examples include Mach Number, AOA, normal G, ground speed, RWR cues, and other text symbols located on the sides of the HUD.

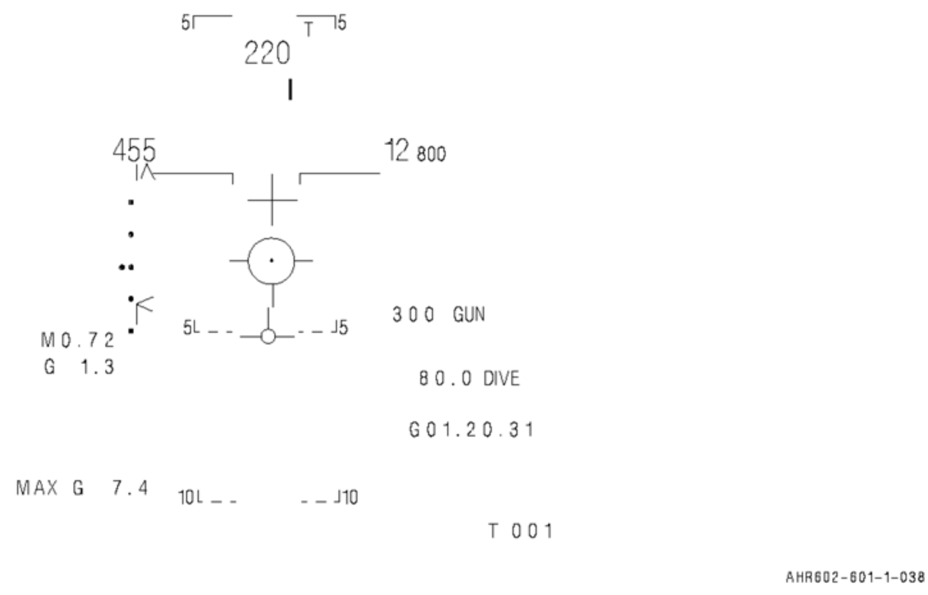


Figure 23-31. Sample HUD with Write Time Changes

2. Some symbology is removed based upon the master mode. Examples include:

   a. Nav, A/G, A/A modes – altitude and airspeed boxes have been removed regardless of the HUD reject level.

   b. A/G and A/A mode – aircraft heading is a three digit number only. The heading tape has been removed. The AOA and vertical analog scales have been removed regardless of the HUD reject level selected. There is no difference between the NORM and REJ1 HUD reject levels.

3. The most important symbology is still written at the full intensity. Examples include the velocity vector, pitch ladders, airspeed, altitude, steer to point circle, and main weapon symbology.

23.19 HUD STEERING (WITH H4.0)

The steering bug and range depicted in the HUD always reference the steer to point (STP). The STP is the steering reference selected on the EHSD (waypoint, markpoint, targetpoint, TACAN, or an offset). When a non–TACAN STP is within the HUD FOV, a circle represents the STP position unless it is designated, in which case a diamond represents it. See Figure 23-32. The reattack symbology always references the system designation (e.g. waypoint designation, radar designation, HUD designation). Since designations are always stored in targetpoint zero, steering and range to the system designation can be obtained by selecting targetpoint zero.

23.20 BACKUP/DEGRADED OPERATIONS

23.20.1 Backup Mode Initialization

Whenever the backup mode is entered the following items are affected as indicated:

1. HUD – Reverts to backup display.
2. DDI – On TAV–8B with OMNI 7.1 and Day Attack aircraft, displays HUD display.
3. Left DDI – On Radar and Night Attack aircraft, displays map display.

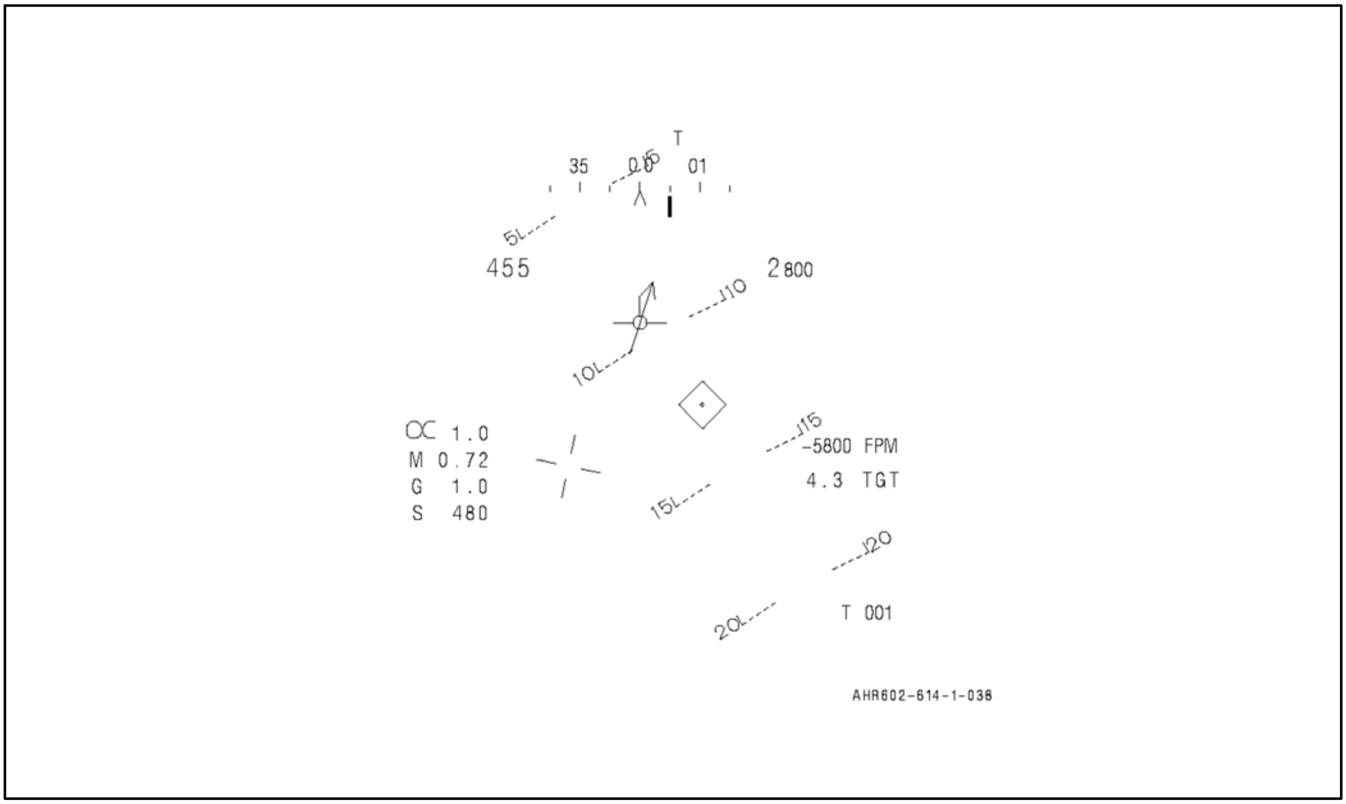


Figure 23-32. HUD Steering (with H4.0)

4. Right DDI – On Radar and Night Attack aircraft, displays HUD display.
5. SAAHS – Degraded mode.
6. VHF/UHF radio – Operates in manual mode using radio set control and ACNIP.
7. INS – No steering. Pitch, roll, true heading, and present position displayed.
8. IFF – Turned off but can be turned back on. Mode 3 code initialized to 0000 but can be reset. Mode 4A/B usable. Modes 1 and 2 inoperative.
9. Radar altimeter – Turned off but can be turned back on. Low altitude warning light fixed at 200 feet.
10. HOTAS functions – TDC inoperative. Sensor control switch depressed position functions as HUD scene reject. Waypoint increment button on the stick functions as the DAT button, alternating the HUD repeater and the map display between the DDIs.
11. SMS – No computed deliver modes, CIP/AUT light on. Weapon deliver possible in DSL, DSL–1, and DIR modes using the roll stabilized sight.
12. RWR – No head–down ECM threat lethality display. Head–up ECM display on HUD and right DDI.
13. EMCON – Turned off but can be turned back on.
14. FLIR – On Radar and Night Attack aircraft, reverts to default mode. Sensor select switch depressed position alternately enables and disables FLIR video on HUD.

23.20.2 Attitude Heading Reference System

The attitude heading reference system is an INS backup mode. The INS system provides automatic INS degrading to AHRS when INS BIT detects a significant fault in the system. When AHRS options appear automatically as a result of INS failure, the best available heading source is displayed and used. AHRS display on the EHSI is one of two types, first order or higher order. Higher order is available when gyro is selected on the miscellaneous control panel on the ground. First order AHRS may be displayed when NAV is selected and INS BIT detects a failure which degrades INS outputs or when GYRO is selected in flight. Full up INS mode cannot be regained in flight after selection of GYRO mode. For full description of GYRO mode, see INS gyro alignment (AHRS) procedures paragraph 23.1.6. See Figure 23-33 for AHRS displays on the DDI. A description of the AHRS displays follows:

23.20.2.1 DG (Directional Gyro)

The DG legend appears as an AHRS option when directional gyro signals are available in the event of degraded INS outputs. The box around DG means that directional gyro heading is displayed.

23.20.2.2 COMP (Compass)

The COMP legend appears as an AHRS option when magnetic azimuth detector (MAD) signals are available in the event of degraded INS outputs. The box around COMP means that magnetic heading is displayed.

23.20.2.3 SLV (Slave)

The SLV legend appears when AHRS options become available due to INS failure in which INS outputs are degraded. Since slave heading is a mixture of HDG/COMP and HDG/DG, the SLV legend will appear only if magnetic heading and directional gyro outputs are available. The box around SLV means that slave heading is displayed.

23.20.2.4 ERECT

The ERECT legend appears when INS is in AHRS mode of operation. Pressing this pushbutton sends fast erect signal to the INS for fast leveling of the platform. The signal continues for as long as this pushbutton is pressed.

23.20.2.5 HDG/DG

The HDG/DG legend appears and directional gyro heading is displayed when the mission computer system has determined DG heading to be the best available AHRS option. Pressing the HDG/DG pushbutton causes available AHRS options to be displayed with a box around DG.

23.20.2.6 HDG

The HDG legend appears when DG heading is selected. Pressing left arrow pushbutton causes compass rose to rotate counterclockwise for as long as the pushbutton is pressed. Pressing right arrow pushbutton causes compass rose to rotate clockwise for as long as the pushbutton is pressed. This is done to slew compass rose to applicable heading due to processing of the directional gyro.

23.20.2.7 SYNC

The SYNC legend appears when slave heading is selected. Pressing SYNC pushbutton slaves the platform heading to magnetic heading.

23.20.2.8 HDG/CMP

The HDG COMP legend appears and magnetic heading is displayed when the mission computer system has determined the magnetic heading to be the best available AHRS option. Pressing the HDG/COMP pushbutton causes available AHRS option to be displayed with a box around COMP.

23.20.2.9 HDG/SLV

The HDG/SLV legend appears and slave heading is displayed when the mission computer system has determined the slave heading is the best available AHRS option. Pressing the HDG/SLV pushbutton causes available AHRS option to be displayed with a box around SLV.

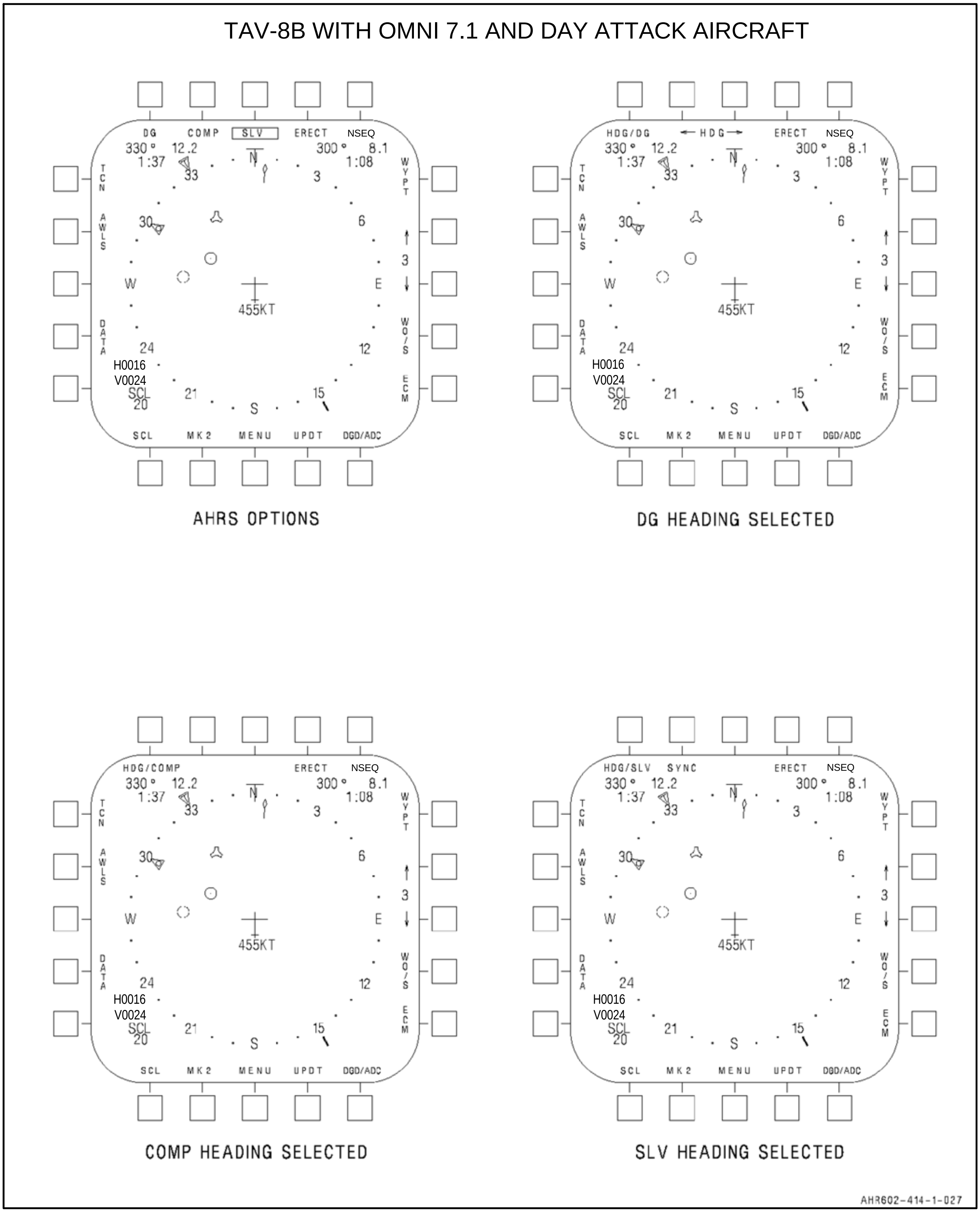


Figure 23-33. AHRS Display (Sheet 1 of 2)

TAV-8B WITH H4.0 AND RADAR AND NIGHT ATTACK AIRCRAFT

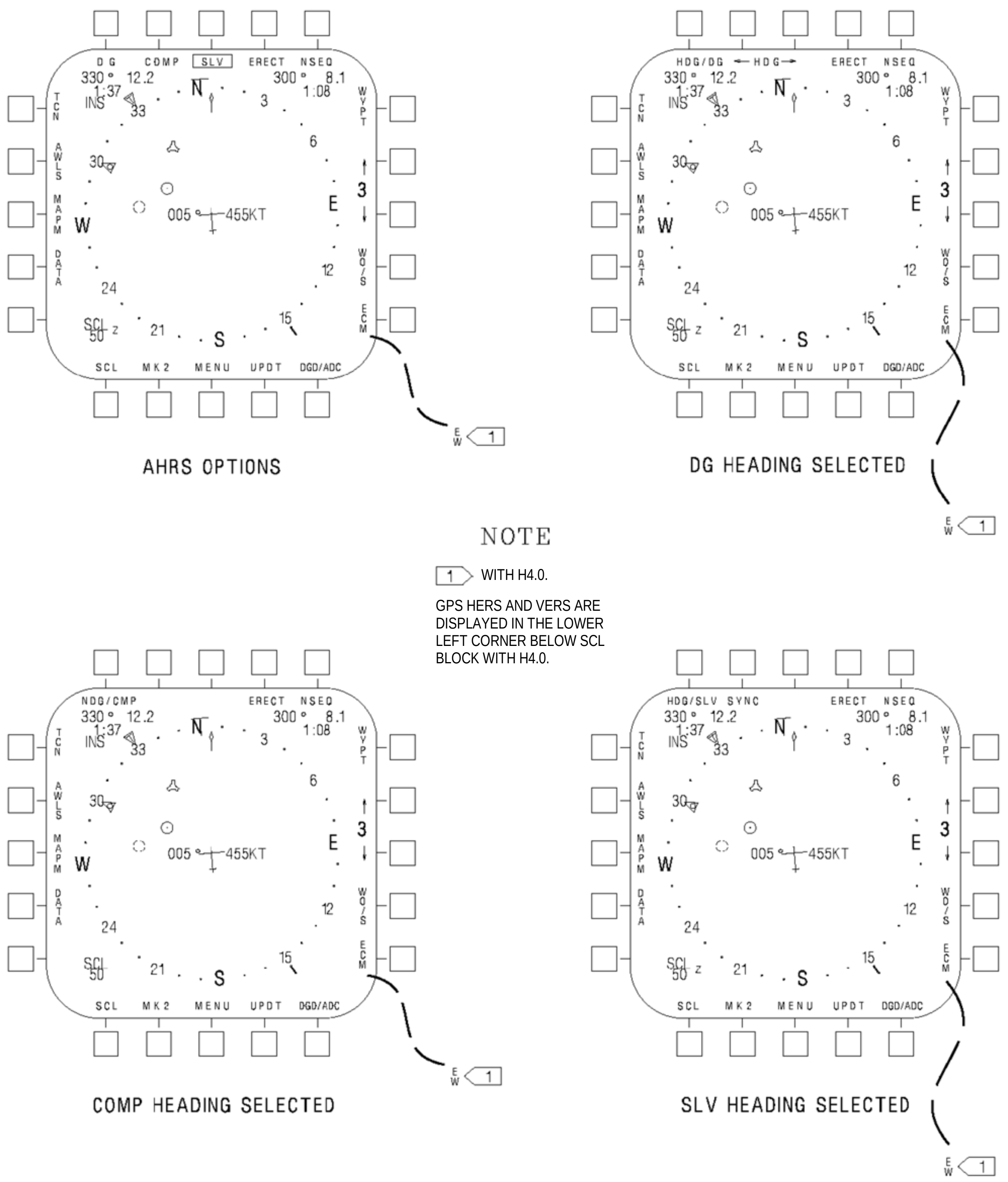


Figure 23-33. AHRS Display (Sheet 2)

PART VIII

Weapons Systems

Refer to NTRP 3.22-4-AV8B

PART IX

Flight Crew Coordination

CHAPTER 24

Crew Resource Management

The AV–8B crew resource management (CRM) program shall be conducted IAW OPNAV 3710.7 and OPNAV 1542.7. The goal of CRM is to improve mission effectiveness by minimizing crew preventable errors, maximizing crew coordination, and optimizing risk management. This will allow aircrew to use and integrate all available skills and resources to collectively achieve and maintain crew efficiency, situational awareness, and mission effectiveness. For a single seat aircraft this translates to close coordination with outside sources such as LSIs, LSSs, LSOs, wingman, flight leaders, air traffic controllers, and ground personnel. The seven critical CRM behavioral skills shall be integrated throughout the Harrier community's academics, simulators and flight training. Aircrew shall receive annual CRM ground training from an AV–8B trained CRM Instructor or Facilitator and the annual NATOPS check shall serve as the annual CRM flight evaluation.

