A1-AV8BB-NFM-000

NATOPS FLIGHT MANUAL

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

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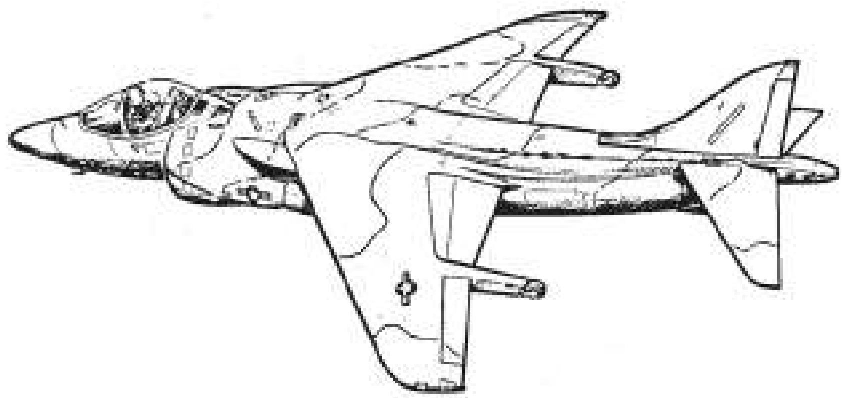

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DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
RADM WILLIAM A. MOFFETT BUILDING
47123 BUSE ROAD, BLDG 2272
PATUXENT RIVER, MD 20670-1547

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//
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MAG FOURTEEN//CO/OPSO/MO/DSS//
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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.

B. IN THE AFFECTED PUBLICATIONS(S) JUST AFTER THE IC SUMMARY PAGE. IF THE IC MESSAGE INCLUDES REPLACEMENT PAGES, THEY WILL BE ADDITIONALLY PLACED WITHIN THE MANUAL AND REPLACED PAGES DELETED.
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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
COMNAVAIRFOR SAN DIEGO CA//N421A//
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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.
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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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      (1) MAJ MICHAEL HUNTING, VMAT-203, (252) 466-2638, DSN

582-2638, E-MAIL MICHAEL.HUNTING(AT)USMC.MIL

B. NAVAIR POCS:

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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 $\pm 5^{o}$ vice 687 $\pm 5^{o}$	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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AV-8B/TAV-8B NATOPS Flight Manual

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

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CHAPTER 19 — EMERGENCY PROCEDURES CHECKLIST DISPLAY

CHAPTER 22 — COMMUNICATIONS

CHAPTER 23 — NAVIGATION

Page No.

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)

This publication and changes to it are automatically sent to activities that are established on the Automatic Distribution Requirements List (ADRL) maintained by Naval Air Technical Data and Engineering Services Command (NATEC), in San Diego, CA. If there is continuing need for this publication, each activity's Central Technical Publication Librarian must coordinate with the NATOPS Model Manager of this publication to ensure appropriate numbers of this and associated derivative manuals are included in the automatic mailing of updates to this publication.

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:

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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	

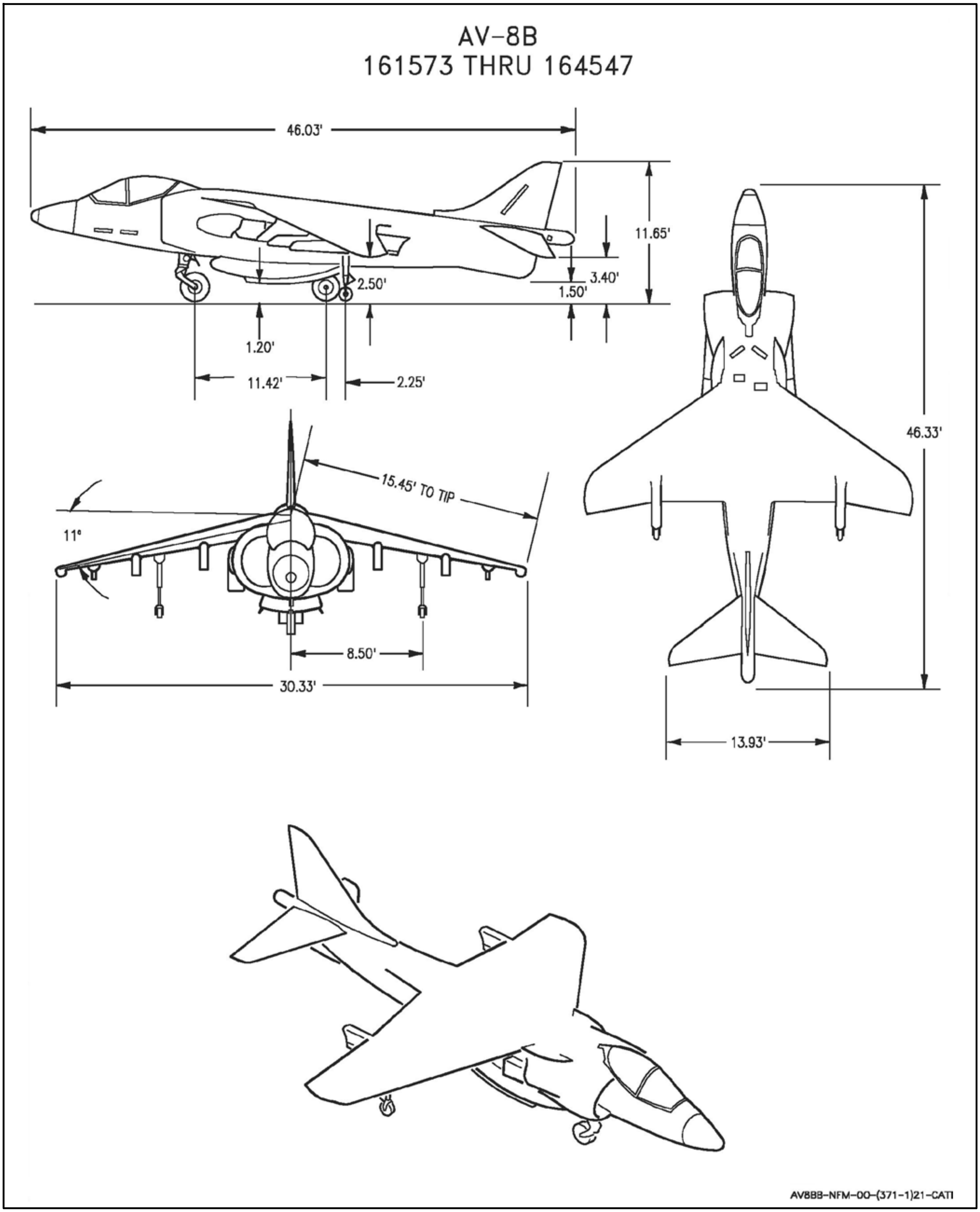
REFERENCE

(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 ____________

BY ____________ MODEL MANAGER ____________ AIRCRAFT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1.20'
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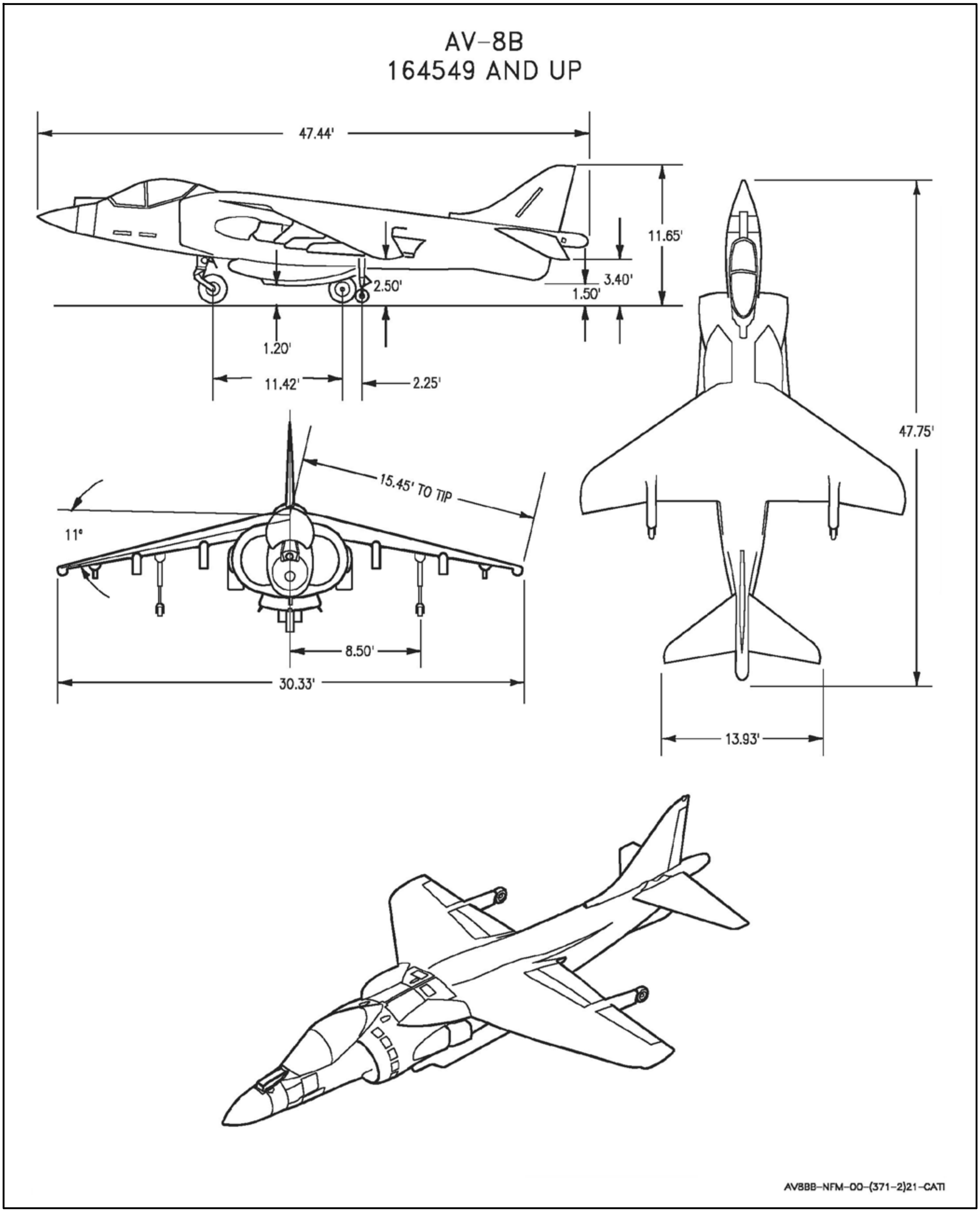
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1.20'
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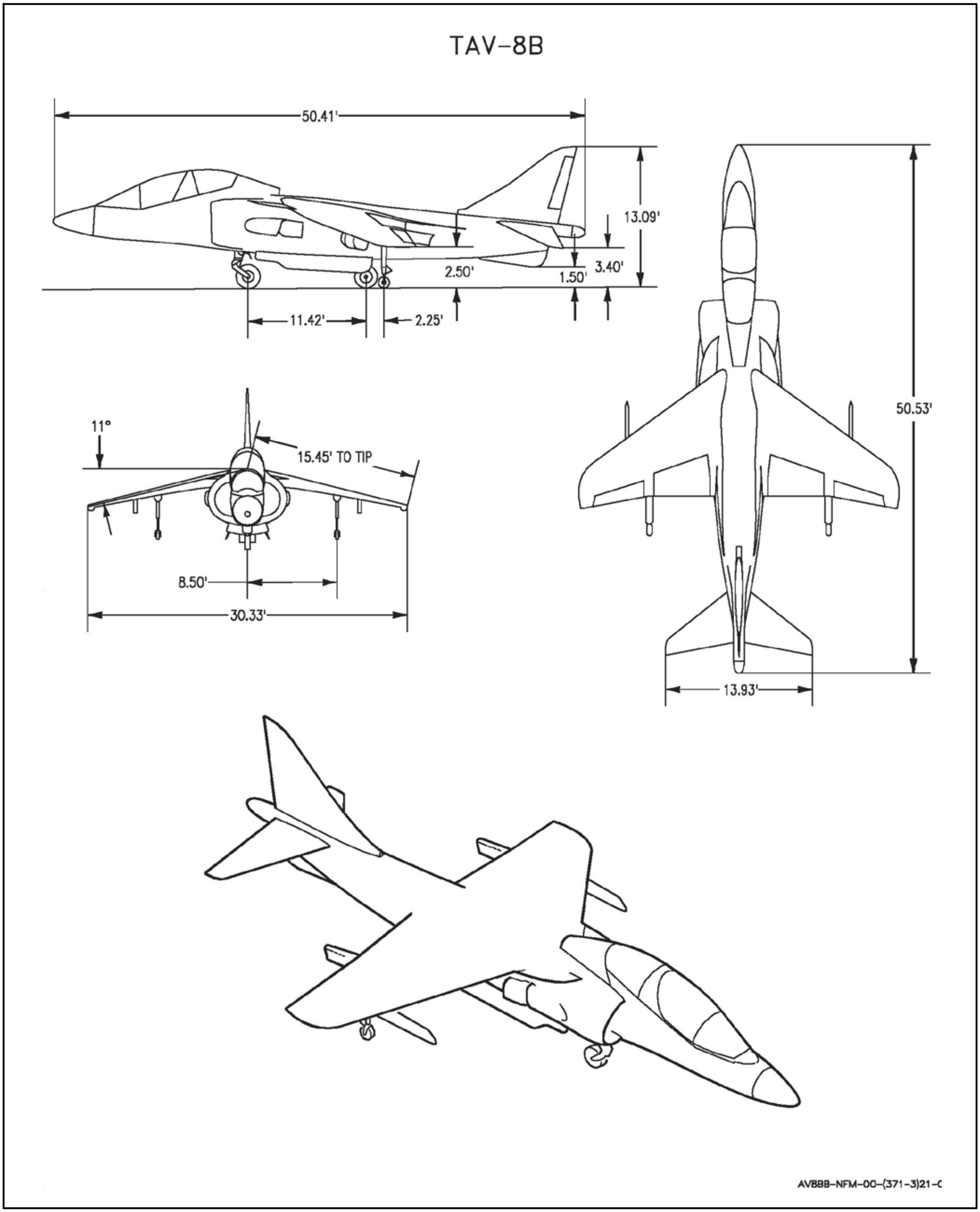
AV8BB–NFM–00–(371–2)21–CATI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30.33'
50.53'
13.93'
AV8BB-NFM-00-(371-3)21-C

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).

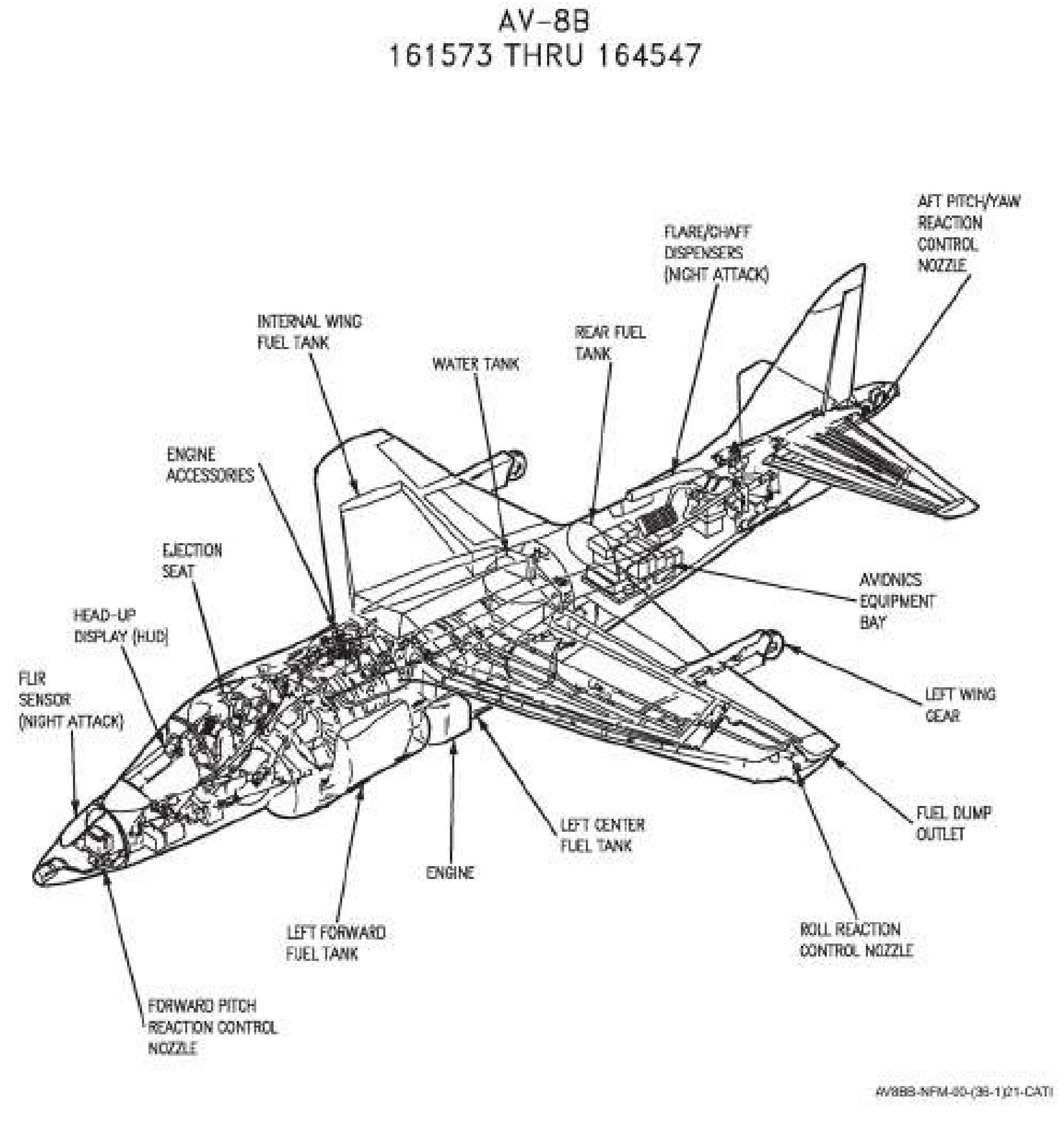


Figure 1-1. General Arrangement (Sheet 1 of 3)

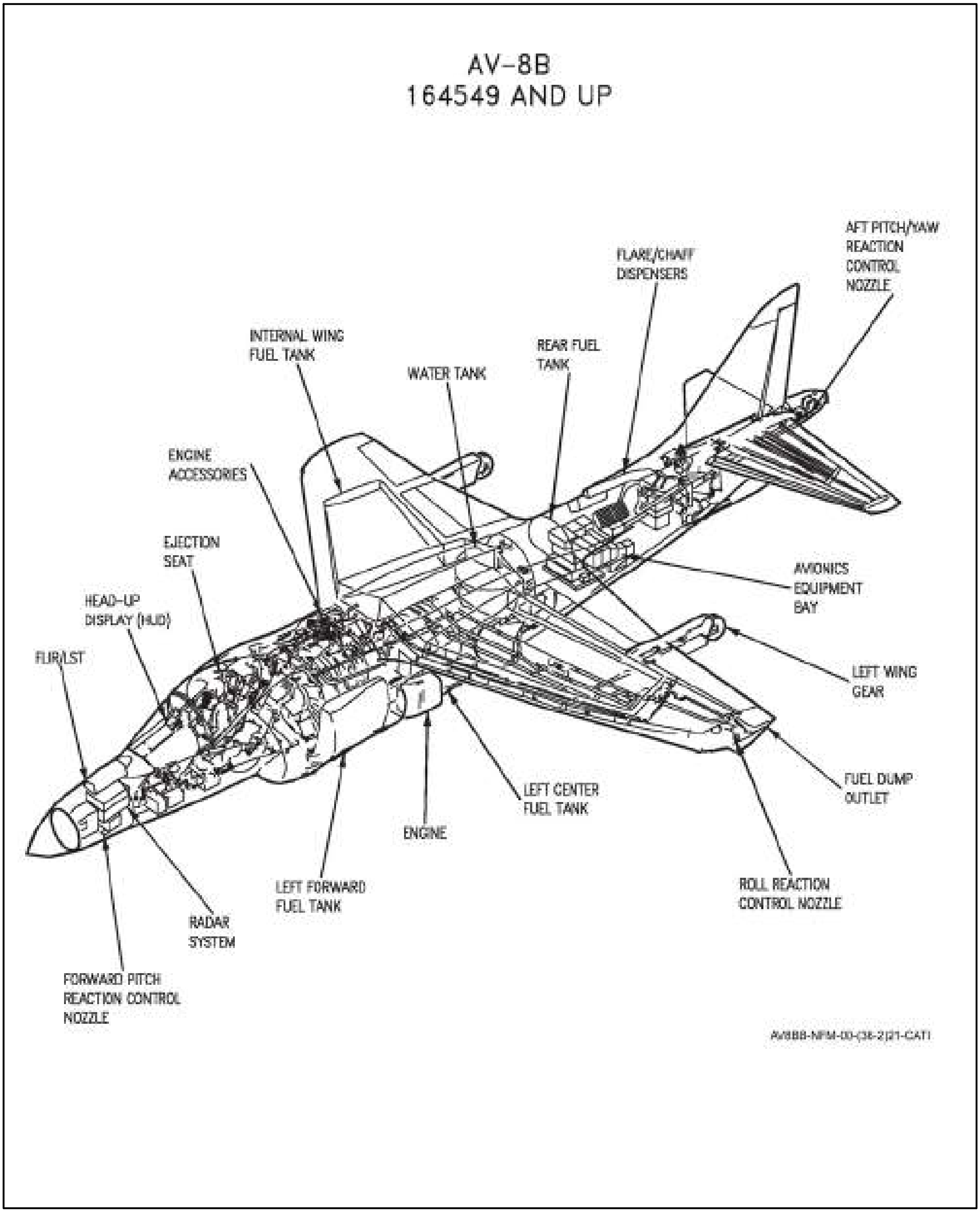


Figure 1-1. General Arrangement (Sheet 2)

TAV-8B

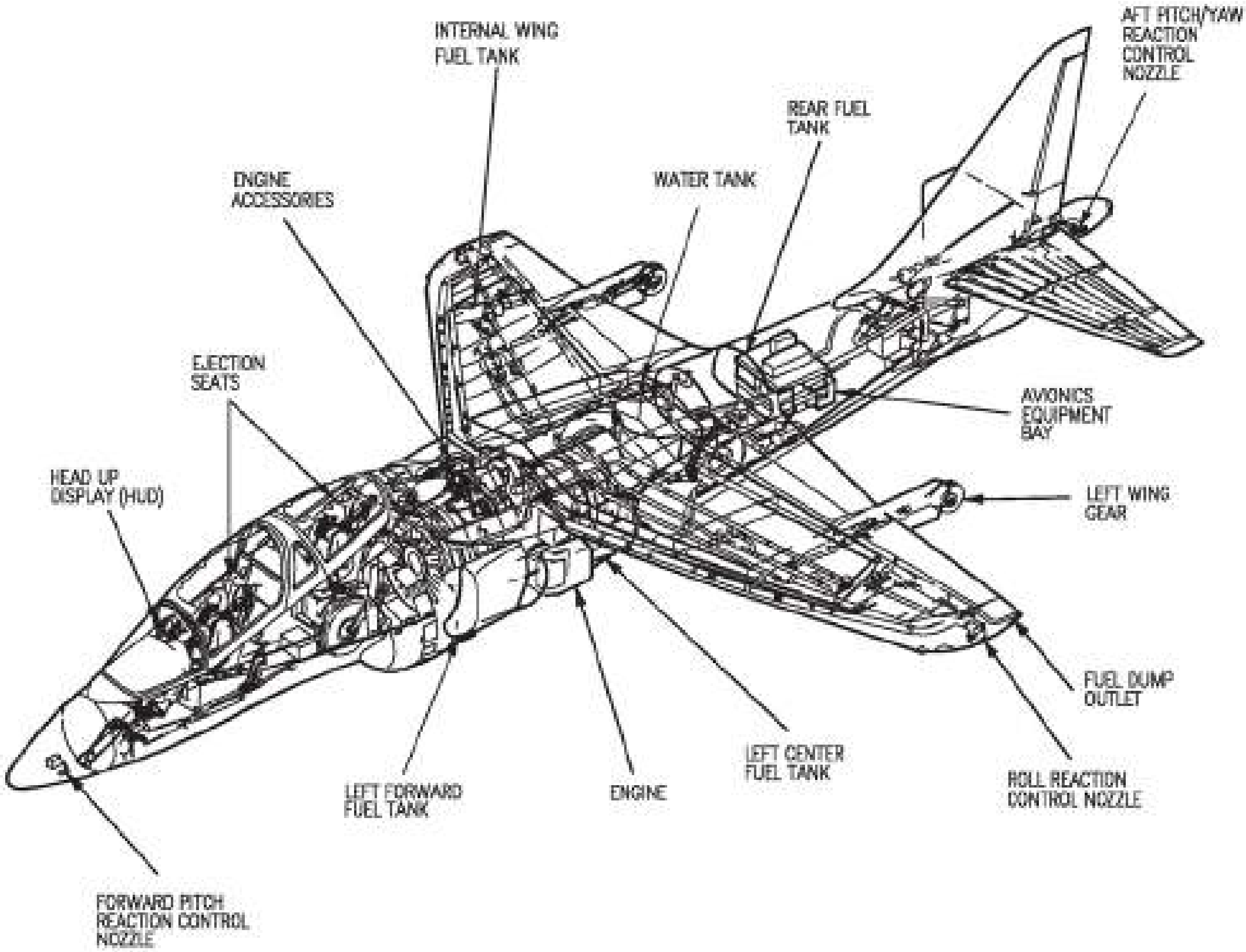
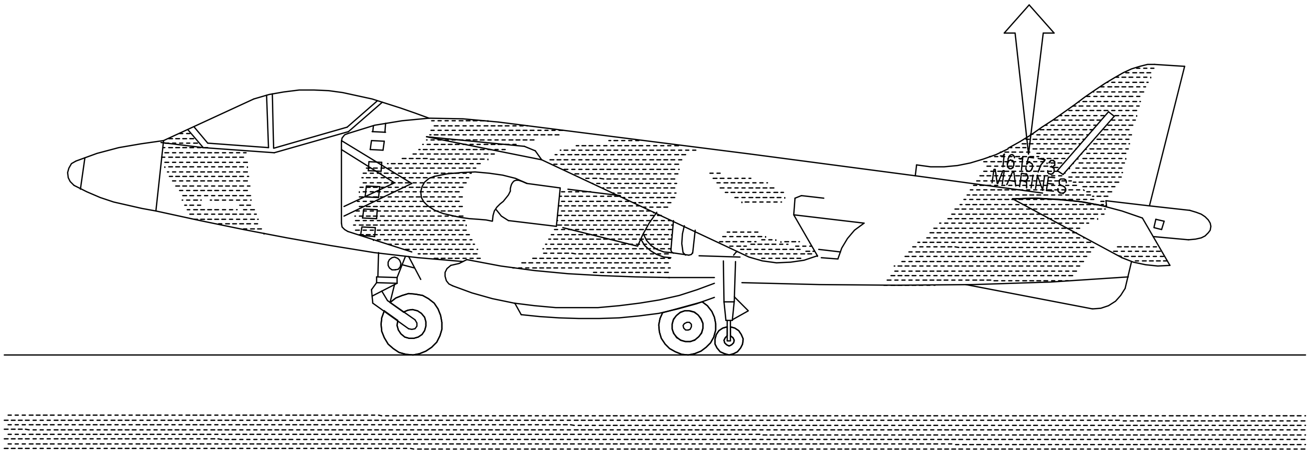


Figure 1-1. General Arrangement (Sheet 3)

AV-8B



BLOCK 2(6)
161573 THRU 161578

BLOCK 3(6)
161579 THRU 161584

BLOCK 4(9)
162068 THRU 162076

BLOCK 5(12)
162077 THRU 162088

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)
163197 THRU 163519

BLOCK 12(15)
163569 THRU 163673

BLOCK 13(33)
163674 THRU 163855

BLOCK 14(11)
163862 THRU 163872

BLOCK 15(13)
163873 THRU 164116

BLOCK 16(5)
164117 THRU 164121

BLOCK 17(13)
164123 THRU 164135

BLOCK 18(24)
164139 THRU 164547

BLOCK 19(24)
164549 THRU 164571

BLOCK 20(0)
NONE

BLOCK 21(6)
165001 THRU 165006

REMAN (77)
165305 THRU 166413

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

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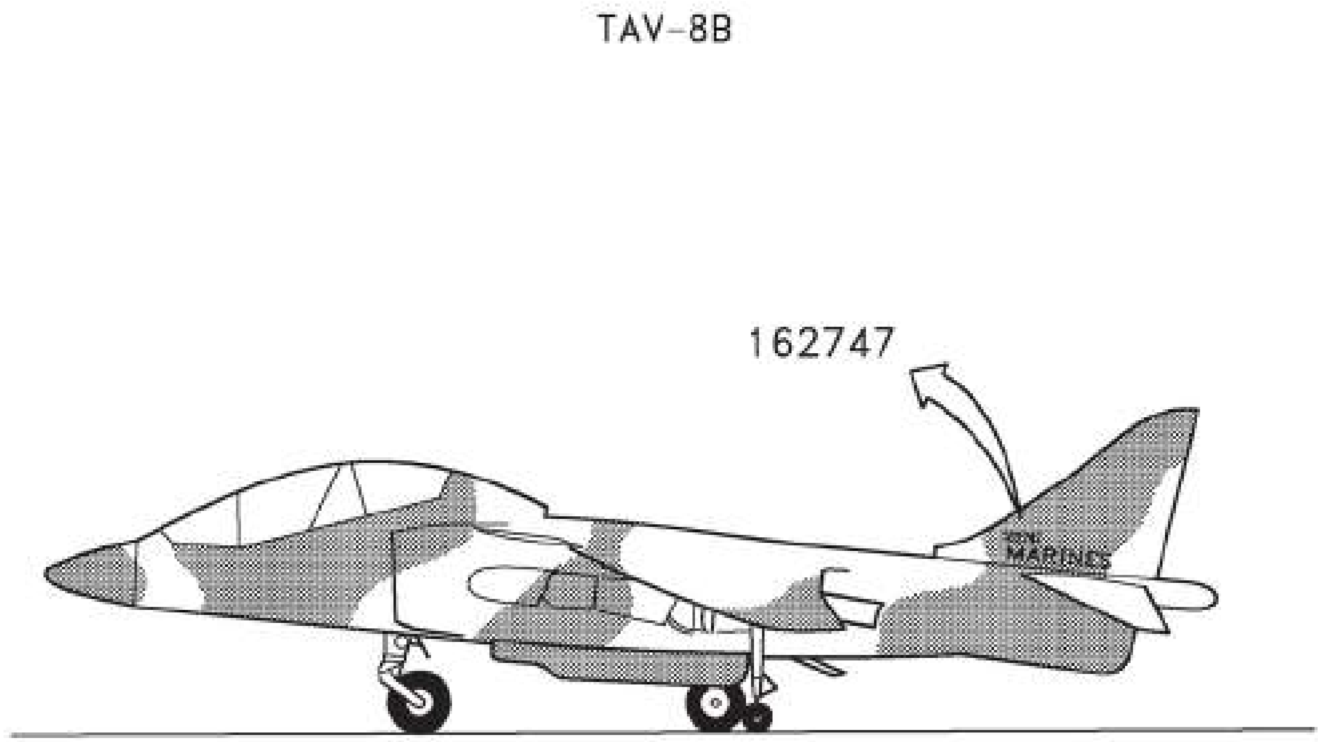


BLOCK 7 (1)
162747

BLOCK 9 (2)
162963 AND 162971

BLOCK 10 (3)
163180 THRU 163191

BLOCK 11 (3)
163196 THRU 163207

BLOCK 12 (3)
163856 THRU 163858

BLOCK 13 (3)
163859 THRU 163861

BLOCK 16 (3)
164113 THRU 164122

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.

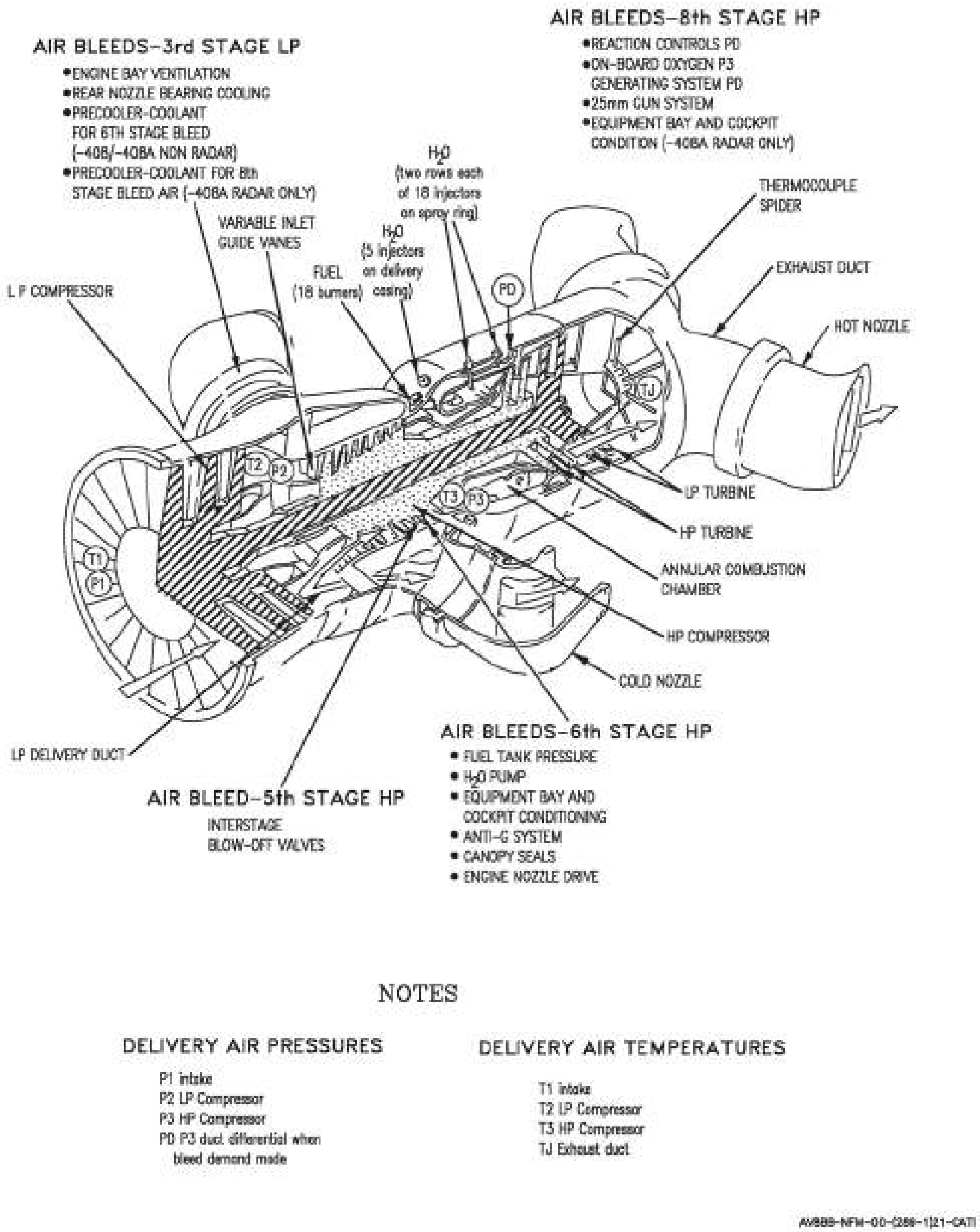


Figure 2-1. Engine

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.

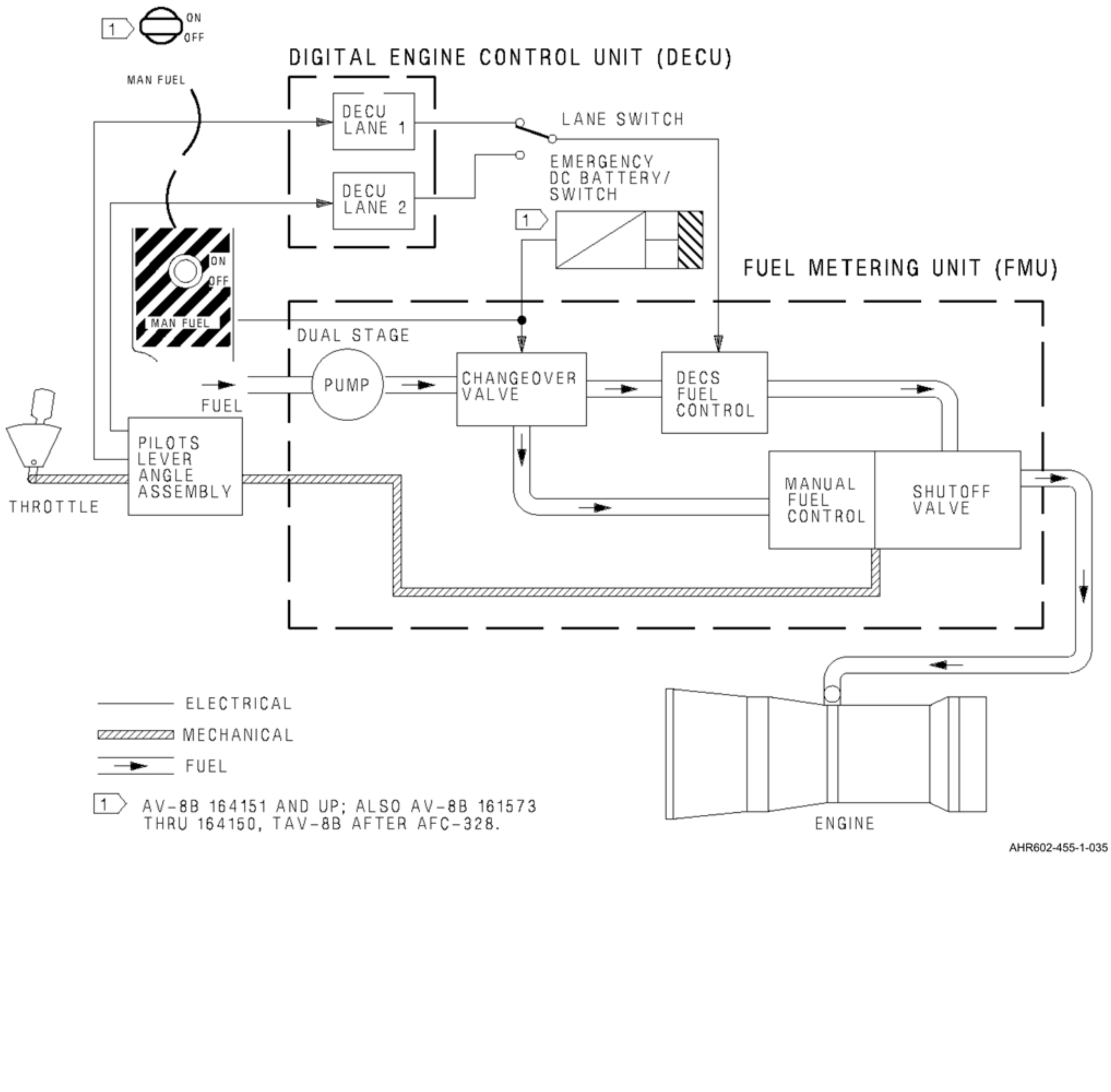


Figure 2-2. Digital Engine Control System

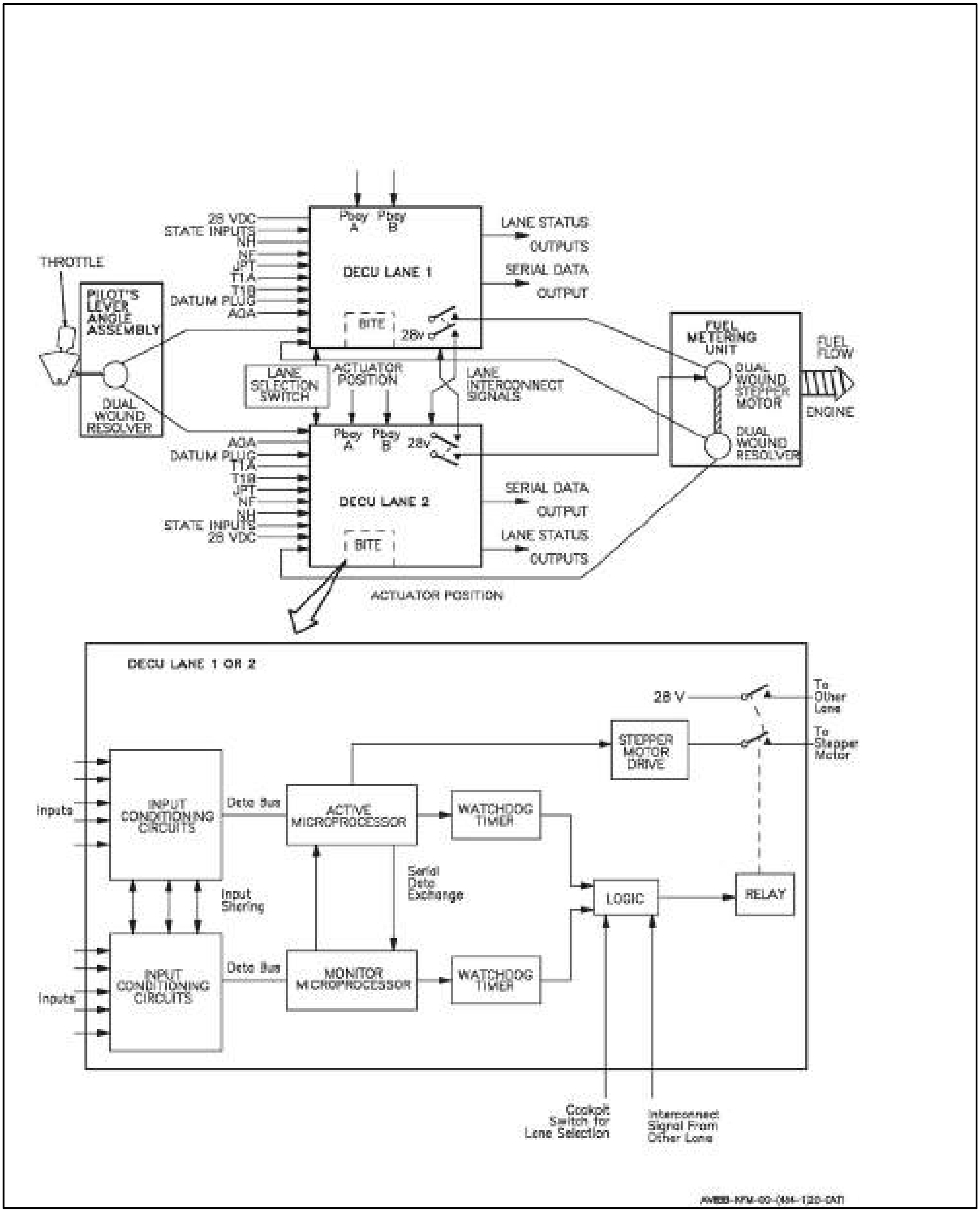


Figure 2-3. Digital Engine Control Unit

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.

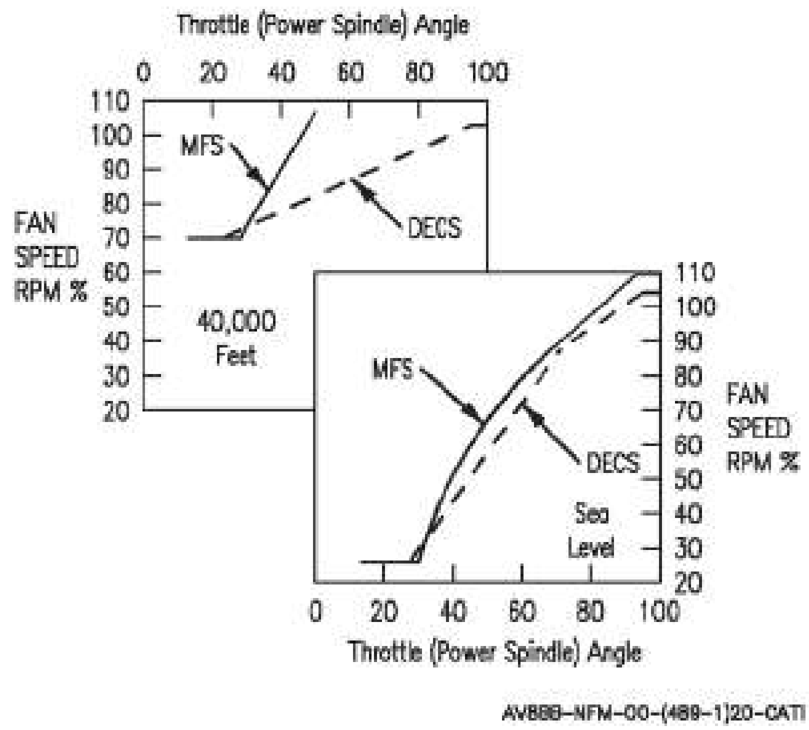


Figure 2-4. DECS/MFS Comparison

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.

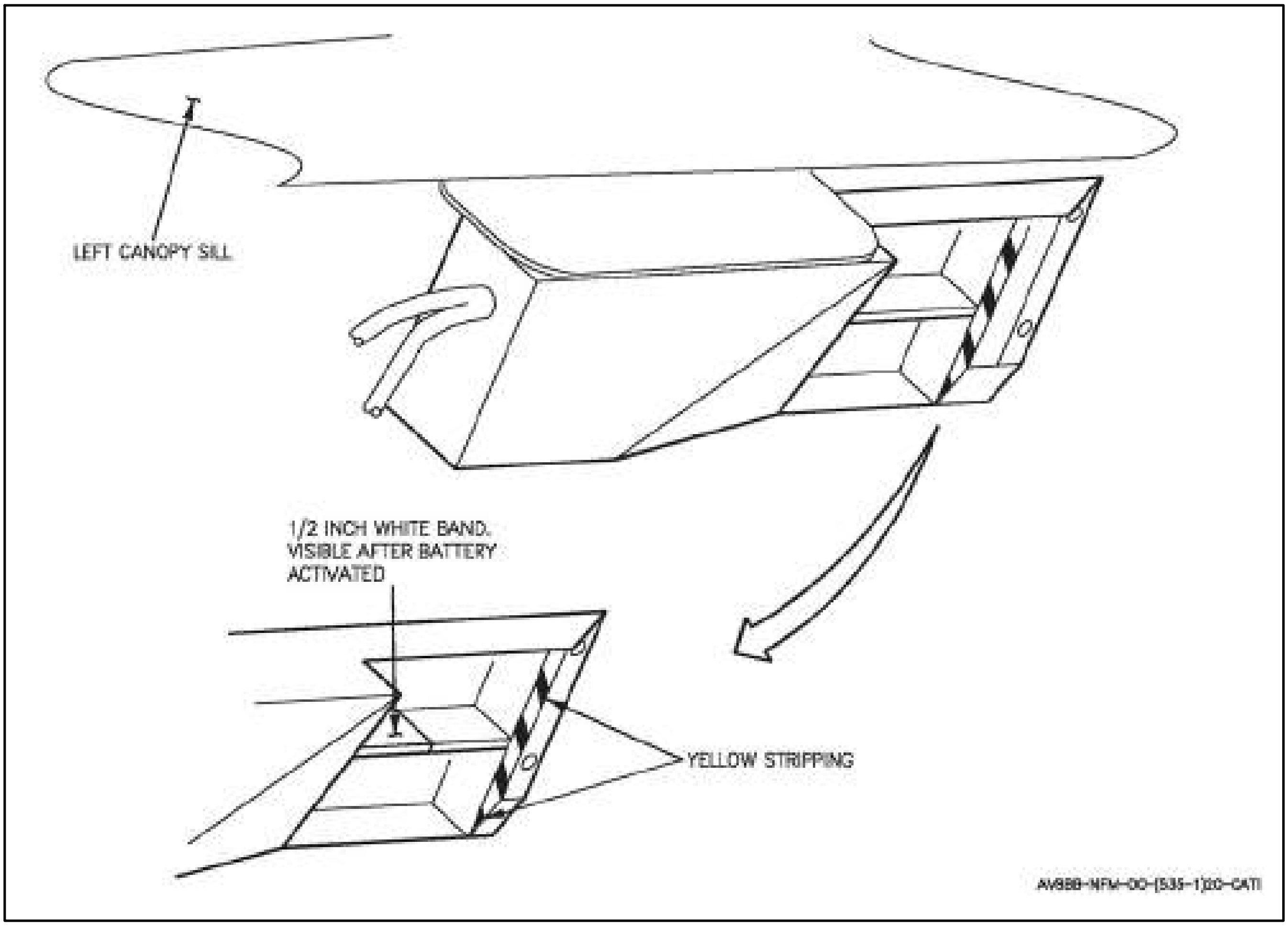


Figure 2-5. MFS Emergency Battery

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.

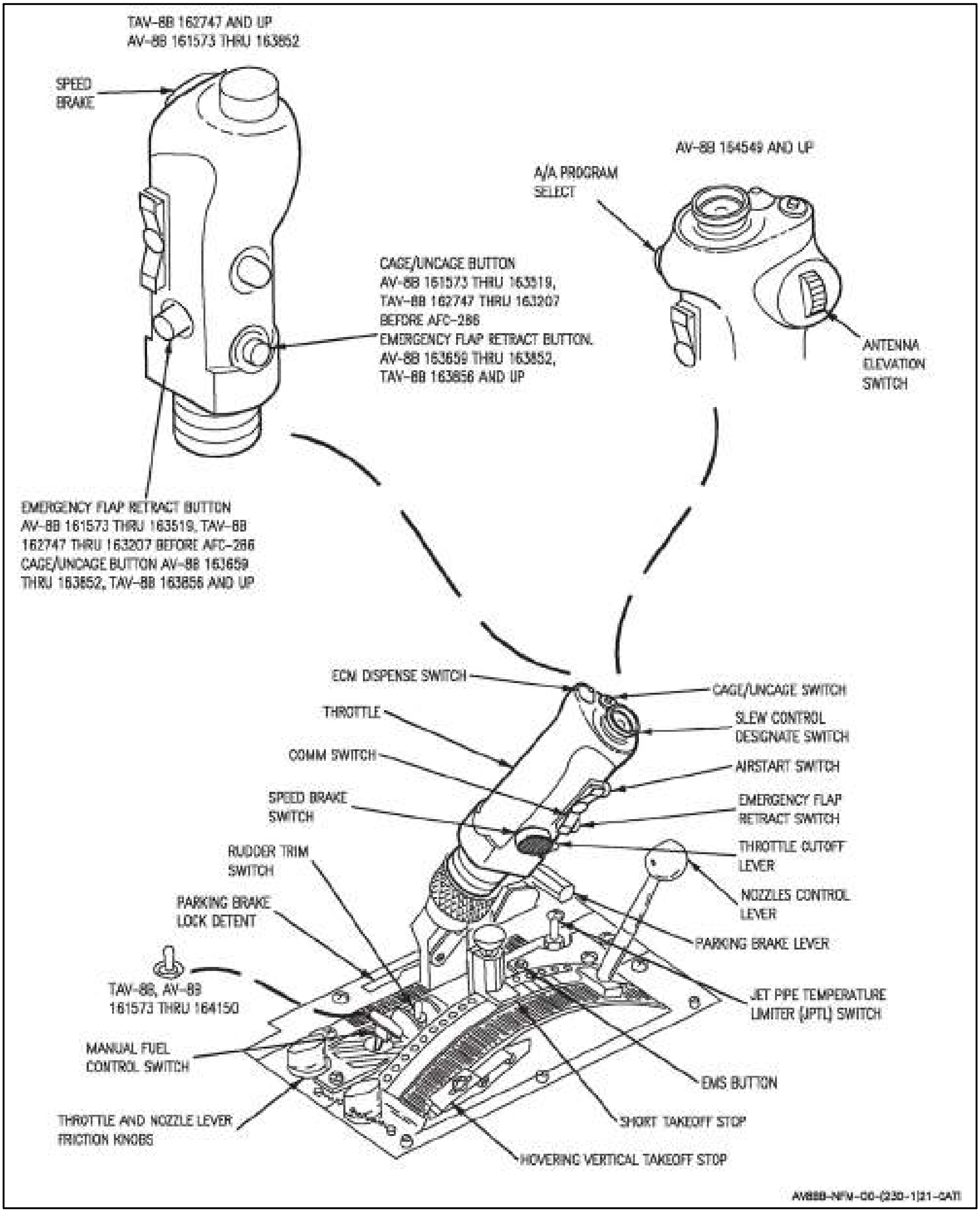


Figure 2-6. Throttle Nozzle Quadrant

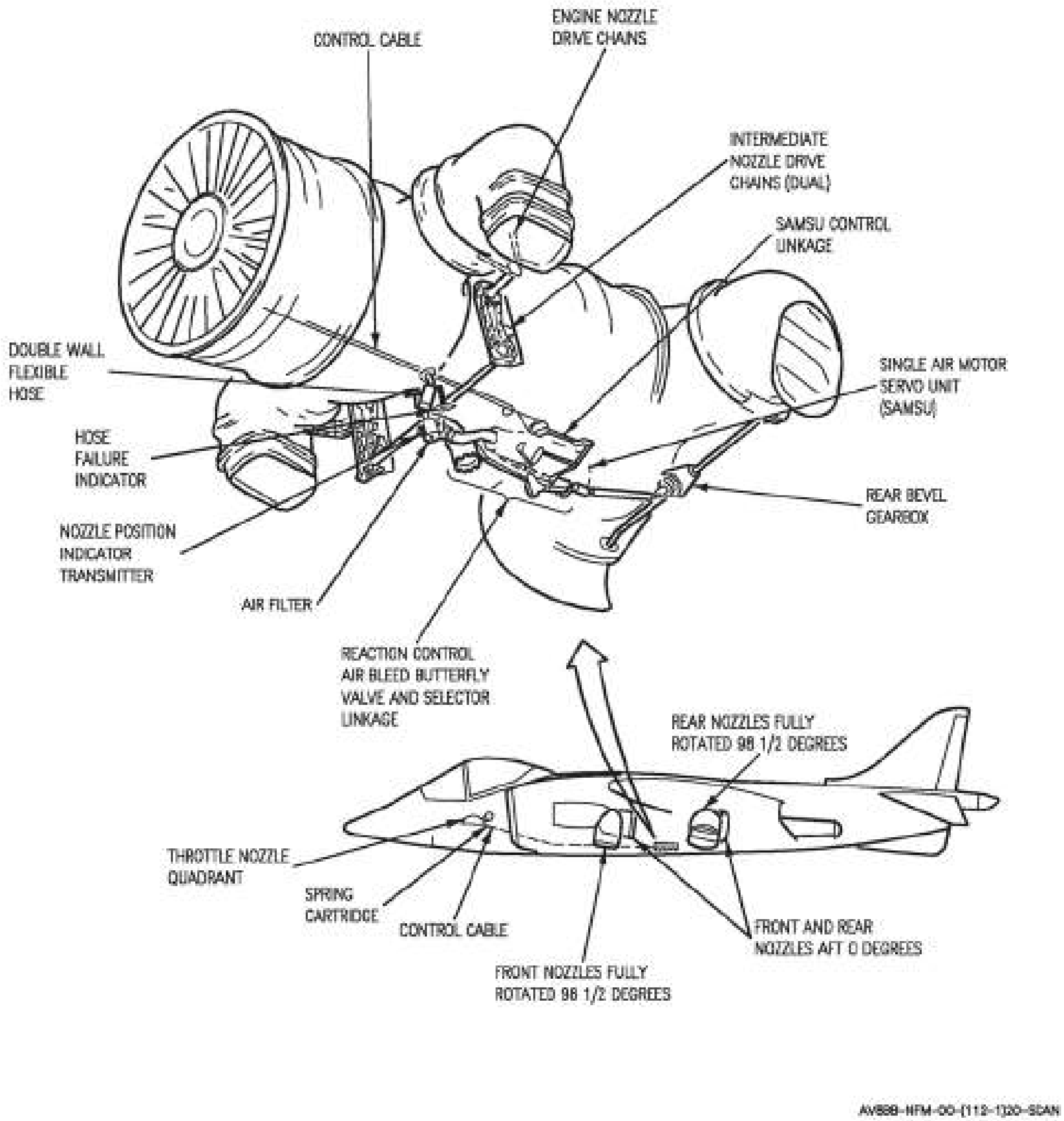


Figure 2-7. Nozzles Control Mechanism

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.

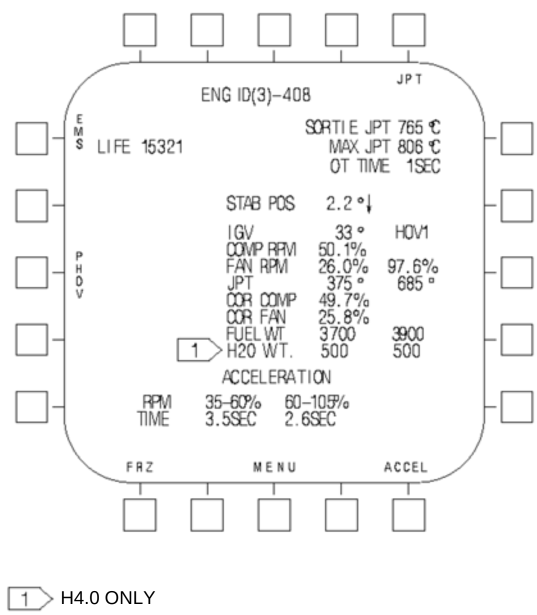


Figure 2-8. Engine DDI Display

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

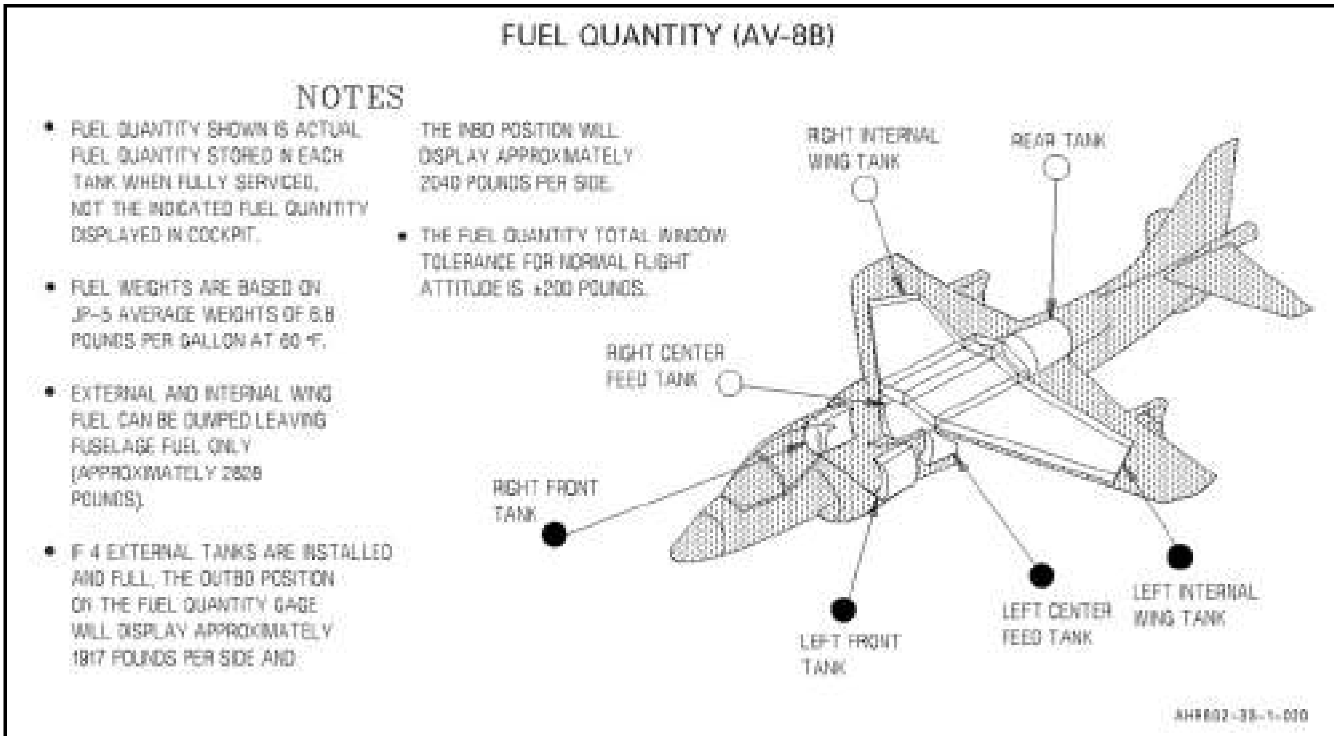
A BINGO caution light, on the left main instrument panel, comes on within ±200 pounds of a preset value controlled by the pilot. An adjustable fuel quantity display on the fuel quantity indicator may be set to any level up to 9,900 pounds. If BINGO is set above 2,800 and fuel dump is selected, fuel dumping 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.

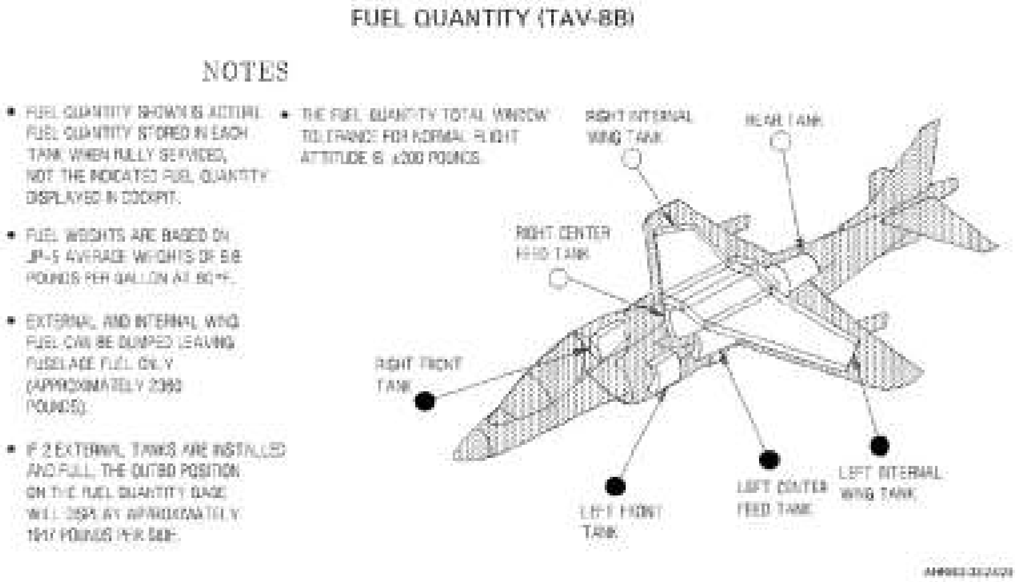
2.7.7.5 BIT Display

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.



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)



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.

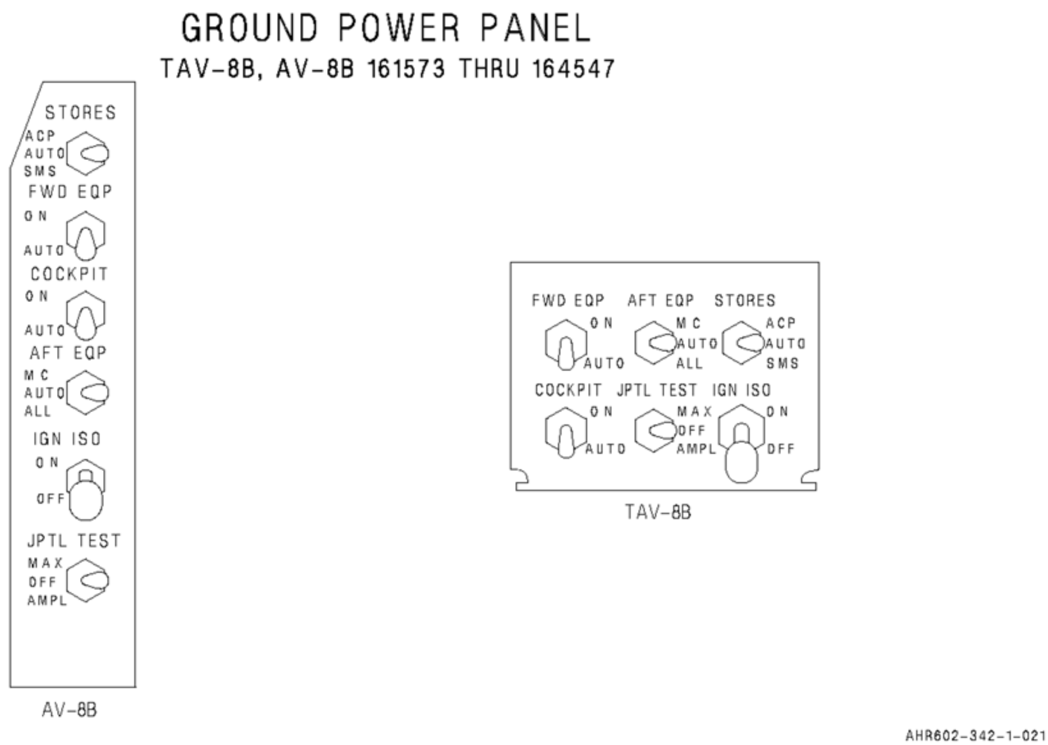
2.11.1.2 Position Lights

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

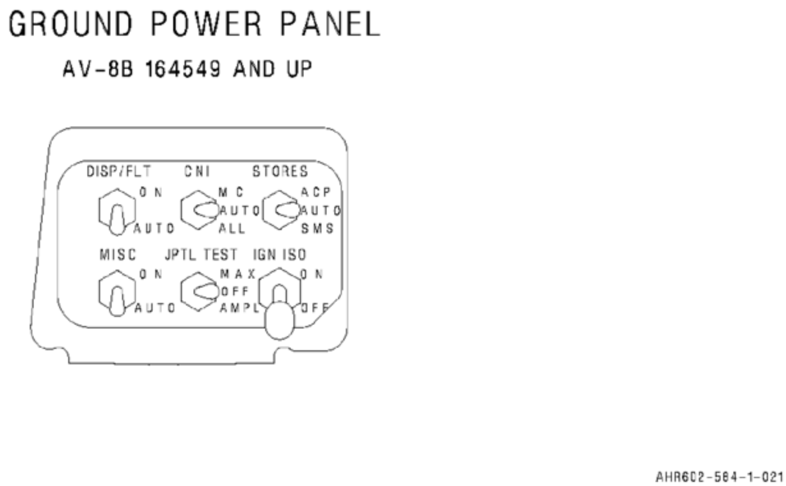


SWITCH	POSITION	EQUIPMENT
STORES	ACP	ARMAMENT CONTROL PANEL
	SMS	STORES MANAGEMENT COMPUTER ARMAMENT CONTROL PANEL
FWD EQP	ON	ARBS [2] FLIR INS
COCKPIT	ON	[1] DDI EDP HUD UHF [5] DISPLAY COMPUTER [2] L/R MPCD [2] VRS [2] DDS [1] HSI TURN AND SLIP INDICATOR STANDBY ATTITUDE INDICATOR STANDBY ALTIMETER [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 ARMAMENT CONTROL PANEL		TACTS DECM/ASPJ
MISC	ON	TACAN EXT LTS	RWR	
DISP/FLT	ON	HUD EDP FLIR INVERTER UFC VRS	L/R MPCD VRS DSS DVMS ADC SAAHS	TURN AND SLIP INDICATOR STANDBY ATTITUDE INDICATOR STANDBY ALTIMETER STANDBY REFERENCE ALTIMETER VIBRATOR DISPLAY PROCESSOR-GENERATOR
CNI	MC	MISSION COMPUTER		
	ALL	MISSION COMPUTER CNI DATA COMPUTER RADAR ALTIMETER RADAR BEACON KY-58	UHF/VHF NO.1 UHF/VHF NO.2 ECM RWR IFF	INS DVMS RADAR DECM/ASPJ
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.

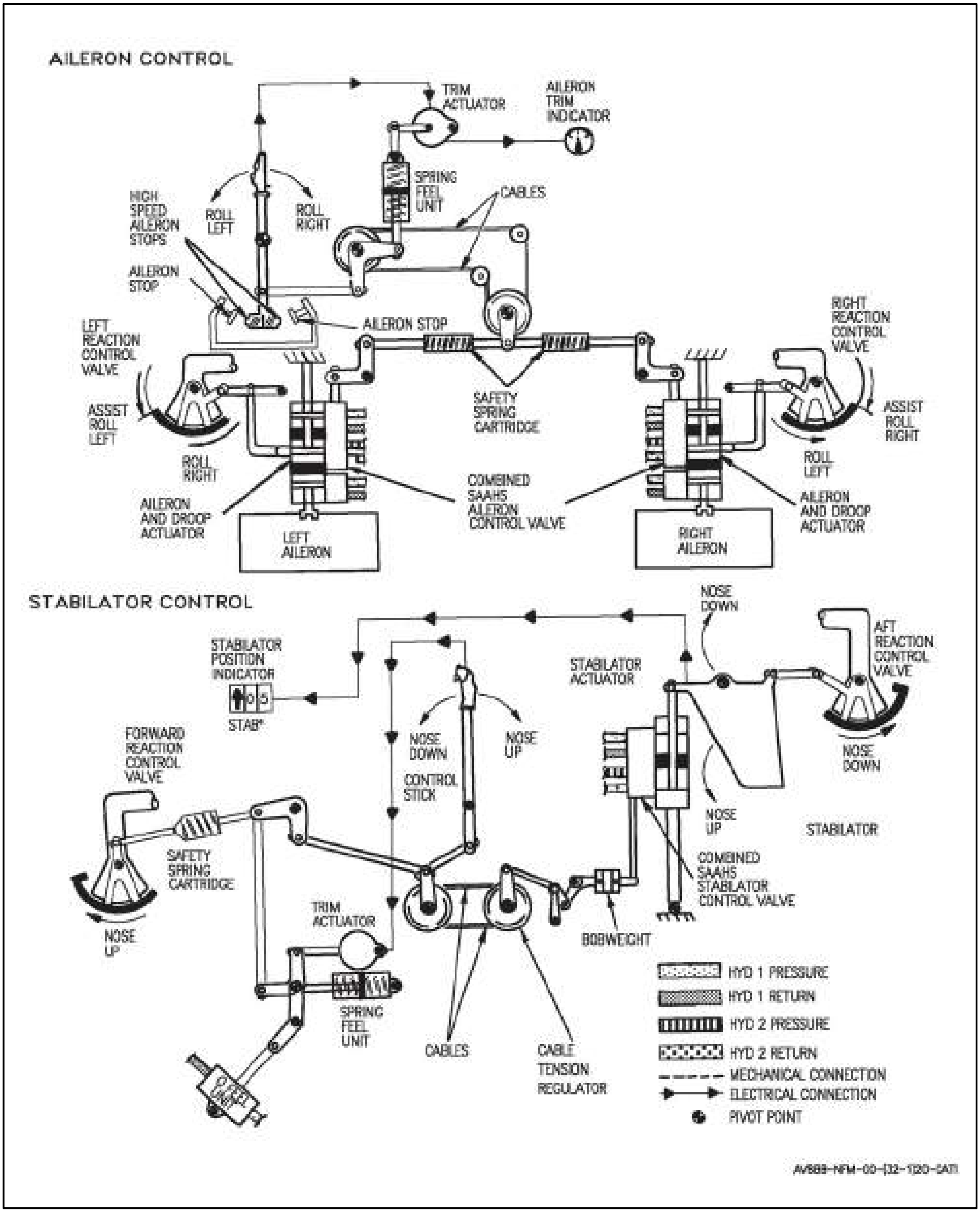


Figure 2-12. Flight Controls (Sheet 1 of 2)

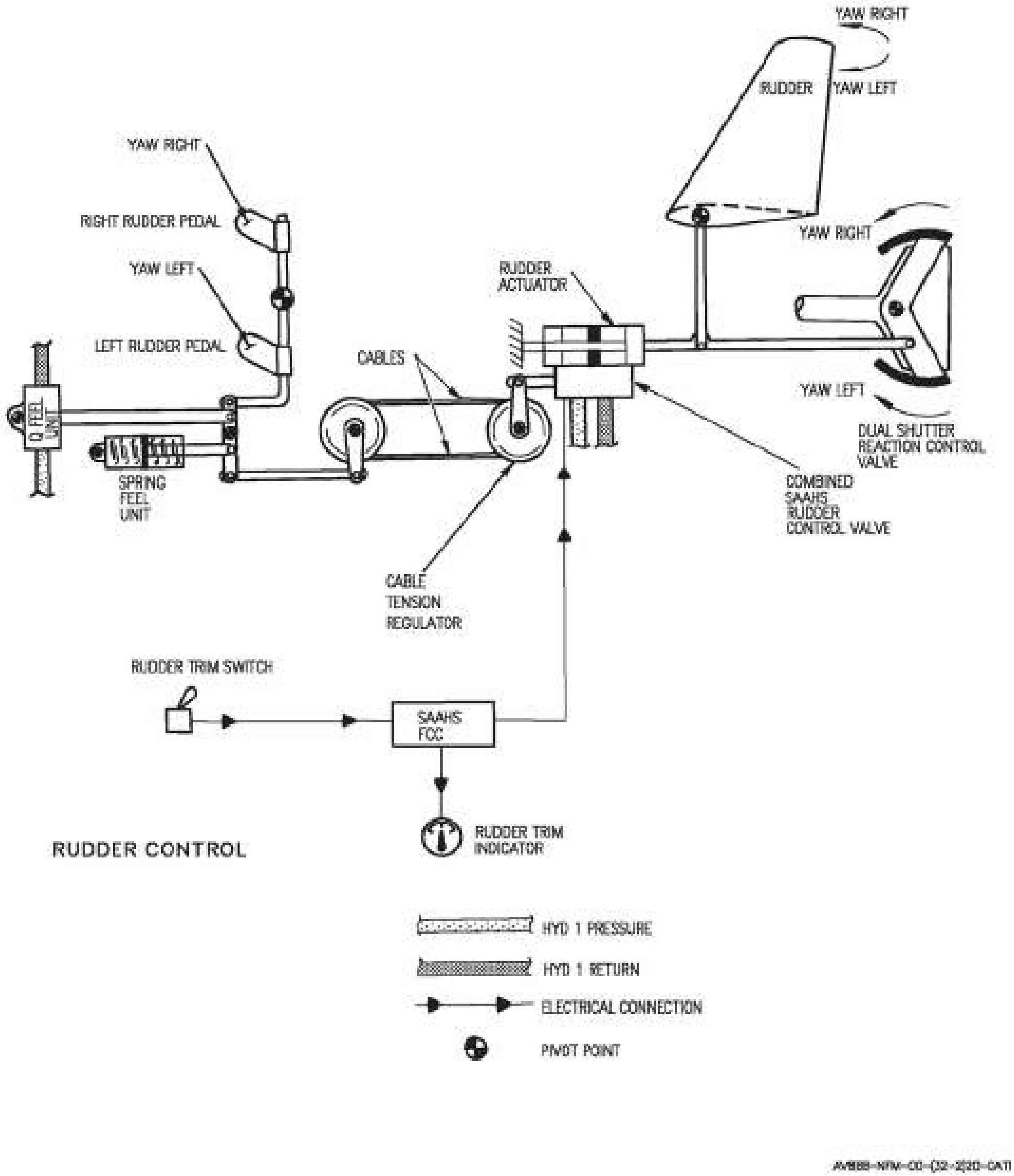


Figure 2-12. Flight Controls (Sheet 2)

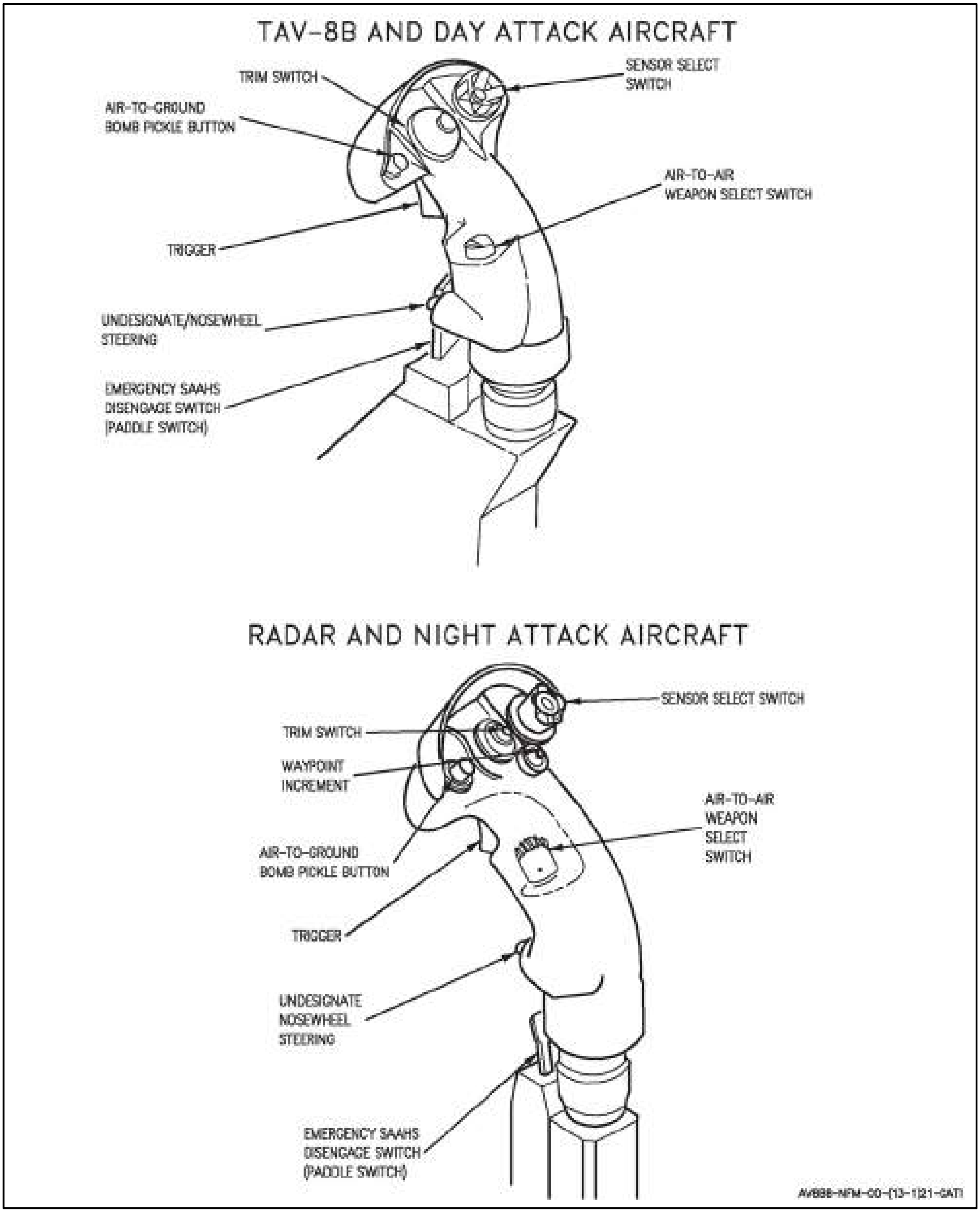


Figure 2-13. Control Stick Grip

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.