24.1 SEVEN CRITICAL SKILLS

24.1.1 Decision Making

The ability to choose a course of action using logical and sound judgment based on available information. Effective decision–making requires:

1. Assessing the situation.
2. Verifying information.
3. Identifying solutions.
4. Anticipating decision consequences.
5. Making the decision.
6. Telling others of the decision and rationale.
7. Evaluating the decision.

24.1.2 Assertiveness

An individual's willingness to actively participate, state, and maintain a position, until convinced by the facts that other options are better. Assertiveness is respectful and professional, used to resolve problems appropriately, and to improve mission effectiveness and safety.

24.1.3 Mission Analysis

The ability to develop short–term, long–term, and contingency plans and to coordinate, allocate, and monitor crew and aircraft resources. Effective planning leads to flight conduct that removes uncertainty, increases mission effectiveness, and enhances safety.

24.1.4 Communication

The ability to clearly and accurately send and acknowledge information, instructions, or commands, and provide useful feedback. Effective communication is vital to ensure that all crewmembers understand aircraft and mission status.

24.1.5 Leadership

The ability to direct and coordinate the activities of other crewmembers or wingmen, and to encourage the crew to work together as a team. There are two types of leadership.

24.1.5.1 Designated Leadership

Leadership by authority, crew position, rank, or title. This is the normal mode of leadership.

24.1.5.2 Functional Leadership

Leadership by knowledge or expertise, Functional leadership is temporary and allows the most qualified individual to take charge of the situation.

24.1.6 Adaptability/Flexibility

The ability to alter a course of action based on new information, maintain constructive behavior under pressure, and adapt to internal and external environmental changes. The success of a mission depends upon the the crew's ability to alter behavior and dynamically manage crew resources to meet situational demands.

24.1.7 Situational Awareness

The degree of accuracy by which one's perception of the current environment mirrors reality. Maintaining a high level of situational awareness will better prepare crews to respond to unexpected situations.

24.2 LOSS OF AIRCREW COORDINATION

The loss of aircrew coordination often results in one or more of the following:

1. Fixation on one task to the detriment of others.
2. Confusion.
3. Violation of NATOPS/flight minimums/SOP.
4. No one in charge/lack of flight leadership.
5. No lookout doctrine.
6. Absence of communication.
7. Failure to meet timeline or accomplish the mission.

24.3 FLIGHT MEMBER POSITIONS

24.3.1 Mission Commander

The mission commander shall be a qualified aviator designated by appropriate authority. The mission commander shall be responsible for all phases of the assigned mission except those aspects of safety of flight which are related to the physical control of aircraft and fall within the prerogatives of the pilot in command. The mission commander shall direct a coordinated plan of action and be responsible for effectiveness of the mission. The mission commanders responsibilities include, but are not limited to:

1. Allocation of assets.
2. Supervise and allocate planning tasks.
3. Assess capabilities and limitations of the flight.
4. Establish go/no-go criteria.
5. Assign roles and responsibilities.
6. Ensure compliance with applicable orders, directives, rules of engagement (ROE)/rules of conduct (ROC), and training rules.
7. Delegate authority as required.

24.3.2 Formation Leader

A formation of two or more Naval aircraft shall be under the direction of a formation leader who is authorized to pilot Naval aircraft. The formation leader may also be the mission commander when so designated. The status of each member of the formation shall be clearly briefed and understood prior to takeoff. The formation leader is responsible for the safe and orderly conduct of the formation. The formation leaders responsibilities are the same as the mission commanders responsibilities with regard to his flight and in accordance with the mission commanders directives. A section leader is a formation leader of two aircraft and may be part of a larger element. A division leader is a formation leader of three or more aircraft and may be subordinate to a larger element formation leader or mission commander.

24.3.3 Wingman

A wingman is any member of a flight which is not specifically designated/assigned as a formation leader. A wingman is responsible for the safe and orderly conduct of his aircraft. Additional responsibilities include but are not limited to:

1. Understand the mission requirements.
2. Be involved in the planning process.
3. Be capable of assuming the lead when required.
4. Notify the leader of deficiencies (lost, confused, systems degradation, etc.).
5. Assist in look-out responsibilities.
6. Collision avoidance.

24.4 AIRCREW RESPONSIBILITIES BY FLIGHT PHASE

24.4.1 Mission Planning

All members of the flight should be involved in the mission planning process and must be familiar with the mission requirements prior to the flight brief.

24.4.2 Brief

The flight brief shall be conducted with all members of the flight present. Any supporting assets (ground controlled intercept (GCI), fighter escort, EW, etc.) shall be briefed face-to-face if possible. Flights requiring special coordination or control should also be briefed face-to-face. Each type of flight or phase of flight may require unique briefing requirements. The following is a partial list of flights and associated briefing requirements:

1. Shipboard operations — LSO.
2. Forward site operations — LSS.
3. FCF — QA, AMO, or designated representative.
4. Single aircraft operations — Operations Officer or designated representative.
5. Multi-element flights — Mission Commander, formation leader, subordinate formation leader.
6. Ground controlled intercept/vectoring — GCI, CCI, Strike vectoring controller, ASRT, etc.
7. Instrument flights — weather forecasters.
8. Ordnance flights — ordnance crew for loadout, weapon/fuzing selection, restrictions and arm/dearm considerations/procedures.

24.4.3 Pre-Takeoff

As a single piloted aircraft, much of the preflight, prestart and post-start evolutions will be conducted individually or with the aid of the ground maintenance crew (plane captain, ordnance, etc). Timing must be considered when operating with coordinating activities. Marshalling and taxi with a flight should be in order with special emphasis on FOD avoidance. Squadrons should establish a minimum taxi interval based upon the local FOD situation. Engine acceleration clears should be held until clear of other aircraft and in a relatively FOD free location (i.e., Takeoff position or approaching takeoff position). Although the wheel brakes are not designed for lengthy taxi evolutions and nozzles are recommended for speed control, this must be tempered with FOD and interval considerations when operating in formation. Section taxi may be the most expeditious method, but like airborne, the wingman cannot focus on other tasks while taxiing and allow himself to get behind.

24.4.4 Departure

The AV-8B is capable of several types of takeoffs, and formations of AV-8Bs have several options. In addition to the typical takeoff considerations such as gross weight, performance, surface type and abort capability, when conducting a formation takeoff the following should also be considered and briefed: interval for FOD avoidance, staggered line-up for abort, cross wind handling characteristics, jet exhaust/turbulence patterns and avoidance, abort criteria and configuration changes prior to IMC. Departure procedures are dependent upon the takeoff type, weather and mission requirements. The following are some considerations: clearance compliance, climb schedule and interval of multi-plane-formations, weather avoidance or penetration and individual departure to join on top.

24.4.5 En route

En route procedures differ greatly with mission type but some special considerations are: formation type, position, altitude, airspeed and role assignment and execution, navigation/INS management, lookout, command and control requirements, coordination, deconfliction, ordnance and attack procedures and switchology, reconstitution and rendezvous, support requirements, timing, fuel planning and management.

24.4.6 Recovery

Egress, approach and landing options are numerous and dependent upon mission objectives, weather, and landing types. The following is a list of considerations: course rule, re-entry procedures, approach and landing weather, landing type and capabilities (i.e., gross weight, performance, cross winds, ceiling and visibility), fuel for normal and alternate recoveries, formation size and composition based upon maneuverability and landing area congestion, instrument recovery-penetration procedures with two or more aircraft in formation and power/maneuvering margins for wingmen, jet wash/turbulence avoidance, landing interval and priorities, dearming procedures, FOD mechanisms for landing and taxi, navigation, either internal (INS, TACAN, VISUAL) or external (GCI, GCA, APPROACH CONTROL), terminal control and use or LSO, LSS.

24.4.7 Mission Critique

Mission assessment is critical following a flight whether the mission was a multi-aircraft strike, an FCLP period, or a functional check flight. A critical and credible debrief will improve future mission success and evaluate current mission effectiveness. A proper debrief should provide flight members and supporting agencies with information on strengths and weaknesses so that future training and mission planning can address problem areas and exploit strong areas.

24.5 EMERGENCIES

Mission planning and briefing should address contingencies which may affect the flight. Proper planning will minimize the effect of deviations from the planned mission. The possibility of a mission abort or even the loss of an aircraft or pilot can be significantly reduced by anticipating critical phases of flight and preparing for potential emergency situations. An example is the thorough brief of bird strike emergencies and alternate landing areas along a low-level navigation route. Part V of this manual provides emergency procedures for the pilot, but each formation leader should state the procedures to be followed by other members of the flight in the event of an emergency situation. An example may be for the aircraft experiencing the emergency to operate as a single aircraft and the other member of the section to assume a chase position and provide assistance in the form of navigation, communication, reading checklist procedures and acting as an observer for external indications and look-out. Standardized procedures for downed aircraft and search and rescue (SAR) operations should be stated by the formation leader. Role assignments for visual identification, comm relay and location should be stated.

PART X

NATOPS Evaluation

CHAPTER 25

NATOPS Evaluation

25.1 CONCEPT

The standard operating procedures prescribed in this manual represent the optimum operation of the AV-8B/TAV-8B. The NATOPS evaluation is intended to evaluate systems knowledge and compliance with NATOPS procedures through observation of pilots and squadrons. The objective of the NATOPS evaluation program is to assist the commanding officer in improving unit readiness, safety, and standardization through constructive comment.

25.2 IMPLEMENTATION

The NATOPS Evaluation program shall be carried out in every unit operating naval aircraft. Pilots desiring to attain/retain qualification in the AV-8B/TAV-8B shall be evaluated initially in accordance with OPNAV Instruction 3510.9 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 OPNAV 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.

25.3 DEFINITIONS

The following terms, used throughout this section, are defined as to their specific meaning within the NATOPS program.

25.3.1 NATOPS Evaluation

A periodic evaluation of individual pilot standardization consisting of an open book examination, a closed book examination, an oral examination, and a flight evaluation.

25.3.2 NATOPS Re-Evaluation

A partial NATOPS Evaluation administered to a pilot who has been placed in an Unqualified status by receiving an Unqualified grade for any of his ground examinations or the flight evaluations. Only those areas in which an unsatisfactory level was noted need be observed during a re-evaluation.

25.3.3 Qualified

Well standardized; evaluee demonstrated highly professional knowledge of and compliance with NATOPS standards and procedures; momentary deviations from or minor omission in non-critical areas are permitted if prompt and timely remedial action is initiated by the evaluee.

25.3.4 Conditionally Qualified

Satisfactorily standardized; one or more significant deviations from NATOPS standards and procedures, but no errors in critical areas and no errors jeopardizing mission accomplishment or flight safety.

25.3.5 Unqualified

Not acceptably standardized; evaluee fails to meet minimum 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.

25.3.6 Area

A routine of preflight, flight, or postflight.

25.3.7 Sub-Area

A performance sub-division within an area, which is observed and evaluated during an evaluation flight

25.3.8 Critical Area/Sub-Area

Any area or sub-area which covers items of significant importance to the overall mission requirements, the marginal performance of which would jeopardize safe conduct of the flight.

25.3.9 Emergency

An aircraft component, system failure, or condition which requires instantaneous recognition, analysis, and proper action.

25.3.10 Malfunction

An aircraft component or system failure or condition which requires recognition and analysis, but which permits more deliberate action than that required for an emergency.

25.4 GROUND EVALUATION

Within 15 days of commencing the flight evaluation, an evaluee must achieve a minimum grade of 3.5 on the open book examination and a grade of 3.3 on closed book examinations on a 4.0 scale. Achieving these minimum grades constitutes an adjective grade of Qualified. Not achieving these minimum grades constitutes an adjective grade of Unqualified.

25.4.1 Open Book Examination

The open book examination shall include, but not be limited to, the open book examination question bank promulgated by the AV-8B NATOPS Model Manager.

25.4.2 Closed Book Examination

The closed book examination shall include, but not be limited to, the immediate action emergency procedures and a selection of aircraft limitations and system questions from the closed book examination question bank promulgated by the AV-8B NATOPS Model Manager.

25.5 FLIGHT EVALUATION

25.5.1 Standards

The flight evaluation shall be conducted in the simulator unless operational requirements and resources preclude simulator availability. In such cases, a flight evaluation shall be conducted on any flight with the exception of flights launched for FCLP/CQ, FAM or FBO training. A NATOPS Instructor shall be a member of the flight. Emergencies shall not be simulated in the aircraft.

The flight evaluation shall be conducted and graded in the areas of mission planning, briefing, normal operating procedures, crew resource management, emergency procedures, and debriefing. The focus is on normal and emergency procedures, not tactical execution. The flight evaluation objectives are:

1. Evaluate adherence to and execution of NATOPS normal and emergency procedures.
2. Evaluate Crew Resource Management skills.
3. Demonstrate takeoff and landing proficiency.

MAGs and squadrons should develop standardized scenarios to promote consistent evaluation. The flight evaluation should be of a tactical nature in order to present realistic decision making opportunities but tactical execution proficiency shall not be specifically evaluated. Scenarios should be tailored to the pilot's experience and flight qualifications.

Concurrently, the flight evaluation shall also be the annual CRM evaluation. However, NATOPS Instructors and Assistant NATOPS Instructors must be qualified Crew Resource Management Facilitators in order to conduct a CRM evaluation.

Note

The number of flights required to complete the flight evaluation should be kept to a minimum; normally one flight. The areas and sub-areas to be observed and graded on a flight evaluation are outlined in the grading criteria with critical areas marked by an asterisk (*). Sub-area grades will be assigned in accordance with the grading criteria. These sub-areas shall be combined to arrive at the overall grade for the flight. Area grades, if desired, shall also be determined in this manner.

25.5.2 Evaluated Areas and Sub-Areas

25.5.2.1 Mission Planning, Briefing, and Debriefing

1. Oral examination shall be conducted to evaluate system knowledge, aircraft limitations, normal and emergency procedures. At a minimum, three questions will be asked.
2. Flight planning shall be IAW Air NTTP 3-22.1-AV8B AV-8B Employment standards.
3. Flight brief shall be IAW the MAWTS-1 AV-8B Mission Planning, Briefing, and Debriefing Guide.
4. Demonstrate knowledge of the contents and function of all components of flight equipment.
5. Flight debrief shall be IAW the MAWTS-1 AV-8B Mission Planning, Briefing, and Debriefing Guide.

25.5.2.2 Ground Procedures

Demonstrate proficiency in the following:

1. Aircraft Discrepancy Book (ADB) review.
2. Engine start procedures and checklist.
3. Before taxiing procedures and checklist.
4. Post landing procedures and checklist.
5. Shut-down procedures and checklist.

25.5.2.3 Takeoff and Departure (*)

Demonstrate proficiency and proper procedures of the following:

1. Pre-positioning procedures and checklist (CWAIVER).
2. Takeoff checklist.
3. A minimum of one STO with aircraft gross weight greater than 30,000 pounds and outside air temperature greater than 30 °C.
4. A minimum of one CTO.
5. A minimum of one VTO.
6. Departure, climb, and level-off flight regimes.
7. 10,000-foot checklist.
8. 18,000-foot checklist.