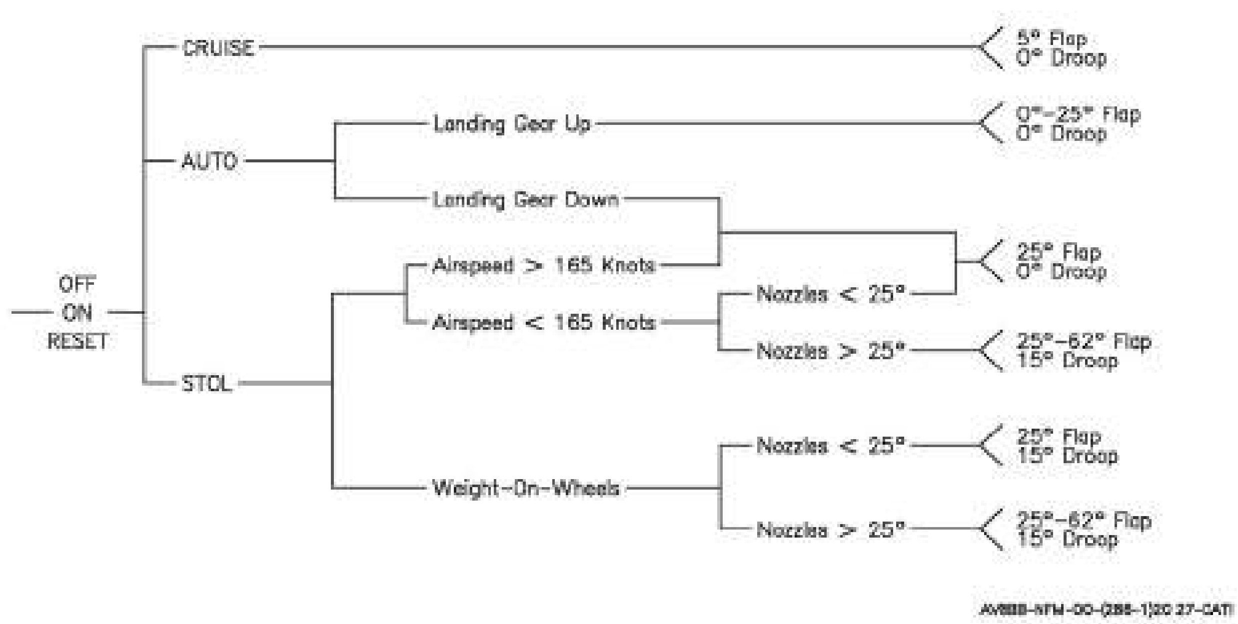


Figure 2-14. Flap and Aileron Droop Logic

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.

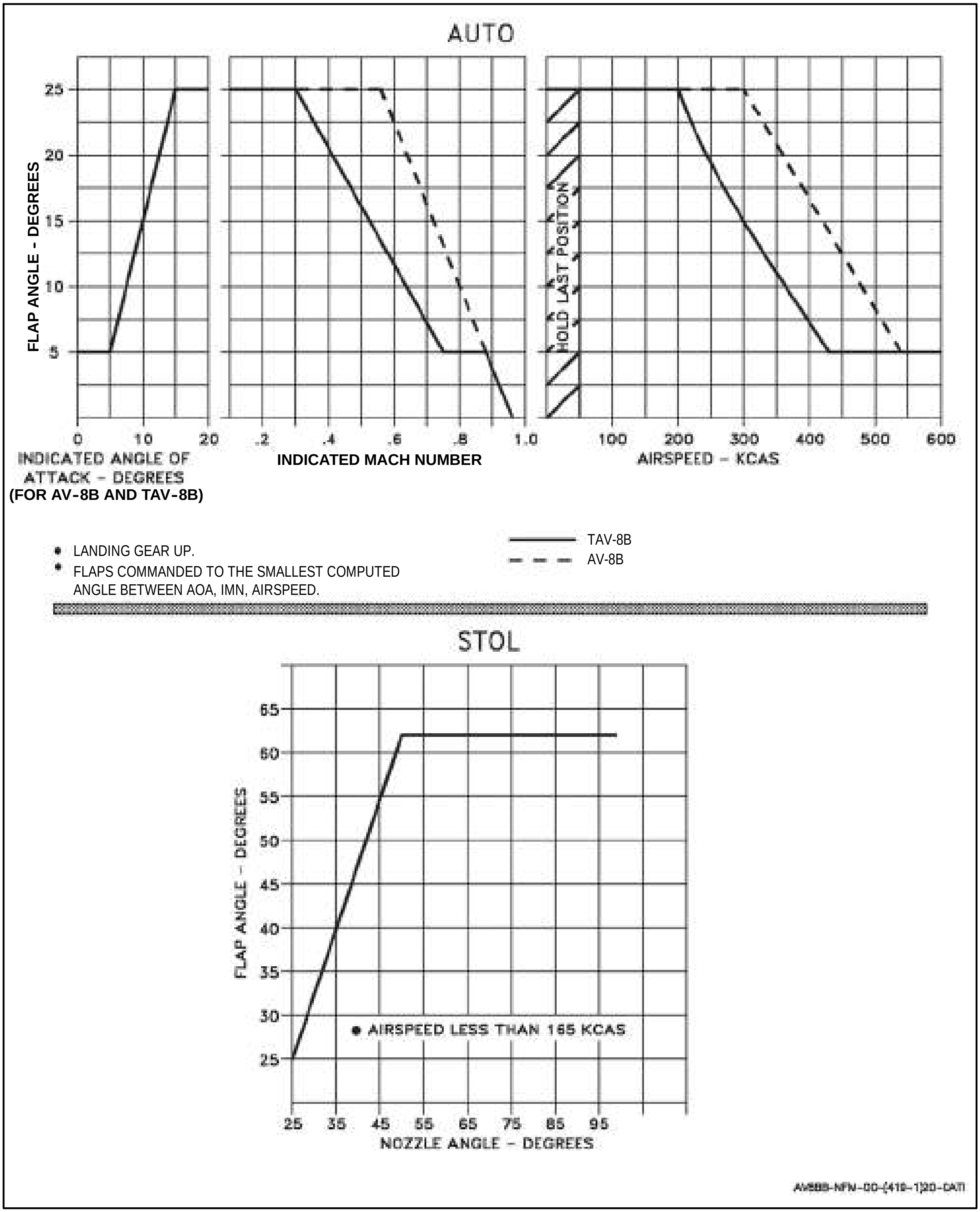


Figure 2-15. Flap Schedules

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.

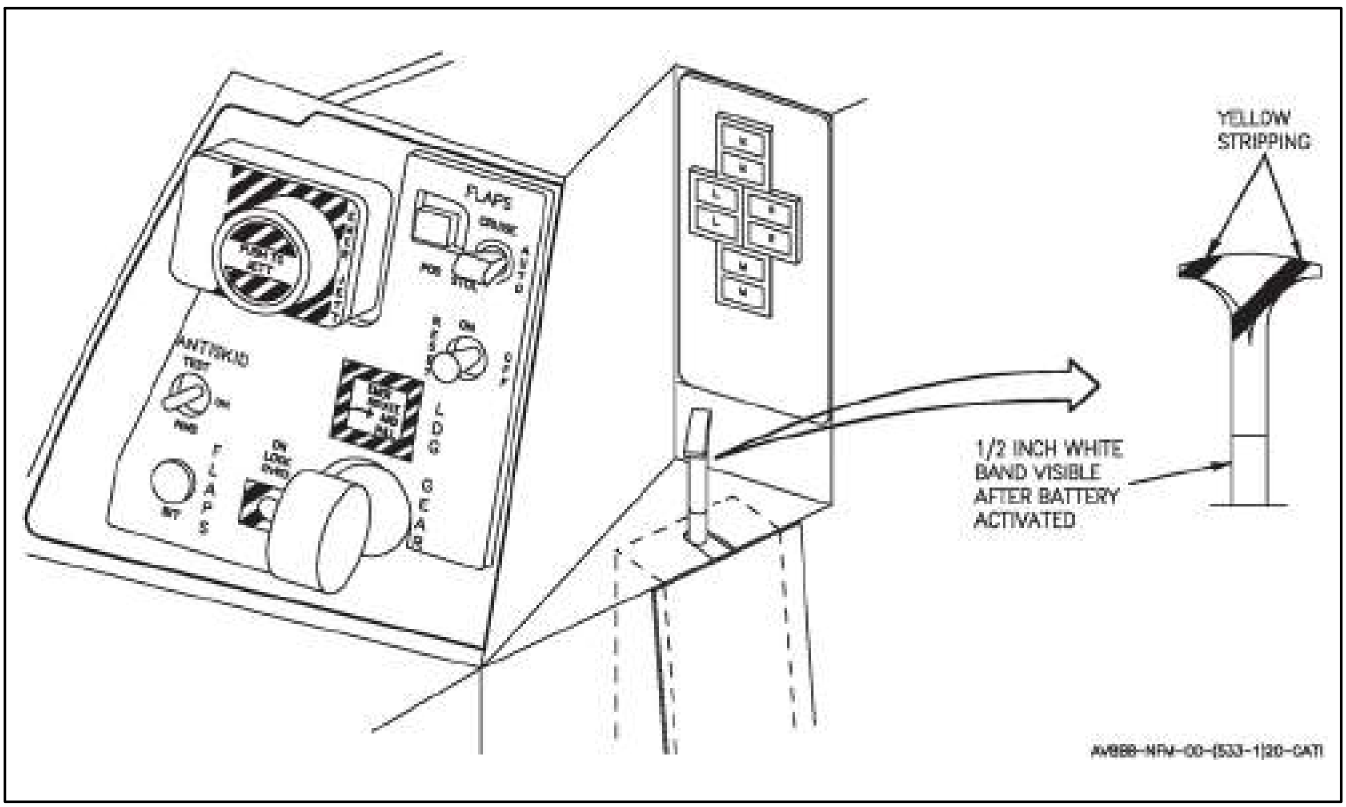


Figure 2-16. Landing Gear Emergency Battery

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.

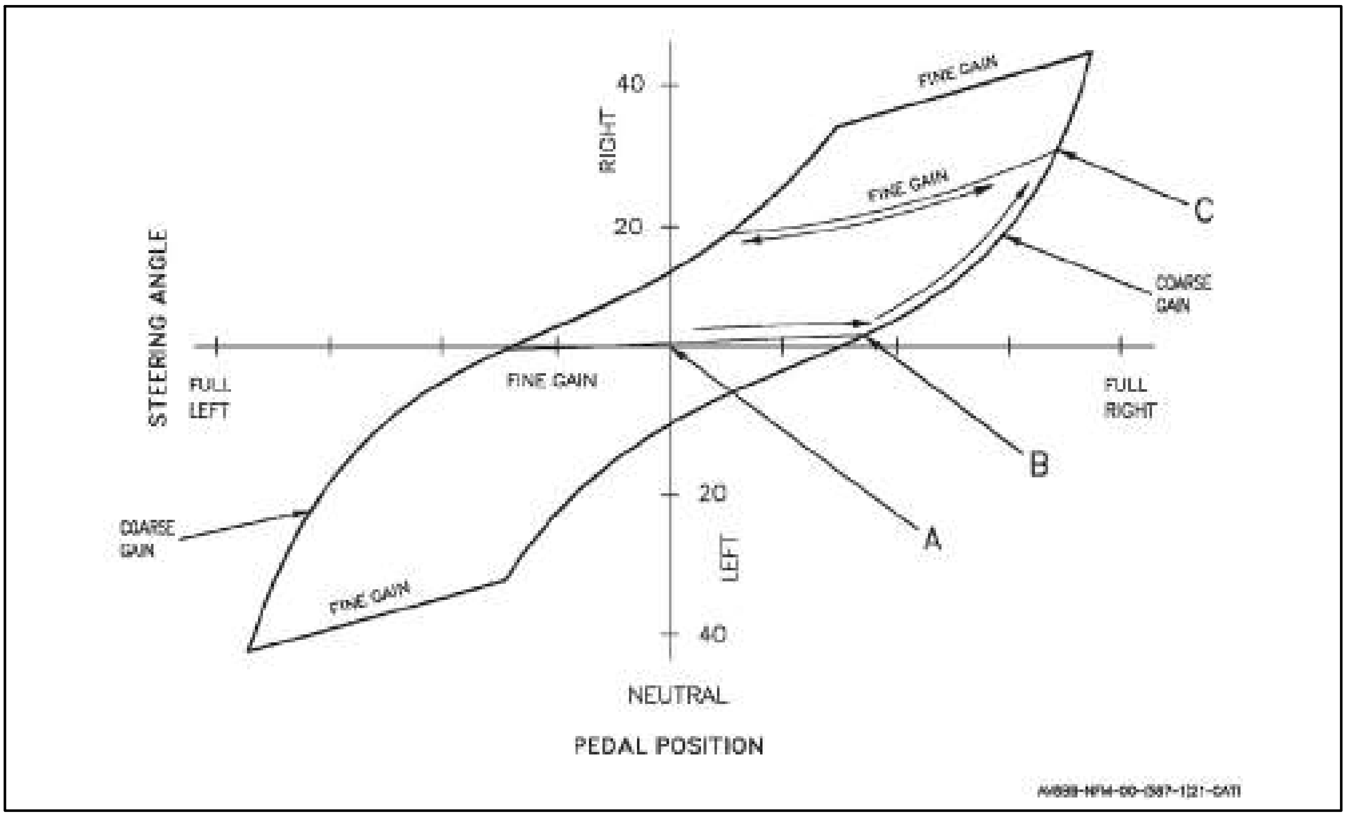


Figure 2-17. Steering Gain (Before AFC-391)

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.

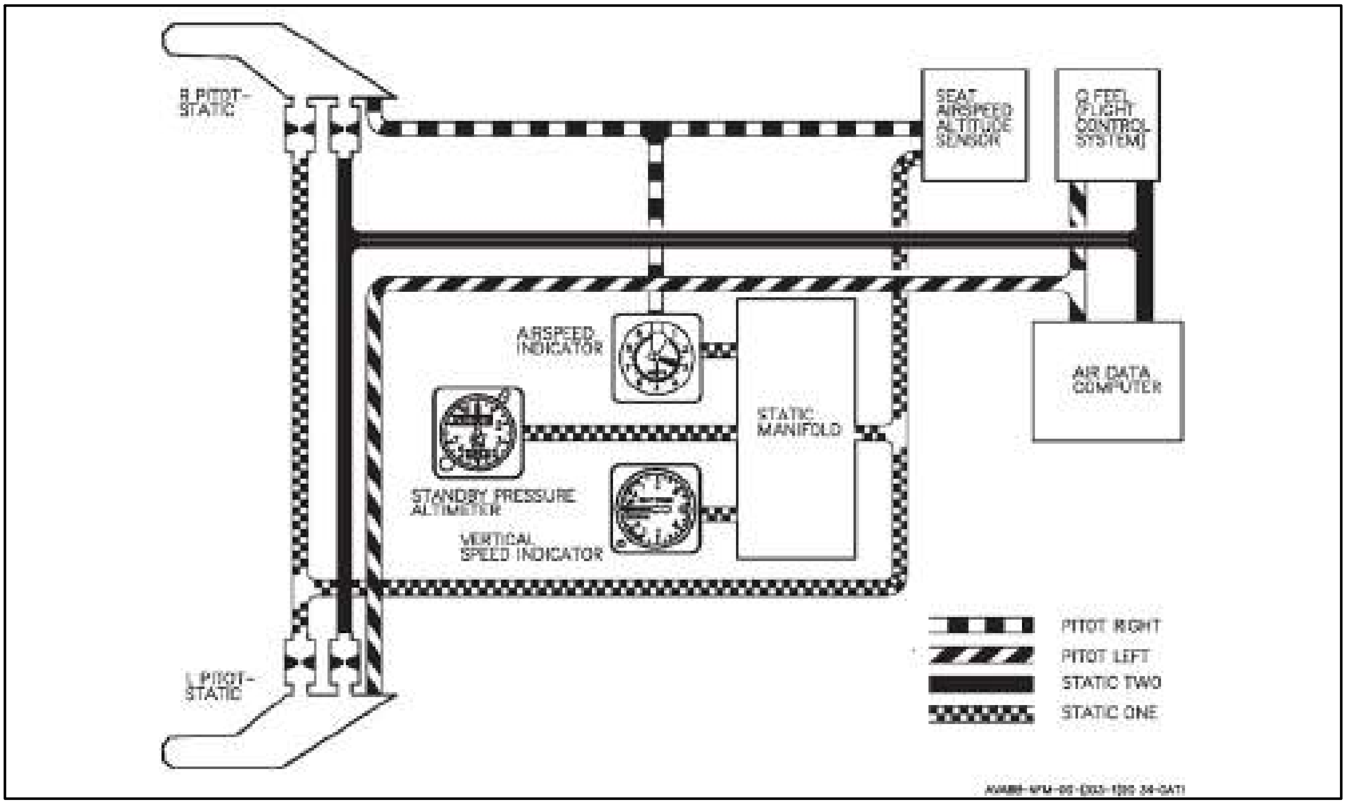


Figure 2-18. Pitot–Static System

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.

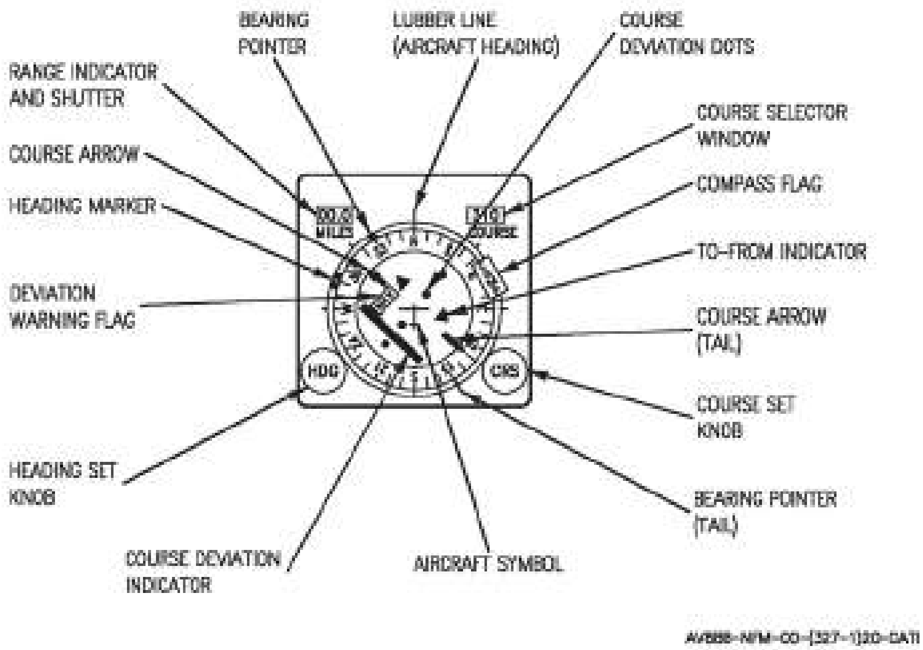


Figure 2-19. Horizontal Situation Indicator

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.

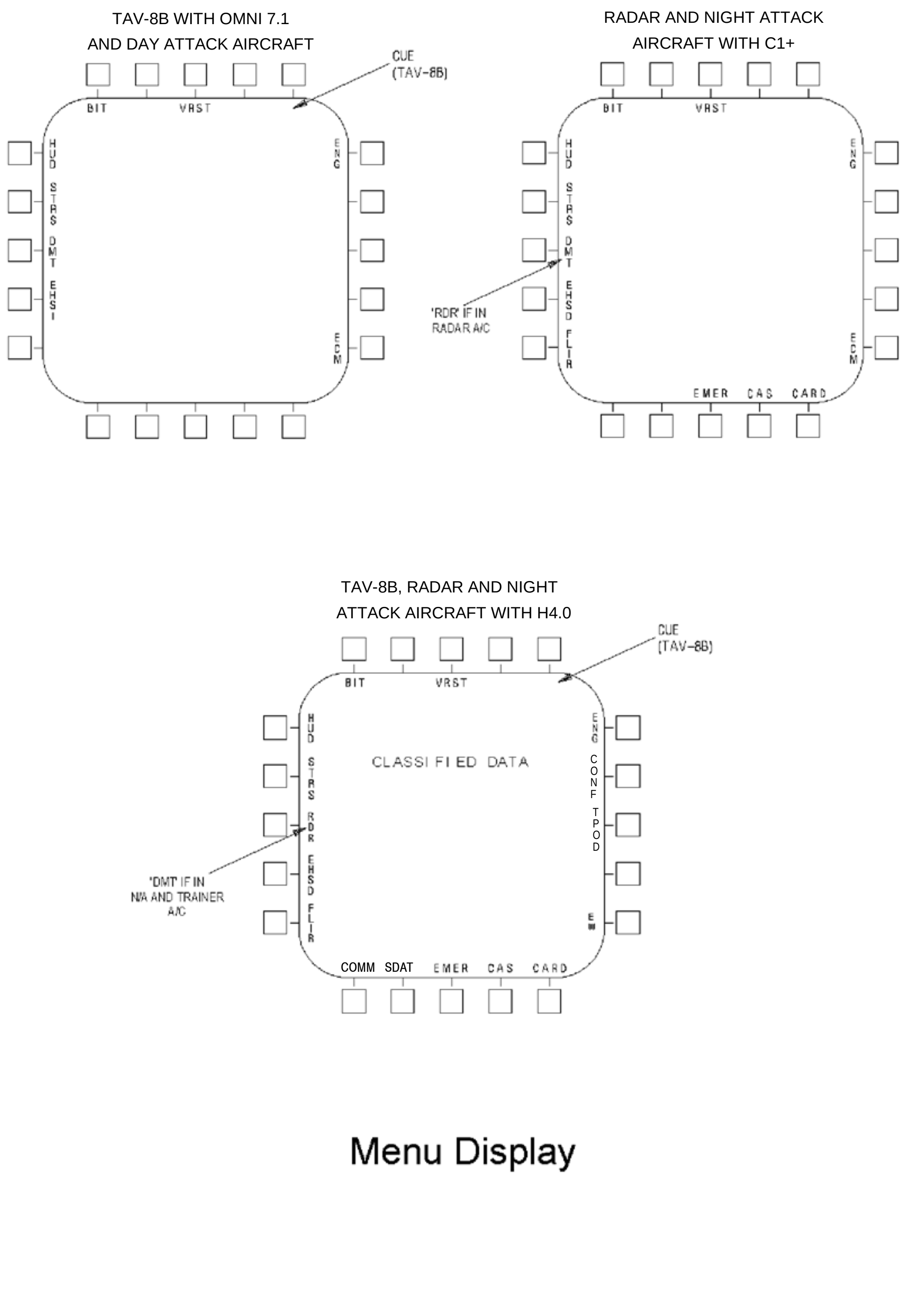


Figure 2-20. Menu Display

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.

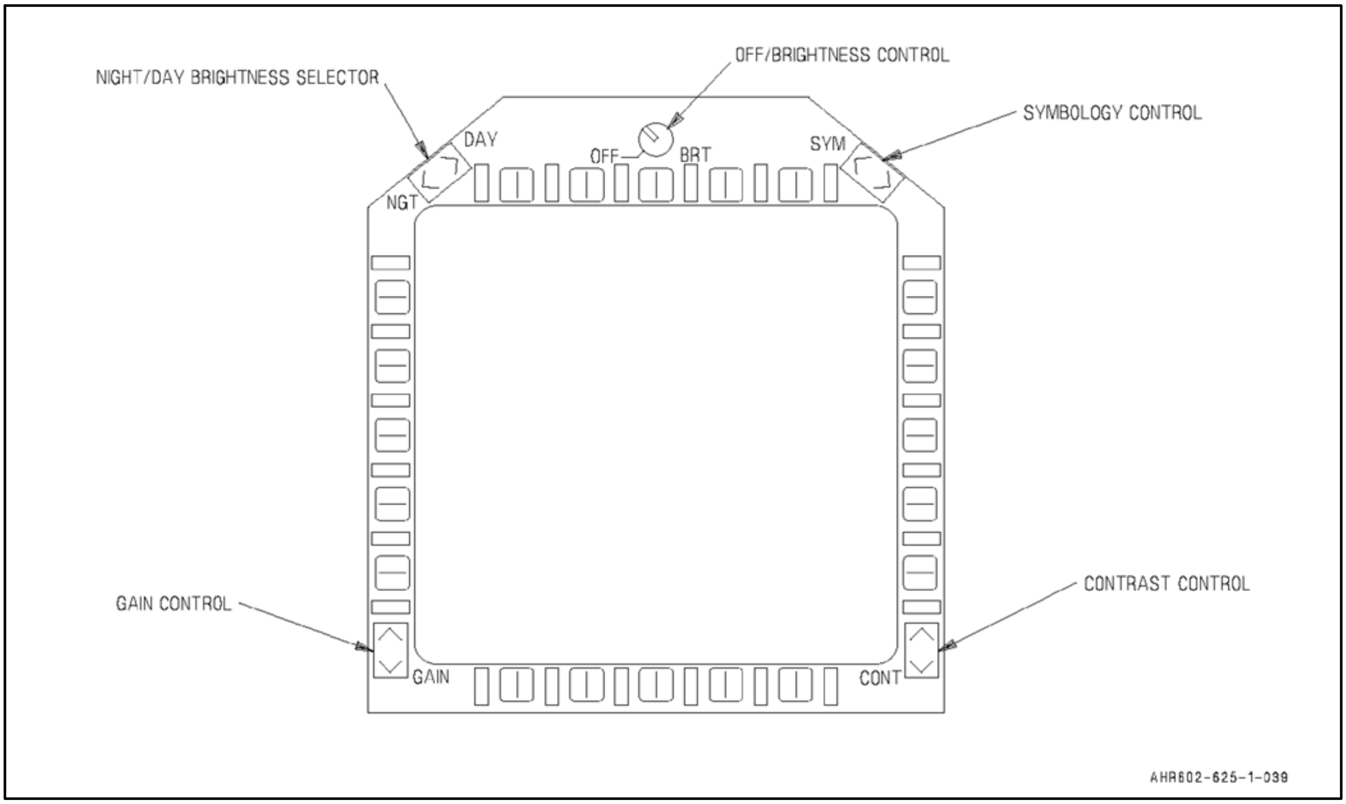


Figure 2-21. Multipurpose Color Display (After ECP 306)

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.

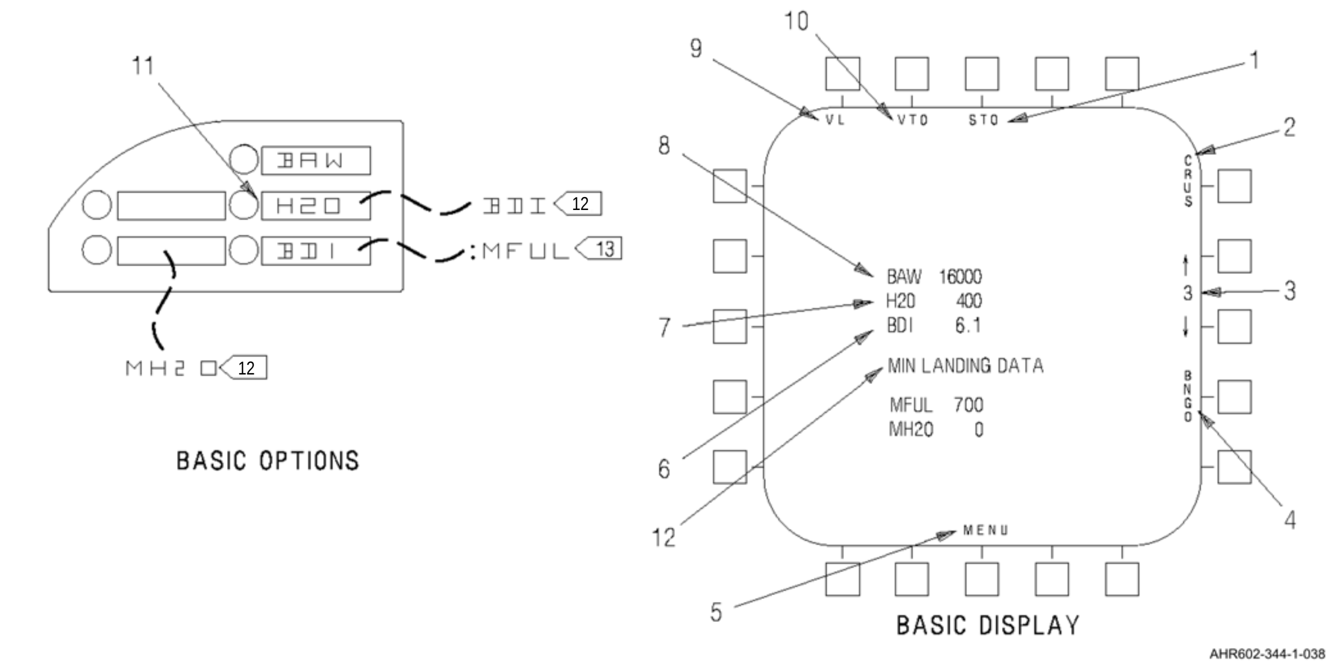
Optimum altitude computations are done next. The fuel required to climb from sea level to the existing altitude is computed. The optimum altitude is computed based on total fuel. If the optimum altitude is greater than the existing altitude, the amount of fuel and distance to climb to the optimum altitude 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

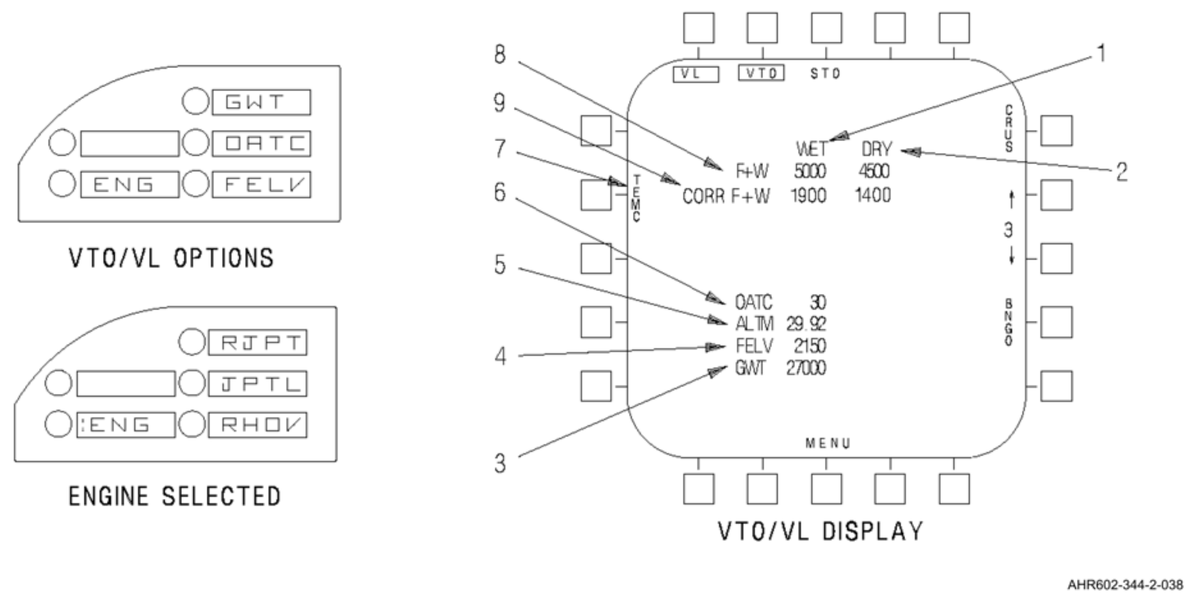
To receive the proper ODU displays for entering engine data, press the VRST pushbutton on the DDI basic menu display. The DDI shows the basic V/STOL-REST display (Figure 2-22). The ODU displays BAW, H2O (OMNI 7.1 and C1+ only), and BDI. Pressing the VL, VTO, or STO pushbutton on the DDI display causes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



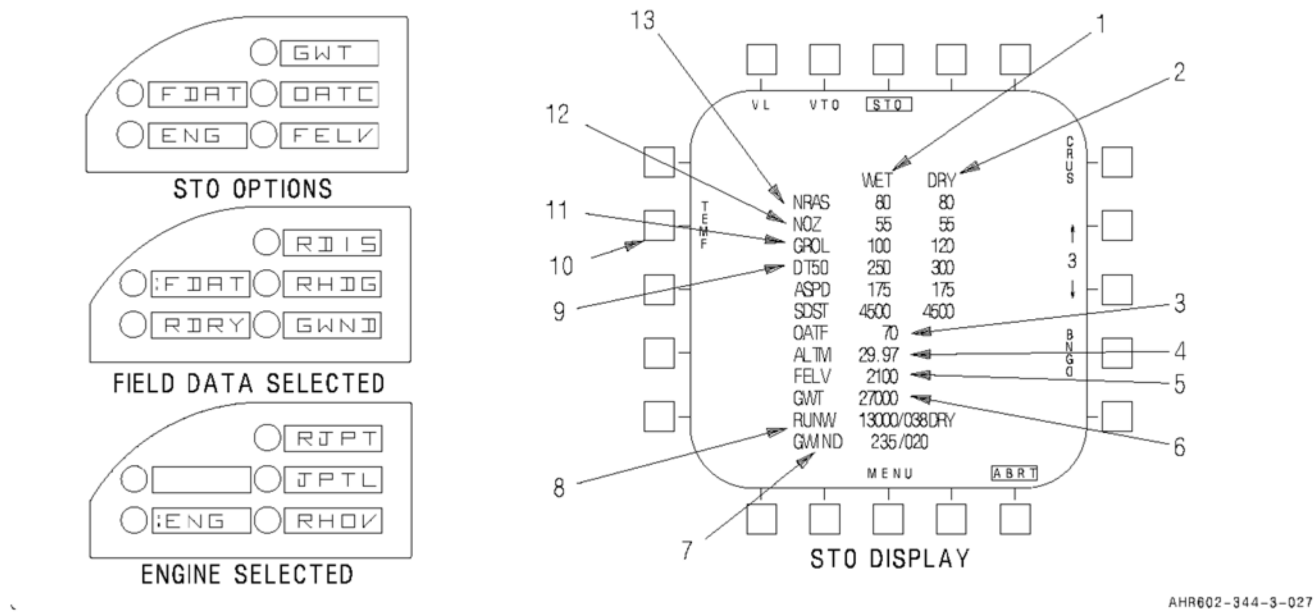
1. Pressing this pushbutton selects short takeoff display and causes STO to be boxed, indicating selection.
2. Pressing this pushbutton selects cruise display and causes CRUS to be boxed, indicating selection.
3. Number (3) indicates selected waypoint. Waypoint can be changed by pressing the increment (↑) 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)



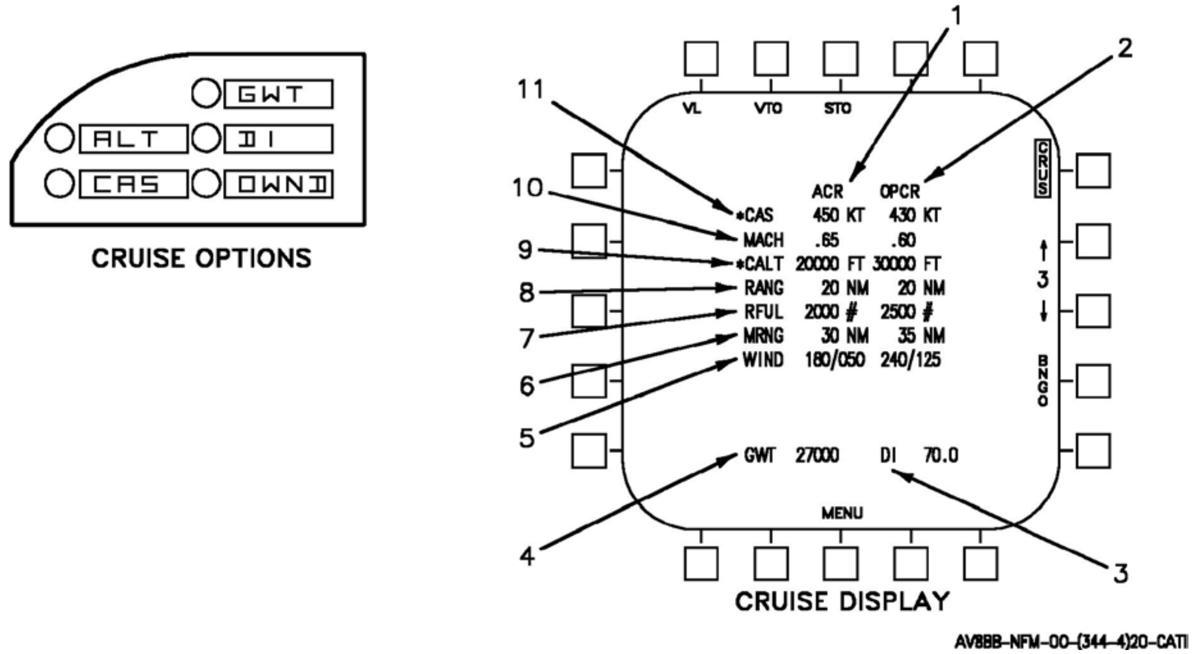
1. Wet is displayed above left column. The numerics listed below WET are the values to be used in a water injected takeoff or landing. WET data are not displayed if outside air temperature is below −5 °C.
2. Dry is displayed above right column. The numerics listed below DRY are values to be used in a 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)



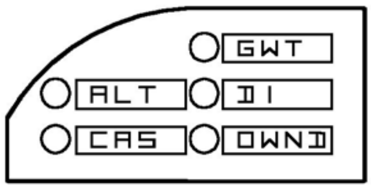
1. WET is displayed above left column. The data in the WET column are the variables to be used if a water injected short takeoff is to be done. The data is always computed when STO is selected, but will not be displayed if outside air temperature is below -5 °C.
2. DRY is displayed above right column. 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)

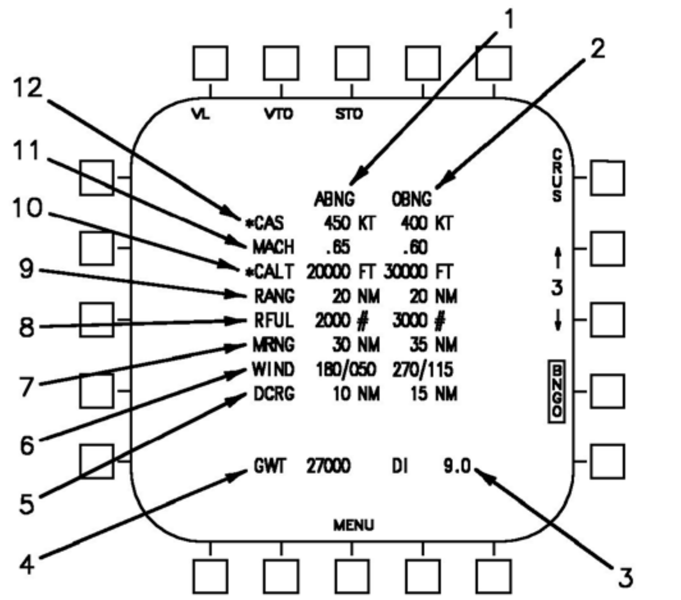


1. Altitude cruise (ACR) is displayed above left column. Numbers in this column are computed to indicate to the pilot the flight data required to obtain maximum cruise performance at existing altitude. An asterisk (*) next to the ACR legend indicates existing aircraft altitude is greater than optimum 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)



BINGO OPTIONS



BINGO DISPLAY

AV8BB-NFM-00-(344-5)20-CAT1

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.

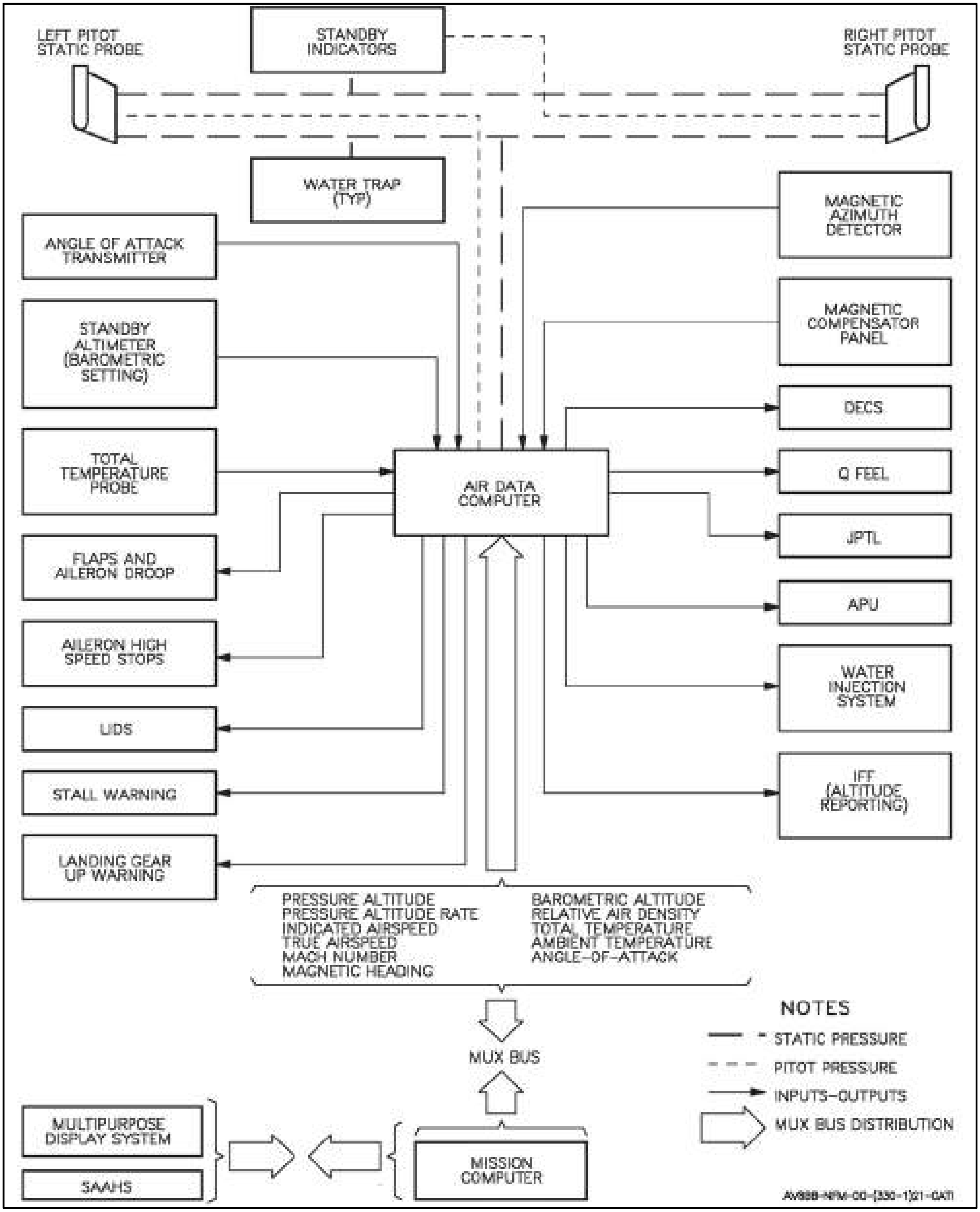


Figure 2-23. Air Data Computer Interface

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.

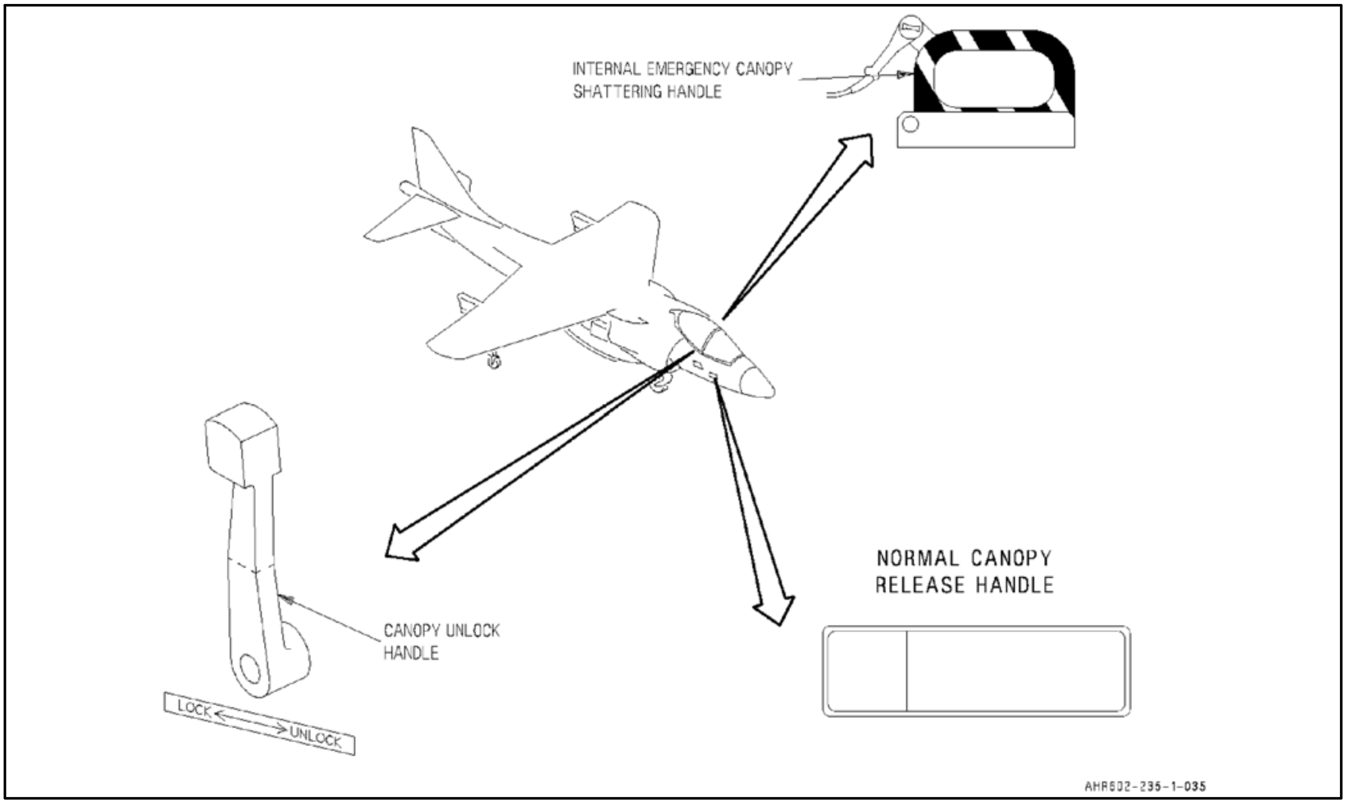


Figure 2-24. Canopy Controls (AV–8B)

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.

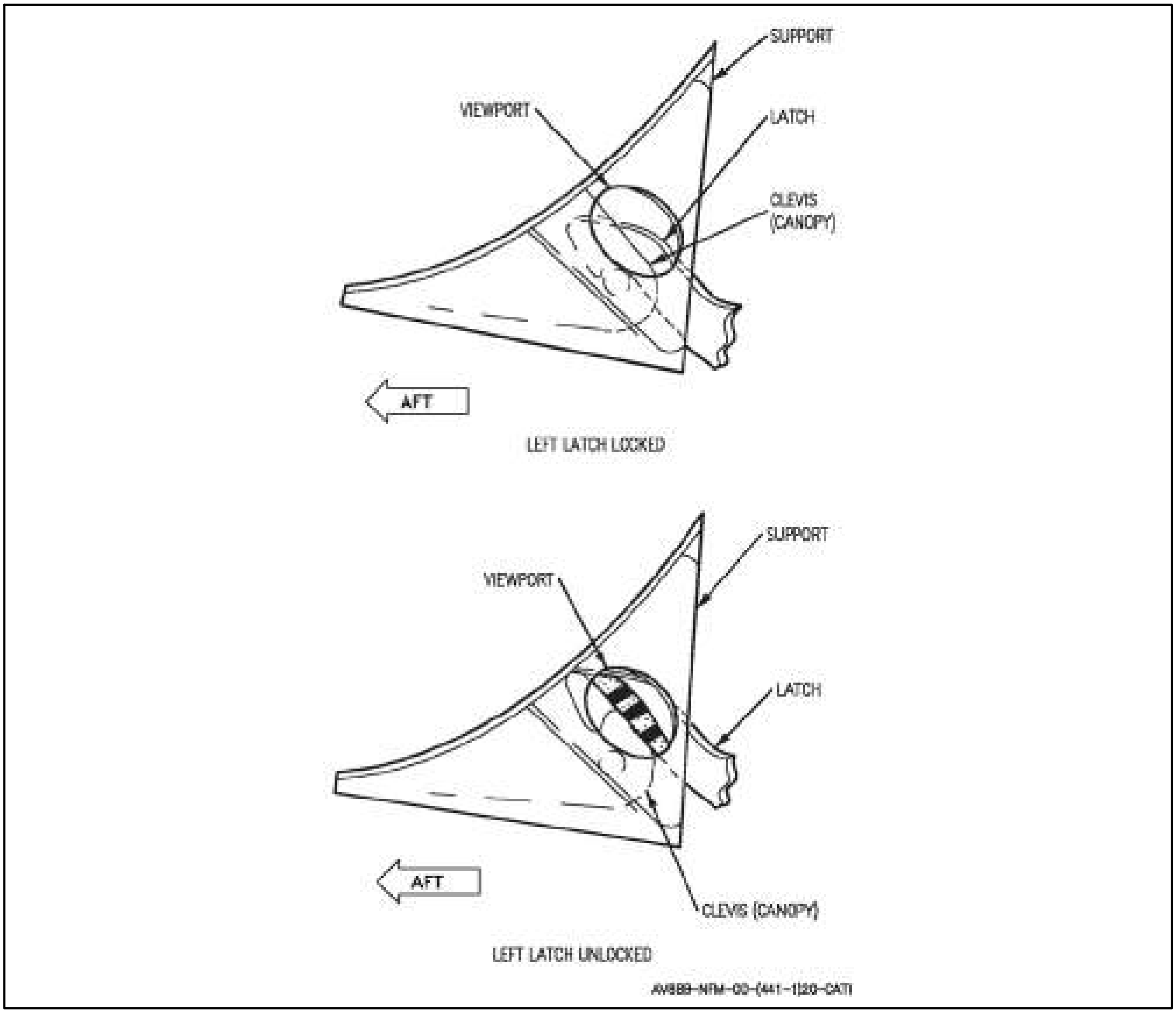


Figure 2-25. Canopy Latch Viewport

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.

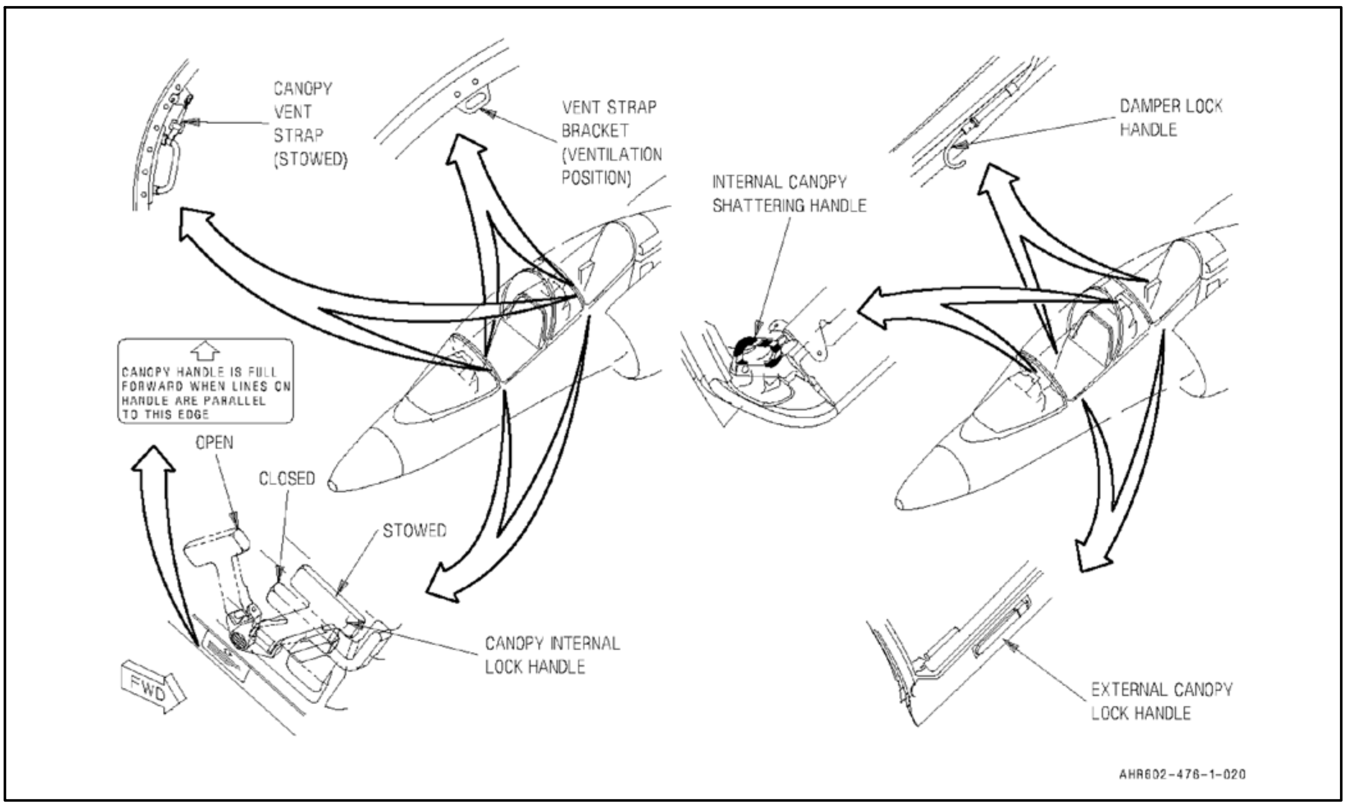


Figure 2-26. Canopy Controls (TAV-8B)

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.

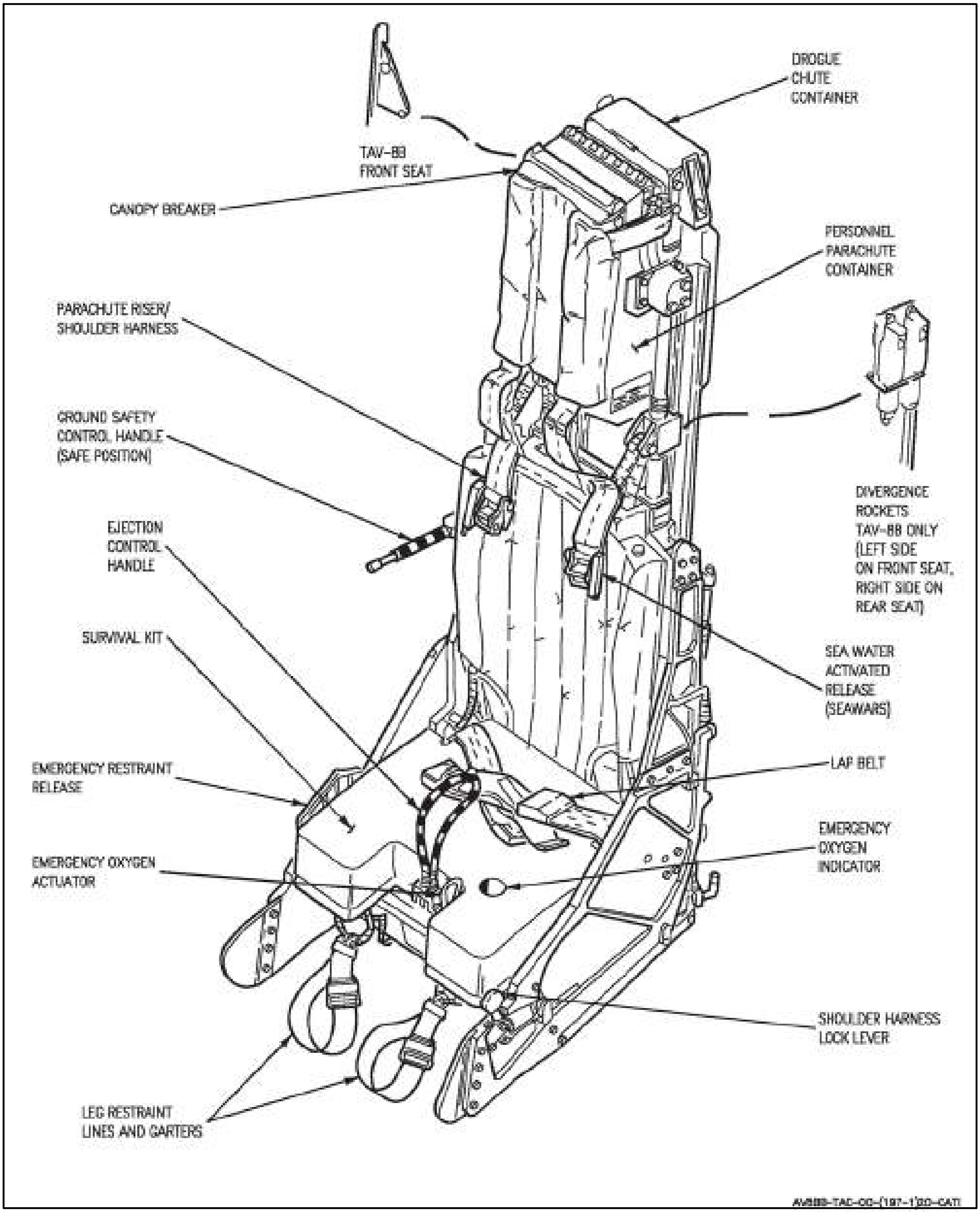


Figure 2-27. Ejection Seat

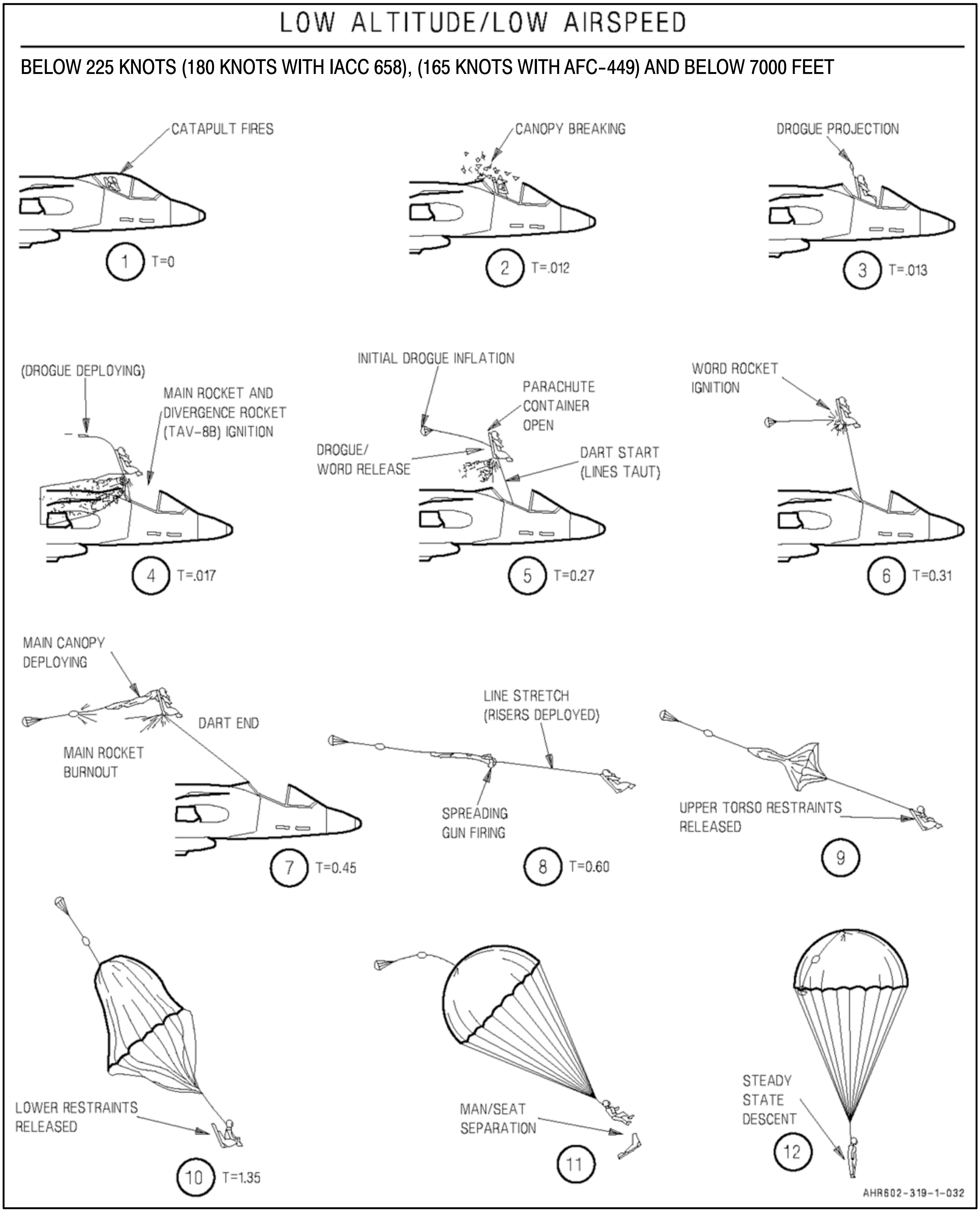


Figure 2-28. Ejection Sequences (Sheet 1 of 4)

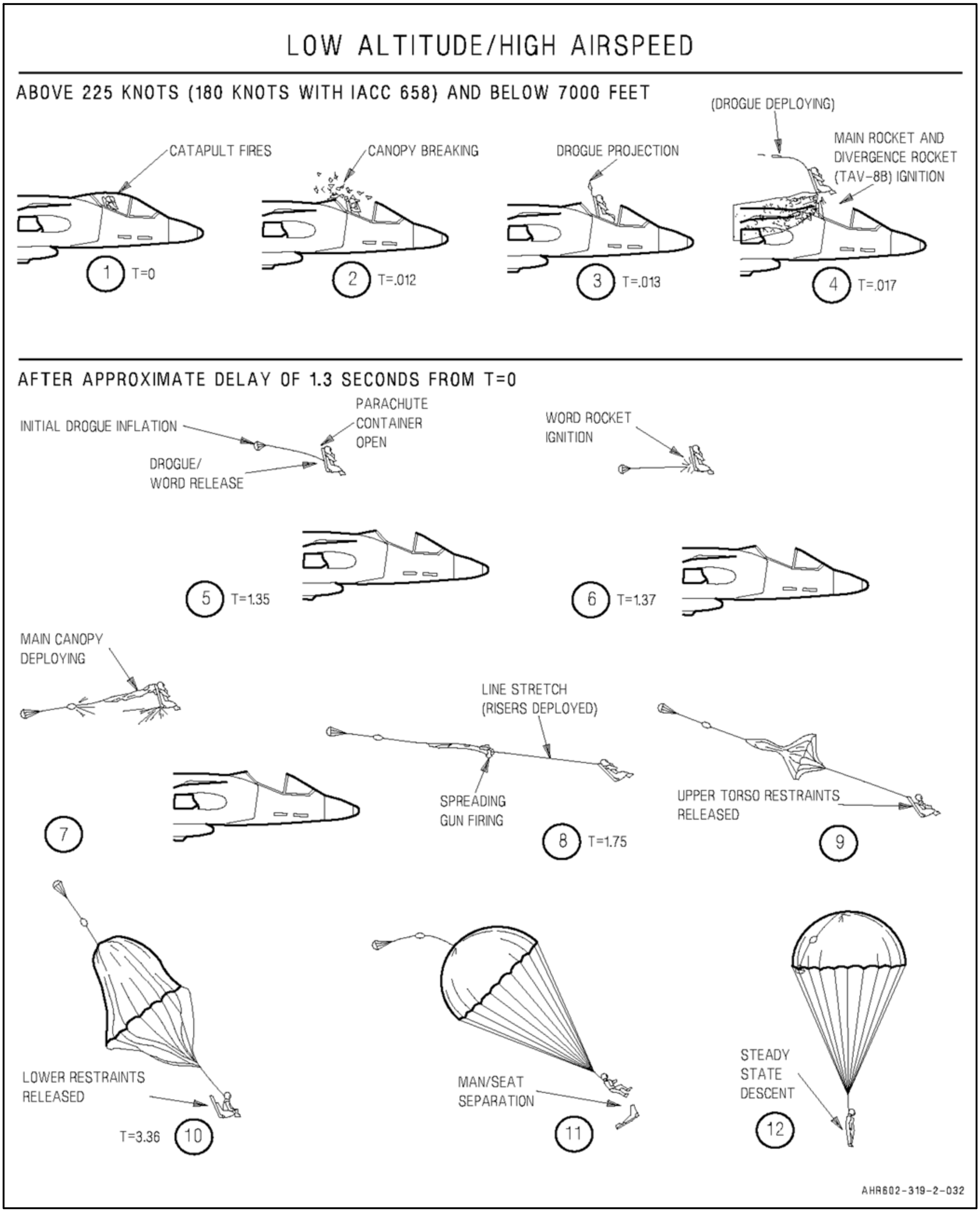


Figure 2-28. Ejection Sequences (Sheet 2)

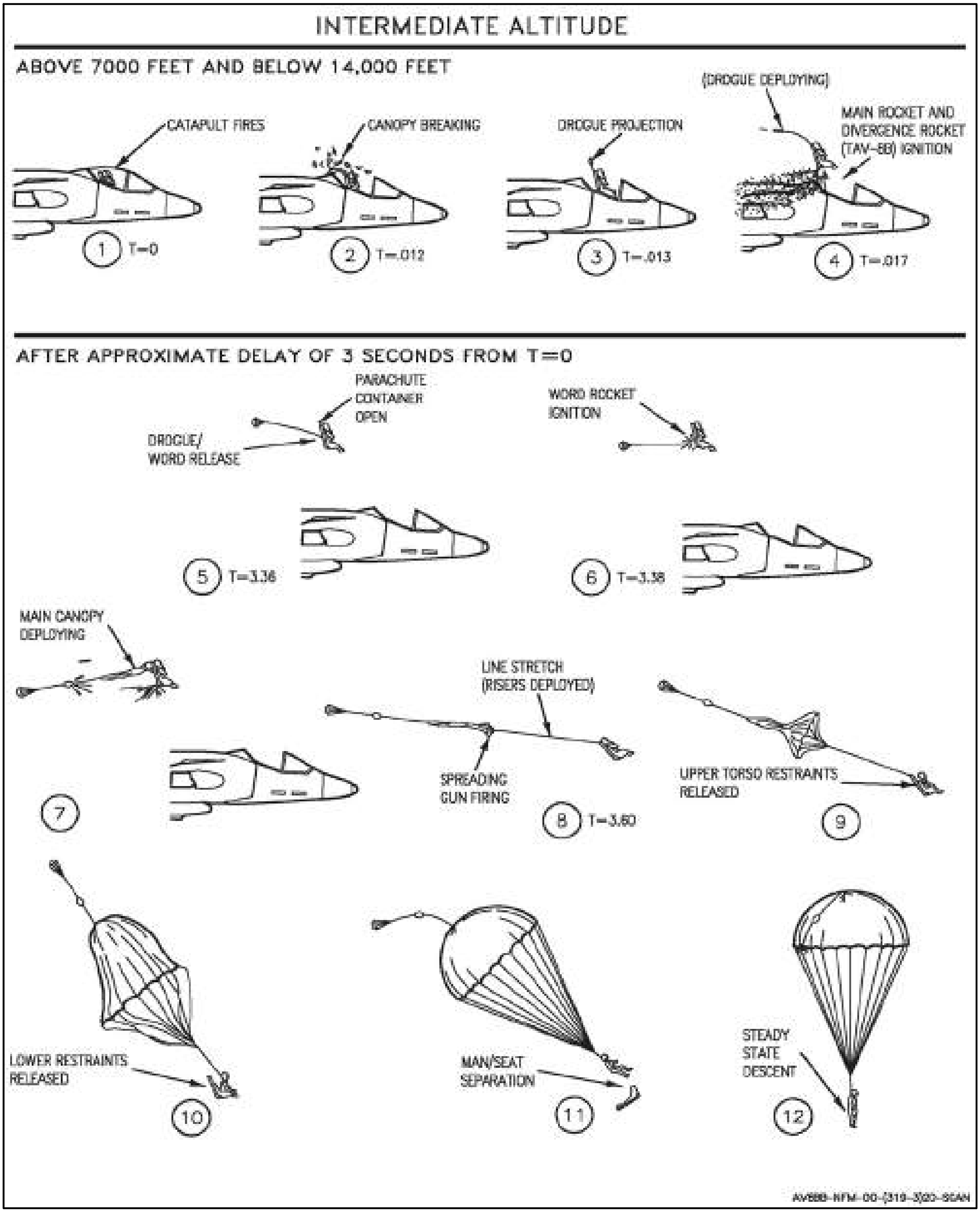


Figure 2-28. Ejection Sequences (Sheet 3)