25.5.2.4 Approach and Landing (*)

Demonstrate proficiency and proper procedures of the following:

1. Descent checklist (SWIFT-A checks).
2. Landing checklist.
3. A minimum of one of each of the following landings with at least one executed SAAHS off:
   a. CL
   b. VNSL
   c. RVL
   d. VL

25.5.2.5 Communications

Demonstrate proficiency and proper procedures of the following:

1. Standard radio communications.
2. Standard visual signals.

25.5.2.6 Emergency Procedures (*)

At a minimum, respond to the number of emergencies specified in each phase of flight. One emergency shall result in the necessity to execute a timely ejection.

1. Ground Emergencies: one.
2. Takeoff Emergencies: two.
3. In-flight Emergencies to a full-stop landing: one.
4. Emergencies during landings: two.

25.5.2.7 Crew Resource Management

Demonstrate proficiency IAW Chapter 24 of this manual.

25.5.2.8 Mission Evaluation

This area includes missions covered in the NATOPS Flight Manual, Tactical Employment, ANTTP 3-22.1-AV8B, NWP, and NWIPs for which standardized procedures/techniques have been employed.

25.5.3 Applicable Publications

The NATOPS Flight Manual contains the standard operations criteria for AV-8B/TAV-8B aircraft. Publications relating to environmental procedures peculiar to shorebased and shipboard operations and tactical missions are the AV-8B NATIP, Tactical Employment, ANTTP 3-22.1-AV8B, NWP, NWIPs, ATC/CATCC Manual, Local Air Operations Manual, Ship Operations Manual, and local range regulations SOPs as long as these publications are not in violation of the NATOPS flight manual.

25.5.4 Flight Evaluation Grading

Only the areas and sub-areas listed in paragraph 25.5.2 shall be graded. Critical areas are marked by an asterisk (*). The grade assigned is determined by assessing the degree of adherence and proficiency to standard operating procedures. Momentary deviations from standard operating procedures should not be considered unqualifying provided such deviations do not jeopardize flight safety and the evaluee applies prompt corrective action. A grade of Unqualified in any critical area and/or sub-area will result in an overall grade of Unqualified for the flight evaluation. Otherwise, flight evaluation grades shall be determined by assigning the numerical grade equivalents to the adjective grade for each sub-area. Only the numerals 0, 2 or 4 shall be assigned. 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 sub-areas and divide this sum by the number of sub-areas 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

25.6 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 grade on any ground examination or the flight evaluation shall be placed in an Unqualified status until achieving a grade of Conditionally Qualified or Qualified on a re-evaluation.

25.7 RECORDS AND REPORTS

A NATOPS Evaluation Report (OPNAV From 3710-7) shall be completed for each evaluation and forwarded to the evaluee's commanding officer only. This report shall be filed in the individual NATOPS Flight Personnel Training/Qualification jacket and retained therein permanently.

25.8 CRITIQUE

The critique is the terminal point in the NATOPS evaluation and will be given by the Evaluator/Instructor administering the check. Preparation for the critique involves processing, reconstructing data collected, and oral presentation of the NATOPS Evaluation Report. Deviations from standard operating procedures will be covered in detail using all collected data and worksheets as a guide. Upon completion of the critique, the pilot will receive the completed copy of the NATOPS Evaluation Report for certification and signature. The completed NATOPS Evaluation Report will then be presented to the Unit Commanding Officer.

NATOPS EVALUATION QUESTION BANK

NAME: ____

DATE: ____

1. The red flashing light in the gear handle indicates? ____
2. The red steady light in the gear handle indicates? ____
3. The BINGO profile is based on a fuel reserve of ____
4. The max range profile is based on a fuel reserve of ____
5. Fuel may be dumped to a level of ________________________ lbs. (total fuselage fuel).
6. All landing gear are mechanically locked in the down position.
   a. True
   b. False
7. All landing gear are mechanically locked in the up position.
   a. True
   b. False
8. The DECS provides engine control throughout the engine operating range in response to
   a. _________________________ , b. _________________________ , c. _________________________ ,
   d. _________________________ , e. _________________________ , f. _________________________
9. With the MFS activated, the engine is cleared for operation in all flight regimes.
   a. True
   b. False
10. As the nozzles pass approximately ____ ° down from full aft, a microswitch changes the JPT limiter from max thrust to short lift.
11. In the LDG mode of water augmentation:

	−406 engine	−408 engine
a. water flows when below	________ knots	________knots
b. with JPT above	________°C	________°C
c. and throttle above	________ percent rpm	________ percent rpm

12. The JPTL limits are:

	−406 engine	−408 engine
a. Short lift wet	__________________ °C	__________________°C
b. Short lift dry	__________________ °C	__________________ °C
c. Combat	______________________ °C	__________________ °C

d. Max thrust ____________________°C ____________________ °C

e. Gear up, nozzles aft ______________ percent rpm ____________________ percent rpm

13. The 15 SEC light comes on at:

–406 engine ____________________ °C dry or ____________________ °C wet.

–408 engine ____________________ °C dry or ____________________ °C wet.

14. The left fuel feed group consists of which tanks?____

____

____

____

15. The right fuel feed group consists of which tanks?____

____

____

____

16. The fuel low level lights illuminate steady at ______ ± ______ lbs and flash at ______ ± ______ lbs of fuel remaining.

17. The fuel low level indicating system is completely independent of the fuel quantity indicating system.

a. True

b. False

18. During a generator failure the generator should be cycled to off, then on.

a. True

b. False

19. The battery is normally charged by the STBY TRU.

a. True

b. False

20. The HYD 2 loads are: a. ____________________________ , b. ____________________________ ,

c. ____________________________ , and a backup for d. ____________________________ .

21. STOL flap selection provides _____________ ° of flaps if airspeed is over _____________ knots.

22. AUTO flap selection provides ____________________ ° of flaps with gear down.

23. Aileron droop occurs when ______________________ selected, with airspeed below __________________ KCAS and nozzles greater than ______________________ °.

24. Both the AFC and SAS are operational throughout the entire flight envelope.

a. True

b. False

25. What are the recommended controlled ejection conditions?______________________________________

____

____

____

26. What are the procedures for ground egress? ____
____
____
____

27. The emergency jettison and selective jettison are inoperative unless weight is off the wheels.

a. True

b. False

28. Below 0.45 Mach, the maneuvering tone will initially be heard when AOA exceeds ___________ °.

29. Water injection is prohibited below ambient temperatures of ______________ °C (–406 engine) or ______________ °C (–408 engine).

30. Maximum continuous rpm is:

–406 engine ________________ percent, and JPT is ________________ °C.

–408 engine ________________ percent, and JPT is ________________ °C.

31. The optimum airstart envelope is:

–406 engine ________________ to ________________ KCAS.

–408 engine ________________ to ________________ KCAS.

32. Maximum altitude for starting the APU is:

With seals __________________ feet.

Radar aircraft ________________ feet.

33. Maximum airspeed for gear down and locked is ______________________ KCAS.

34. IGV limits for a standard day at 55percent rpm for the –406 engine are ________ ° to ________ ° and at 60percent rpm for the –408 engine are _________ ° to _________ °.

35. What are the crosswind limits for approach speeds greater than 140 knots? Less than 140 knots?
____
____
____

36. Vertical landing capability is based on a hover _______________ °C below the JPTL limiter, to account of re–ingestion.

37. After initiating a penetration descent at 65 percent, the rpm will decrease approximately 1 percent per 1,000 feet of altitude loss.

a. True

b. False

38. Approximately what duct pressure should you read at 55 percent rpm with the –406 engine? _________ psi, and at 60 percent rpm with the –408 engine? ________ psi.

39. If a dual DECU failure occurs with the engine at a steady rpm, the rpm may ______________________
____
____
____

40. Give three indications of sideslip buildup:

    a. ____

    b. ____

    c. ____

41. While in MFS, moving the throttle from the idle stop to the mid-throttle position in less than ____________________ or moving the throttle without appropriate engine response greatly increases the risk of ____________________ .

42. The ____________________ are provided to a stepper motor which in turn operates a ____________________ to properly meter fuel for a desired engine response.

43. What actions can cause fuel system datum cut-back?

    ____

    ____

    ____

44. What does the action of arming the water injection switch result in?

    ____

    ____

    ____

45. Selecting water to LDG with the rpm at 88 percent, what indications will you have of DECU datum shift?

    ____

    ____

    ____

46. To avoid overheating the GTS starter motor, not more than ____________________ GTS/APU starting cycles may be made in any ____________________ minute period.

47. If the water tank empties during "wet" lift, the JPTL automatically resets to dry datum with a resultant loss of thrust.

    a. True

    b. False

48. What is the minimum precharge pressure for the brake accumulator? ____________________.

49. The MFS solenoid changeover valve must have ____________________ and ____________________ to successfully select MFS.

50. The maximum AOA which should not be exceeded above 50 knots with landing gear down is? ____________________.

51. What are the limitations associated with in-flight nozzle vectoring?

    ____

    ____

    ____

52. What are the acceleration limits (LBA)? ____________________

    a. Symmetrical ____

    b. Asymmetrical ____

53. Maximum recommended altitude for engine airstart is:

–406 engine DECS ________________ MFS ________________

–408 engine DECS ________________ MFS ________________

54. The optimum configuration for max range descent is ____________ KCAS, ____________ flap.

55. What four immediate actions should you take if the aircraft starts an uncontrolled roll?

a. ________________

b. ________________

c. ________________

d. ________________

56. What is the spin recovery procedure?________________

57. The ________________ is located on the left console below the landing gear position indicators. The battery is a ________________ for the extension of the landing gear when electrical power is lost.

58. A vertical landing is recommended if any landing gear malfunction is suspected.

a. True

b. False

59. What action should be taken if an over–rotation occurs? ________________

60. A maximum performance STO is performed at ________________ degrees pitch attitude.

61. Three legs of the power hexagon indicate a JPT of:

–406 engine ________________ °C or rpm of ________________ percent.

–408 engine ________________ °C or rpm of ________________ percent.

62. State the proper technique to decel down a line feature with a crosswind.

63. State the configuration and technique for an optimum climb to cruise altitude.

64. Vertical landing weight is based on ________________ percent of hover capability.

65. State the abort procedures for a CTO or STO. ____
____
____
____

66. State the procedures for a sudden rpm loss/engine failure to accelerate during V/STOL flight.
____
____
____
____

67. State the procedures, speed, and rpm for thunderstorm penetration.
____
____
____

68. State the rpm limits for the following:

	–406 engine	–408 engine
a. Short lift wet	____________________ percent	____________________ percent
b. Short lift dry	____________________ percent	____________________ percent
c. Max thrust	____________________ percent	____________________ percent
d. Combat thrust	____________________ percent	____________________ percent
e. Idle	____________________ percent	____________________ percent

69. Max airspeed for selection of STOL flaps is ______________________ KCAS.

70. When executing the landing checklist, ensure _______________________ of nozzles or greater before selecting STOL flaps.

71. The landing gear emergency battery must be activated with the landing gear handle in the EMER position.

a. True

b. False

PART XI

Performance Data

Refer to NATOPS Flight Manual Performance Charts A1-AV8BB-NFM-400.

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O

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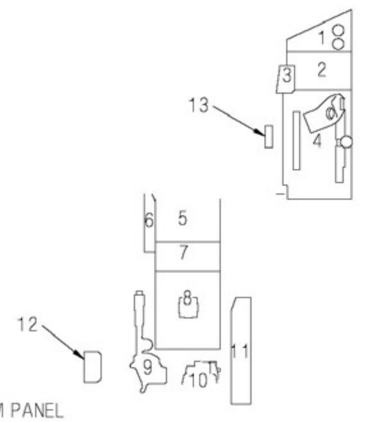
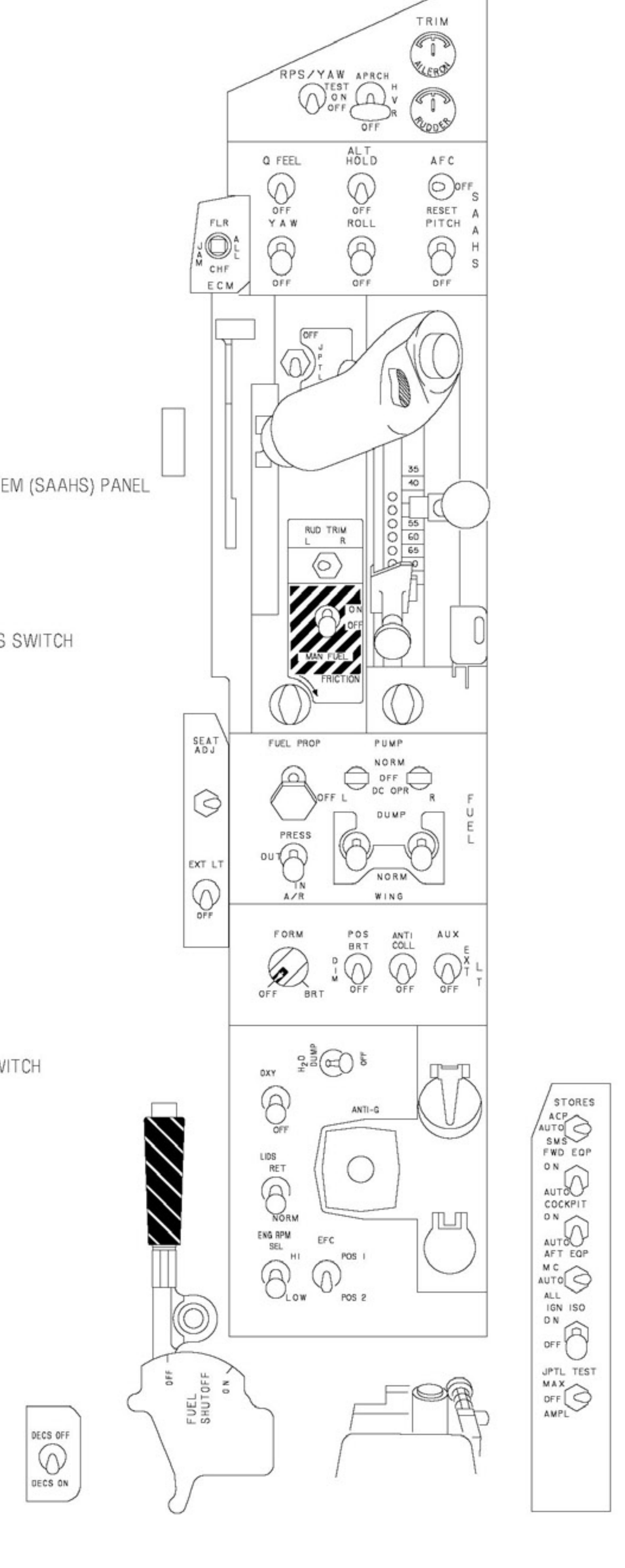
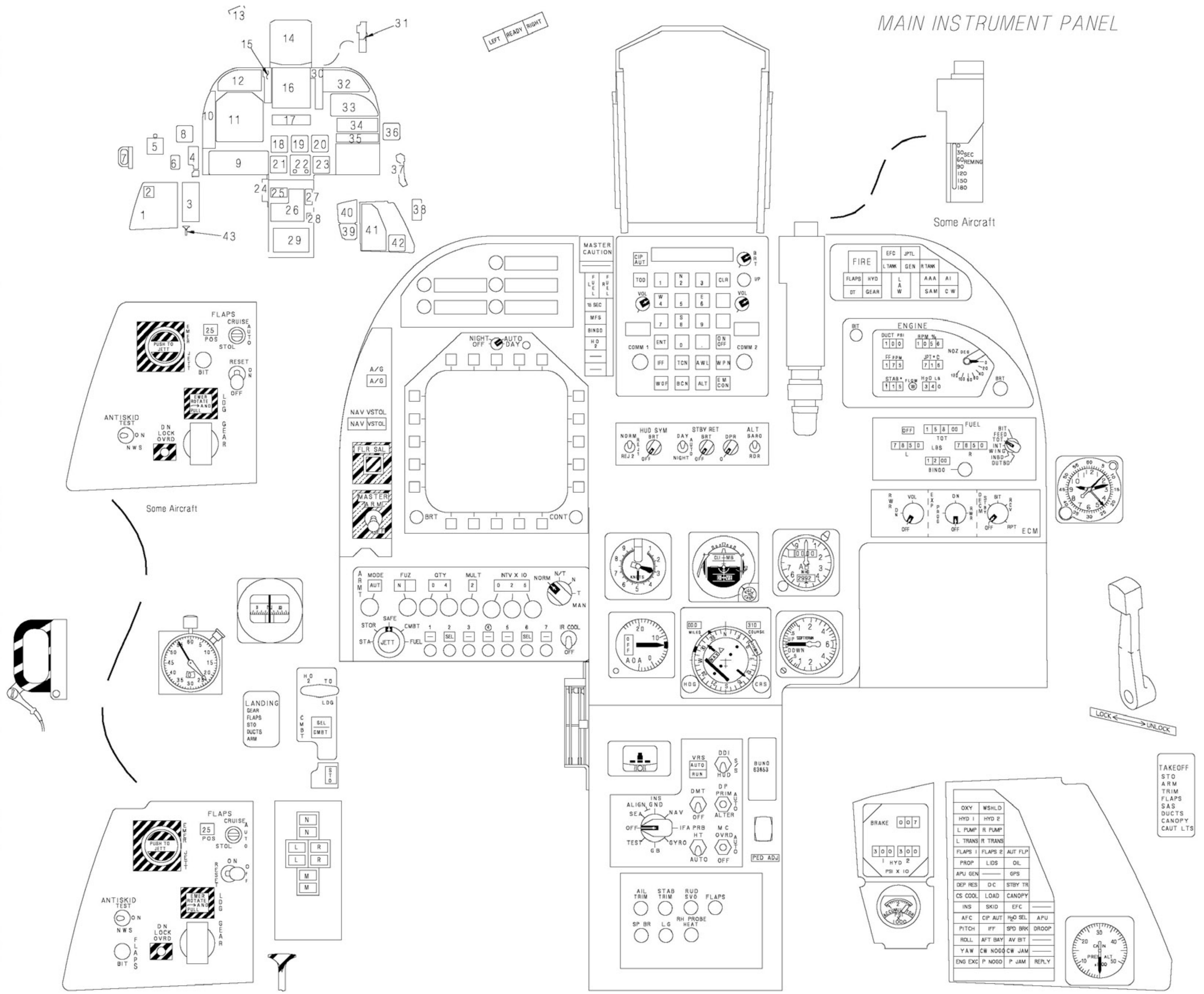
LEFT CONSOLE