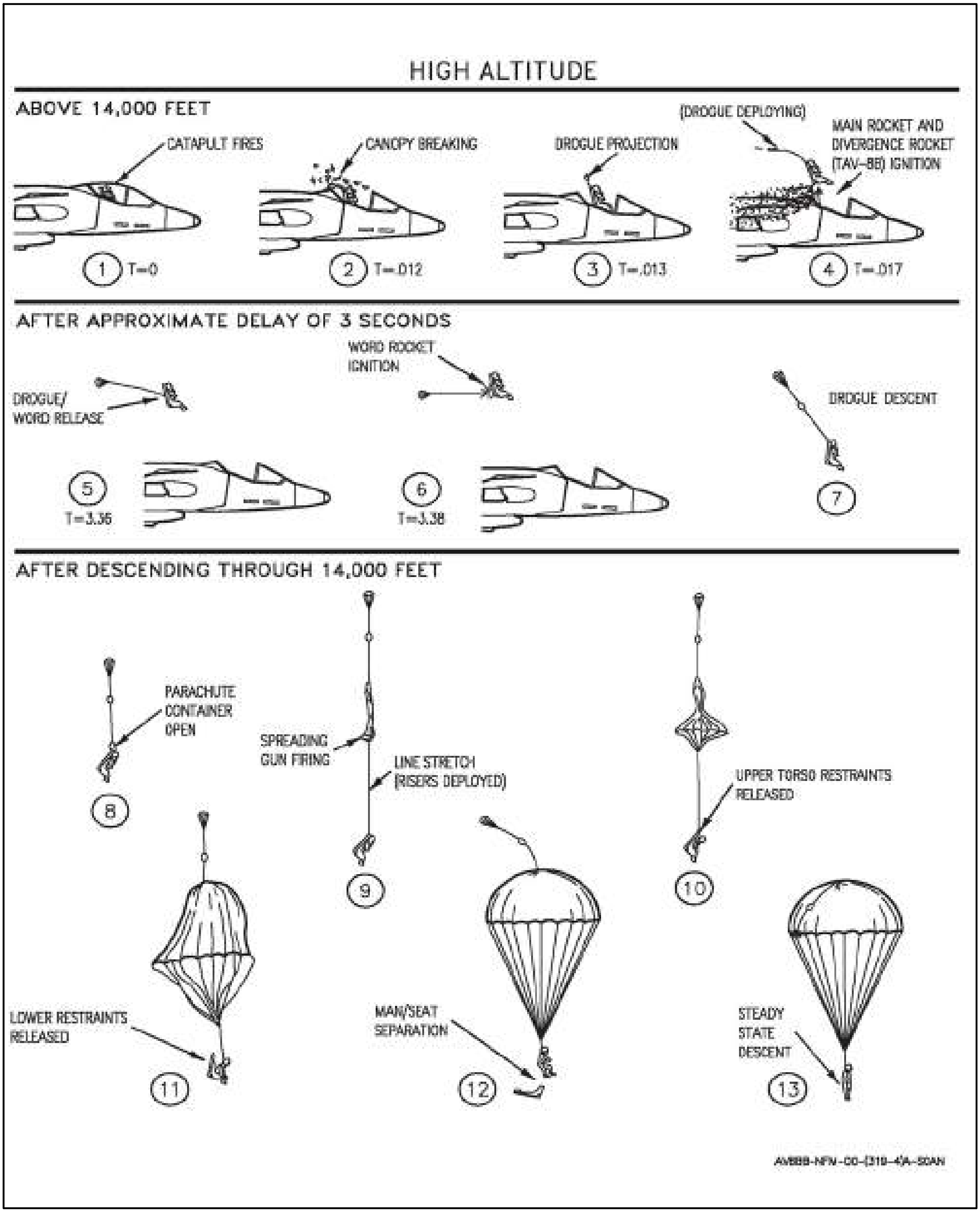


Figure 2-28. Ejection Sequences (Sheet 4)

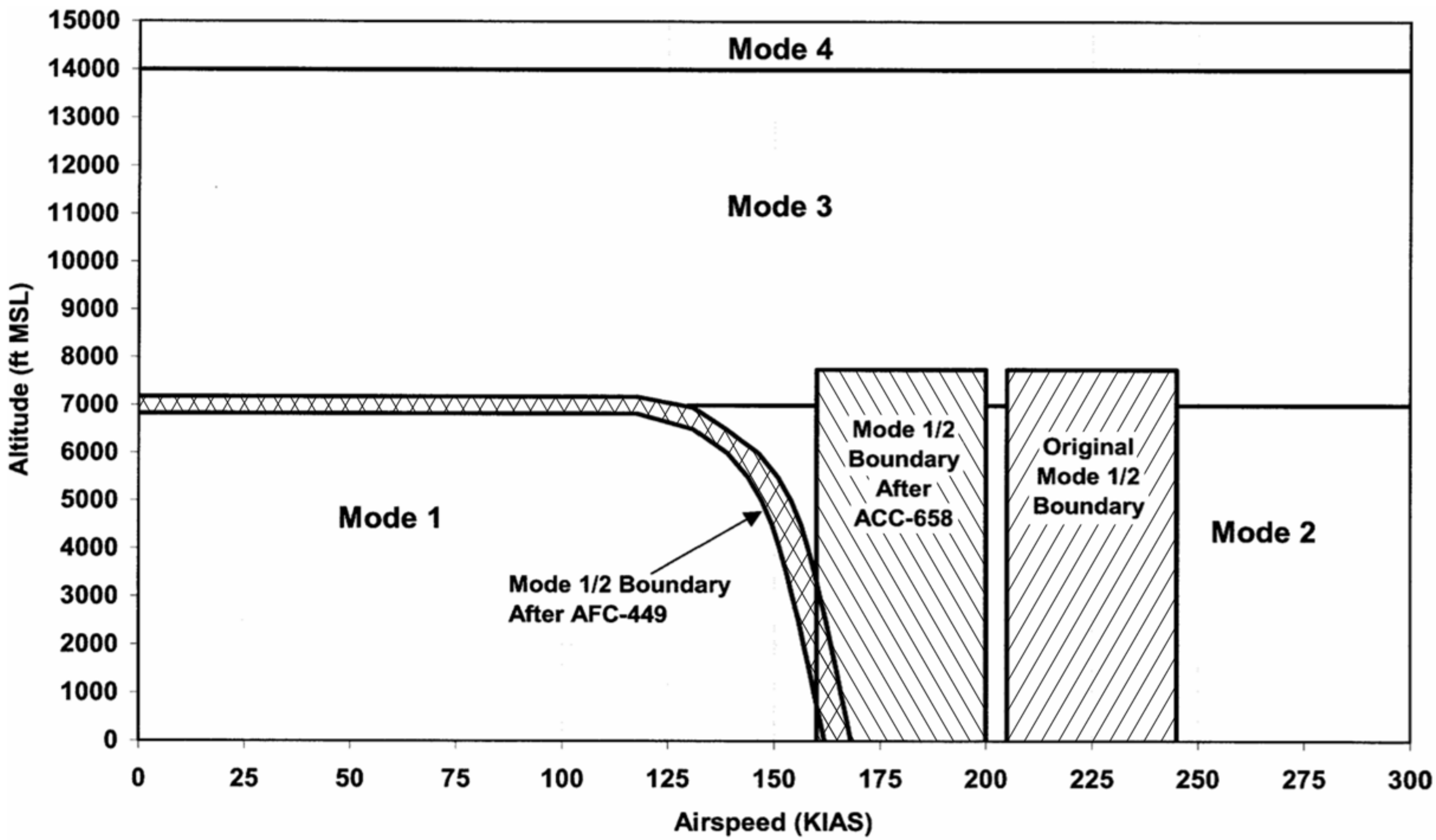


Figure 2-29. T/AV–8B Ejection Seat Modes of Operation

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.

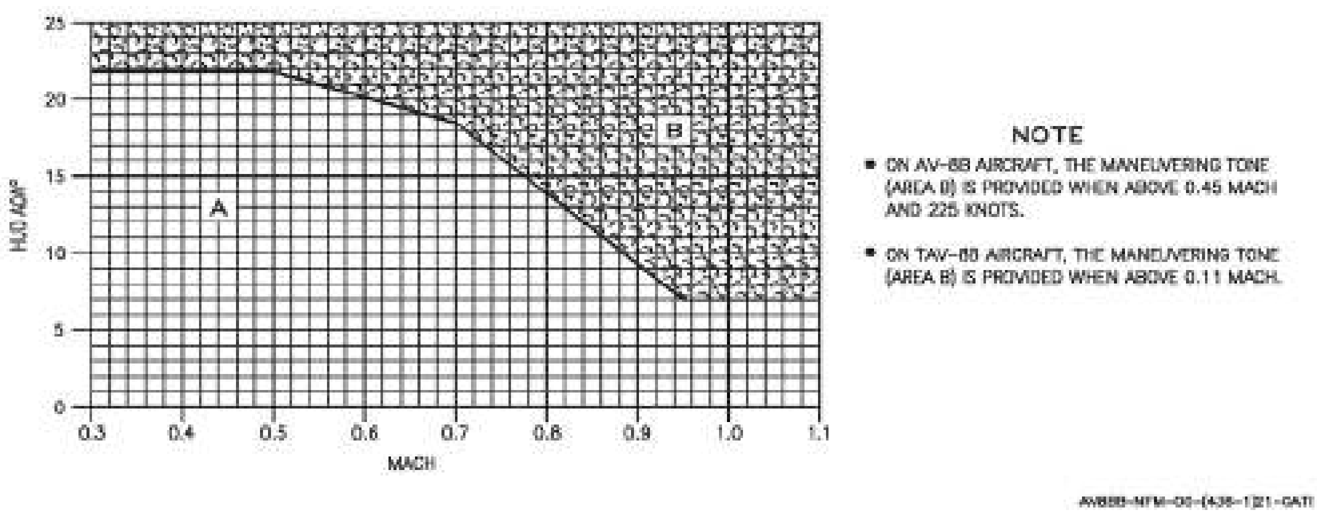


Figure 2-30. Maneuvering Tone (with DEP RES)

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).

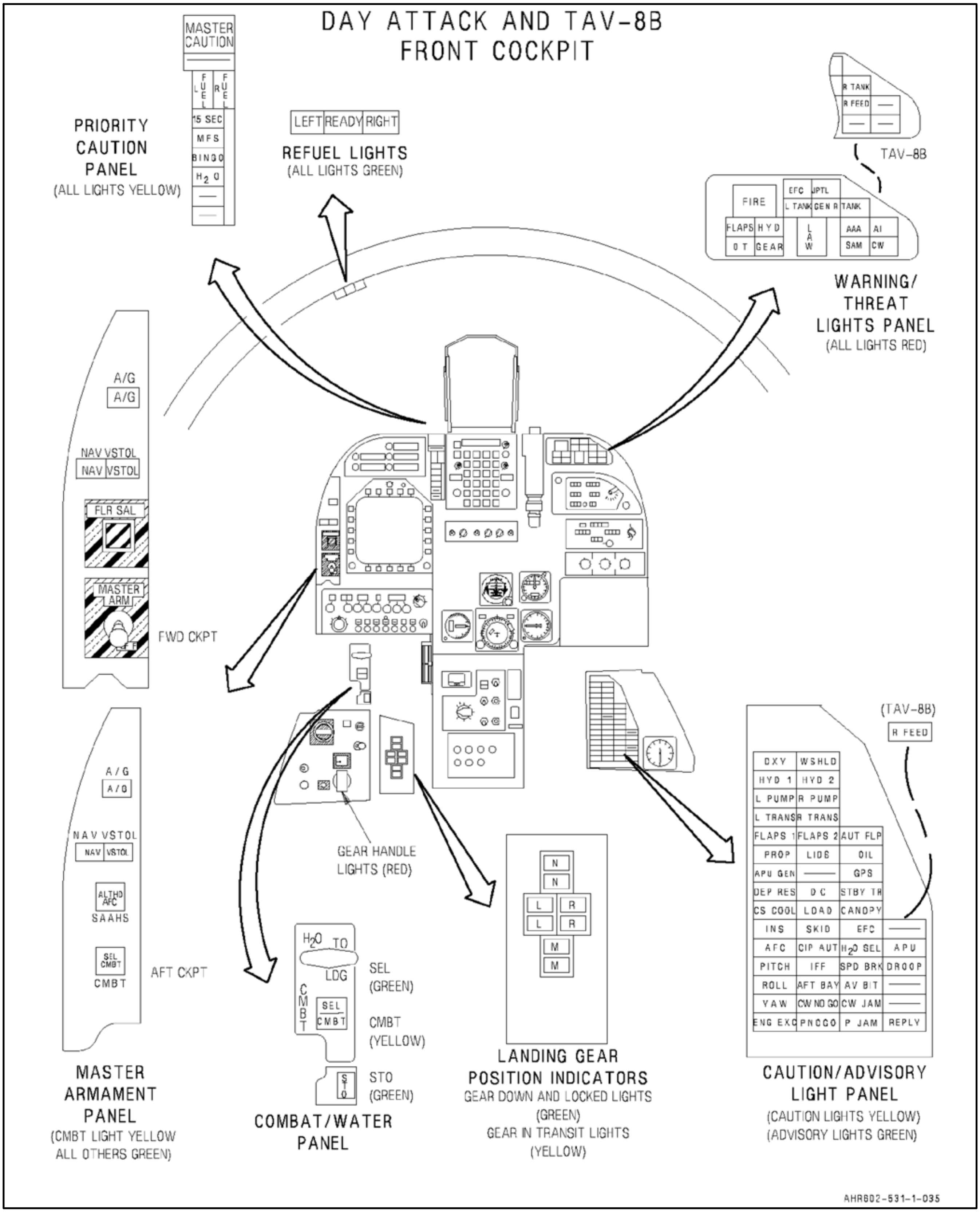


Figure 2-31. Warning/Caution/Advisory Lights (Sheet 1 of 2)

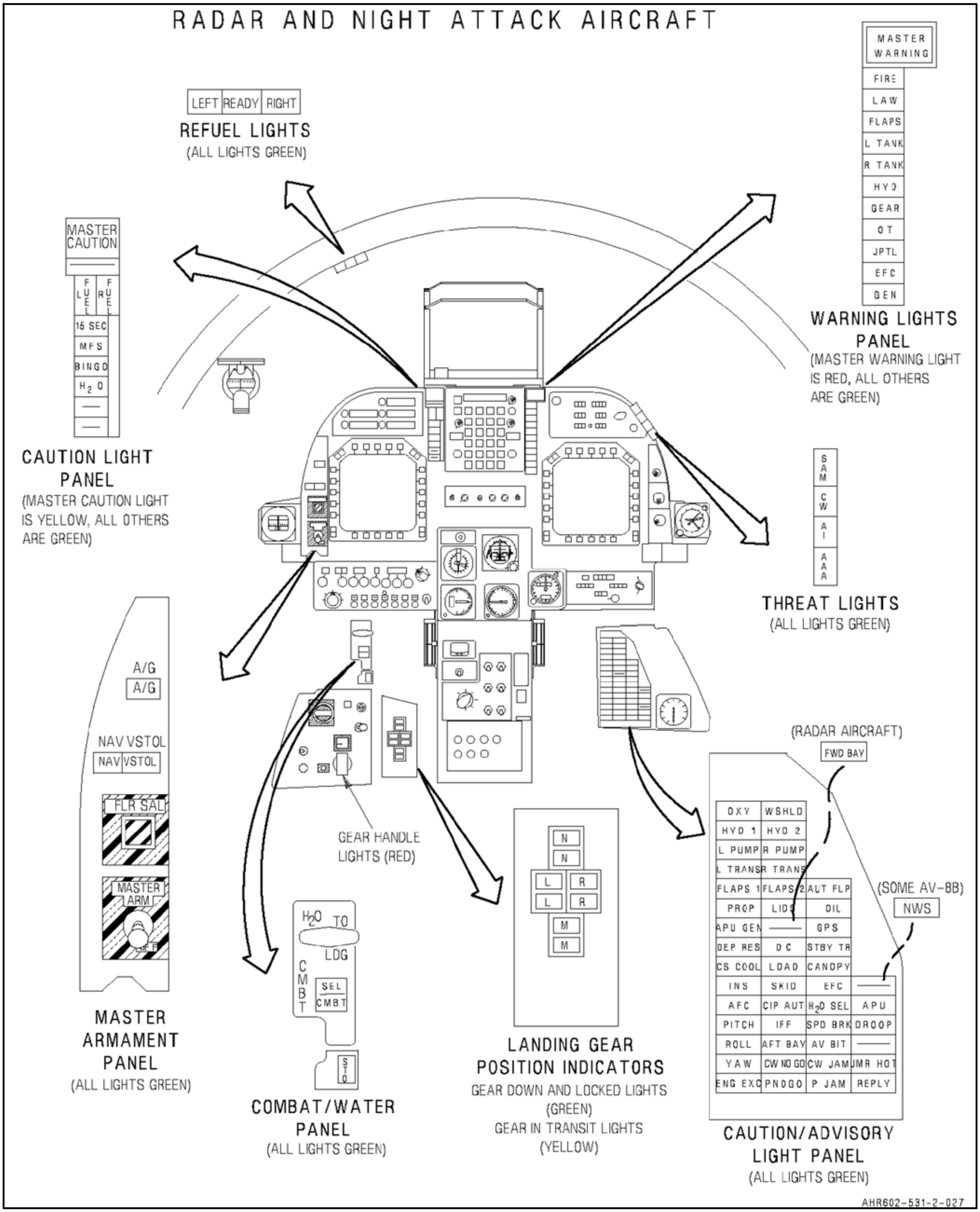


Figure 2-31. Warning/Caution/Advisory Lights (Sheet 2)

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.

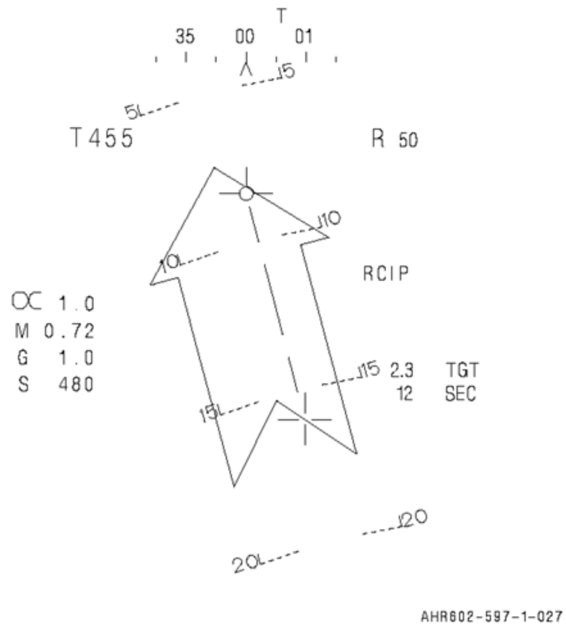


Figure 2-33. GPWS HUD Warning Symbology

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.

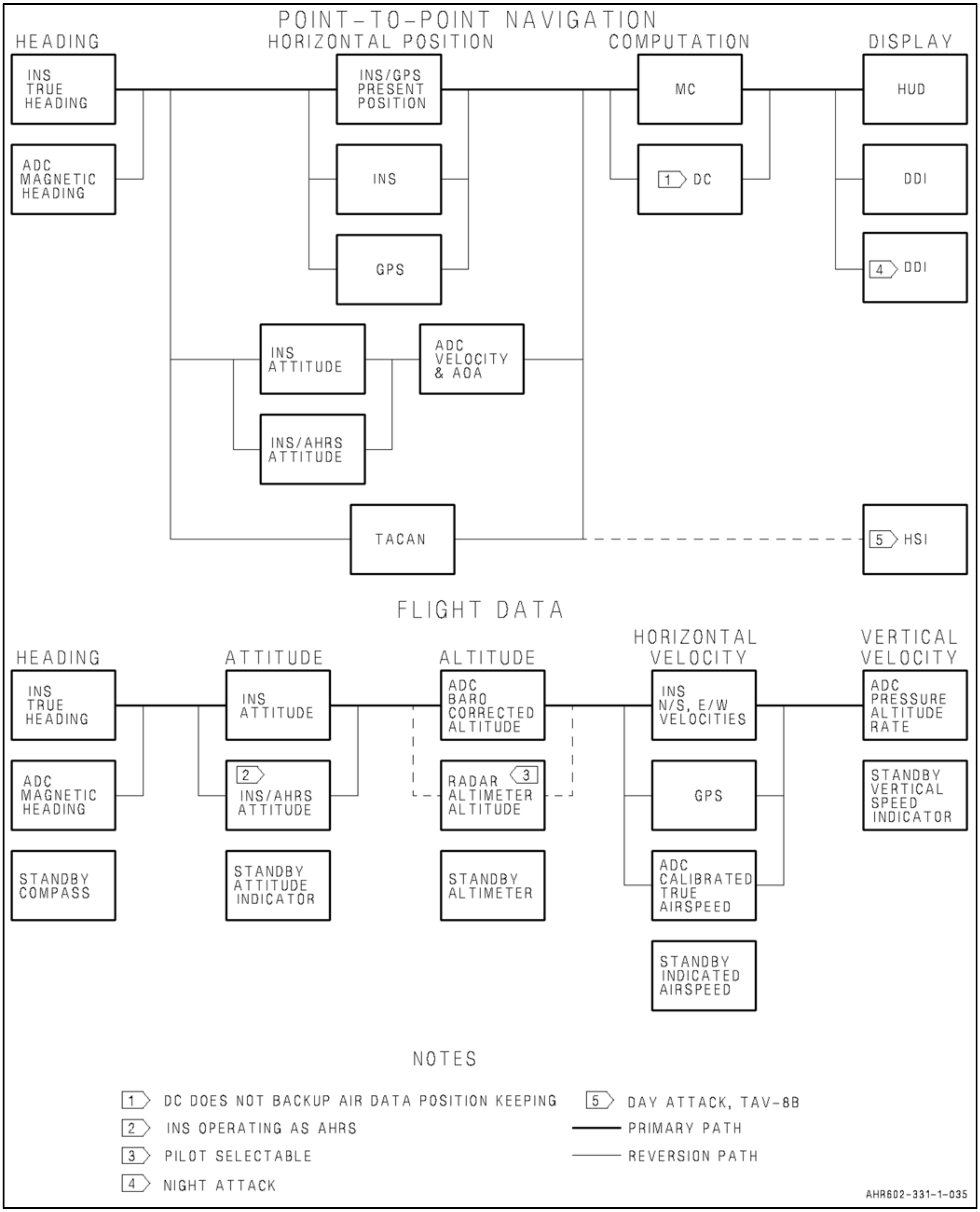


Figure 2-34. Reversions

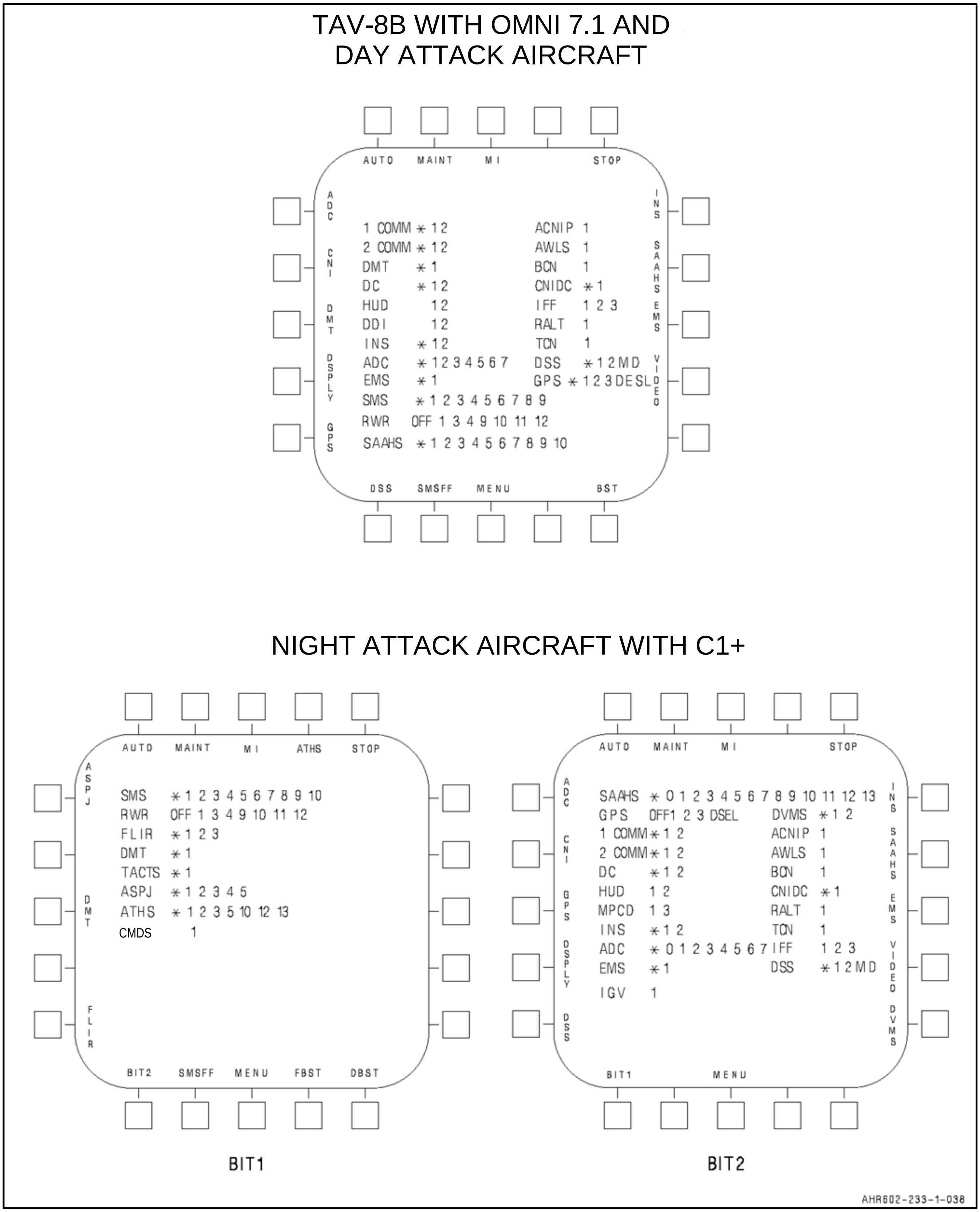


Figure 2-35. BIT Displays (Sheet 1 of 4)

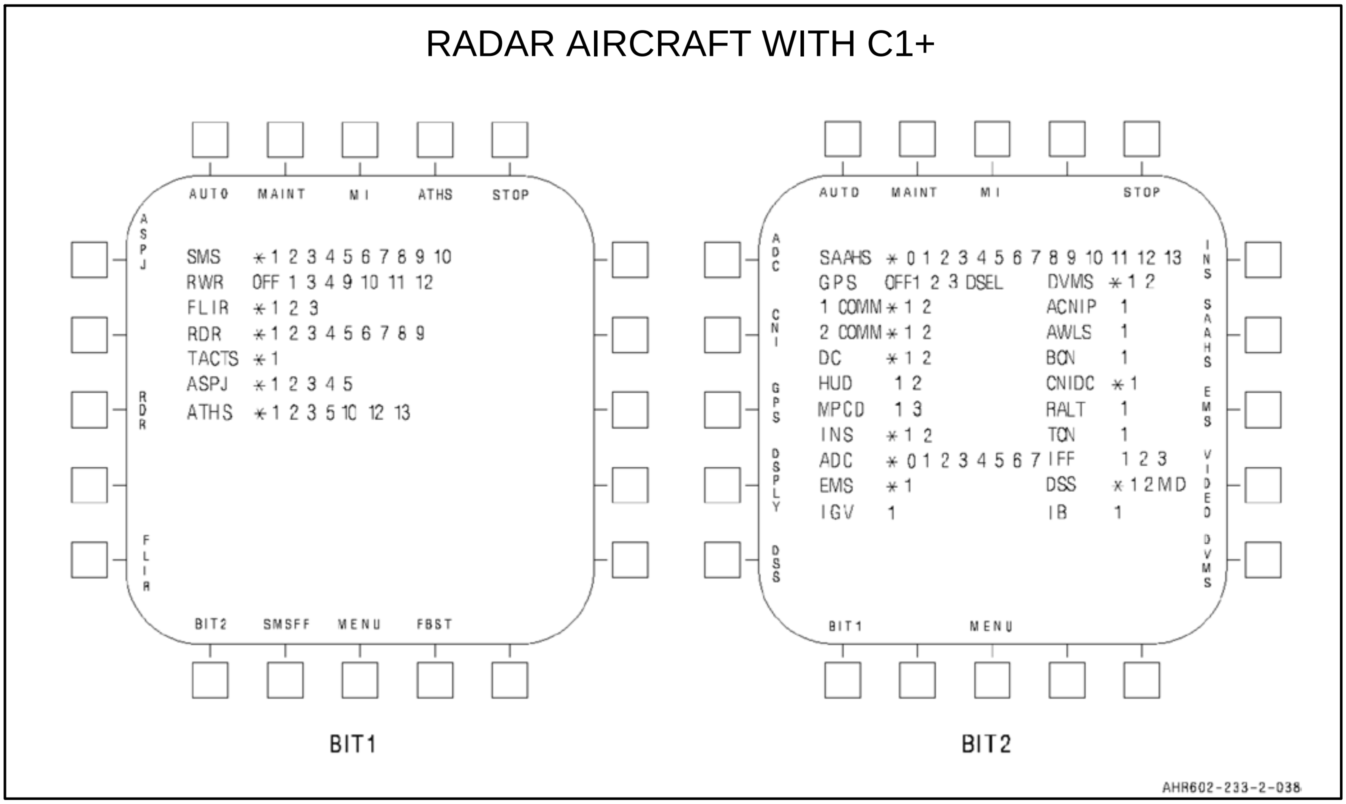


Figure 2-35. BIT Displays (Sheet 2)

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).

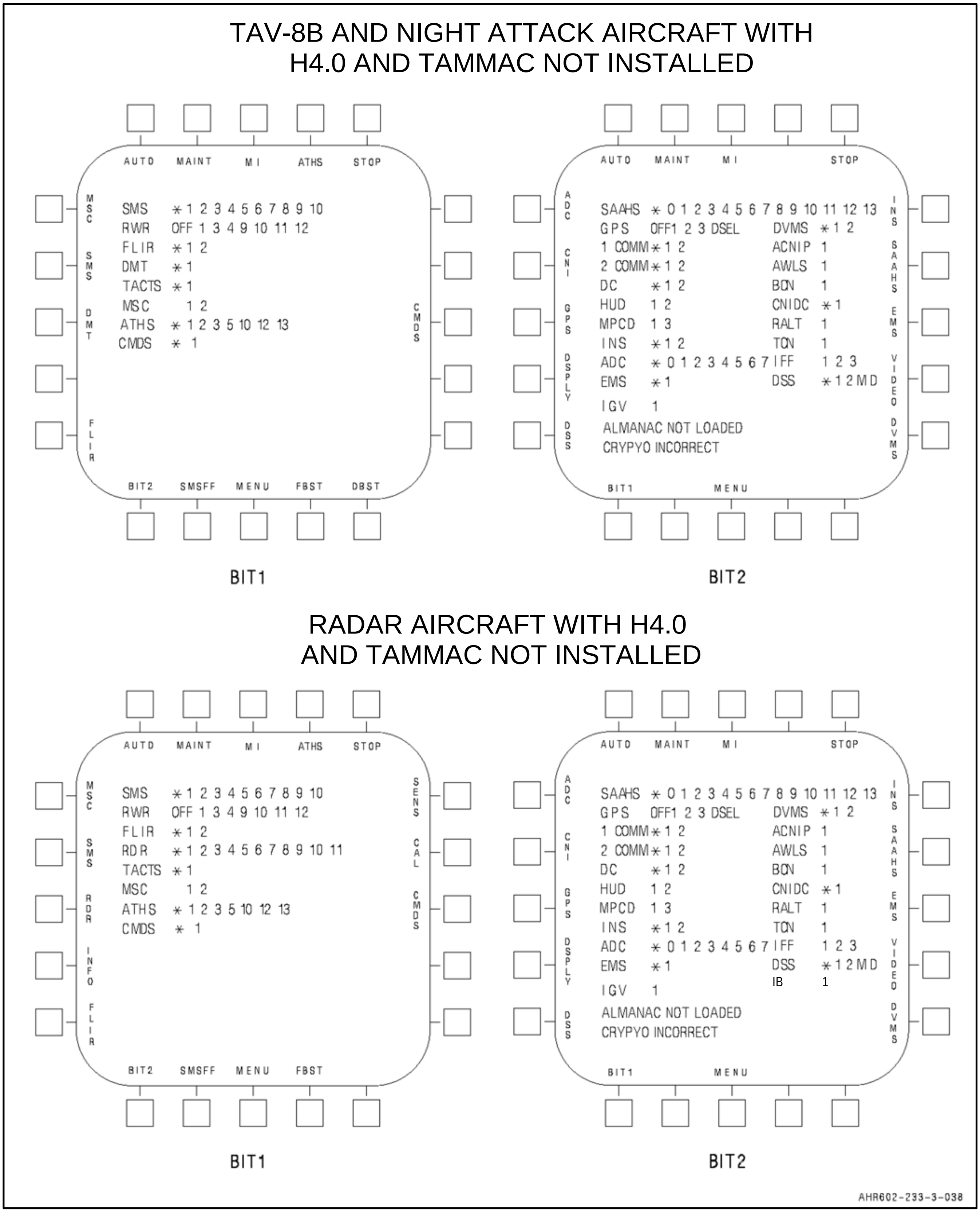


Figure 2-35. BIT Displays (Sheet 3)

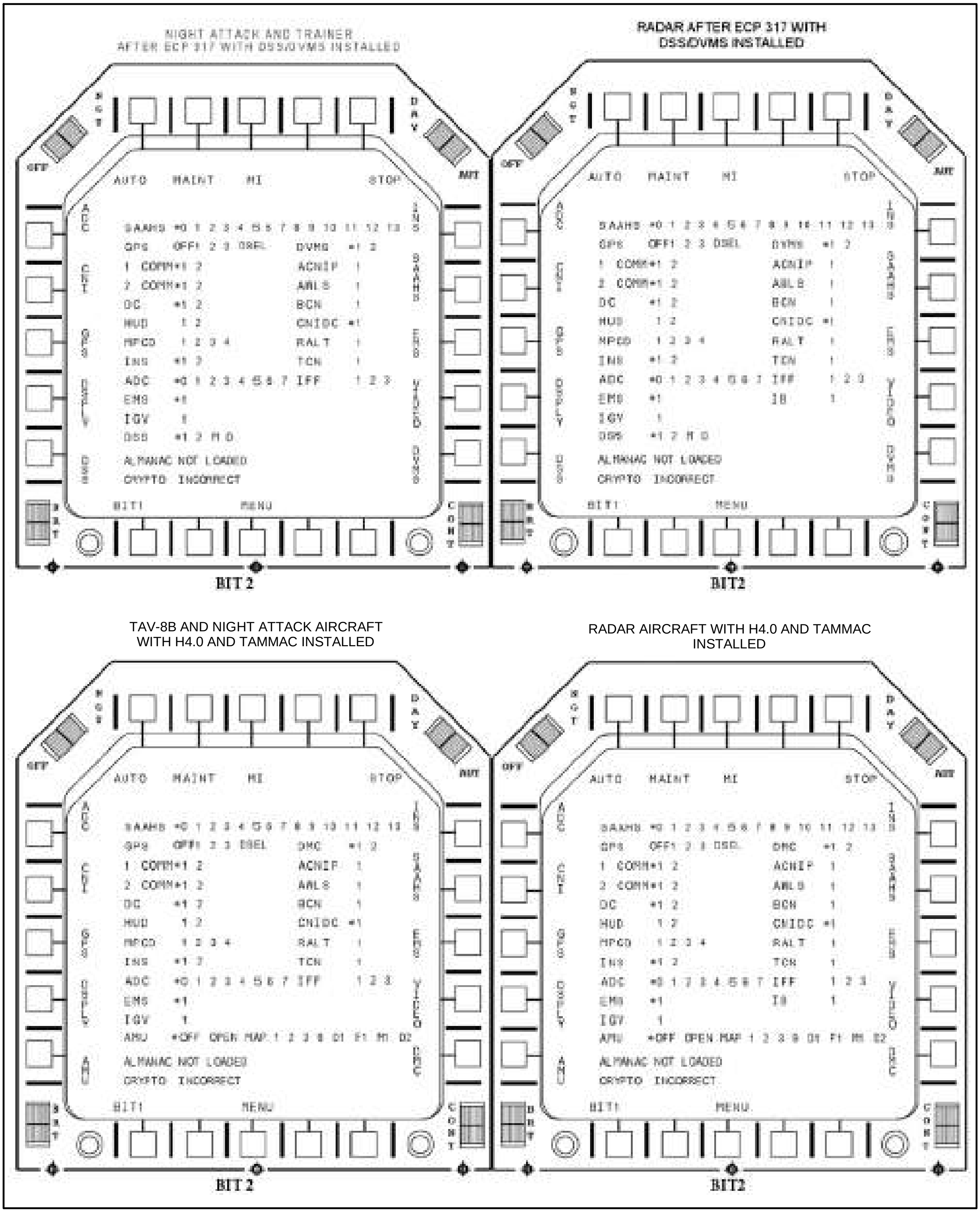


Figure 2-35. BIT Displays (Sheet 4)

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.