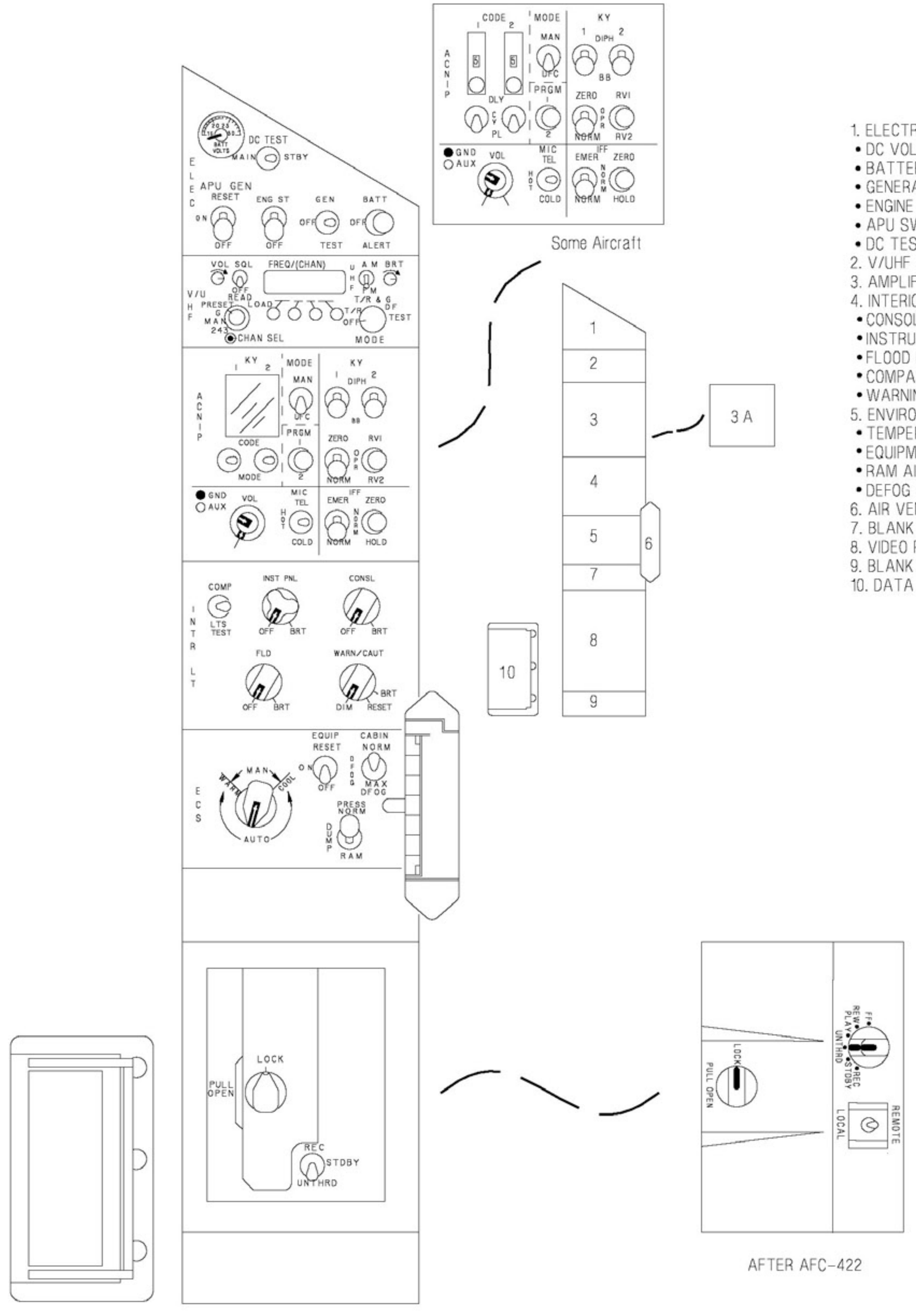
1. TRIM PANEL
   - RUDDER TRIM INDICATOR
   - AILERON TRIM INDICATOR
   - LANDING LIGHT SWITCH
   - RUDDER PEDAL SHAKER (RPS) SWITCH
2. STABILITY AUGMENTATION ATTITUDE HOLD SYSTEM (SAAHS) PANEL
   - ALTITUDE HOLD SWITCH
   - STAB AUG SWITCHES
   - Q FEEL SWITCH
   - AFC SWITCH
3. ECM DISPENSE PANEL
4. THROTTLE QUADRANT
   - ENGINE TEMPERATURE/PRESSURE RATIO LIMITERS SWITCH
   - STO STOP
   - HOVER/VTO STOP
   - NOZZLE CONTROL
   - THROTTLE
   - SPEED BRAKE SWITCH
   - EMERGENCY FLAP RETRACT BUTTON
   - SLEW CONTROL/DESIGNATOR
   - AIRSTART BUTTON
   - CAGE/UNCAGE BUTTON
   - COMMUNICATION SWITCH
   - RUDDER TRIM AND MANUAL FUEL SWITCHES
   - FRICTION CONTROL
   - PARKING BRAKE HANDLE
5. FUEL PANEL
   - FLOW PROPORTIONER
   - L AND R FUEL PUMP SWITCH
   - L AND R WING FUEL DUMP SWITCH
   - AIR REFUELING (A/R) SWITCH
6. SEAT ADJUST AND EXTERIOR LIGHTS MASTER SWITCH
7. EXTERNAL LIGHTS PANEL
   - FORMATION LIGHTS KNOB
   - POSITION LIGHTS SWITCH
   - ANTI-COLLISION LIGHTS SWITCH
   - AUXILIARY LANDING LIGHT SWITCH
8. PILOT SERVICES PANEL
   - ANTI-G SUIT DISCONNECT
   - OXYGEN DISCONNECT
   - ANTI-G VALVE
   - WATER DUMP SWITCH
   - OXYGEN SWITCH
   - LIDS SWITCH
   - ENGINE RPM SELECT SWITCH
   - ENGINE FUEL CONTROL SWITCH (Some Aircraft)
9. LOW PRESSURE FUEL SHUTOFF HANDLE
10. OXYGEN MONITOR
    - BIT BUTTON
11. GROUND POWER PANEL
12. DECS ENABLE SWITCH (Some Aircraft)
13. MFS EMERGENCY BATTERY

MAIN INSTRUMENT PANEL



1. LANDING GEAR/FLAPS CONTROL PANEL
   - LANDING GEAR HANDLE
   - ANTISKID SWITCH
   - FLAP MODE SELECT SWITCH
   - FLAP POSITION INDICATOR
   - FLAP POWER SWITCH
2. EMERGENCY JETTISION SWITCH
3. LANDING GEAR POSITION INDICATORS
4. COMBAT/WATER PANEL
5. STOP WATCH (GFE)
6. LANDING CHECKLIST
7. INTERNAL EMERGENCY CANOPY SHATTERING HANDLE
8. STANDBY MAGNETIC COMPASS
9. ARMAMENT CONTROL PANEL
10. MASTER ARMAMENT PANEL
    - A/G MODE SWITCH
    - NAV MODE SWITCH
    - VSTOL MODE SWITCH
    - FLR SAL SWITCH
    - MASTER ARM SWITCH
11. DIGITAL DISPLAY INDICATOR (DDI)
12. OPTION DISPLAY UNIT
13. REFUEL LIGHTS
14. HEAD-UP DISPLAY (HUD)
15. PRIORITY CAUTION LIGHT
16. UPFRONT CONTROL
17. HUD CONTROL PANEL
18. STANDBY AIRSPEED INDICATOR
19. STANDBY ATTITUDE INDICATOR
20. STANDBY ALTIMETER
21. STANDBY ANGLE-OF-ATTACK INDICATOR
22. HORIZONTAL SITUATION INDICATOR
23. STANDBY VERTICAL VELOCITY INDICATOR
24. AIR VENT
25. TURN AND SLIP INDICATOR
26. MISCELLANEOUS SWITCH PANEL
    - VIDEO RECORDER LIGHTS/SWITCH
    - VRS DISPLAY SELECT SWITCH
    - DISPLAY PROCESSOR SWITCH
    - DUAL MODE TRACKER SWITCH
    - MISSION COMPUTER SWITCH
    - PROBE HEAT SWITCH
    - INS MODE SELECTOR KNOB
27. BUREAU NUMBER
28. RUDDER PEDAL ADJUST CONTROL
29. CIRCUIT BREAKER PANEL
30. HUD VIDEO CAMERA
31. MOTION PICTURE CAMERA
32. WARNING/THREAT LIGHTS (latest configuration)
33. ENGINE PERFORMANCE INDICATOR
    - BIT SWITCH
    - DUCT PRESSURE
    - TACHOMETER
    - JET PIPE TEMPERATURE
    - NOZZLE POSITION
    - DISPLAY BRIGHTNESS CONTROL
    - WATER QUANTITY
    - WATER FLOW LIGHT
    - STABILATOR POSITION
    - FUEL FLOW
34. FUEL QUANTITY INDICATOR
    - FUEL QUANTITY INDICATIONS
    - BINGO FUEL SET
    - INDICATION SELECT SWITCH
    - ON/OFF INDICATOR
35. ECM CONTROL PANEL
36. CLOCK
37. CANOPY UNLOCK HANDLE
38. TAKEOFF CHECKLIST
39. BRAKE ACCUMULATOR PRESSURE INDICATOR
40. HYDRAULIC PRESSURE INDICATORS
    - BRAKE PRESSURE
    - HYDRAULIC PRESSURE SYSTEM NO. 1 AND NO. 2
41. CAUTION/ADVISORY LIGHT PANEL (latest configuration)
42. COCKPIT ALTIMETER
43. LDG GEAR EMERGENCY BATTERY

RIGHT CONSOLE



1. ELECTRICAL PANEL
   - DC VOLTMETER
   - BATTERY SWITCH
   - GENERATOR SWITCH
   - ENGINE START SWITCH
   - APU SWITCH
   - DC TEST SWITCH
2. V/UHF RADIO SET CONTROL (RSC)
3. AMPLIFIER-CONTROL (ACNIP)
4. INTERIOR LIGHTS CONTROL PANEL
   - CONSOLE LIGHTS KNOB
   - INSTRUMENT LIGHTS KNOB
   - FLOOD LIGHTS KNOB
   - COMPASS LIGHT/LIGHTS TEST SWITCH
   - WARNING/CAUTION LIGHTS KNOB
5. ENVIRONMENTAL CONTROL PANEL
   - TEMPERATURE CONTROLLER
   - EQUIPMENT BAY COOL SWITCH
   - RAM AIR SWITCH
   - DEFOG SWITCH
6. AIR VENT
7. BLANK
8. VIDEO RECORDER
9. BLANK
10. DATA STORAGE SET (DSS) RECEPTACLE

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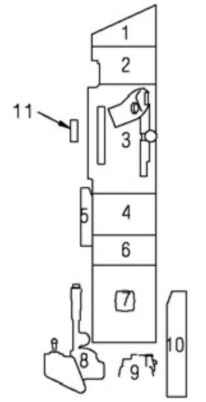
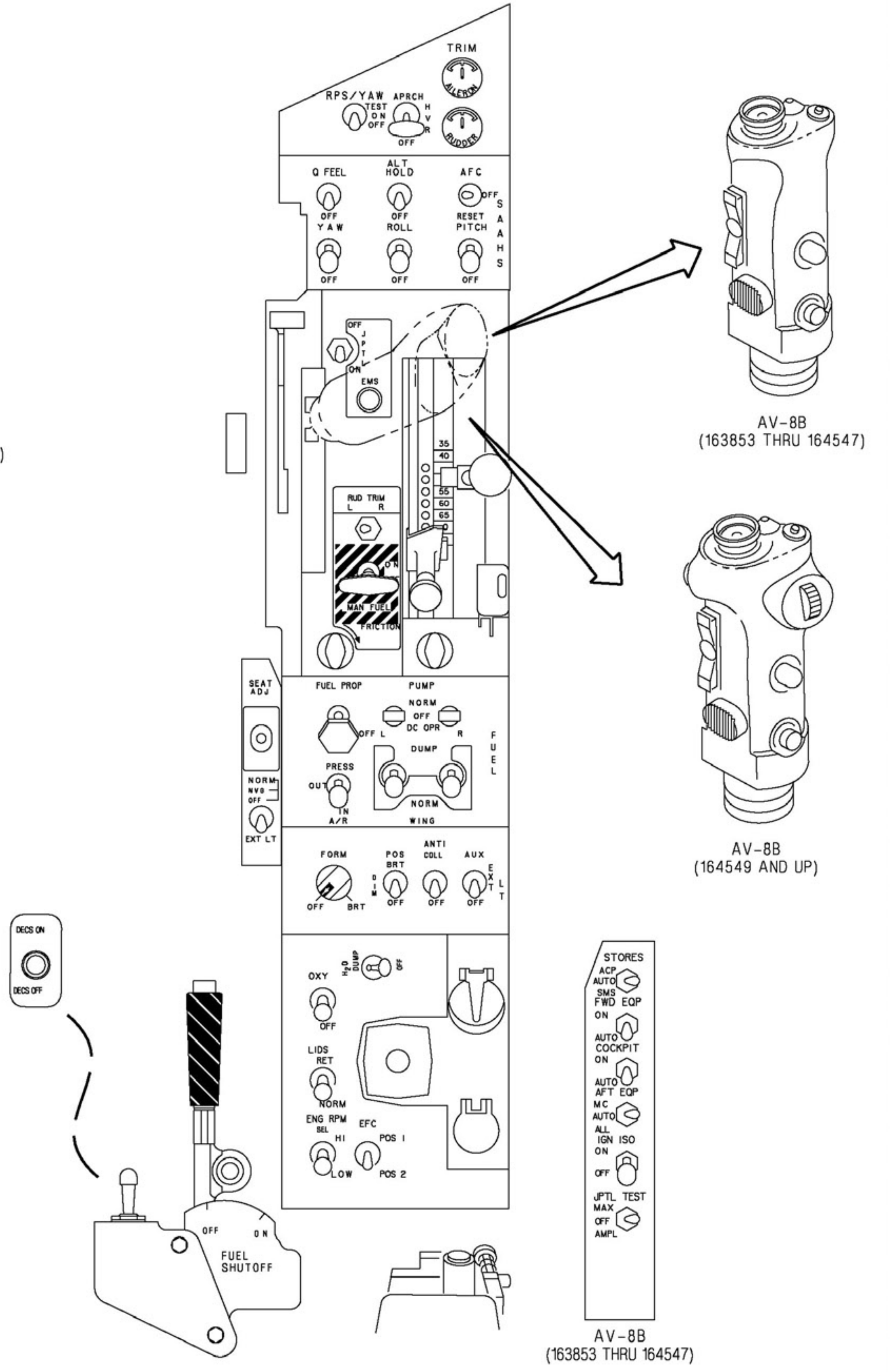
Cockpit, AV- 8B 161573 Thru 163852