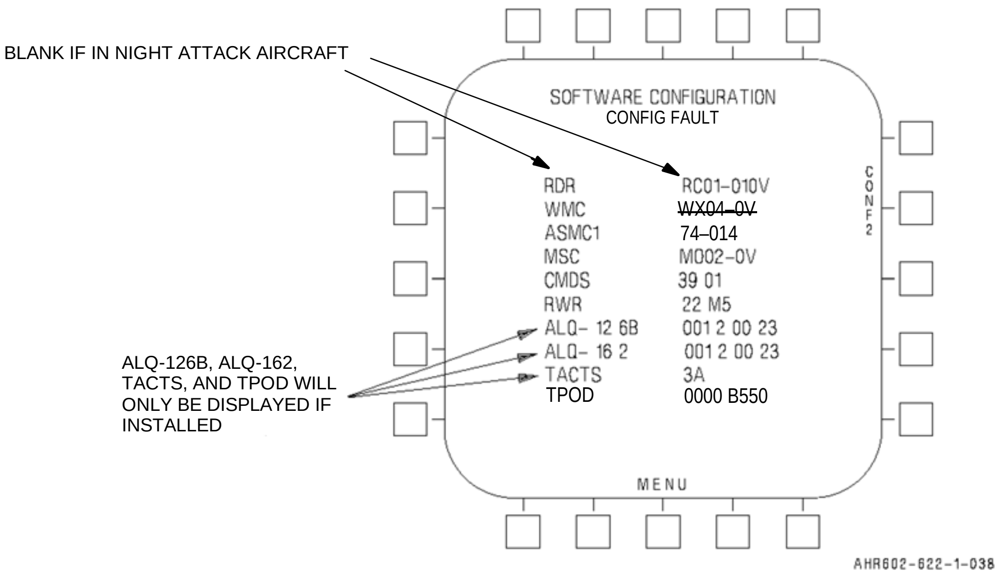


Figure 2-37. Configuration Page 1 (Configuration fault detected)

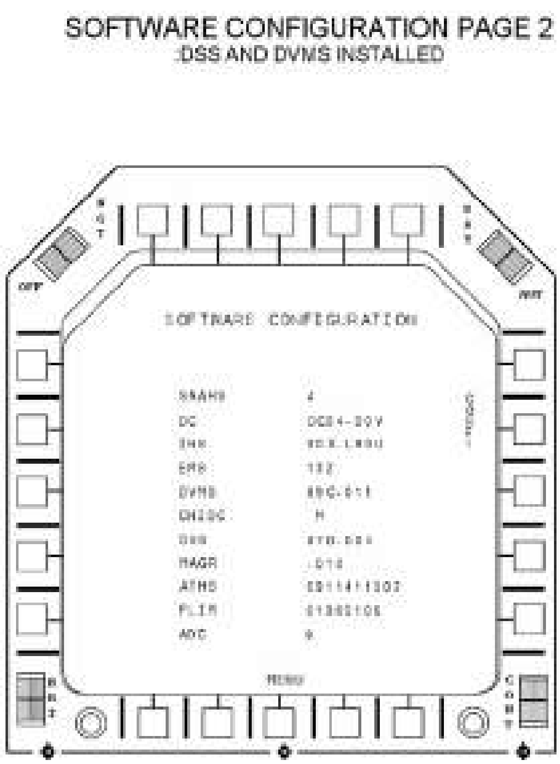


Figure 2-38. Configuration Page 2 (DSS and DVMS Installed) (Sheet 1 of 2)

SOFTWARE CONFIGURATION PAGE 2
:TAMMAC INSTALLED

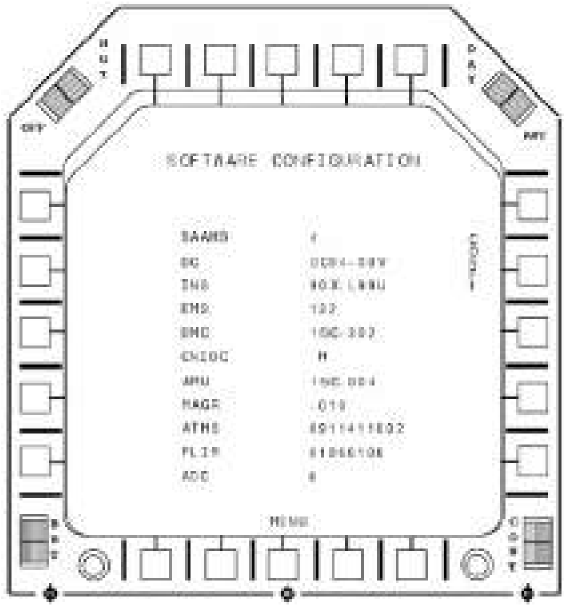


Figure 2-38. Configuration Page 2 (DSS and DVMS Installed) (Sheet 2)

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 (short lift wet – short lift dry) 1.5 MIN (short lift wet – normal lift wet) 2.5 MIN [3] (short lift wet – normal lift dry) 10 MIN [3] (short lift wet – combat) 15 MIN (short lift wet – maximum thrust)
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)

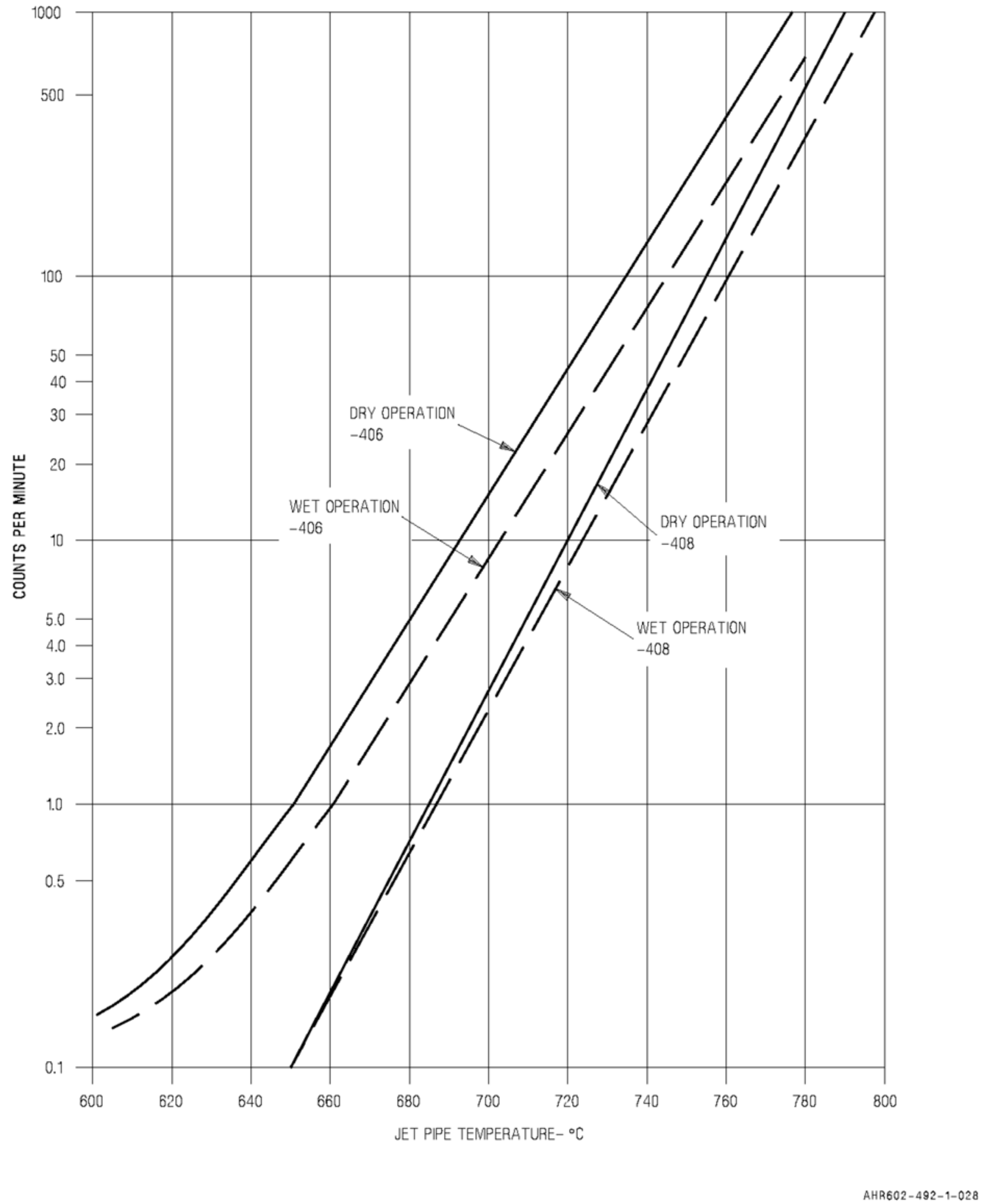


Figure 4-3. Engine Life Count Rates Versus JPT

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.

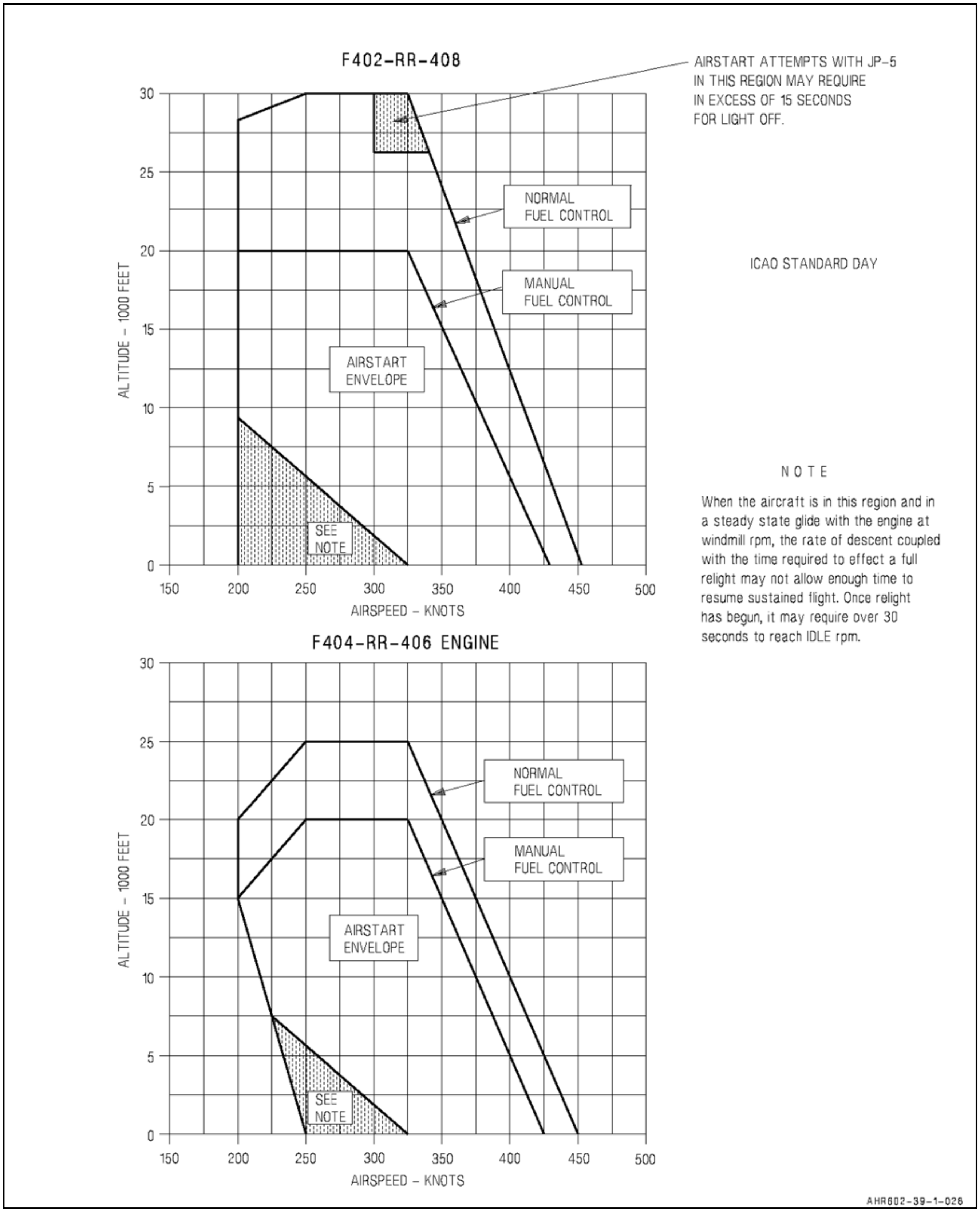


Figure 4-4. Engine Airstart Envelope

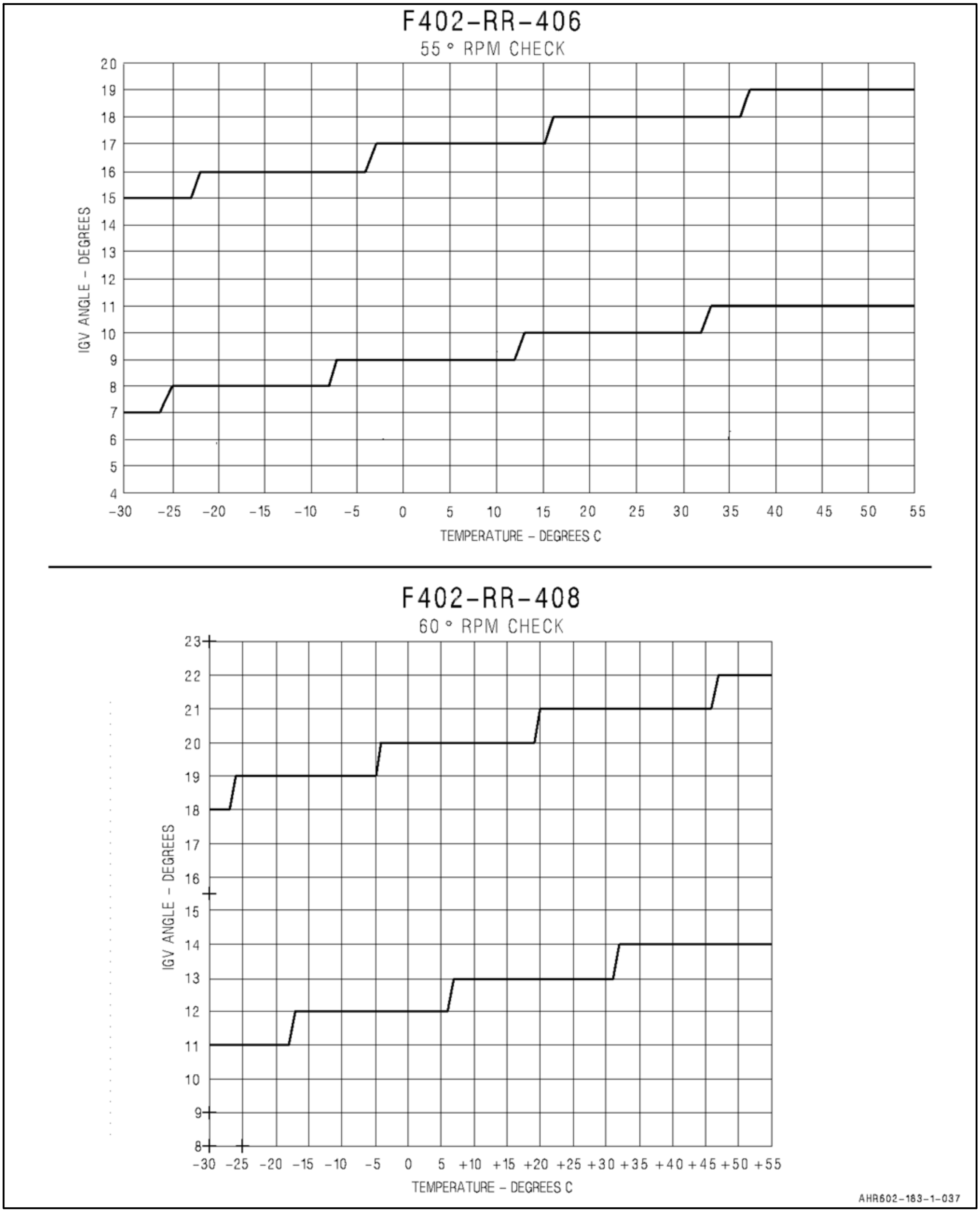


Figure 4-5. Effect of OAT on Variable Inlet Guide Vanes Engine

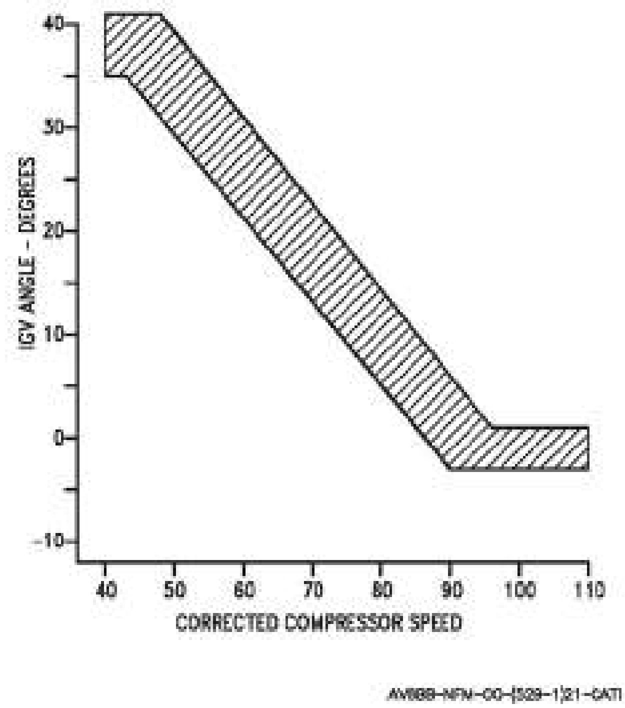


Figure 4-6. IGV Schedule

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.

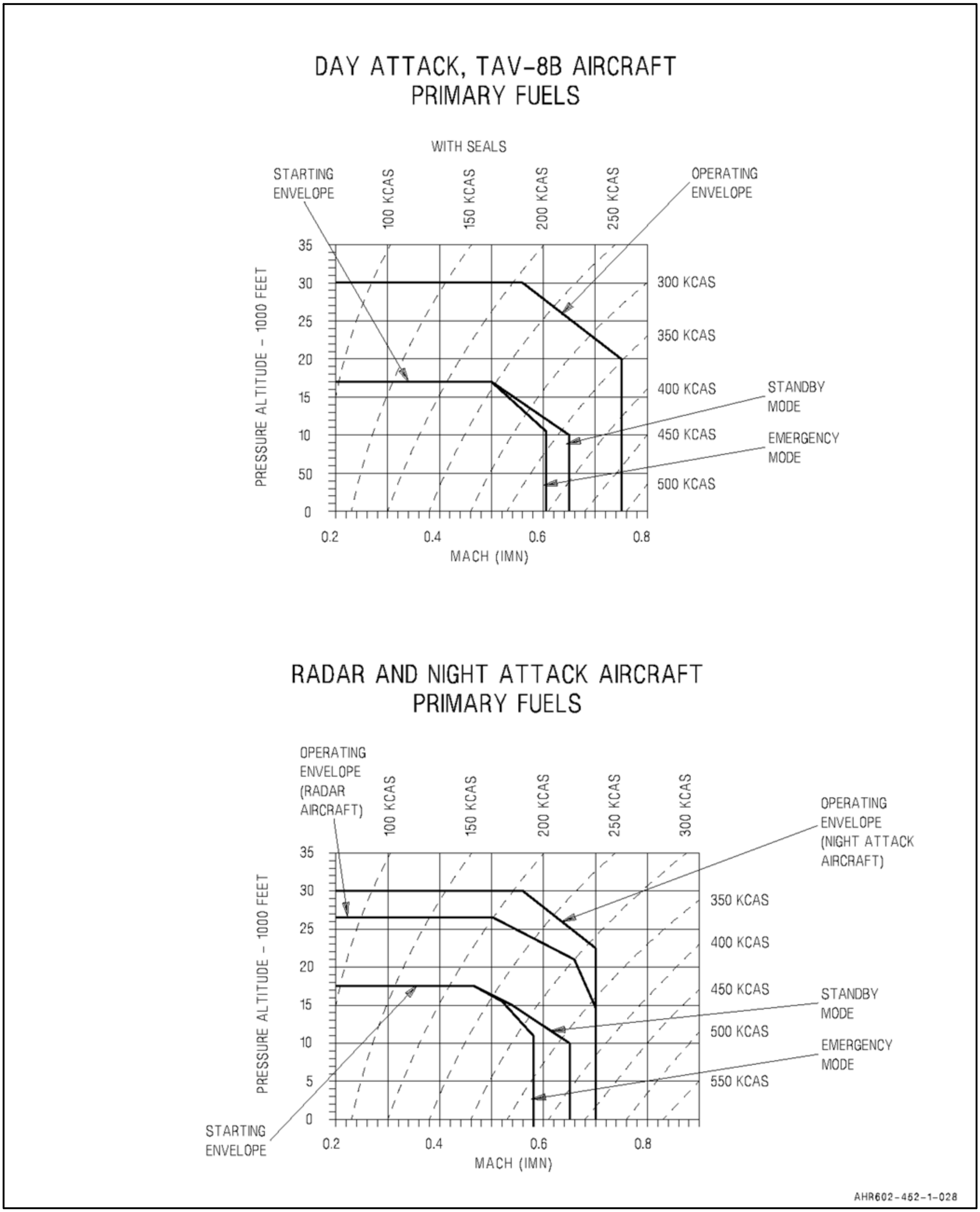


Figure 4-7. APU Starting and Operating Envelope (Sheet 1 of 2)

CAUTION

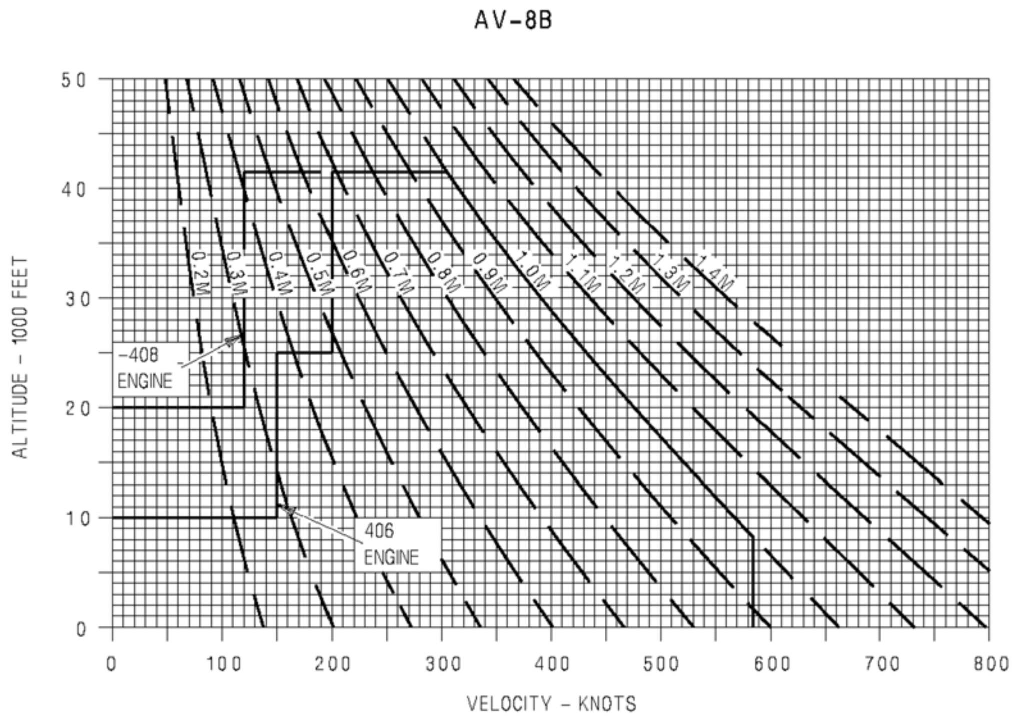
- If the GTS/APU inflight operating limits are exceeded, overheat damage may occur. Excessive heat damage can lead to GTS turbine failure with blade pieces exiting the GTS exhaust duct at high velocity.
- Continuous operation is affected by altitude, airspeed, AOA, and ambient air temperature. Limit 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.



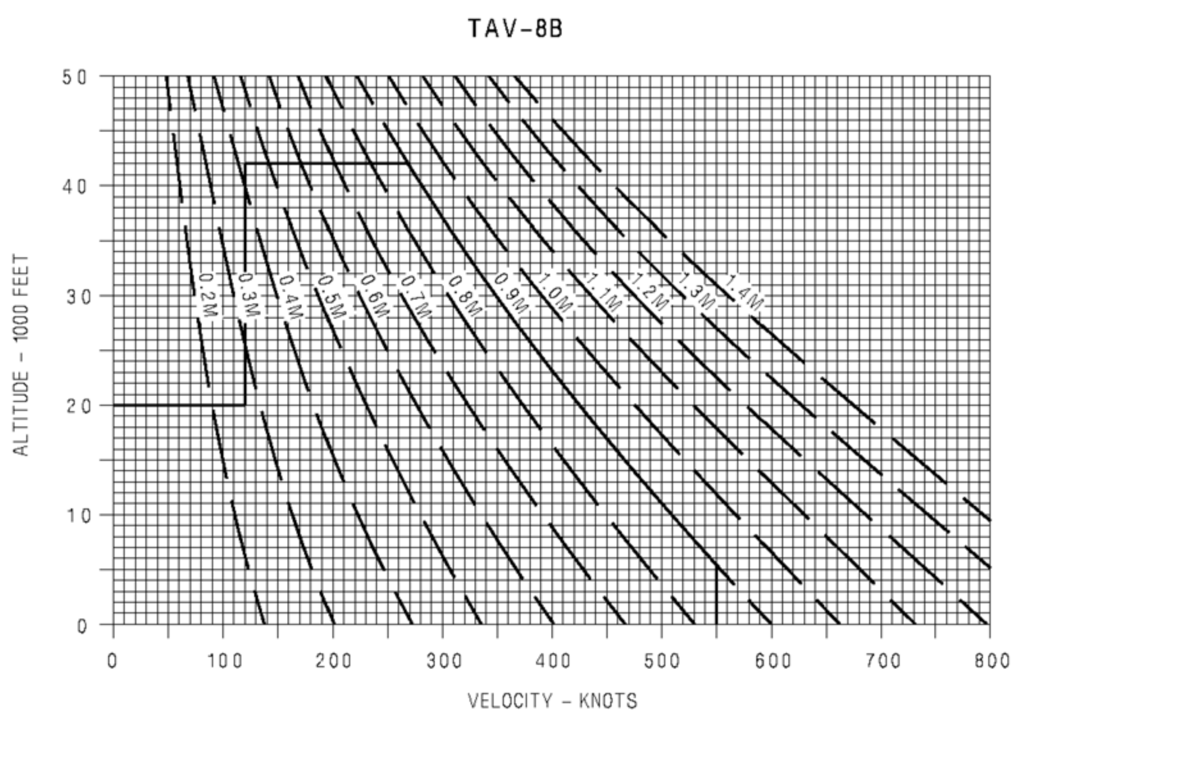


Figure 4-8. Airspeed Limitations

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.

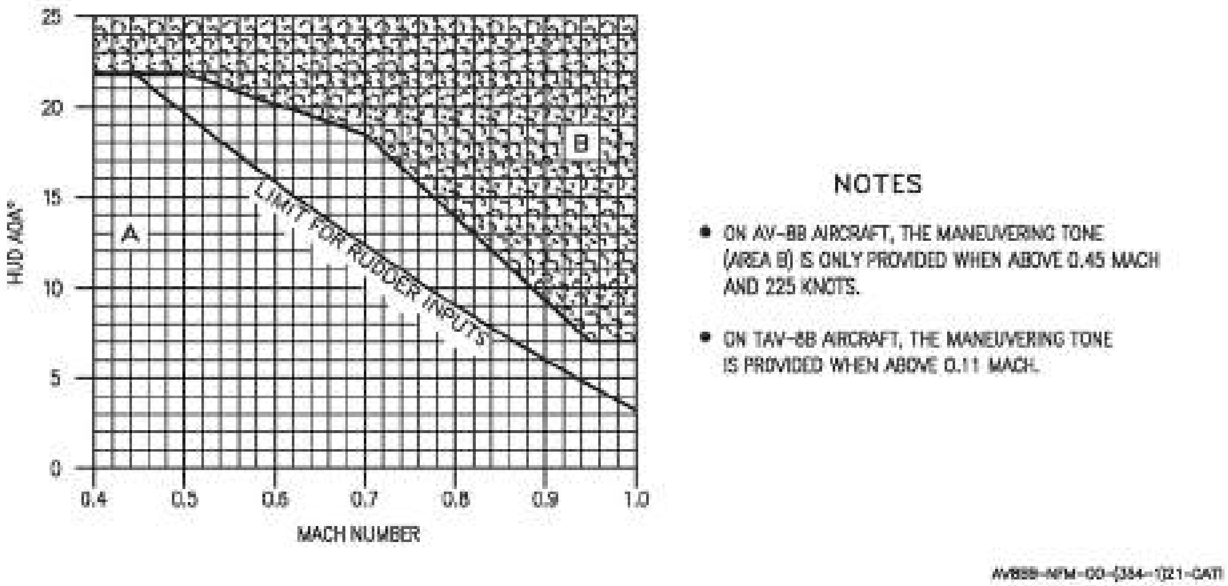


Figure 4-9. AOA Limits – Flaps – AUTO – SAS OFF – Nozzles 0°

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.

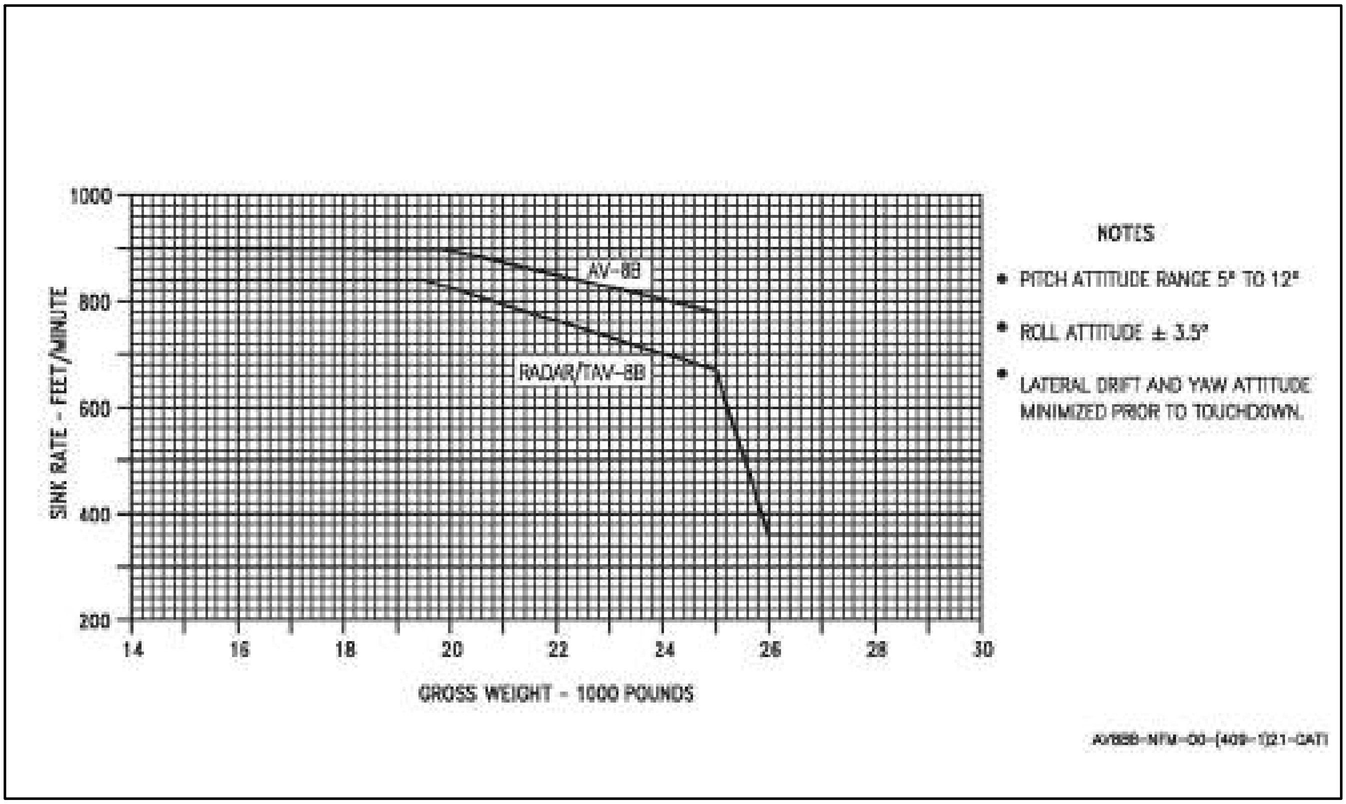


Figure 4-10. Sink Rate Limitations

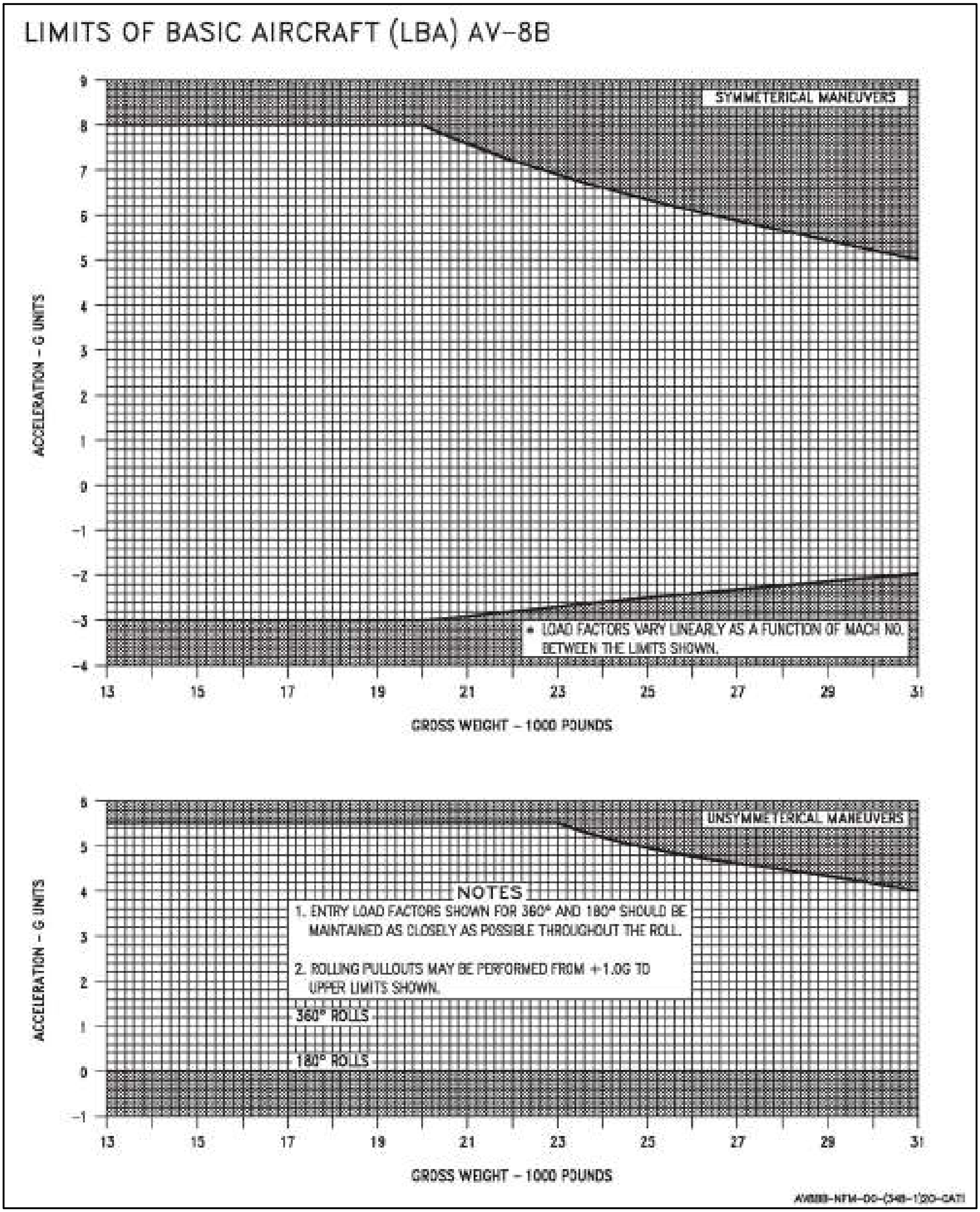


Figure 4-11. Acceleration Limitations (Sheet 1 of 2)

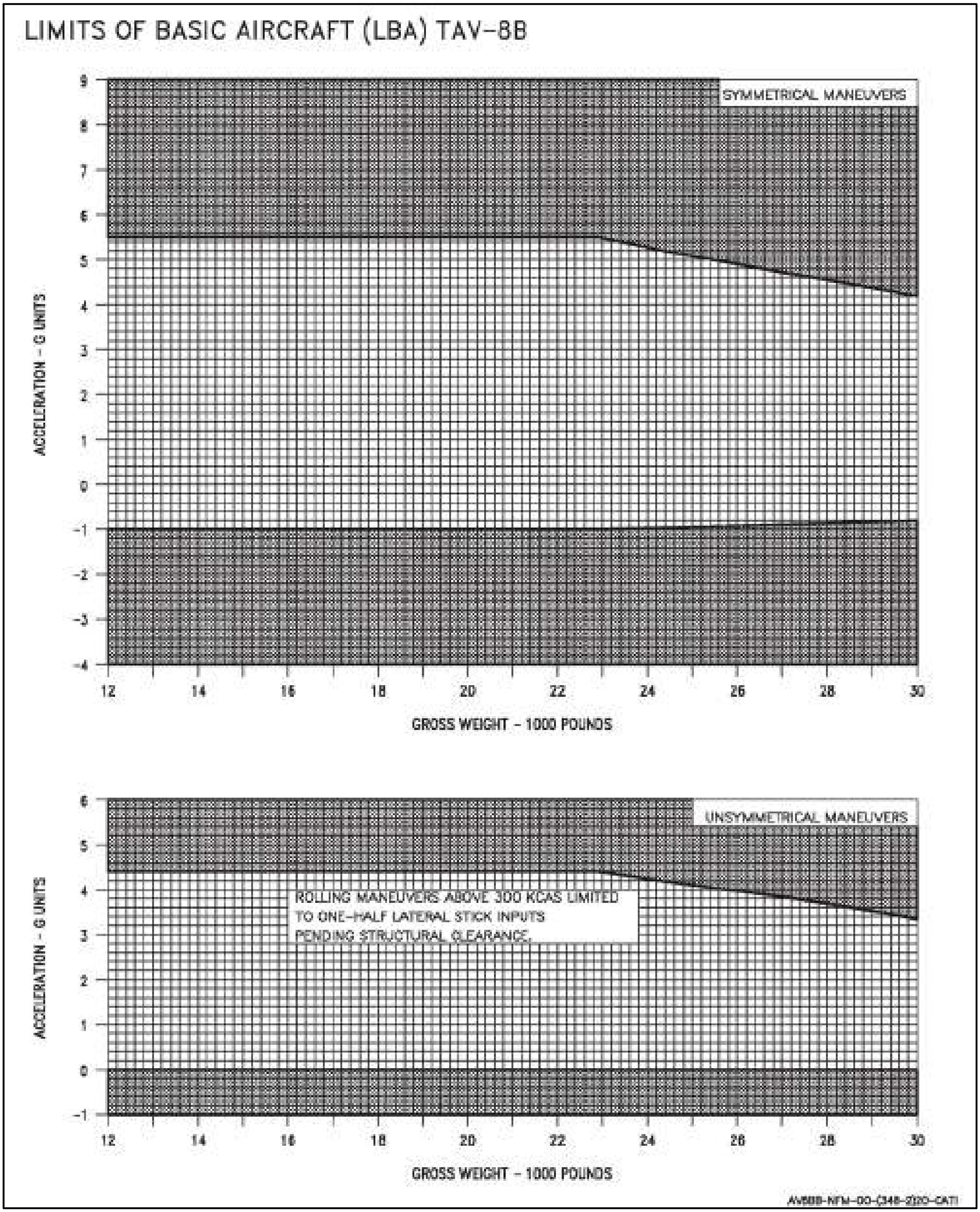


Figure 4-11. Acceleration Limitations (Sheet 2)