LEFT CONSOLE





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   - CAGE/UNCAGE BUTTON
   - COMMUNICATION SWITCH
   - RUDDER TRIM AND MANUAL FUEL SWITCHES
   - FRICTION CONTROL
   - BRAKE LOCK LEVER
   - ECM DISPENSE SWITCH
   - A/A RADAR SWITCH (AV-8B 164549 AND UP)
   - ANTENNA ELEVATION SWITCH (AV-8B 164549 AND UP)
4. FUEL PANEL
   - FLOW PROPORTIONER
   - L AND R FUEL PUMP SWITCH
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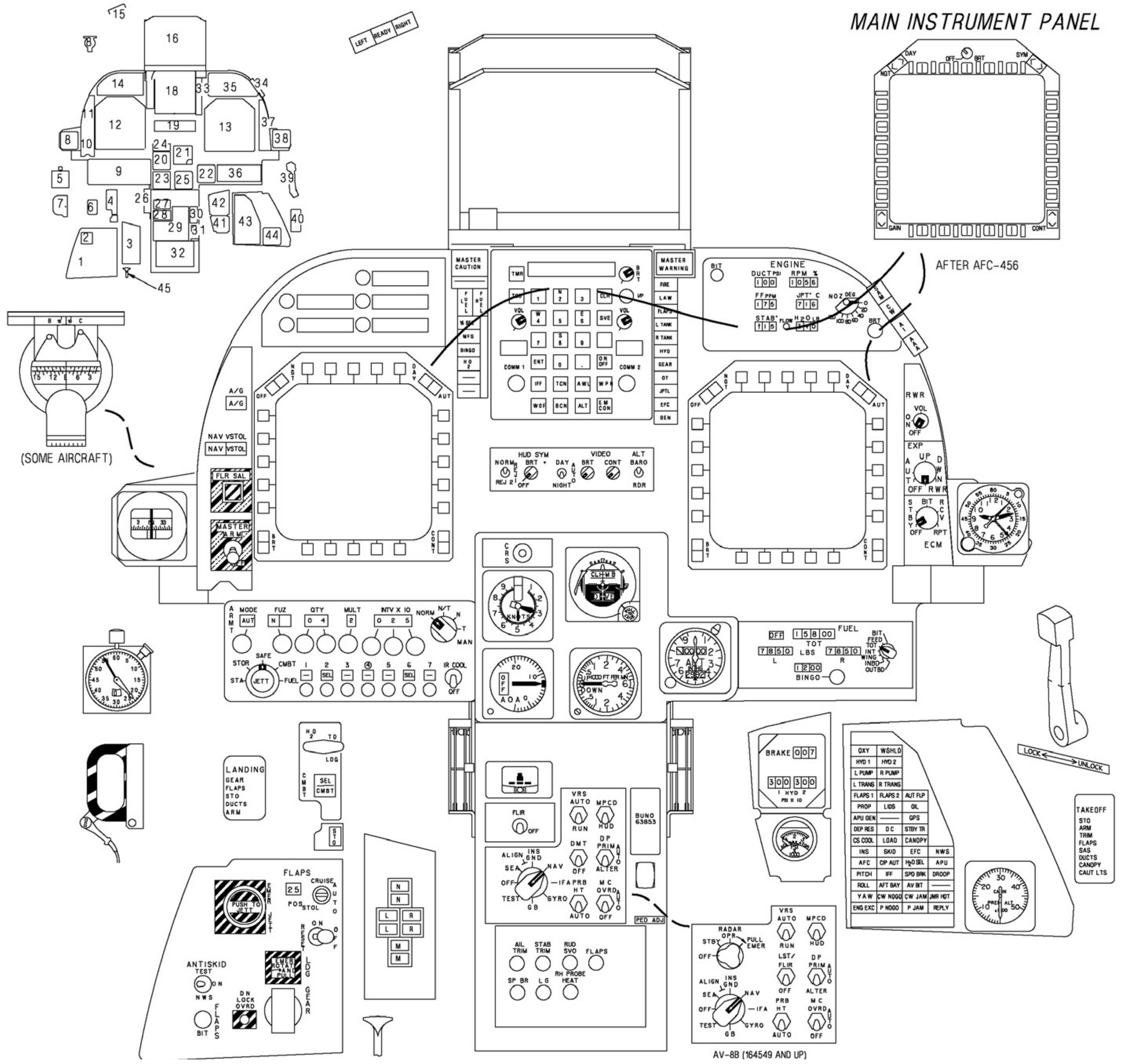
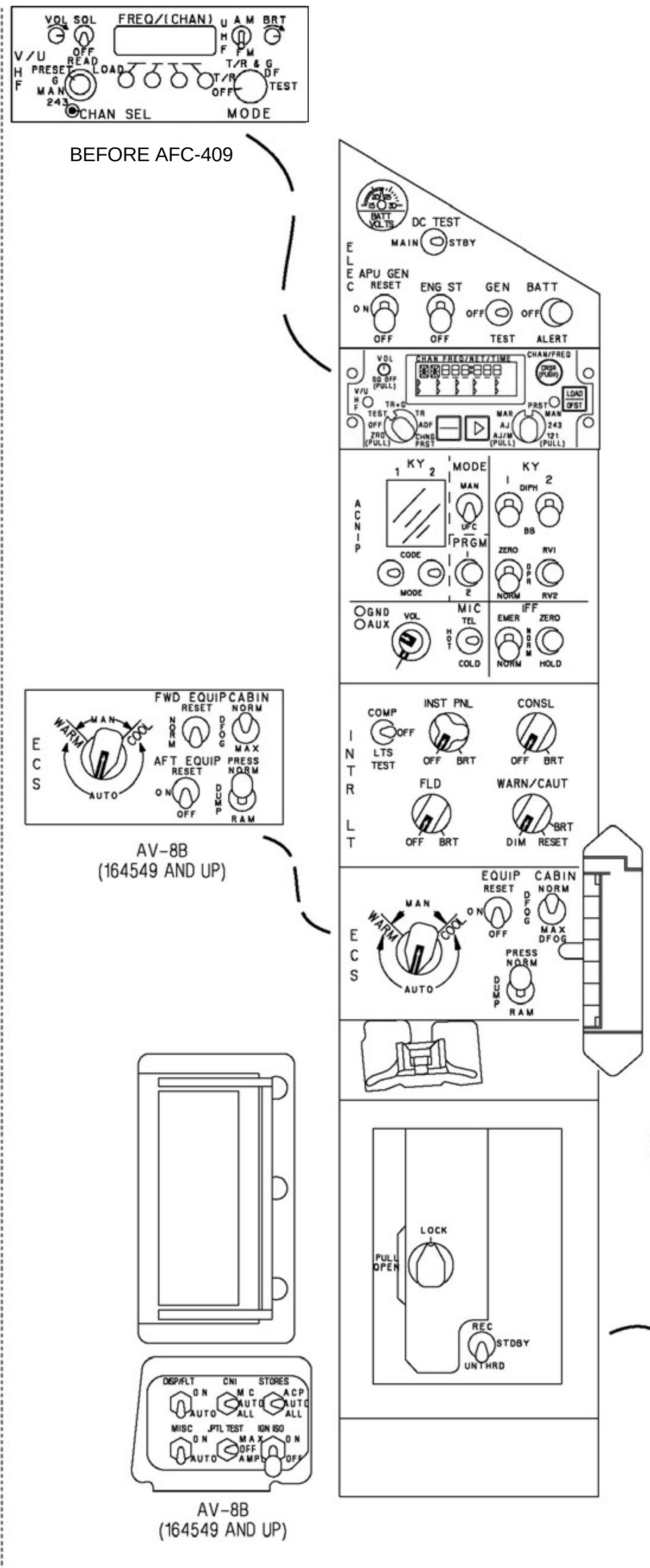
7. PILOT SERVICES PANEL
   - ANTI-G SUIT DISCONNECT
   - OXYGEN/COMMUNICATION DISCONNECT
   - ANTI-G VALVE
   - WATER DUMP SWITCH
   - OXYGEN SWITCH
   - LIDS SWITCH
   - ENGINE RPM SELECT SWITCH
   - ENGINE FUEL CONTROL SWITCH
8. FUEL SHUTOFF HANDLE
   - DECS ENABLE SWITCH
9. OXYGEN MONITOR
   - BIT BUTTON
10. GROUND POWER PANEL (AV8B 163853 THRU 164547)
11. MFS EMERGENCY BATTERY

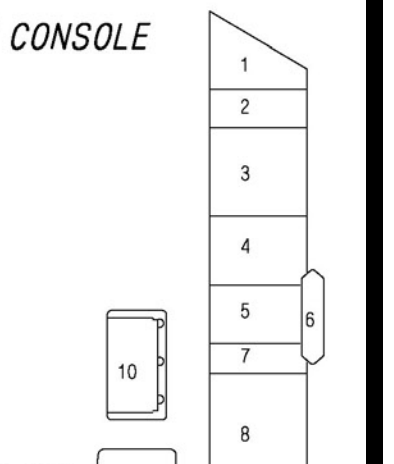
MAIN INSTRUMENT PANEL



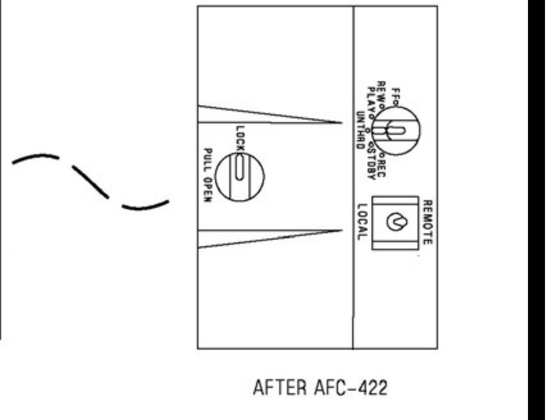
1. LANDING GEAR/FLAPS CONTROL PANEL
   - LANDING GEAR HANDLE
   - ANTI SKID SWITCH
   - FLAP MODE SELECT SWITCH
   - FLAP POSITION INDICATOR
   - FLAP POWER SWITCH
2. EMERGENCY JETTISON SWITCH
3. LANDING GEAR POSITION INDICATORS
4. COMBAT/WATER PANEL
5. STOP WATCH (GFE)
6. LANDING CHECKLIST
7. INTERNAL EMERGENCY CANOPY SHATTERING HANDLE
8. STANDBY MAGNETIC COMPASS
9. ARMAMENT CONTROL PANEL
10. MASTER ARMAMENT PANEL
11. MODE SWITCHES
    - NAVIGATION
    - AIR/GROUND
    - V/STOL
12. LEFT MULTIPURPOSE COLOR DISPLAY (MPCD)
13. RIGHT MULTIPURPOSE COLOR DISPLAY (MPCD)
14. OPTION DISPLAY UNIT
15. REFUEL LIGHTS
16. HEAD-UP DISPLAY (HUD)
17. PRIORITY CAUTION LIGHT
18. UPFRONT CONTROL
19. HUD CONTROL PANEL
20. STANDBY AIRSPEED INDICATOR
21. STANDBY ATTITUDE INDICATOR
22. STANDBY ALTIMETER
23. STANDBY ANGLE-OF-ATTACK INDICATOR
24. COURSE (CRS) CONTROL SWITCH PANEL
25. STANDBY VERTICAL VELOCITY INDICATOR
26. AIR VENT
27. TURN AND SLIP INDICATOR
28. FLIR POWER PANEL (AV-8B 163853 THRU 164547)
29. MISCELLANEOUS SWITCH PANEL
    - VRS AUTO/RUN SWITCH
    - VRS DISPLAY SELECT SWITCH
    - DISPLAY PROCESSOR SWITCH
    - PROBE HEAT SWITCH
    - LST/FLIR SWITCH (164549 AND UP)
    - MISSION COMPUTER SWITCH
    - DUAL MODE TRACKER SWITCH (AV-8B 163863 THRU 164547)
    - INS MODE SELECTOR KNOB
    - RADAR SWITCH (AV-8B 164549 AND UP)
30. BUREAU NUMBER
31. RUDDER PEDAL ADJUST CONTROL
32. CIRCUIT BREAKER PANEL
33. WARNING LIGHTS PANEL
34. THREAT LIGHTS
35. ENGINE DISPLAY PANEL
    - STABILATOR POSITION
    - NOZZLE POSITION
    - TACHOMETER
    - JET PIPE TEMPERATURE
    - FUEL FLOW
    - BIT SWITCH
    - DUCT PRESSURE
    - WATER QUANTITY
    - WATER FLOW LIGHT
36. FUEL QUANTITY INDICATOR
    - FUEL QUANTITY INDICATIONS
    - BINGO FUEL SET
    - INDICATION SELECT SWITCH
    - ON OFF INDICATOR
37. ECM CONTROL PANEL
38. CLOCK
39. CANOPY UNLOCK HANDLE
40. TAKEOFF CHECK LIST
41. BRAKE ACCUMULATOR PRESSURE INDICATOR
42. HYDRAULIC PRESSURE INDICATORS
    - BRAKE PRESSURE
    - HYDRAULIC PRESSURE SYSTEM NO. 1 AND NO. 2
43. CAUTION/ADVISORY LIGHT PANEL
44. COCKPIT ALTIMETER
45. LDG GEAR EMERGENCY BATTERY

RIGHT CONSOLE





1. ELECTRICAL PANEL
   - DC VOLTMETER
   - BATTERY SWITCH
   - GENERATOR SWITCH
   - ENGINE START SWITCH
   - APU SWITCH
   - DC TEST SWITCH
2. V/UHF RADIO SET CONTROL (RCS)
3. AMPLIFIER-CONTROL (ACNIP)
4. INTERIOR LIGHTS CONTROL PANEL
   - CONSOLE LIGHTS KNOB
   - INSTRUMENT LIGHTS KNOB
   - FLOOD LIGHTS KNOB
   - COMPASS LIGHT/LIGHTS TEST SWITCH
   - WARNING/CAUTION LIGHTS KNOB
5. ENVIRONMENTAL CONTROL PANEL
   - TEMPERATURE CONTROLLER
   - EQUIPMENT BAY COOL SWITCH (AV-8B 163853 THRU 164547)
   - RAM AIR SWITCH
   - DEFOG SWITCH
   - FWD EQUIPMENT COOL SWITCH (AV-8B 164549 AND UP)
   - AFT EQUIPMENT COOL SWITCH (AV-8B 164549 AND UP)
6. AIR VENT
7. NVG STOWAGE
8. VIDEO RECORDER
9. BLANK
10. DATA STORAGE SET (DSS) RECEPTACLE
11. GROUND POWER PANEL (AV8B 164549 AND UP)

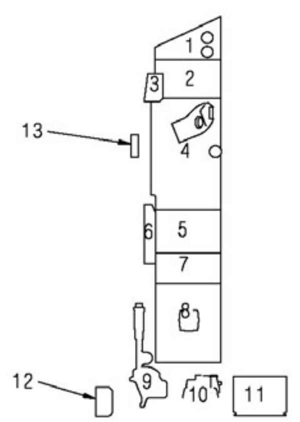


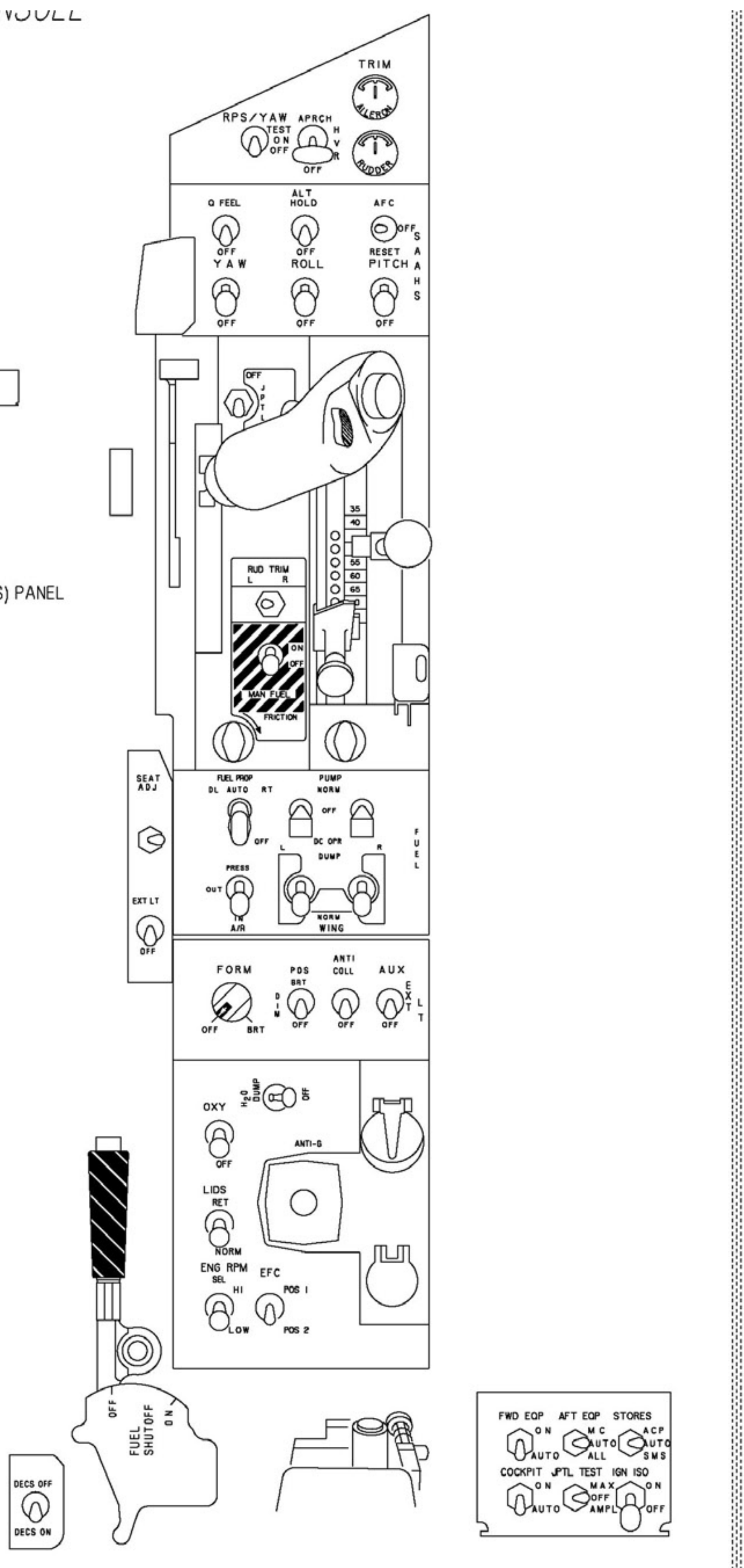
AHR602-556-1-039

Cockpit, AV-8B 163853 And Up

FO-2 (Reverse Blank)