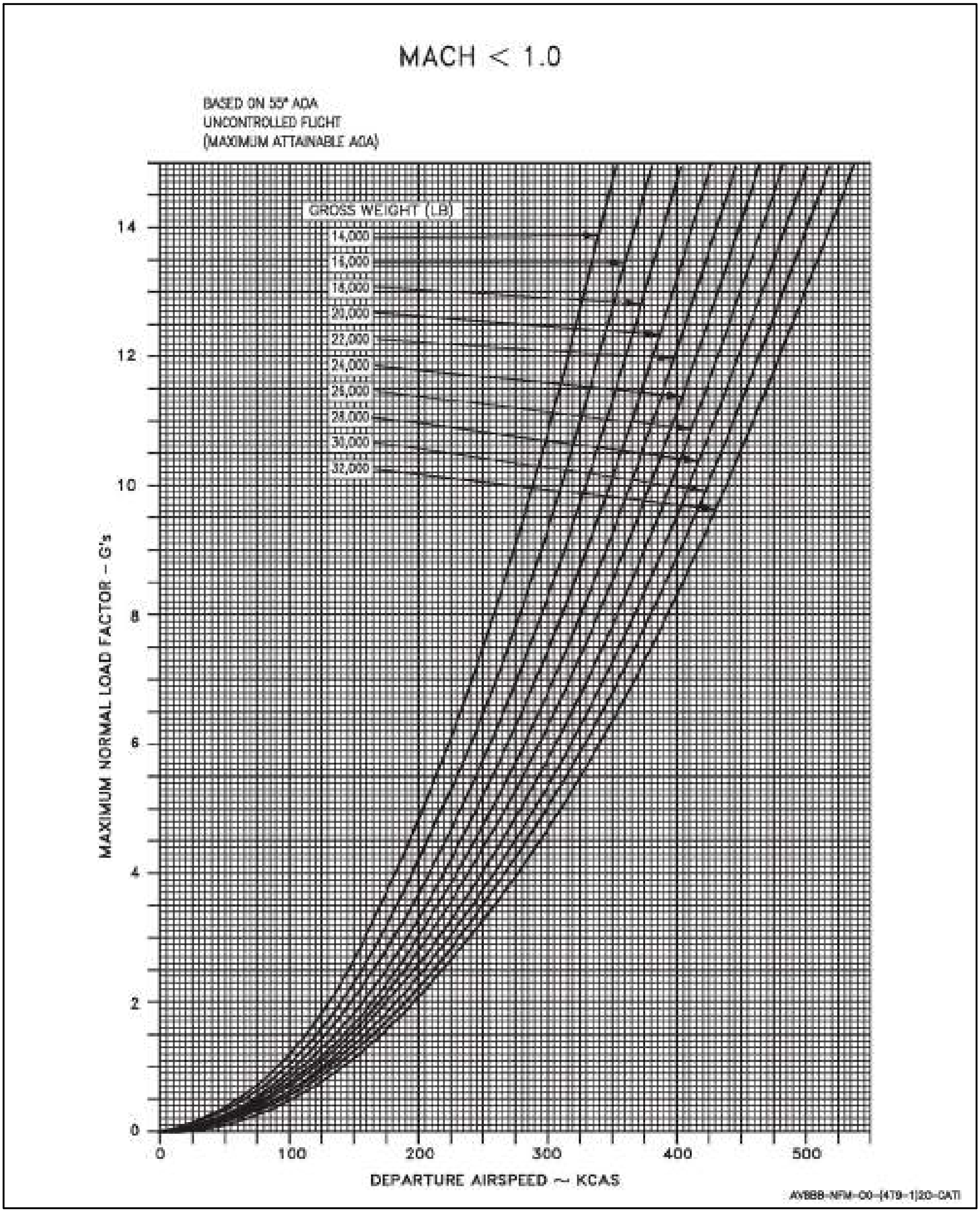
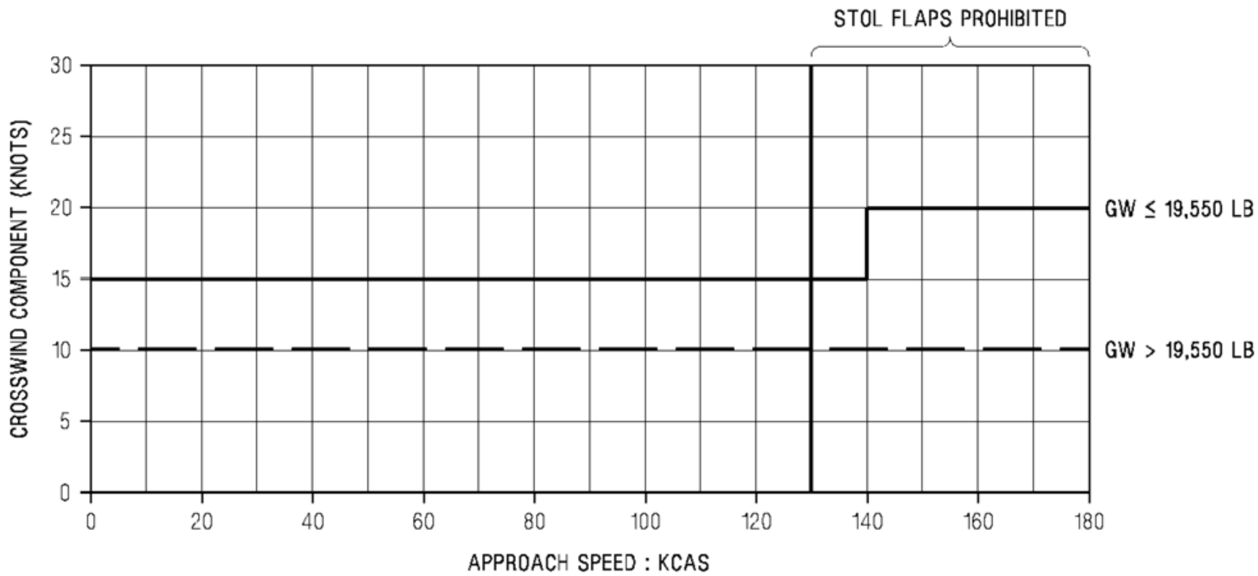


Figure 4-12. Maximum Possible Normal Load Factor

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.

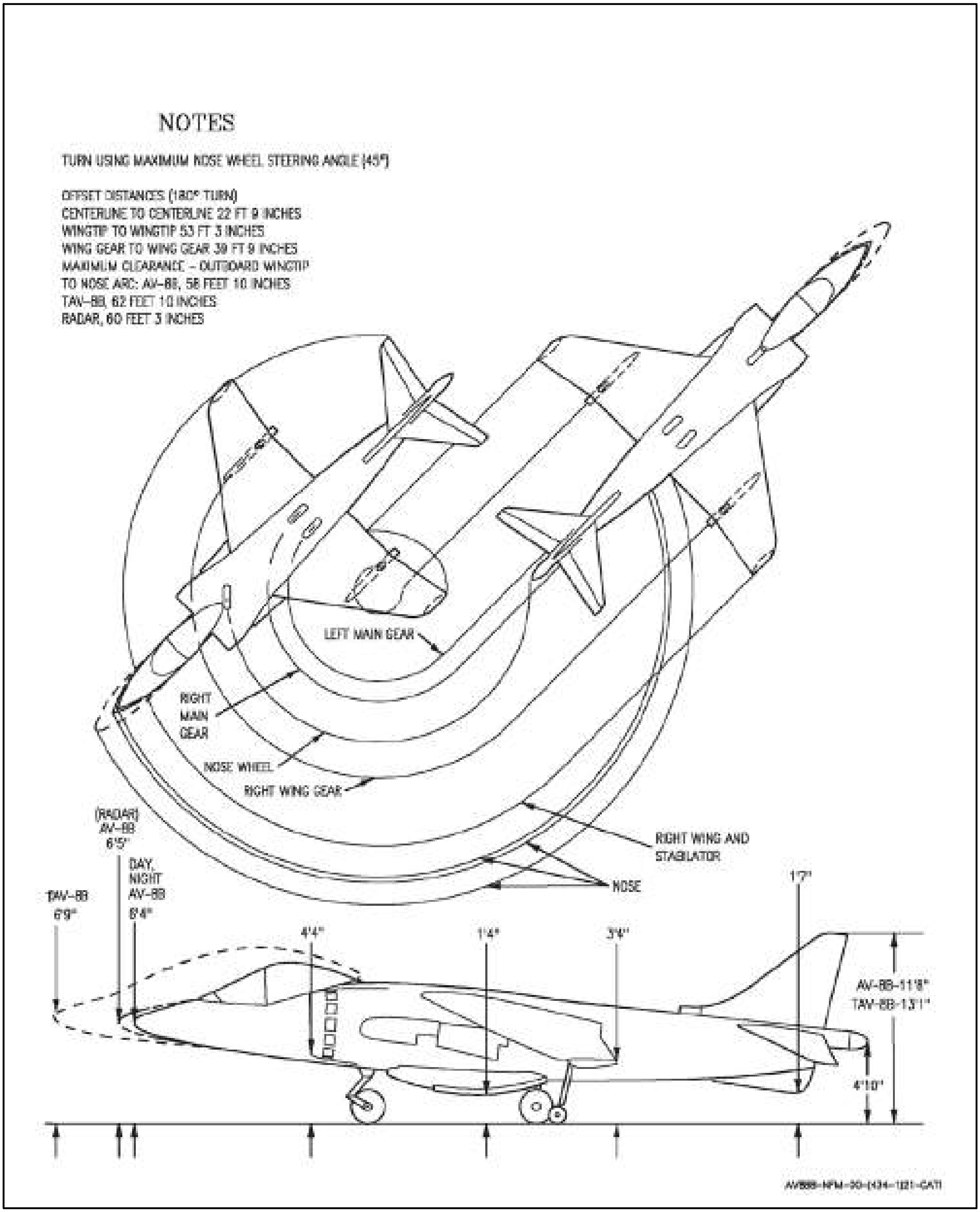


Figure 7-1. Minimum Turn Radius and Ground Clearance

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.

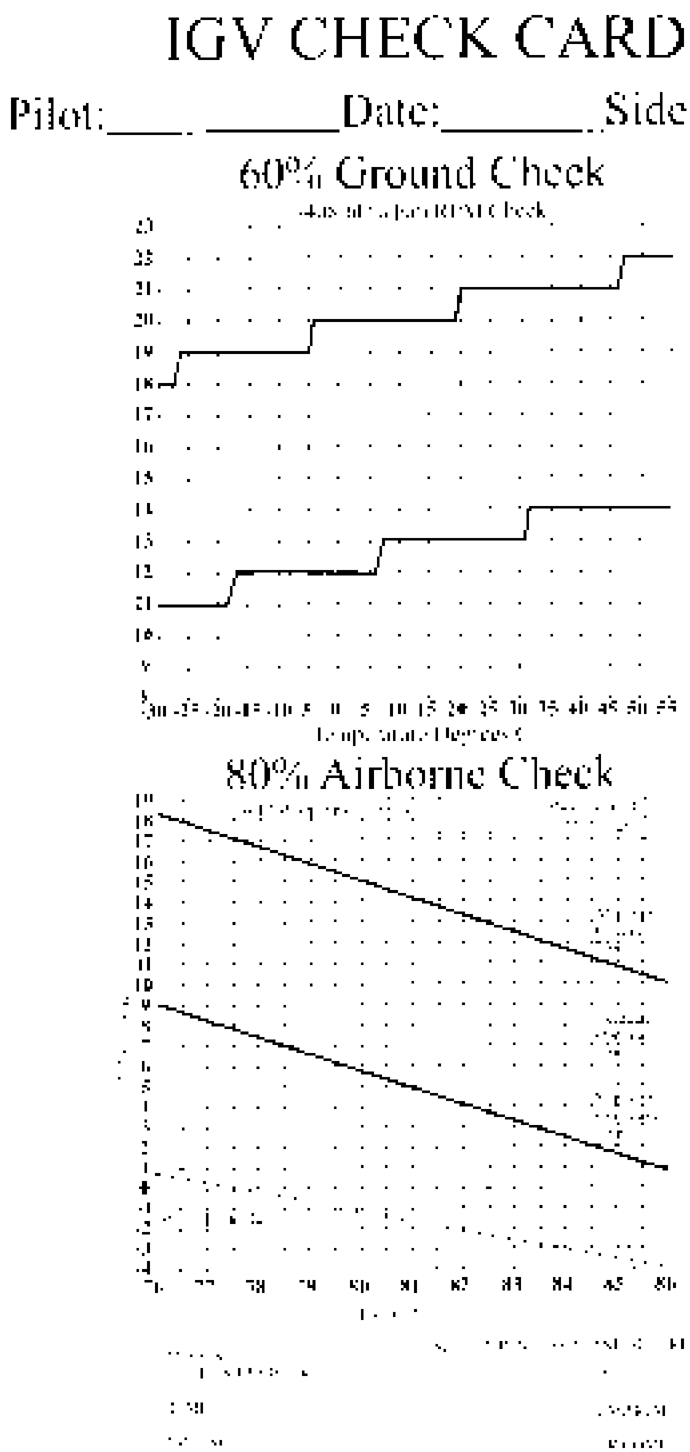


Figure 7-2. 60/80% Check Card for -408A

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.

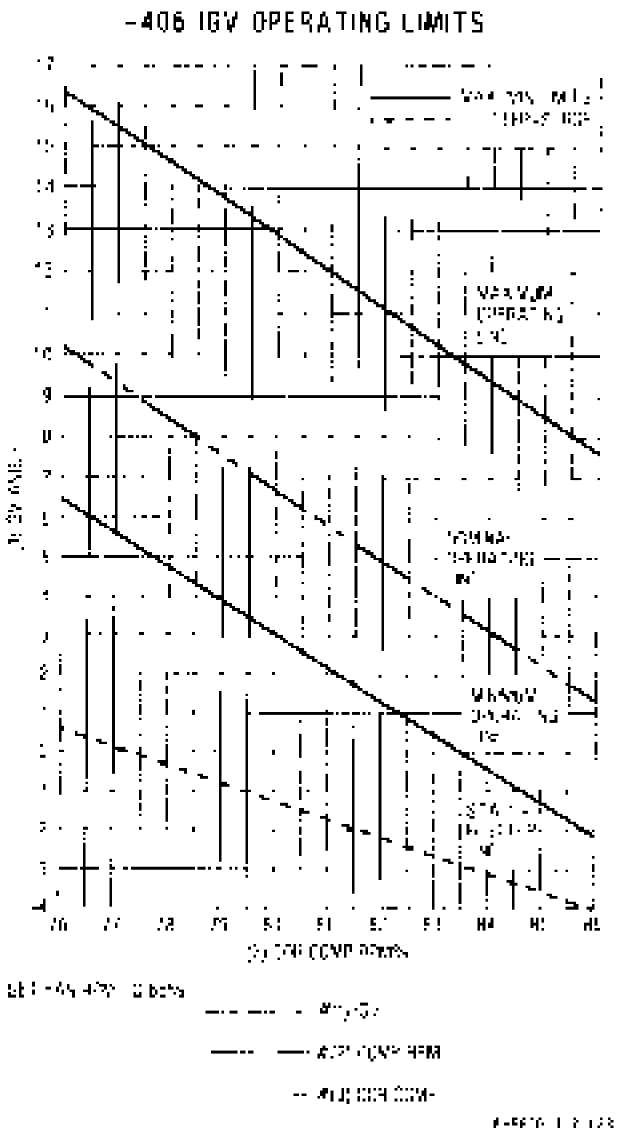


Figure 7-3. 65% Check Card for -406A

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.

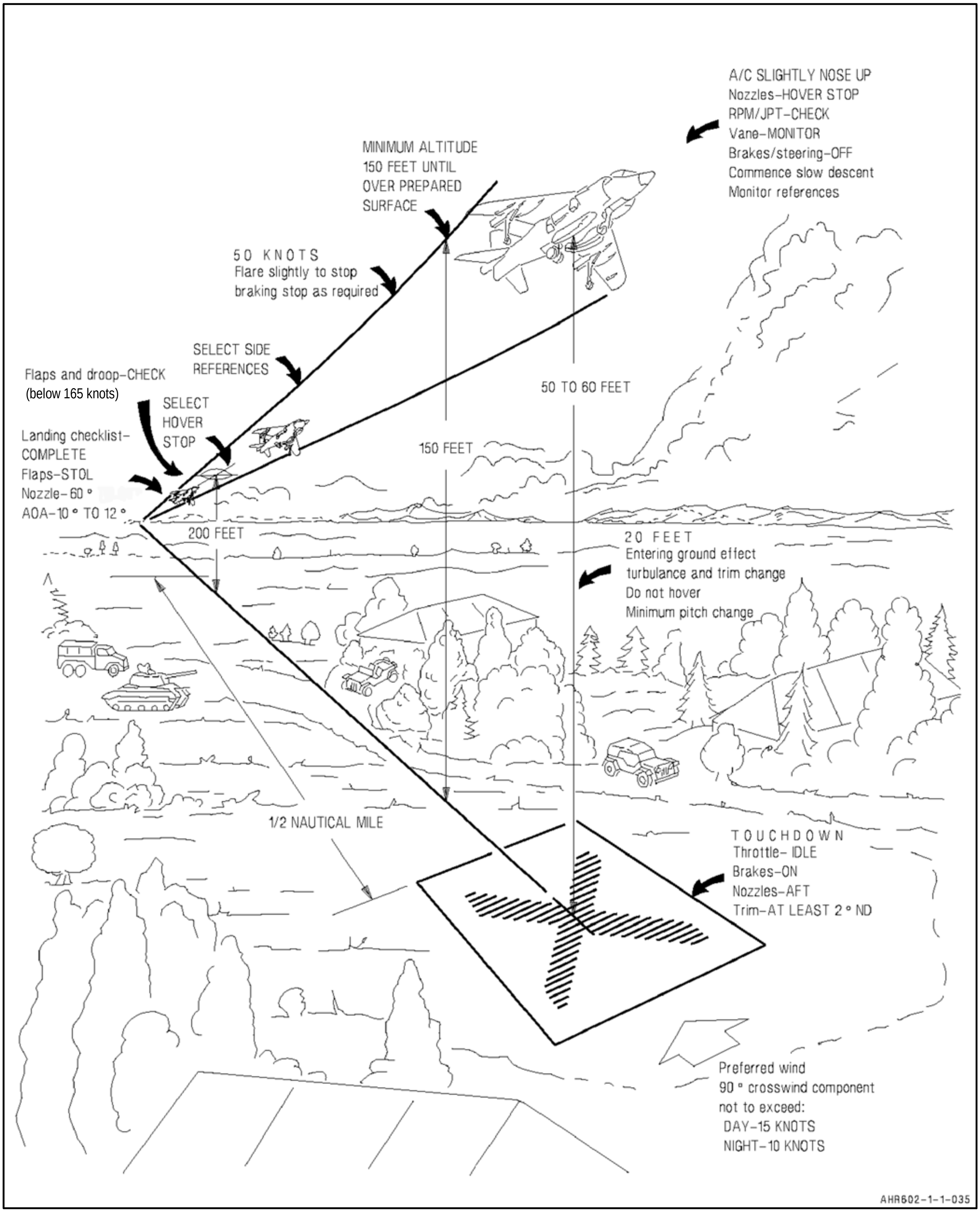


Figure 7-4. Vertical Landing

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.

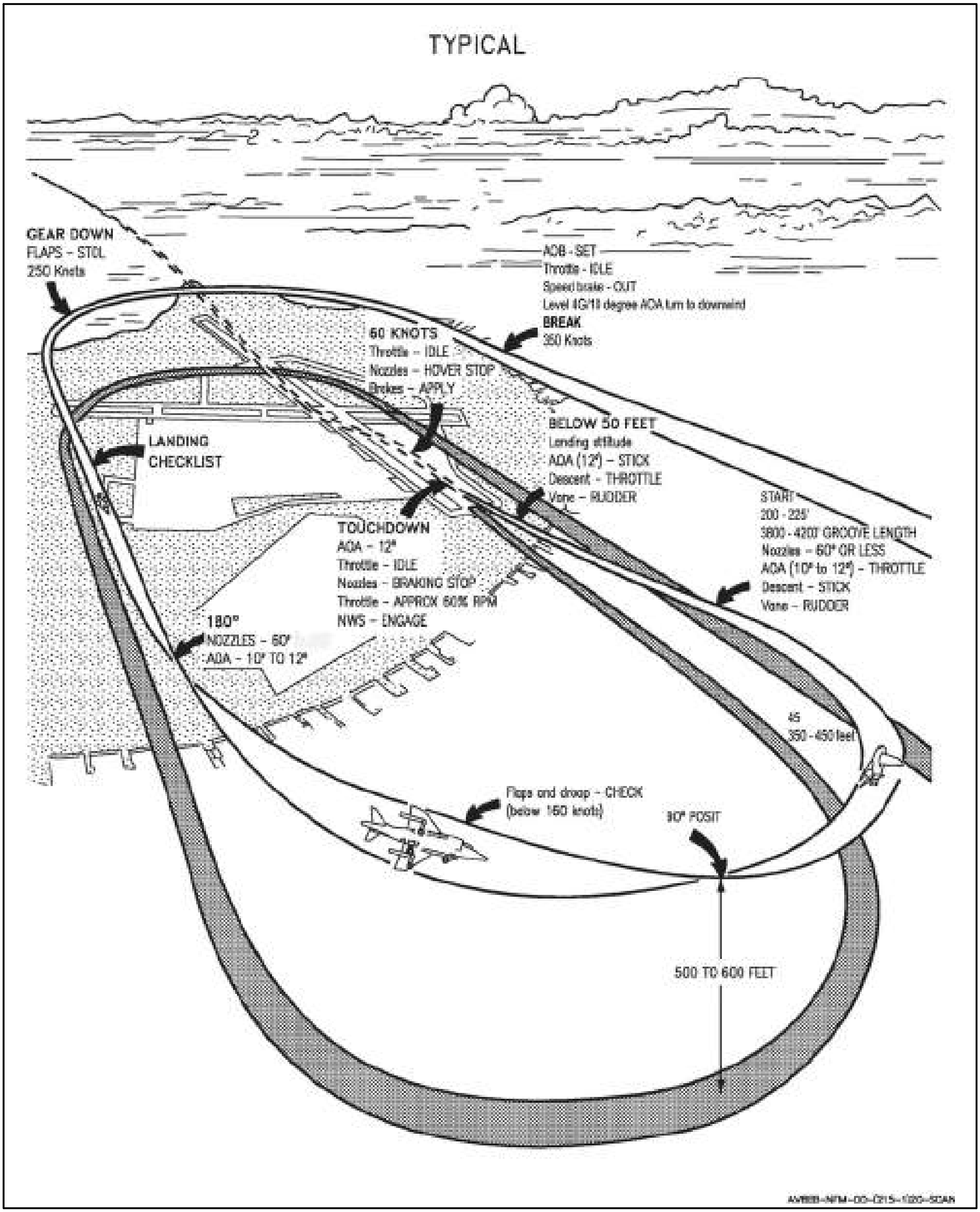


Figure 7-5. Slow Landing (Fixed Nozzle)

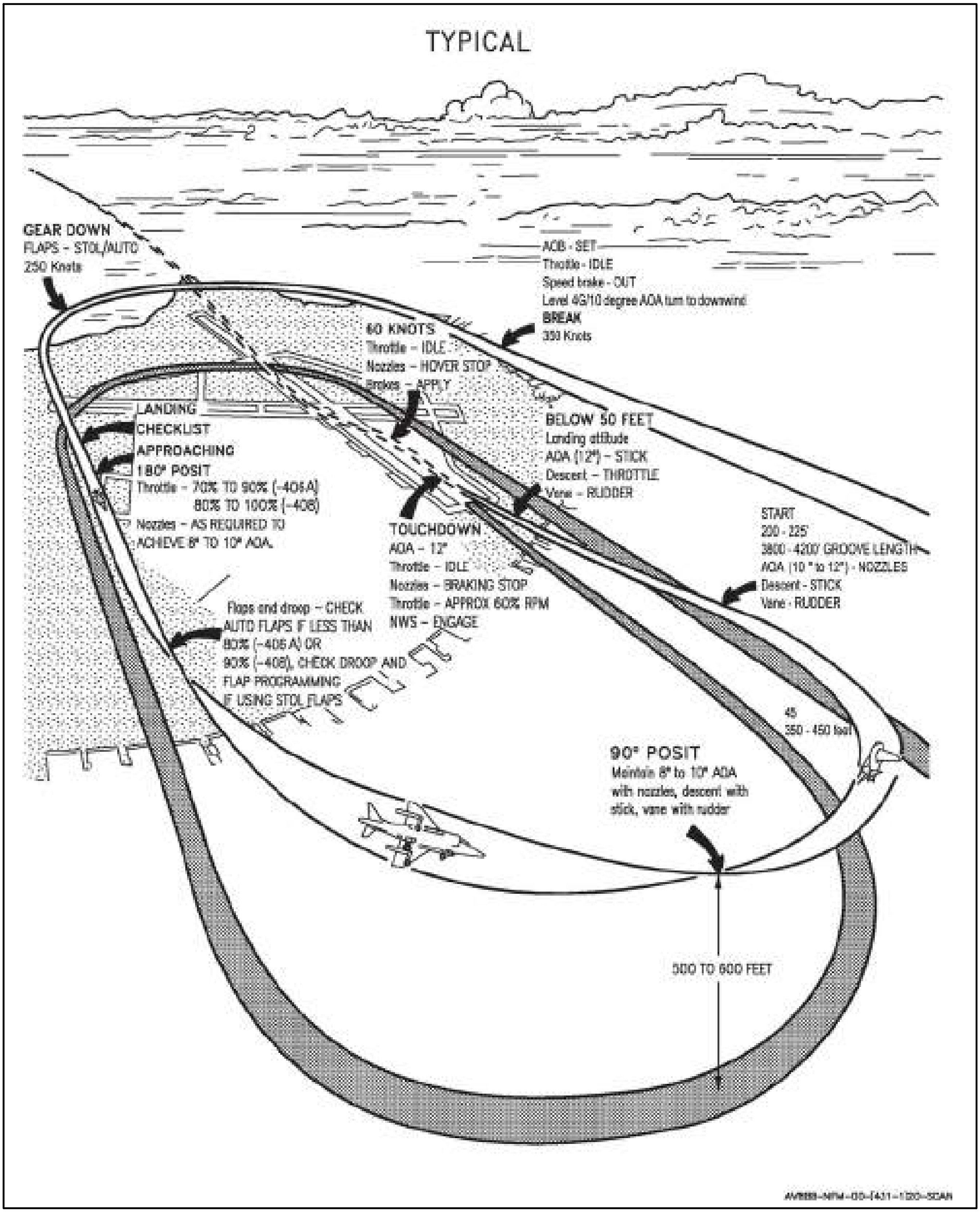


Figure 7-6. Slow Landing (Variable Nozzle)

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.

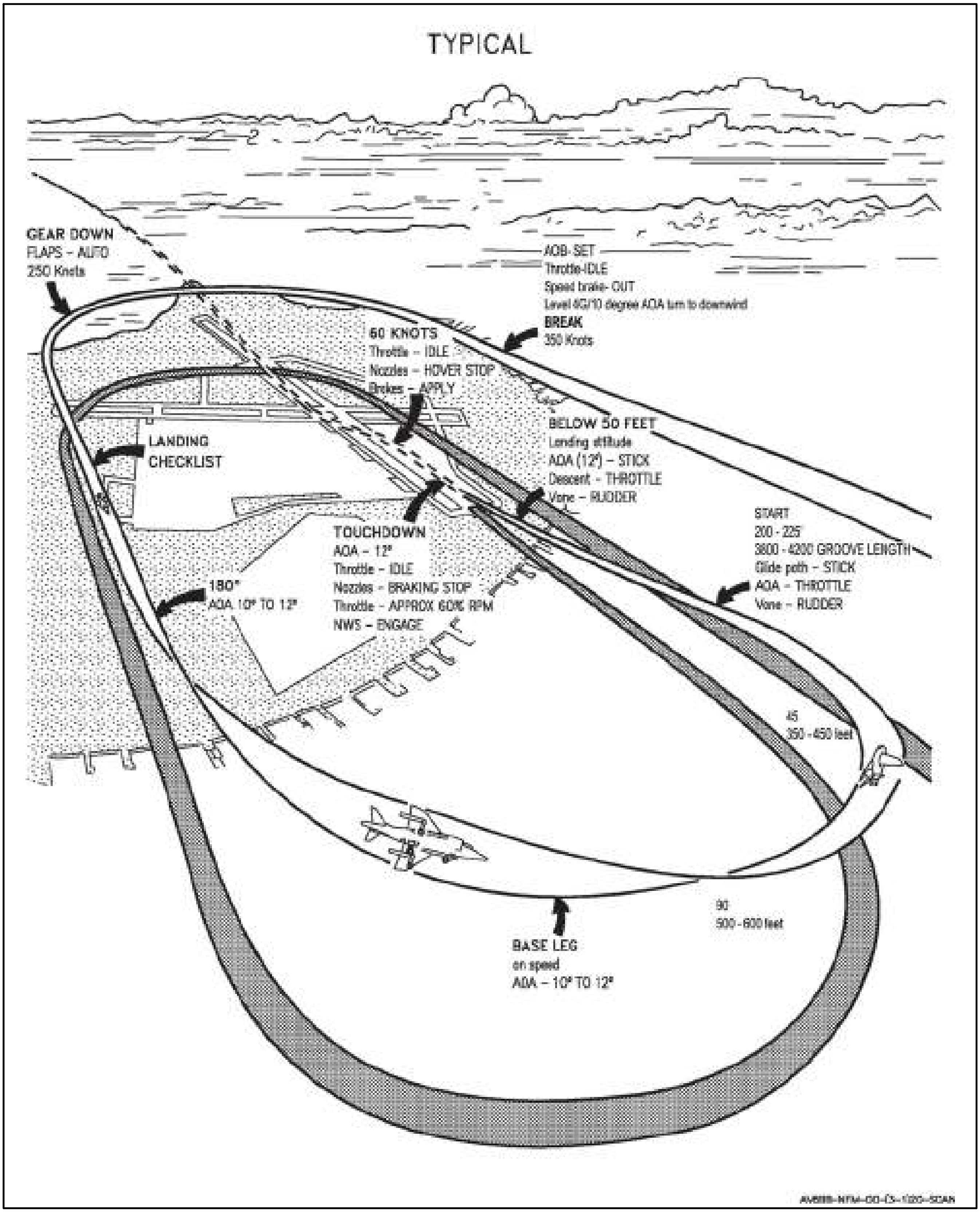


Figure 7-7. Conventional Landing

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.

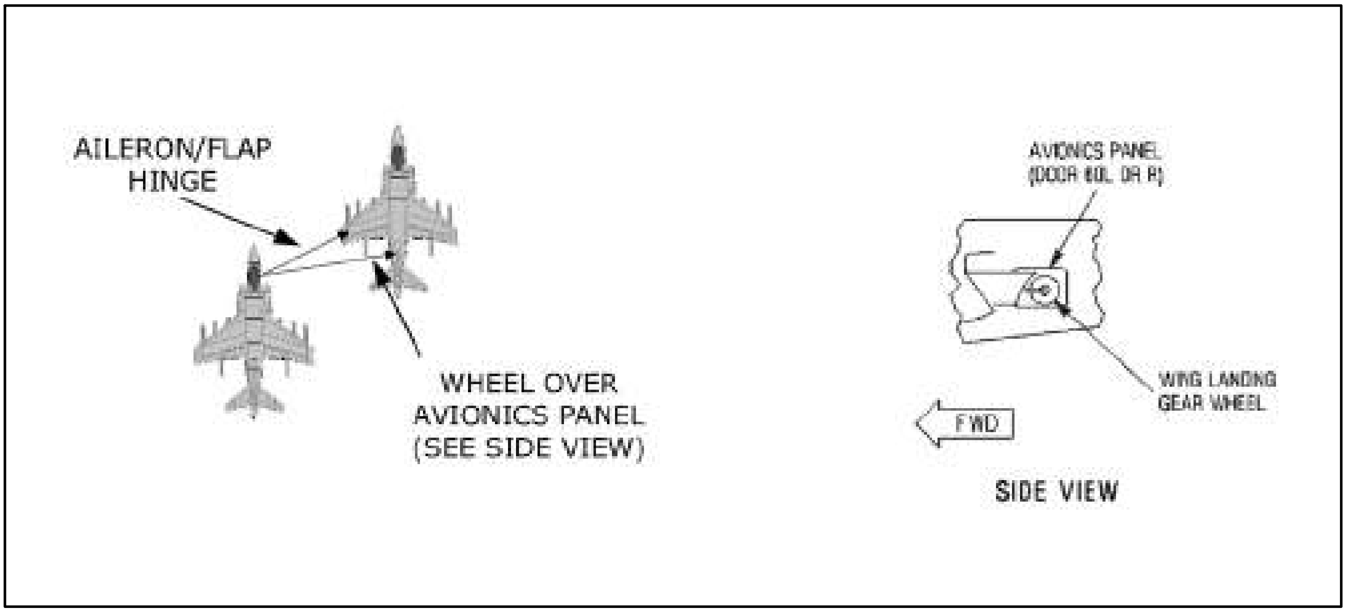


Figure 9-2. Section Parade

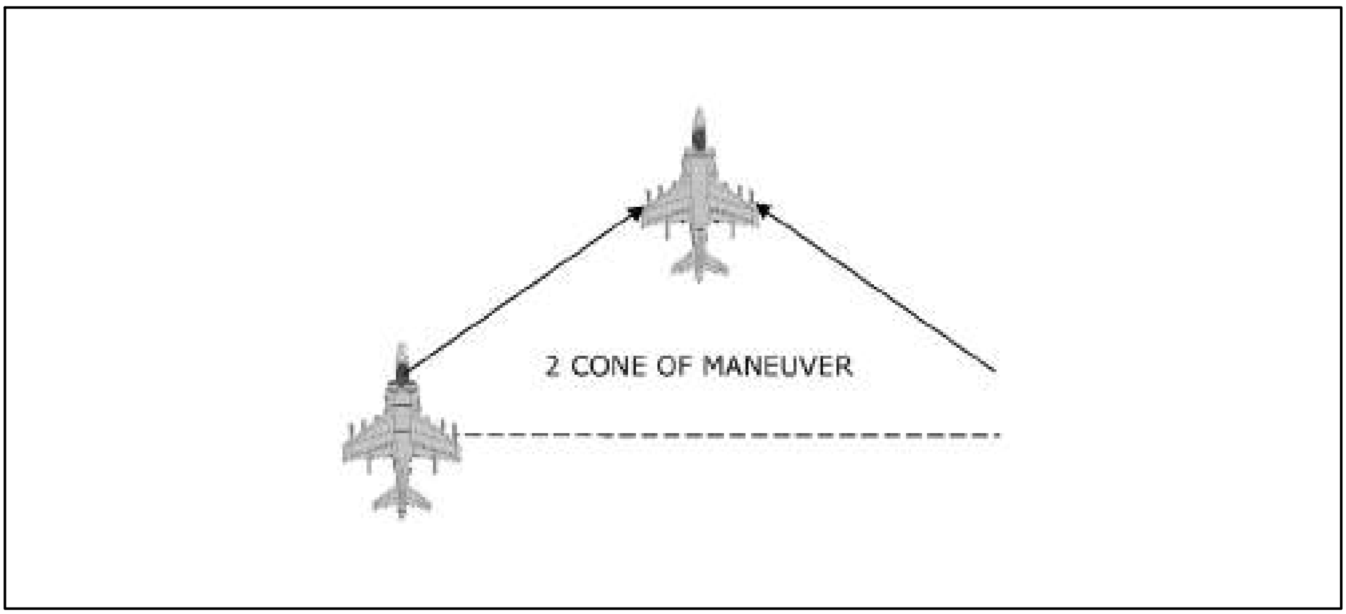


Figure 9-3. Section Cruise

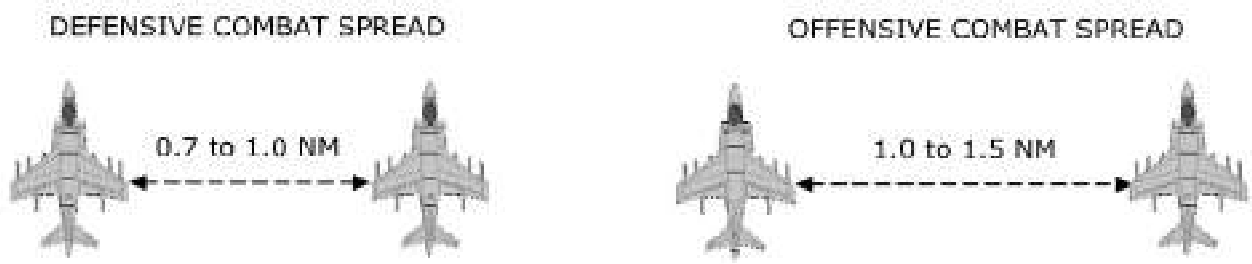


Figure 9-4. Combat Spread

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.