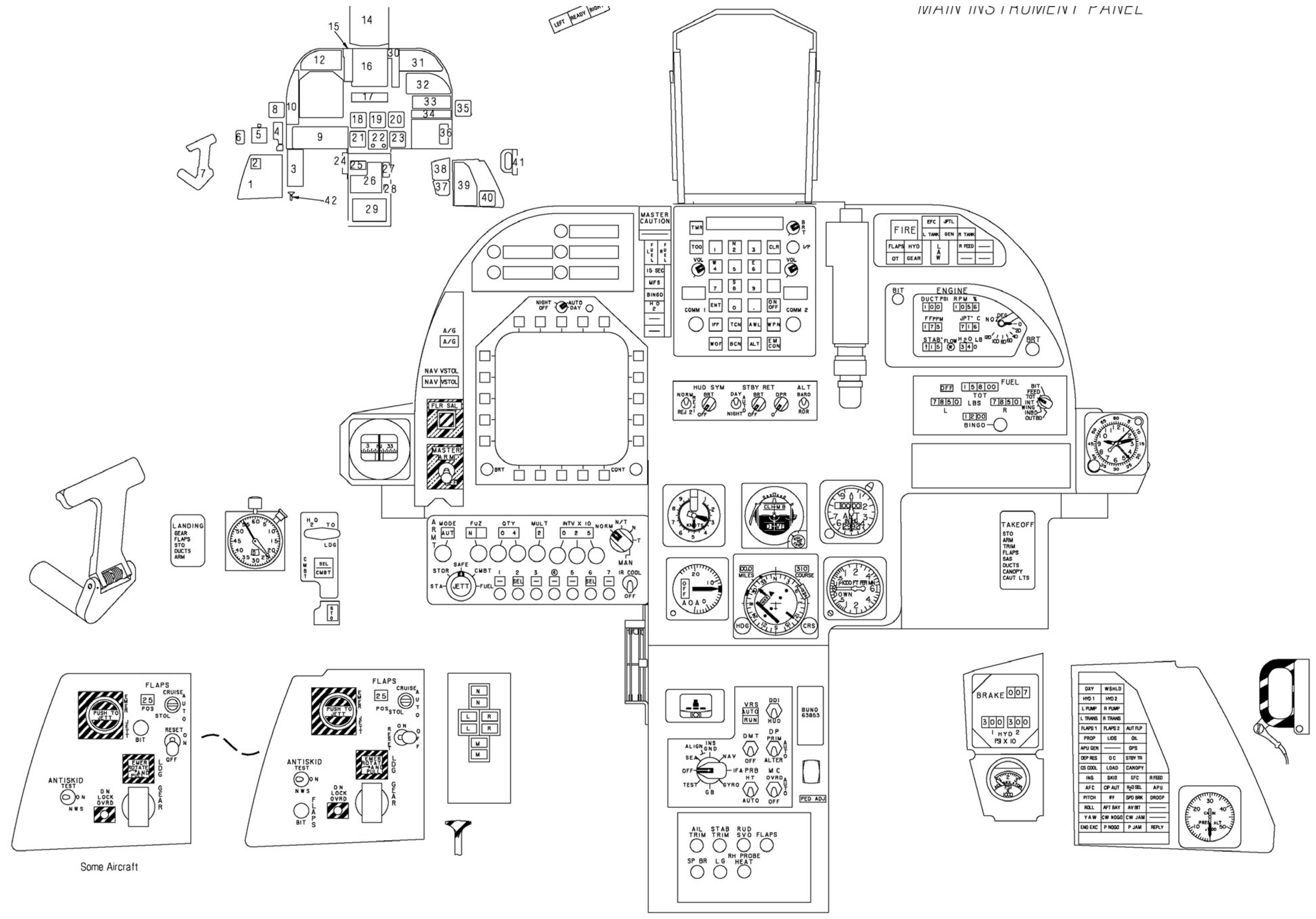
LEFT CONSOLE





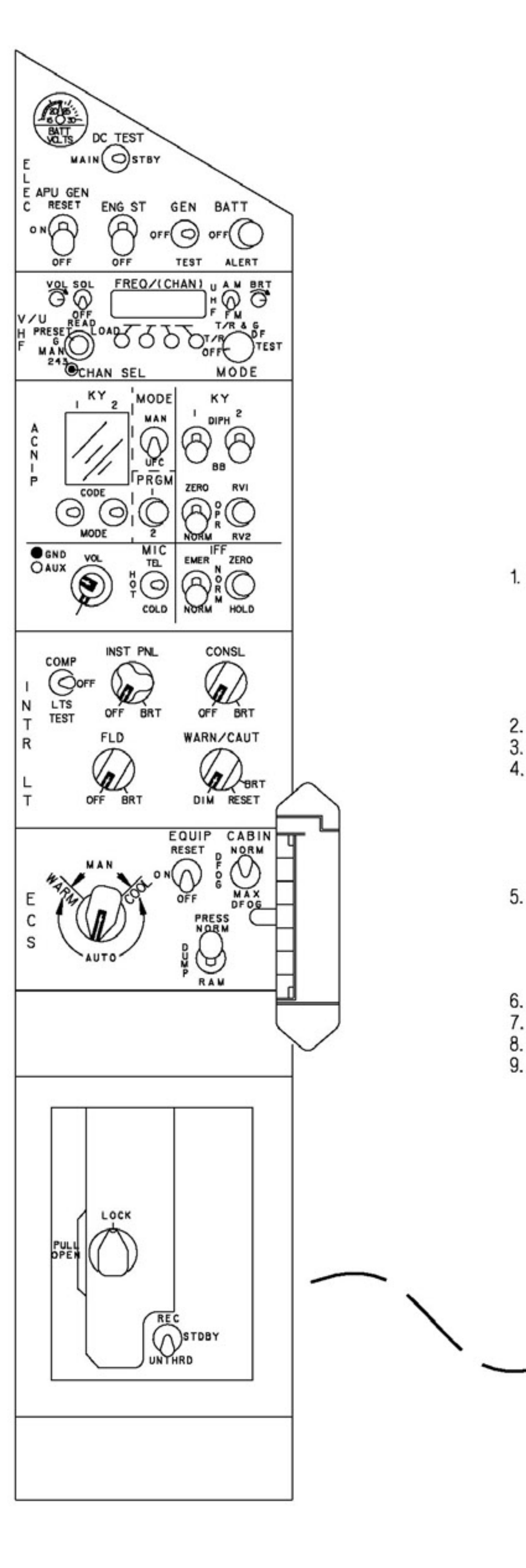
1. TRIM PANEL
   - RUDDER TRIM INDICATOR
   - AILERON TRIM INDICATOR
   - LANDING LIGHT SWITCH
   - RUDDER PEDAL SHAKER (RPS) SWITCH
2. STABILITY AUGMENTATION ATTITUDE HOLD SYSTEM (SAAHS) PANEL
   - ALTITUDE HOLD SWITCH
   - STAB AUG SWITCHES
   - Q FEEL SWITCH
   - AFC SWITCH
3. BLANK
4. THROTTLE QUADRANT
   - ENGINE TEMPERATURE/PRESSURE RATIO LIMITERS SWITCH
   - STO STOP
   - HOVER/VTO STOP
   - NOZZLE CONTROL
   - THROTTLE
   - SPEED BRAKE SWITCH
   - EMERGENCY FLAP RETRACT BUTTON
   - SLEW CONTROL/DESIGNATOR
   - AIRSTART BUTTON
   - CAGE/UNCAGE BUTTON
   - COMMUNICATION SWITCH
   - RUDDER TRIM AND MANUAL FUEL SWITCHES
   - FRICTION CONTROL
   - PARKING BRAKE HANDLE
5. FUEL PANEL
   - FLOW PROPORTIONER
   - L AND R FUEL PUMP SWITCH
   - L AND R WING FUEL DUMP SWITCH
   - AIR REFUELING (A/R) SWITCH
6. SEAT ADJUST AND EXTERIOR LIGHTS MASTER SWITCH
7. EXTERNAL LIGHTS PANEL
   - FORMATION LIGHTS KNOB
   - POSITION LIGHTS SWITCH
   - ANTI-COLLISION LIGHTS SWITCH
   - AUXILIARY LANDING LIGHT SWITCH
8. PILOT SERVICES PANEL
   - ANTI-G SUIT DISCONNECT
   - OXYGEN DISCONNECT
   - ANTI-G VALVE
   - WATER DUMP SWITCH
   - OXYGEN SWITCH
   - LIDS SWITCH
   - ENGINE RPM SELECT SWITCH
   - ENGINE FUEL CONTROL SWITCH (Some Aircraft)
9. LOW PRESSURE FUEL SHUTOFF HANDLE
10. OXYGEN MONITOR
    - BIT BUTTON
11. GROUND POWER PANEL
12. DECS ENABLE SWITCH (Some Aircraft)
13. MFS EMERGENCY BATTERY

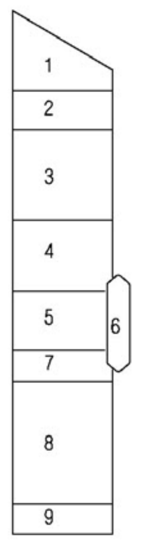
MAIN INSTRUMENT PANEL



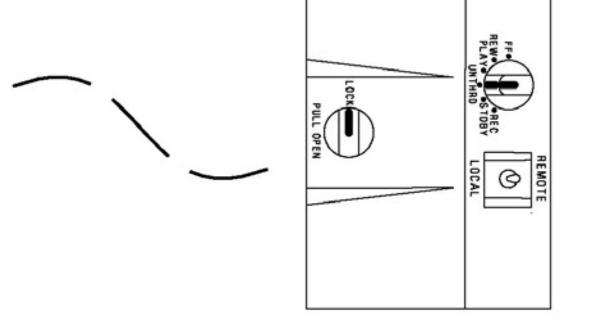
1. LANDING GEAR/FLAPS CONTROL PANEL
   - LANDING GEAR HANDLE
   - ANTISKID SWITCH
   - FLAP MODE SELECT SWITCH
   - FLAP POSITION INDICATOR
   - FLAP POWER SWITCH
2. EMERGENCY JETTISON SWITCH
3. LANDING GEAR POSITION INDICATORS
4. COMBAT/WATER PANEL
5. STOP WATCH (GFE)
6. LANDING CHECKLIST
7. INTERNAL CANOPY LOCK HANDLE
8. STANDBY MAGNETIC COMPASS
9. ARMAMENT CONTROL PANEL
10. MASTER ARMAMENT PANEL
    - A/G MODE SWITCH
    - NAV MODE SWITCH
    - VSTOL MODE SWITCH
    - FLR SAL SWITCH
    - MASTER ARM SWITCH
11. DIGITAL DISPLAY INDICATOR (DDI)
12. OPTION DISPLAY UNIT
13. REFUEL LIGHTS
14. HEAD-UP DISPLAY (HUD)
15. PRIORITY CAUTION LIGHT
16. UPFRONT CONTROL
17. HUD CONTROL PANEL
18. STANDBY AIRSPEED INDICATOR
19. STANDBY ATTITUDE INDICATOR
20. STANDBY ALTIMETER
21. STANDBY ANGLE-OF-ATTACK INDICATOR
22. HORIZONTAL SITUATION INDICATOR
23. STANDBY VERTICAL VELOCITY INDICATOR
24. AIR VENT
25. TURN AND SLIP INDICATOR
26. MISCELLANEOUS SWITCH PANEL
    - VIDEO RECORDER LIGHTS/SWITCH
    - VRS DISPLAY SELECT SWITCH
    - DISPLAY PROCESSOR SWITCH
    - DUAL MODE TRACKER SWITCH
    - MISSION COMPUTER SWITCH
    - PROBE HEAT SWITCH
    - INS MODE SELECTOR KNOB
27. BUREAU NUMBER
28. RUDDER PEDAL ADJUST CONTROL
29. CIRCUIT BREAKER PANEL
30. HUD VIDEO CAMERA
31. WARNING/THREAT LIGHTS (latest configuration)
32. ENGINE DISPLAY PANEL
    - BIT SWITCH
    - DUCT PRESSURE
    - TACHOMETER
    - JET PIPE TEMPERATURE
    - NOZZLE POSITION
    - DISPLAY BRIGHTNESS CONTROL
    - WATER QUANTITY
    - WATER FLOW LIGHT
    - STABILATOR POSITION
    - FUEL FLOW
33. FUEL QUANTITY INDICATOR
    - FUEL QUANTITY INDICATIONS
    - BINGO FUEL SET
    - INDICATION SELECT SWITCH
    - ON/OFF INDICATOR
34. BLANK
35. CLOCK
36. TAKEOFF CHECKLIST
37. BRAKE ACCUMULATOR PRESSURE INDICATOR
38. HYDRAULIC PRESSURE INDICATORS
    - BRAKE PRESSURE
    - HYDRAULIC PRESSURE SYSTEM NO. 1 AND NO. 2
39. CAUTION/ADVISORY LIGHT PANEL (latest configuration)
40. COCKPIT ALTIMETER
41. INTERNAL EMERGENCY CANOPY SHATTERING HANDLE
42. LDG GEAR EMERGENCY BATTERY

RIGHT CONSOLE





1. ELECTRICAL PANEL
   - DC VOLTMETER
   - BATTERY SWITCH
   - GENERATOR SWITCH
   - ENGINE START SWITCH
   - APU SWITCH
   - DC TEST SWITCH
2. V/UHF RADIO SET CONTROL (RSC)
3. AMPLIFIER - CONTROL (ACNIP)
4. INTERIOR LIGHTS CONTROL PANEL
   - CONSOLE LIGHTS KNOB
   - INSTRUMENT LIGHTS KNOB
   - FLOOD LIGHTS KNOB
   - COMPASS LIGHT/LIGHTS TEST SWITCH
   - WARNING/CAUTION LIGHTS KNOB
5. ENVIRONMENTAL CONTROL PANEL
   - TEMPERATURE CONTROLLER
   - EQUIPMENT BAY COOL SWITCH
   - RAM AIR SWITCH
   - DEFOG SWITCH
6. AIR VENT
7. BLANK
8. VIDEO RECORDER
9. BLANK



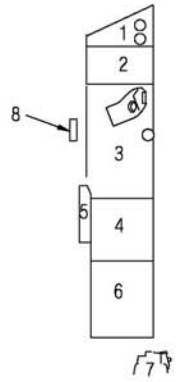
AFTER AFC-422

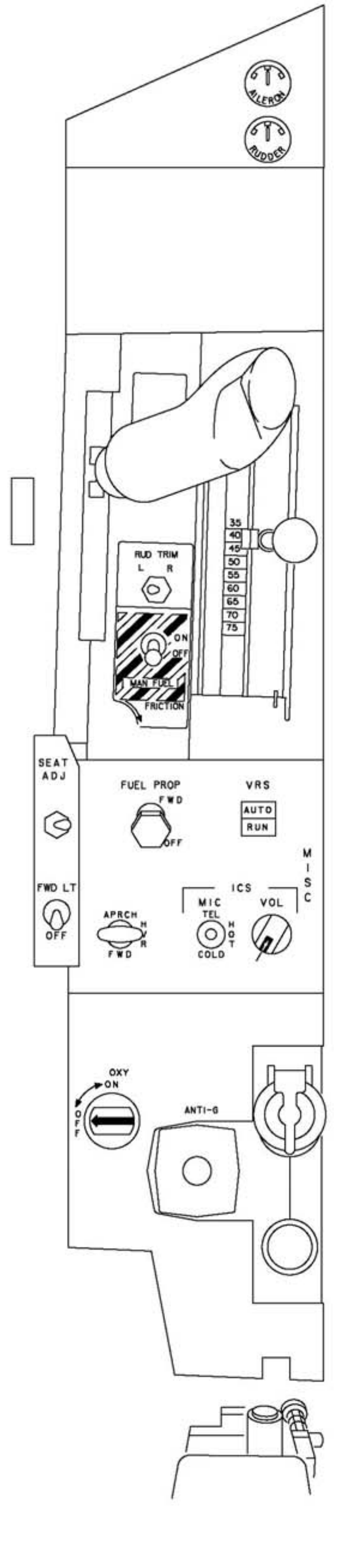
AHR502-486-1-037

Cockpit, TAV-8B

FO-3 (Reverse Blank)

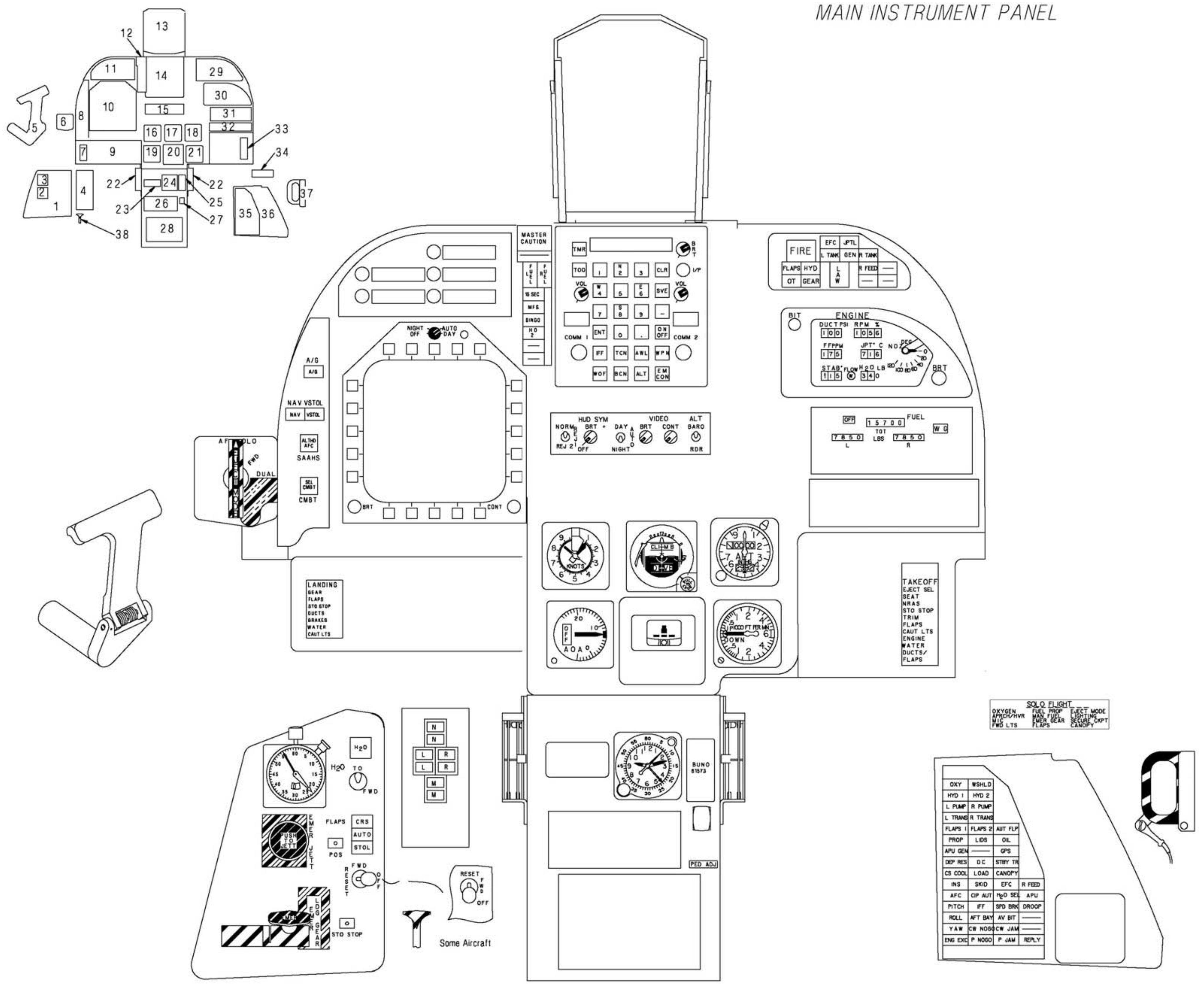
LEFT CONSOLE





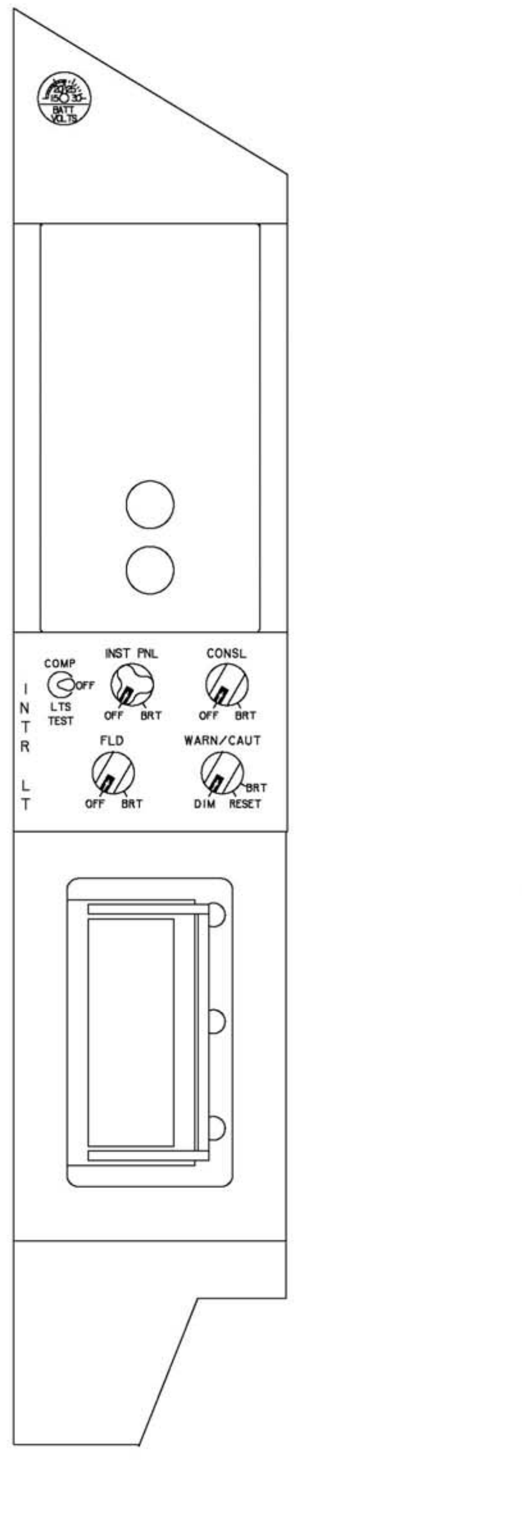
1. TRIM PANEL
   - RUDDER TRIM INDICATOR
   - AILERON TRIM INDICATOR
2. BLANK
3. THROTTLE QUADRANT
   - NOZZLE CONTROL
   - THROTTLE
   - SPEED BRAKE SWITCH
   - EMERGENCY FLAP RETRACT BUTTON
   - SLEW CONTROL/DESIGNATOR
   - AIRSTART BUTTON
   - CAGE/UNCAGE BUTTON
   - COMMUNICATION SWITCH
   - RUDDER TRIM AND MANUAL FUEL SWITCHES
4. MISCELLANEOUS PANEL
   - FUEL FLOW PROPORTIONER
   - LANDING LIGHT SWITCH
   - VIDEO RECORDER SET SWITCH
   - ICS MIC SWITCH
   - ICS VOLUME CONTROL
5. SEAT ADJUST AND EXTERIOR LIGHTS MASTER SWITCH
6. PILOT SERVICES PANEL
   - ANTI-G SUIT DISCONNECT
   - OXYGEN DISCONNECT
   - ANTI-G VALVE
   - OXYGEN VALVE
7. OXYGEN MONITOR
   - BIT BUTTON
8. MFS EMERGENCY BATTERY

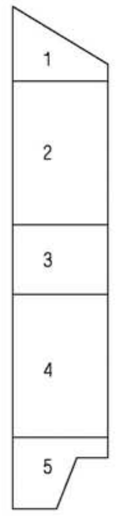
MAIN INSTRUMENT PANEL



1. EMERGENCY LANDING GEAR/FLAPS CONTROL PANEL
   - EMERGENCY LANDING GEAR HANDLE
   - FLAP POSITION INDICATOR
   - STO STOP INDICATOR
   - FLAP POWER SWITCH
   - H_2O TO/FWD SWITCH
   - H_2O LIGHT
2. EMERGENCY JETTISON
3. STOP WATCH (GFE)
4. LANDING GEAR POSITION INDICATORS
5. INTERNAL CANOPY LOCK HANDLE
6. EJECT MODE SELECTOR
7. LANDING CHECKLIST
8. MASTER MODE PANEL
   - A/G MODE SWITCH
   - NAV MODE SWITCH
   - VSTOL MODE SWITCH
   - SAAHS LIGHT
   - CMBT LIGHT
9. BLANK
10. DIGITAL DISPLAY INDICATOR (DDI)
11. OPTION DISPLAY UNIT
12. PRIORITY CAUTION LIGHT
13. HEAD-UP DISPLAY (HUD)
14. UPFRONT CONTROL
15. HUD CONTROL PANEL
16. STANDBY AIRSPEED INDICATOR
17. STANDBY ATTITUDE INDICATOR
18. STANDBY ALTIMETER
19. STANDBY ANGLE-OF-ATTACK INDICATOR
20. TURN AND SLIP INDICATOR
21. STANDBY VERTICAL VELOCITY INDICATOR
22. AIR VENT
23. BLANK
24. CLOCK
25. BUREAU NUMBER
26. BLANK
27. RUDDER PEDAL ADJUST CONTROL
28. BLANK
29. WARNING/THREAT LIGHTS
30. ENGINE DISPLAY PANEL
    - BIT SWITCH
    - DUCT PRESSURE
    - TACHOMETER
    - JET PIPE TEMPERATURE
    - NOZZLE POSITION
    - DISPLAY BRIGHTNESS CONTROL
    - WATER QUANTITY
    - WATER FLOW LIGHT
    - STABILATOR POSITION
    - FUEL FLOW
31. FUEL QUANTITY INDICATOR
    - FUEL QUANTITY INDICATIONS
    - ON/OFF INDICATOR
    - SELECTION INDICATOR
32. BLANK
33. TAKEOFF CHECK LIST
34. SOLO FLIGHT CHECKLIST
35. CAUTION/ADVISORY LIGHT PANEL (Latest configuration)
36. BLANK
37. INTERNAL EMERGENCY CANOPY SHATTERING HANDLE
38. LDG GEAR EMERGENCY BATTERY

RIGHT CONSOLE



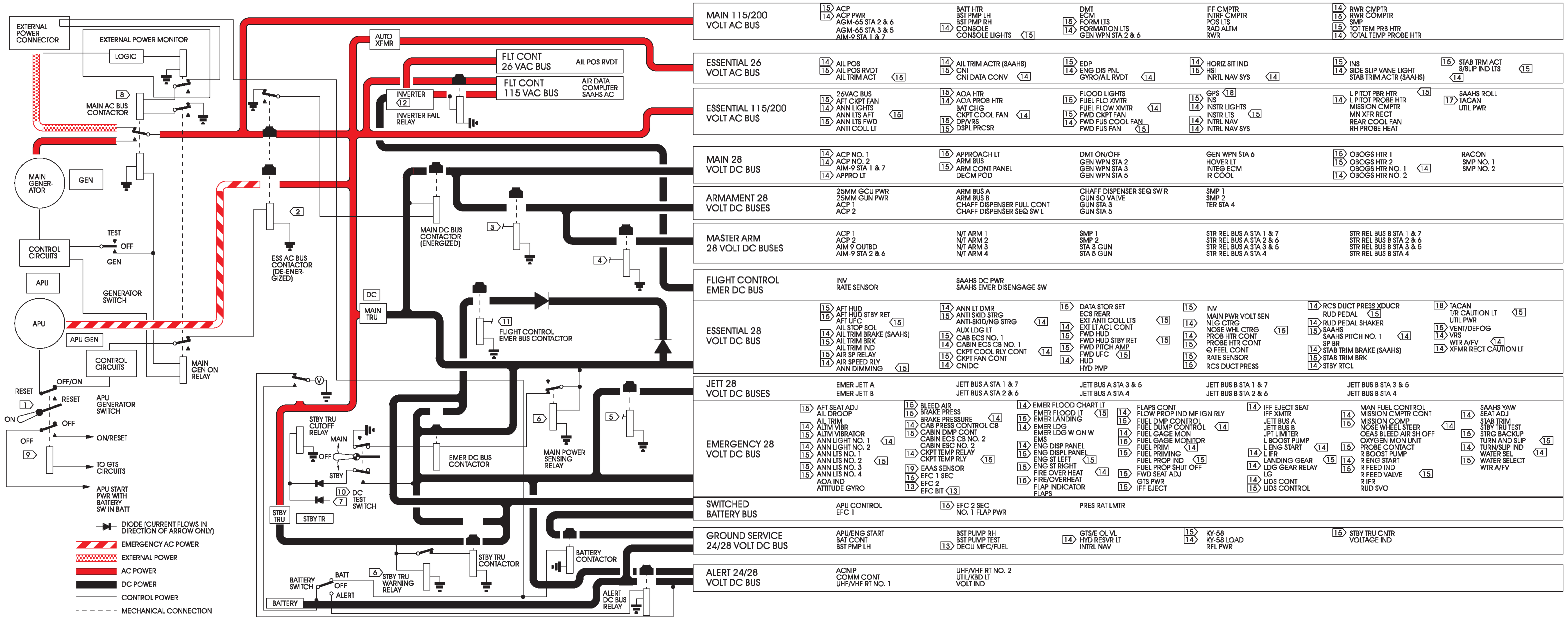


1. ELECTRICAL PANEL
   - DC VOLTMETER
2. STOWAGE BOX
3. INTERIOR LIGHTS CONTROL PANEL
   - CONSOLE LIGHTS KNOB
   - INSTRUMENT LIGHTS KNOB
   - FLOOD LIGHTS KNOB
   - COMPASS LIGHT/LIGHTS TEST SWITCH
   - WARNING/CAUTION LIGHTS KNOB
4. DATA STORAGE SET (DSS)
5. BLANK

AHR602-482-1-037

Rear Cockpit, TAV-8B

Aircraft and Engine Fuel System



EXTERNAL POWER APPLIED

NOTES

Nomenclature callouts on the individual buses are circuit breaker nomenclatures. These nomenclatures do not necessarily identify each system powered by

1 Switch shown in OFF position.

2 Essential ac bus contactor energized with main generator OFF the line and APU generator operating and producing the proper power output.

3 Armament buses energized with gear handle UP and weight OFF landing gear. It will also energize with armament bus override switch on, provided gear handle is DOWN.

4 Master arm buses energized with armament buses energized and master arm switch in ARM.

5 Jettison buses energized with weight OFF landing gear, or gear handle UP, or with armament override switch on and with gear handle DOWN.

6 Voltage sensing relay de-energized if TRU output drops below 24.75 volts dc for approximately 3.5 seconds.

7 Standby TRU cutoff relay energizes during GTS start.

8 External power is applied to system provided the external power is connected and of proper quality, the battery switch is in BATT, and the main generator is not on the line.

9 Switch is electromagnetically held in the ON position when selected with the battery switch in BATT, and will remain in the ON position until any of the following occurs: (1) battery switch placed out of BATT, (2) engine start selected, (3) APU selected ON while on the ground or airspeed exceeds 325 knots with the main generator on the line.

10 Main position energizes the stanby TRU cut off relay to shutdown the standby TRU. The STBY TR light is on and main TRU output (28 volts) is indicated on the voltmeter, which indicates main TRU is charging the battery. STBY position de-energizes emer dc bus contactor to switch power on emergency dc and alert buses from main TRU to standby TRU. Standby TRU charging of the battery is indicated by voltmeter indicating 26 volts or greater.

11 Above Mach 0.4 and 8 ° AOA the flight control emergency bus contactor energizes. If power to the main TRU is lost or interrupted the circuit breakers on the flight control emergency dc bus will remain energized by the standby TRU. If both main TRU and standby TRU fail, the bus is energized by battery power. Once energized the contactor remains energized for a minimum of 30 seconds even though the aircraft goes below Mach 0.4 and/or 8° AOA. The contactor also provides battery power to the flight control ac bus inverter.

12 The inverter powers the ac flight control buses. If the inverter fails, the inverter fail relay de-energizes causing the ac light control buses to be powered by generator power.

13 AV-8B 162068 and up.

14 AV-8B.

15 TAV-8B.

16 AV-8B 161573 thru 163852, TAV-8B 162747 thru 163861 after AFC-370.

17 AV-8B 161573 thru 163852, TAV-8B 162963 thru 163861 before AFC-354 Part 3.

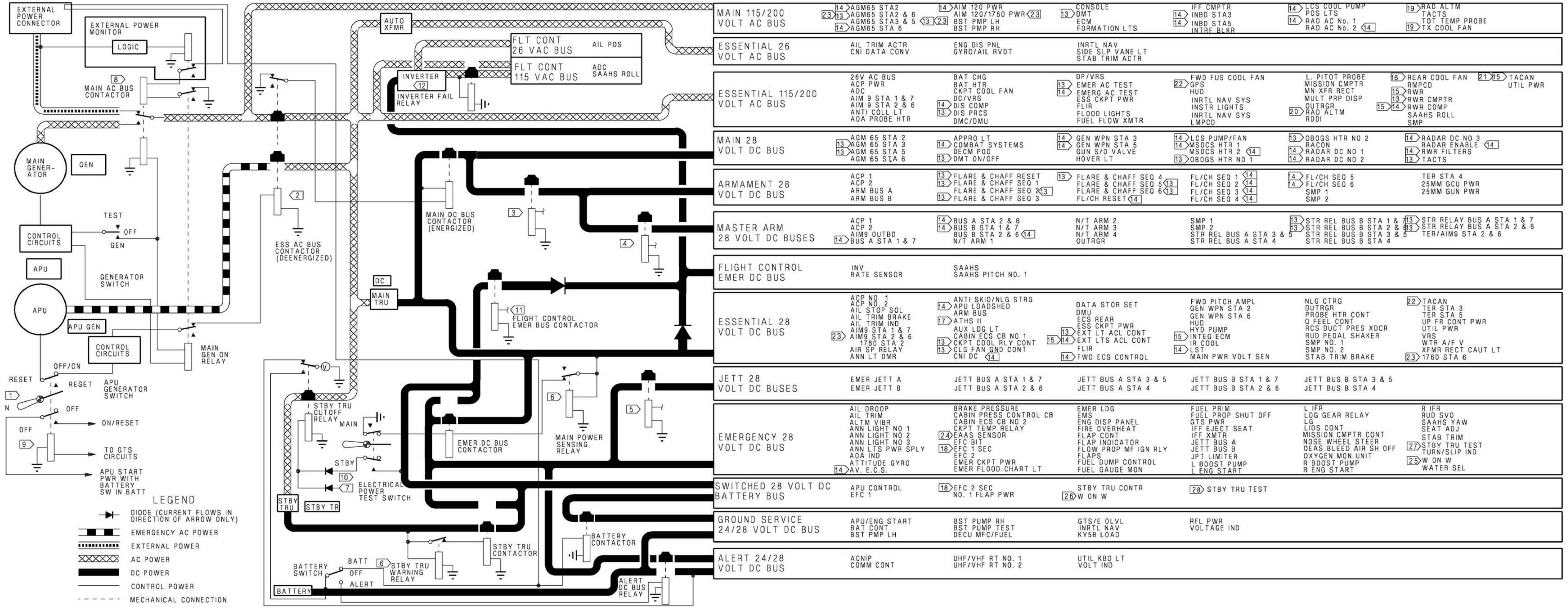
18 AV8-B 161573 thru 163852, TAV-8B 162963 thru 163861 after AFC-354 Part 3.

19 After AFC-449.

AHR602-234-1-036

Electrical System, AV-8B 161573 Thru 163852, TAV-8B 162747 Thru 163861

FO-6 (Reverse Blank)



Electrical System and Circuit Breaker identification,

EXTERNAL POWER APPLIED

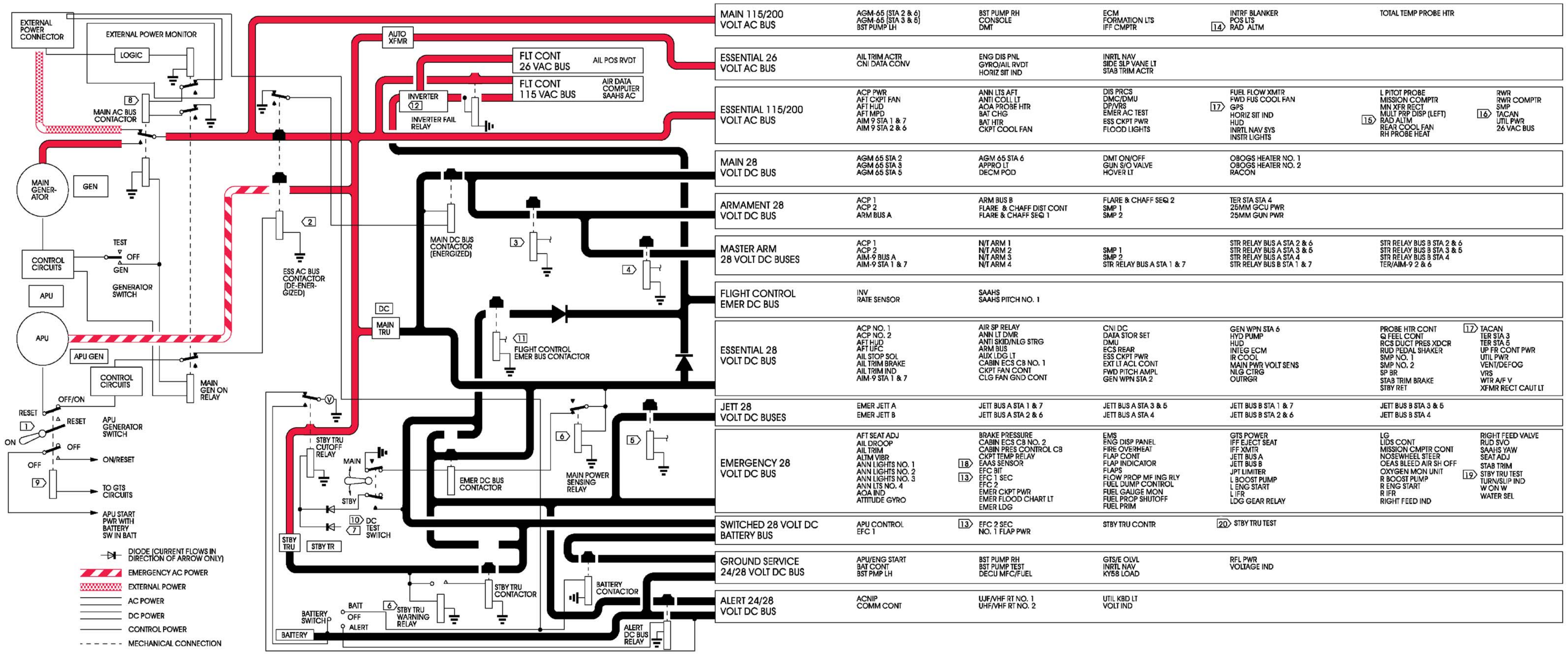
NOTES

Nomenclature callouts on the individual busses are circuit breaker nomenclatures. These nomenclatures do not necessarily identify each system powered by the circuit breakers.

1. Switch shown in OFF position.
2. Essential AC bus contactor energized with main generator OFF the line and APU generator operating and producing the proper power output.
3. Armament buses energized with gear handle UP and weight OFF landing gear. It will also energize with armament bus override switch on, provided gear handle is DOWN.
4. Master arm buses energized when armament buses energized and master arm switch in ARM.
5. Jettison buses energized with weight OFF landing gear, or gear handle UP, or with armament override switch on and gear handle DOWN.
6. Voltage sensing relay deenergized if TRU output drops below 24.75 volts DC for approximately 3.5 seconds.
7. Standby TRU cutoff relay energizes during GTS start.
8. External power is applied to system provided the external power is connected and of proper quality, the battery switch is in BATT, and the main generator is not on the line.
9. Switch is electromagnetically held in the ON position when selected with the battery switch in BATT, and will remain in the ON position until any of the following occurs:
   (1) engine start selected, (2) APU selected ON while on the ground and (3) airspeed exceeds 325 knots with the main generator on the line.
10. Main position energizes the standby TRU cut off relay to shutdown the standby TRU. The STBY TR light is on and main TRU output (28 volts) is indicated on the voltmeter, which indicates main TRU is charging the battery. STBY position deenergizes emer DC bus contactor to switch power on emergency DC and alert buses from main TRU to standby TRU. Standby TRU charging of the battery is indicated by voltmeter indicating 26 volts or greater.
11. Above Mach 0.4 and 8' AOA, the flight control emergency bus contactor energizes. If power on the main TRU is lost or interrupted, the circuit breakers on the flight control emergency DC bus will remain energized by the standby TRU or the battery if both TRU's fail. Once energized, the contactor remains energized for a minimum of 30 seconds, even though the aircraft goes below Mach 0.4 and/or 8' AOA. The contactor also provides battery power to the flight control AC bus inverter.
12. The inverter powers the AC flight control buses. If the inverter fails, the inverter fail relay deenergizes causing the 115 VAC flight control bus to be powered by generator power.
13. AV-8B 163853 thru 164547 (Night Attack).
14. AV-8B 164549 and up (Radar).
15. On AV-8B 164549 and up, power is disabled with APU on line and weight-on-wheels.
16. On AV-8B 164549 and up, power is disabled with APU on line and weight-off-wheels.
17. AV-8B 165305 and up; also AV-8B 163853 thru 165006 after AFC-326/Part 3.
18. AV-8B 165354 and up, also AV-8B 163853 thru 165312 after AFC-395.
19. AV-8B 163853 thru 164547 before AFC-368.
20. AV-8B 164549 and up, also AV-8B 163853 thru 164547 after AFC-368.
21. AV-8B 163853 thru 164547 before AFC-354 Rev A.
22. AV-8B 165384 and up; also AV-8B 163853 thru 165383 after AFC-354 Rev A/Part 3.
23. AV-8B 165413 and up, also AV-8B 163853 thru 165412 after AFC-420.
24. After AFC-449.
25. Before AFC-464.
26. After AFC-464.
27. Before AFC-481.
28. After AFC-481.

AHR602-557-1-037

Electrical System, AV-8B 163853 And Up



NOTES

Nomenclature callouts on the individual buses are circuit breaker nomenclatures. These nomenclatures do not necessarily identify each system powered by the circuit breakers.

1. Switch shown in OFF position.
2. Essential AC bus contactor energized with main generator OFF the line and APU generator operating and producing the proper power output.
3. Armament buses energized with gear handle UP and weight OFF landing gear. It will also energize with armament bus override switch on, provided gear handle is DOWN.
4. Master arm buses energized when armament buses energized and master arm switch in ARM.
5. Jettison buses energized with weight OFF landing gear, or gear handle UP, or with armament override switch on and with gear handle DOWN.
6. Voltage sensing relay de-energized if TRU output drops below 24.75 volts DC for approximately 3.5 seconds.
7. Standby TRU cutoff relay energizes during GTS start.
8. External power is applied to system provided the external power is connected and of proper quality, the battery switch is in BATT, and the main generator is not on the line.
9. Switch is electromagnetically held in the ON position when selected with the battery switch in BATT, and will remain in the ON position until any of the following occurs: (1) engine start selected, (2) APU selected ON while on the ground and (3) airspeed exceeds 325 knots with the main generator on the line.
10. Main position energizes the standby TRU cut off relay to shutdown the standby TRU. The STBY TR light is on and main TRU output (28 volts) is indicated on the voltmeter, which indicates main TRU is charging the battery. STBY position de-energizes emer DC bus contactor to switch power on emergency DC and alert buses from main TRU to standby TRU. Standby TRU charging of the battery is indicated by voltmeter indicating 26 volts or greater.
11. Above Mach 0.4 and 8 AOA, the flight control emergency bus contactor energizes. If power on the main TRU is lost or interrupted, the circuit breakers on the light control emergency DC bus will remain energized by the standby TRU or the battery if both TRU's fail. Once energized, the contactor remains energized for a minimum of 30 seconds, even though the aircraft goes below Mach 0.4 and/or 8 ° AOA. The contactor also provides battery power to the flight control AC bus inverter.
12. The inverter powers the AC light control buses. If the inverter fails, the inverter fail relay de-energizes causing the 115vac flight control bus to be powered by generator power.

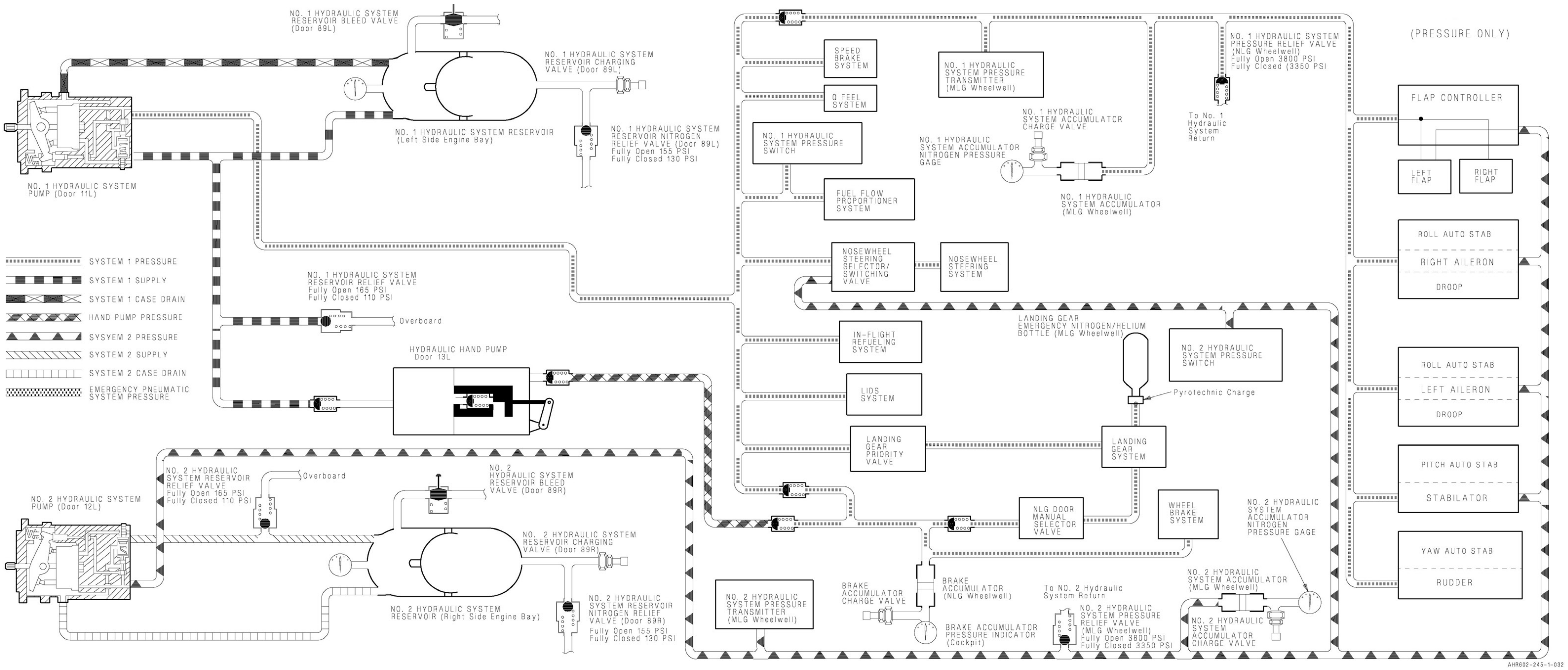
EXTERNAL POWER APPLIED

13. TAV-8B 164113 thru 164542 after AFC-395.
14. TAV-8B 164113 thru 164542 before AFC-368.
15. TAV-8B 164113 thru 164542 after AFC-368.
16. TAV-8B 164113 thru 164542 before AFC-354 Rev A.
17. TAV-8B 164113 thru 164542 after AFC-354 Rev A.
18. After AFC-449.
19. Before AFC-481.
20. After AFC-481.

AHR632-493-1-036

Electrical System, TAV-8B 164113 And Up

FO-8 (Reverse Blank)

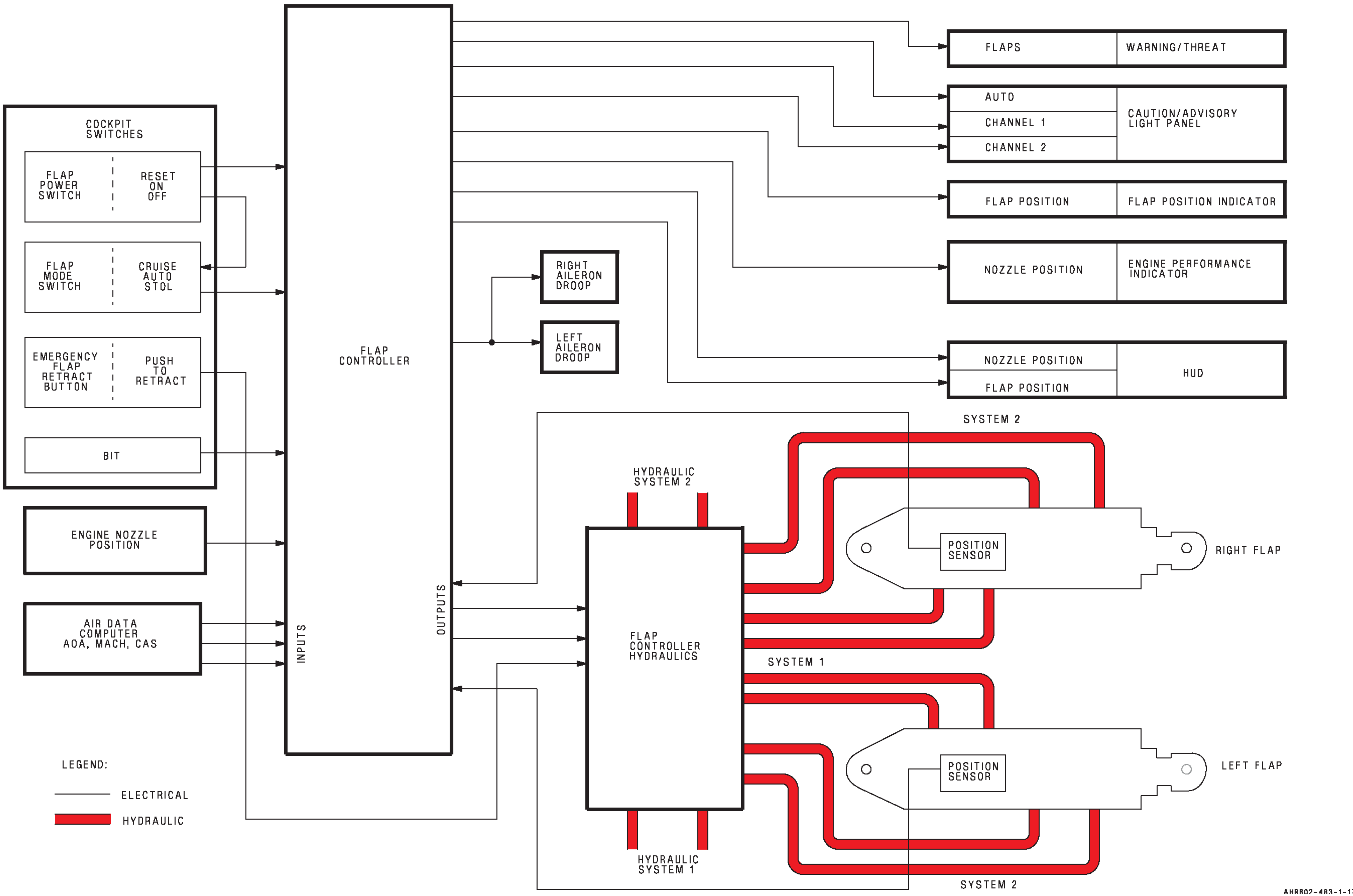


Hydraulic System (Pressure Only)

Environmental Control System, TAV-8B, AV-8B 161573 Thru 164547

Environmental Control System, AV-8B 164549 And Up

FO-11 (Reverse Blank)



Flap System

FO-12 (Reverse Blank)