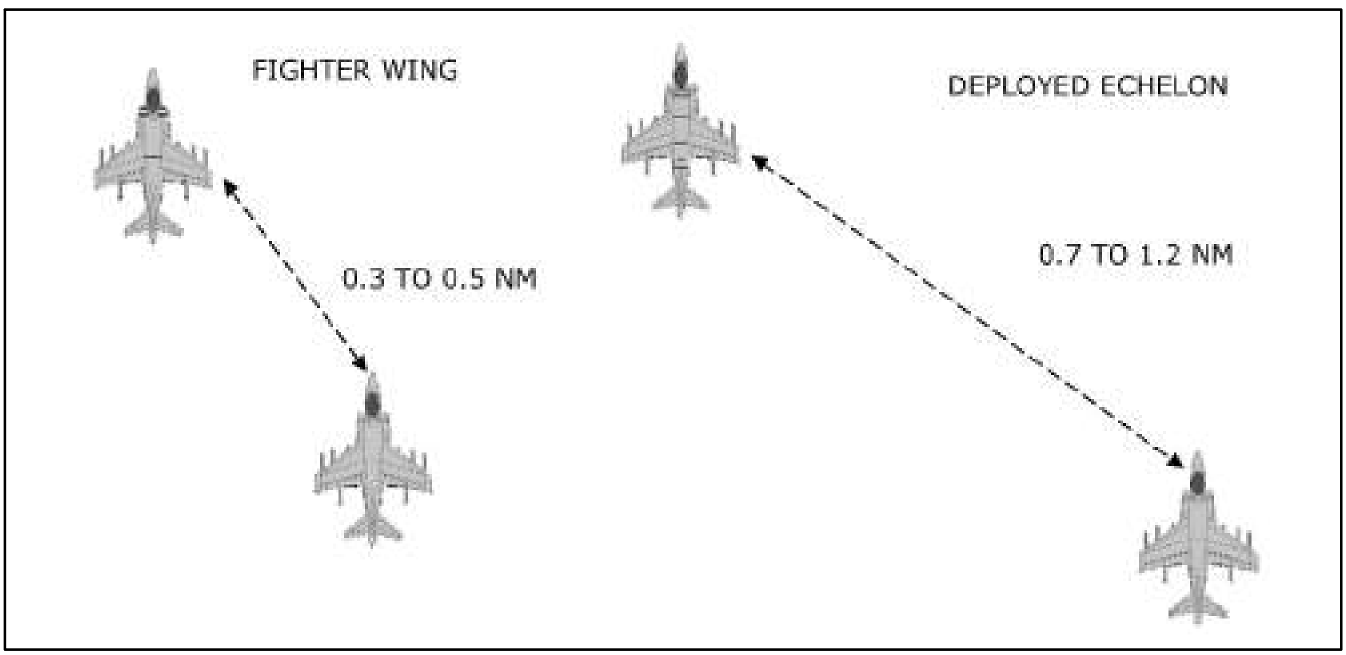


Figure 9-5. Fighter Wing and Deployed Echelon

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.

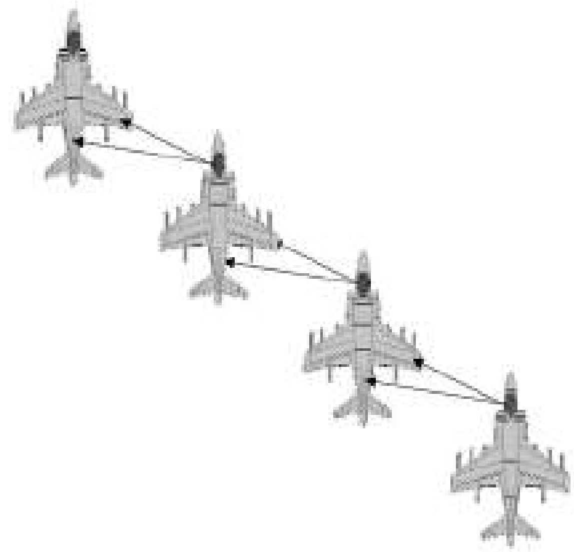


Figure 9-6. Division Parade

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.

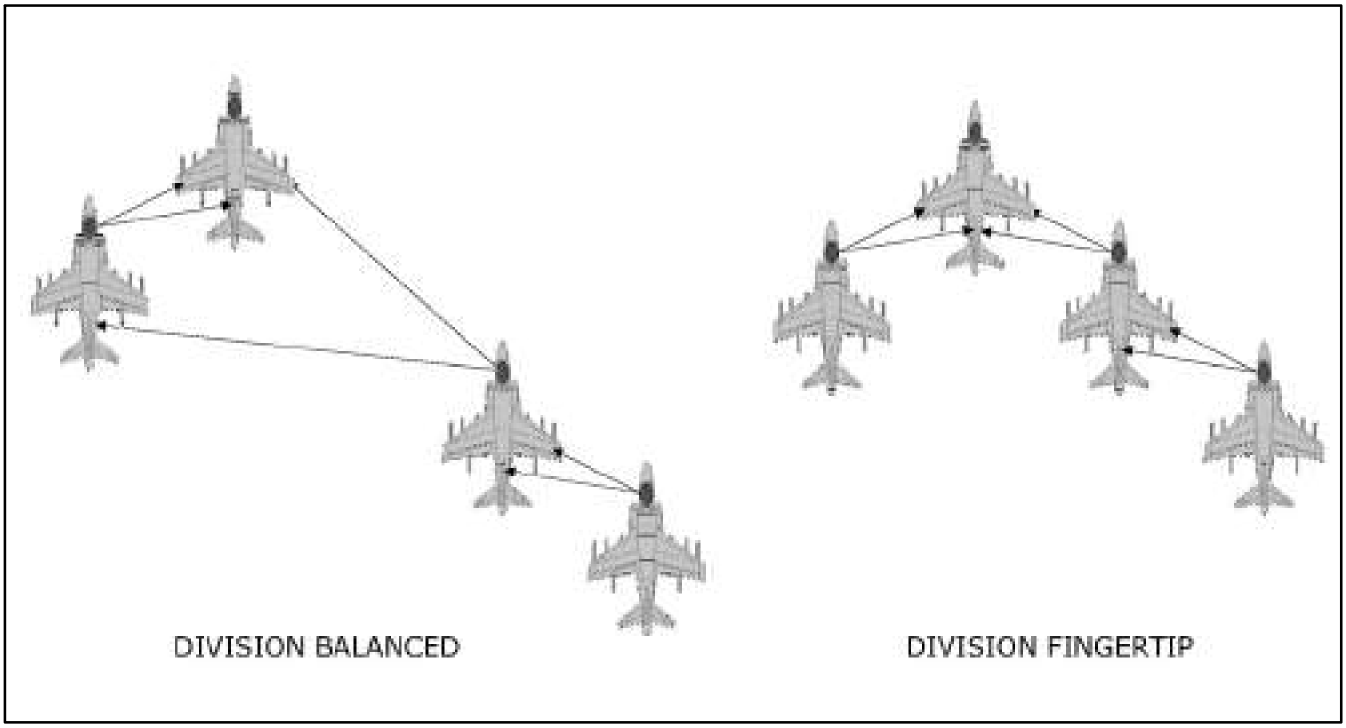


Figure 9-7. Division Fingertip and Balanced Parade

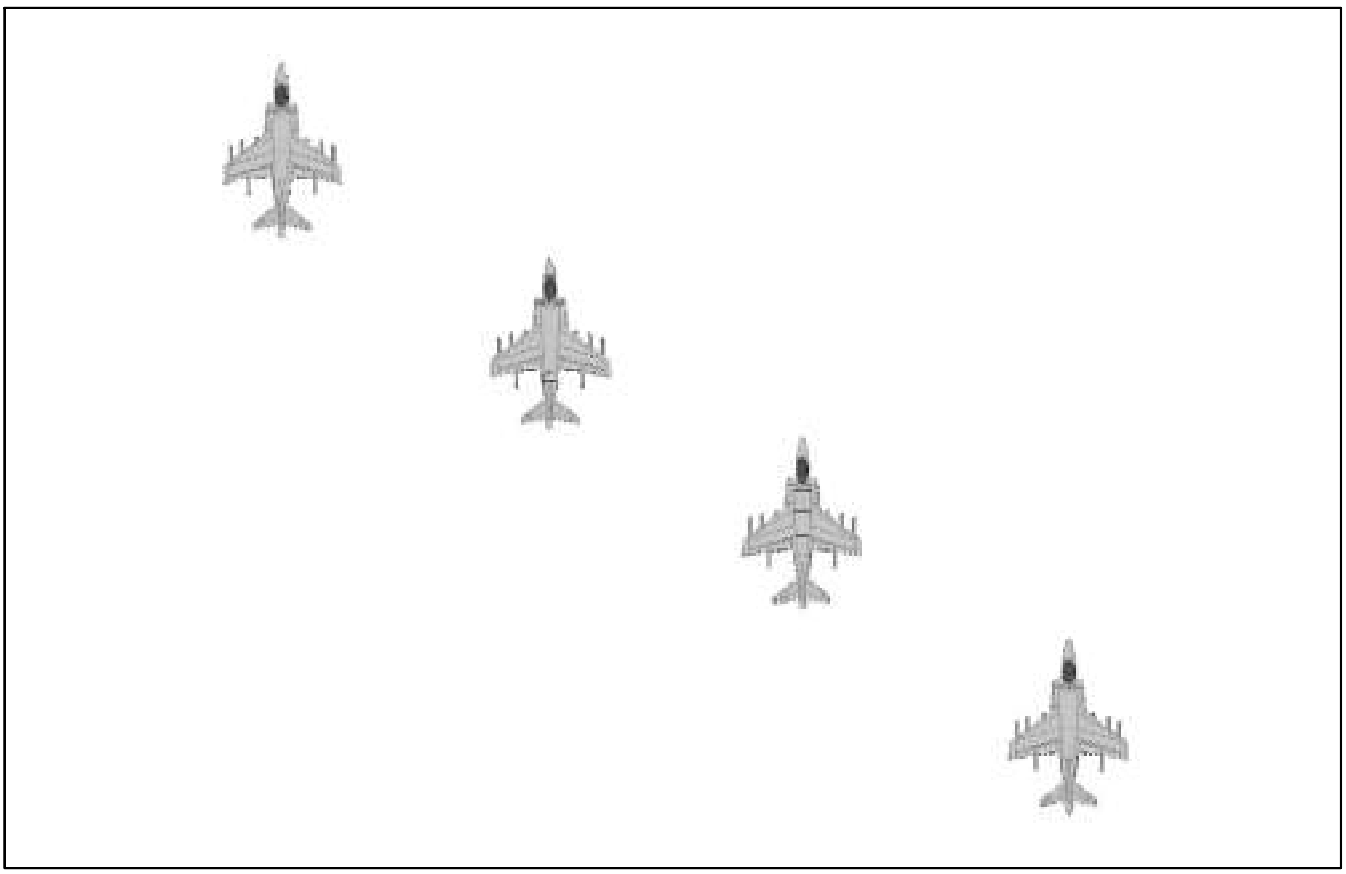


Figure 9-8. Division Cruise

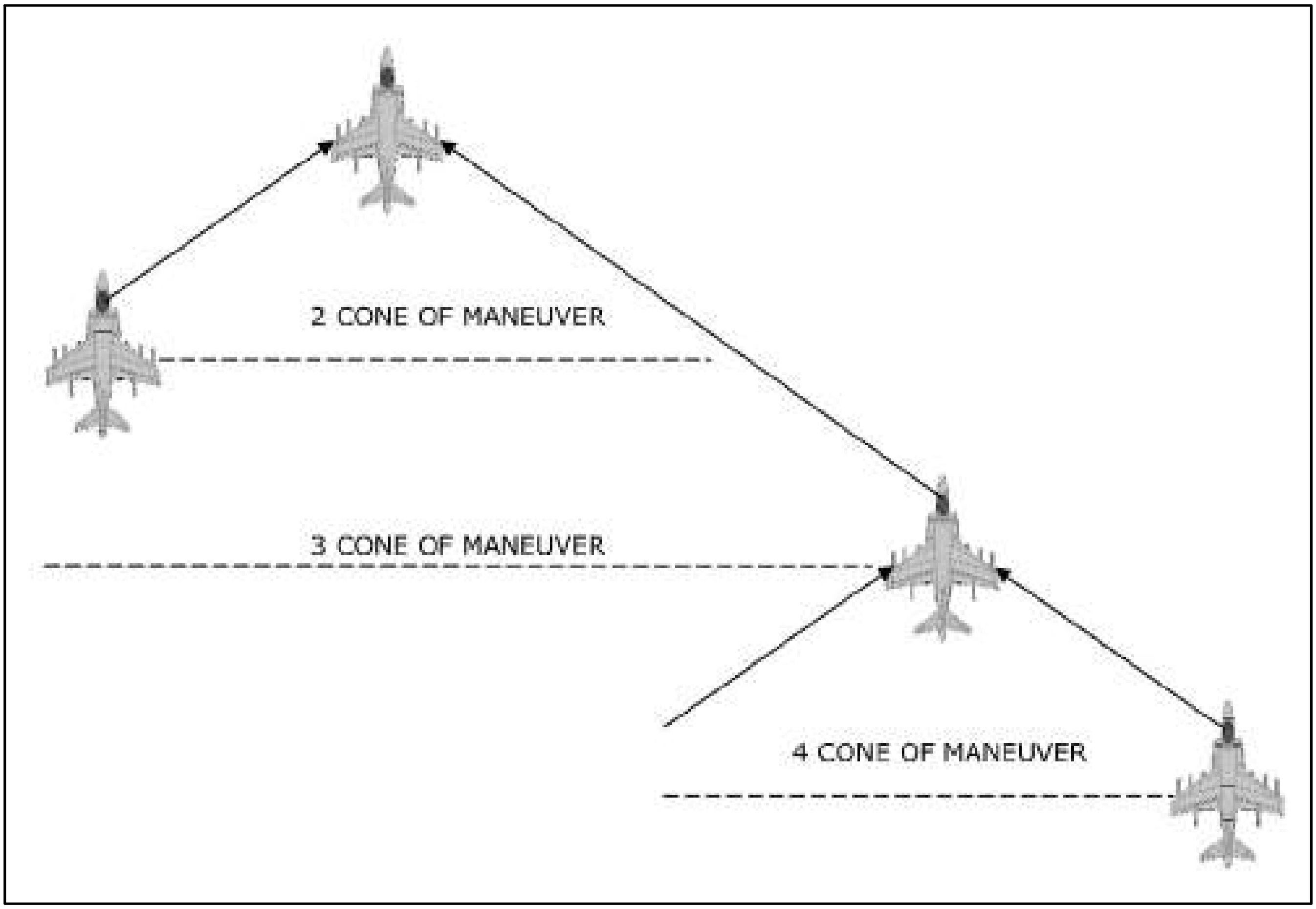


Figure 9-9. Deployed Echelon

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.

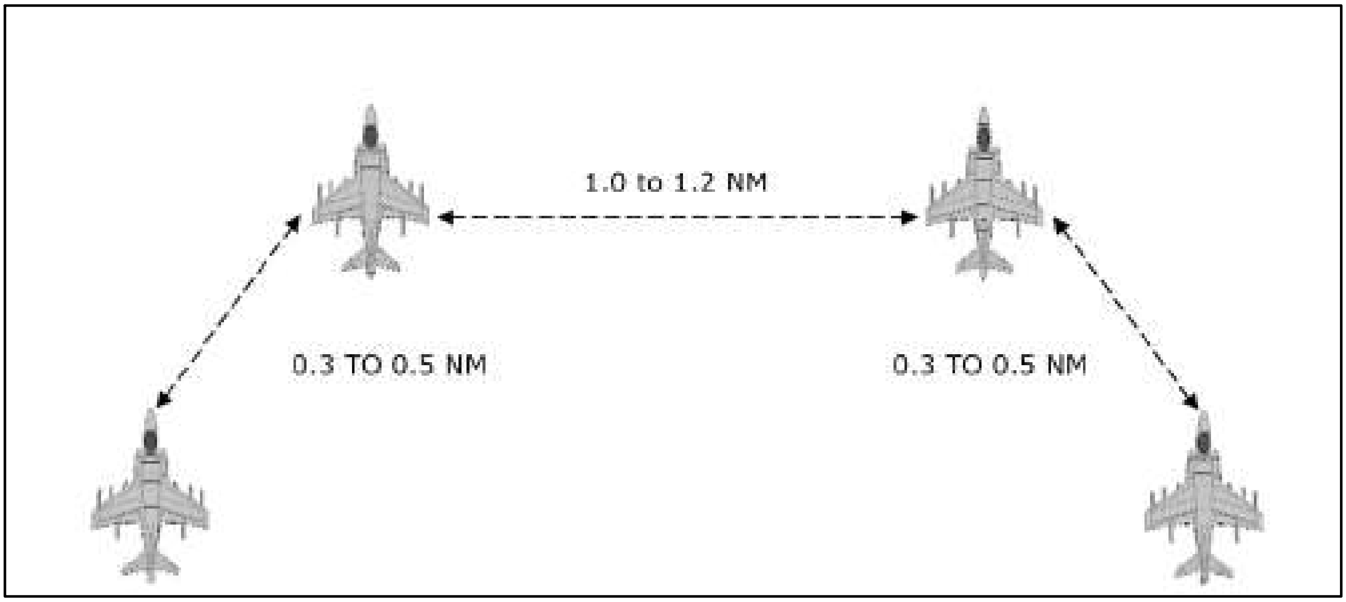


Figure 9-10. Fluid Four

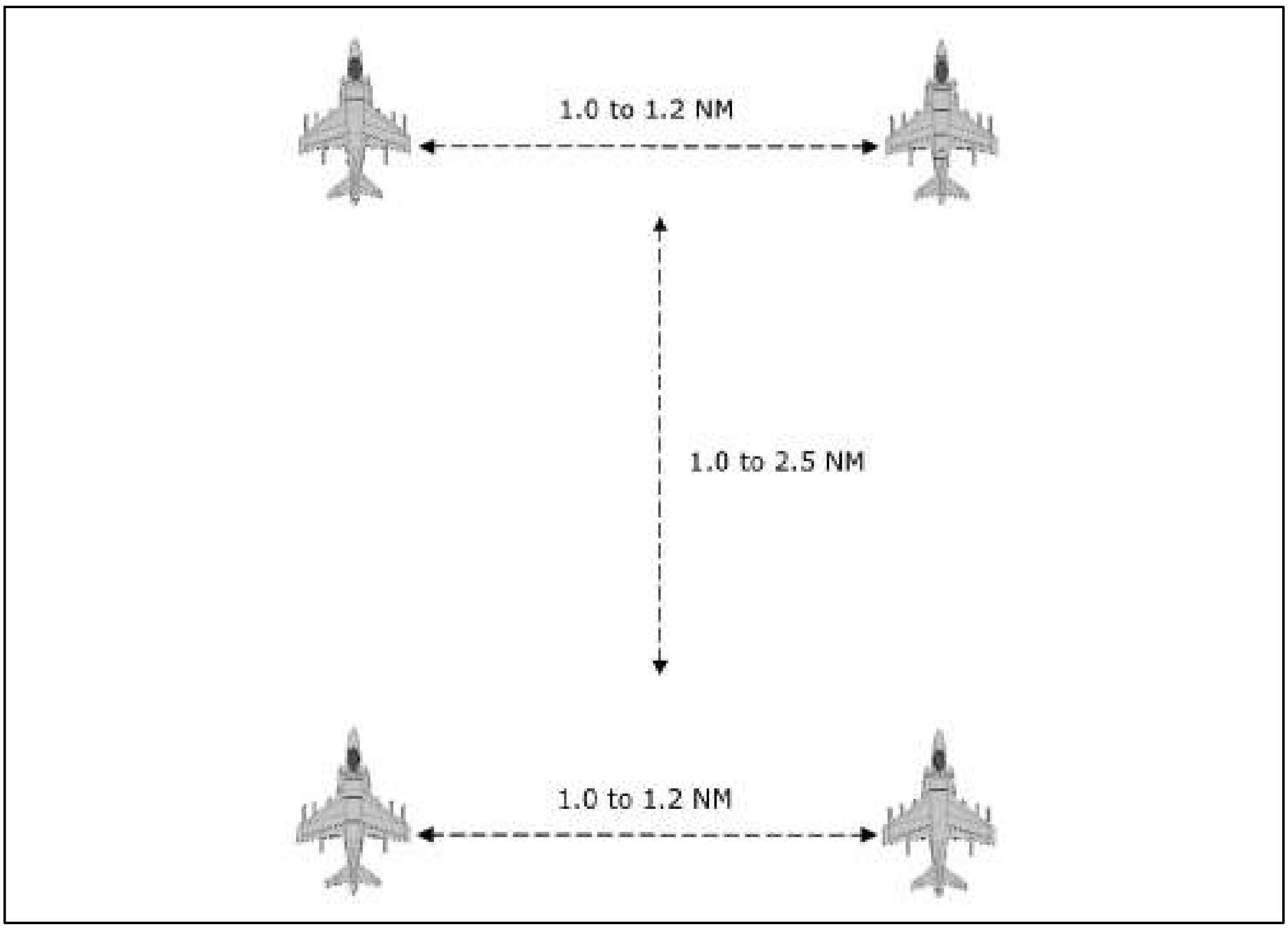


Figure 9-11. Division Box

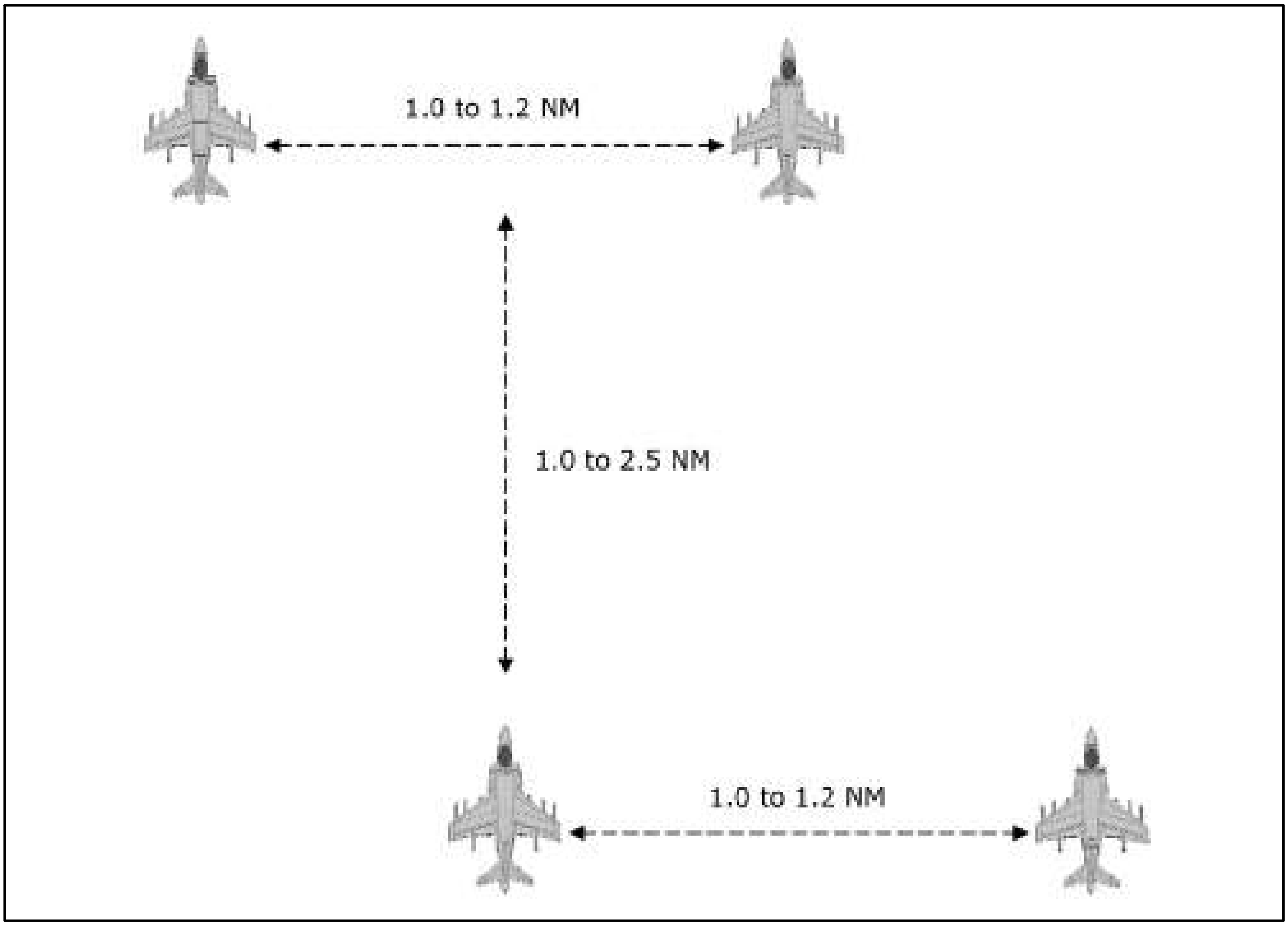


Figure 9-12. Division Offset Box

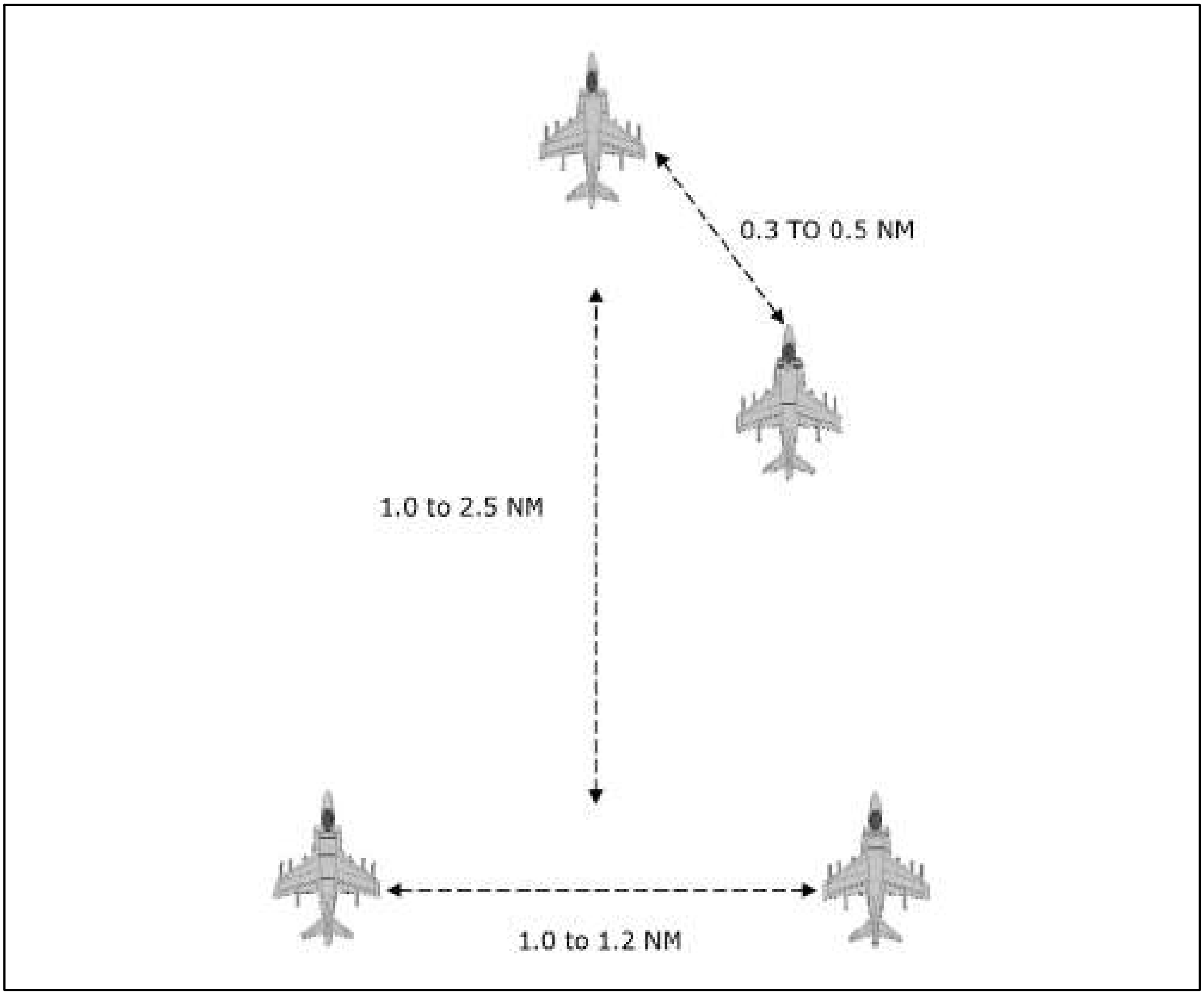


Figure 9-13. Division Wedge

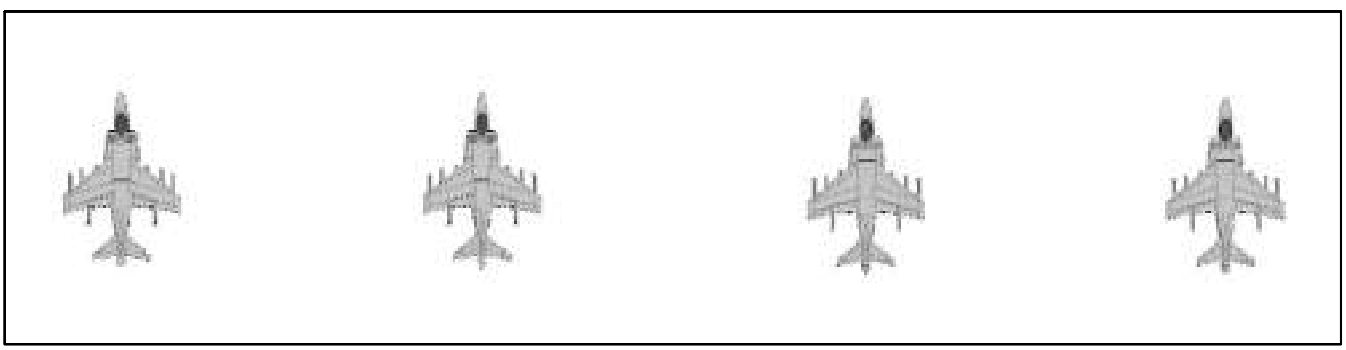


Figure 9-14. Division Wall

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

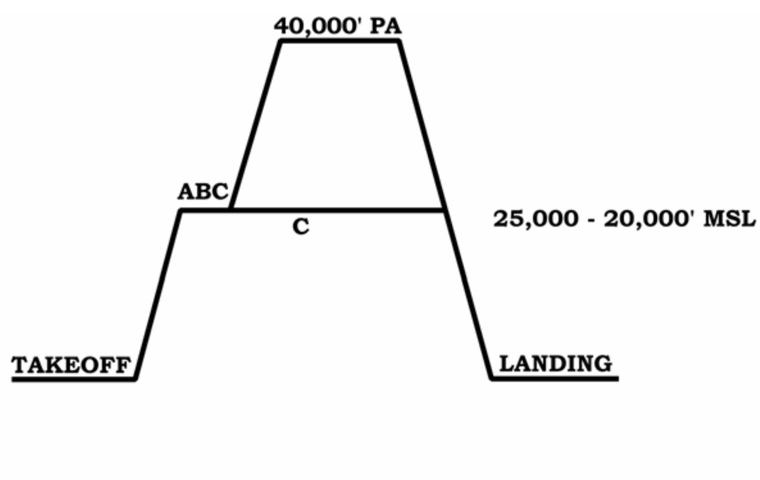
10.1 GENERAL PROCEDURES

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

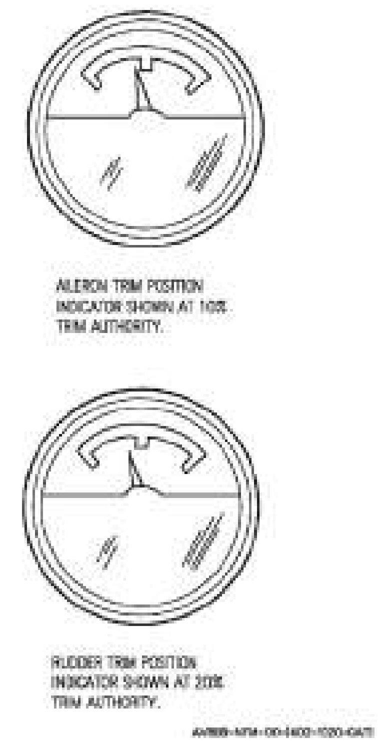


Figure 10-1. Trim Position Indicators

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.

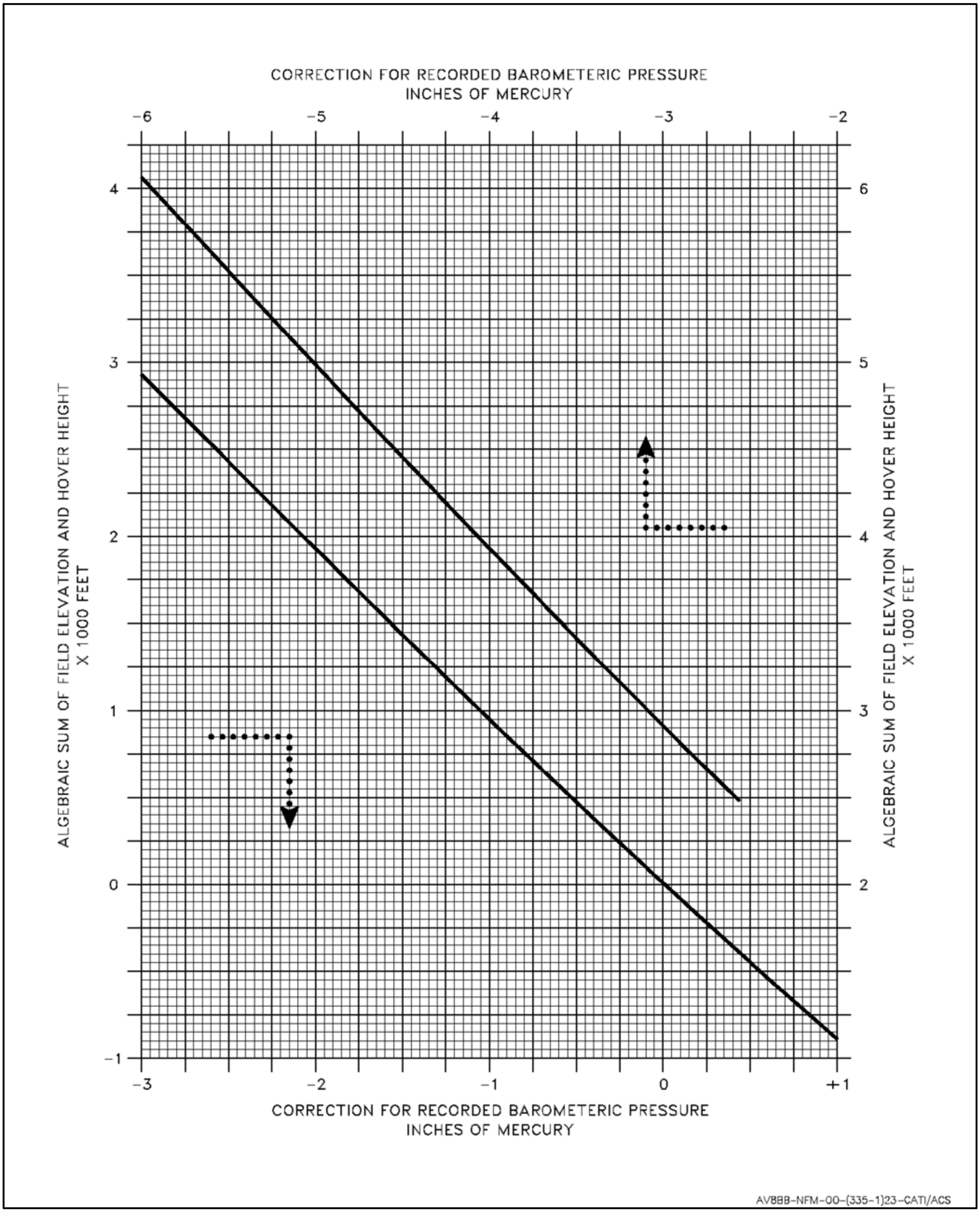


Figure 10-2. Barometric Pressure Correction

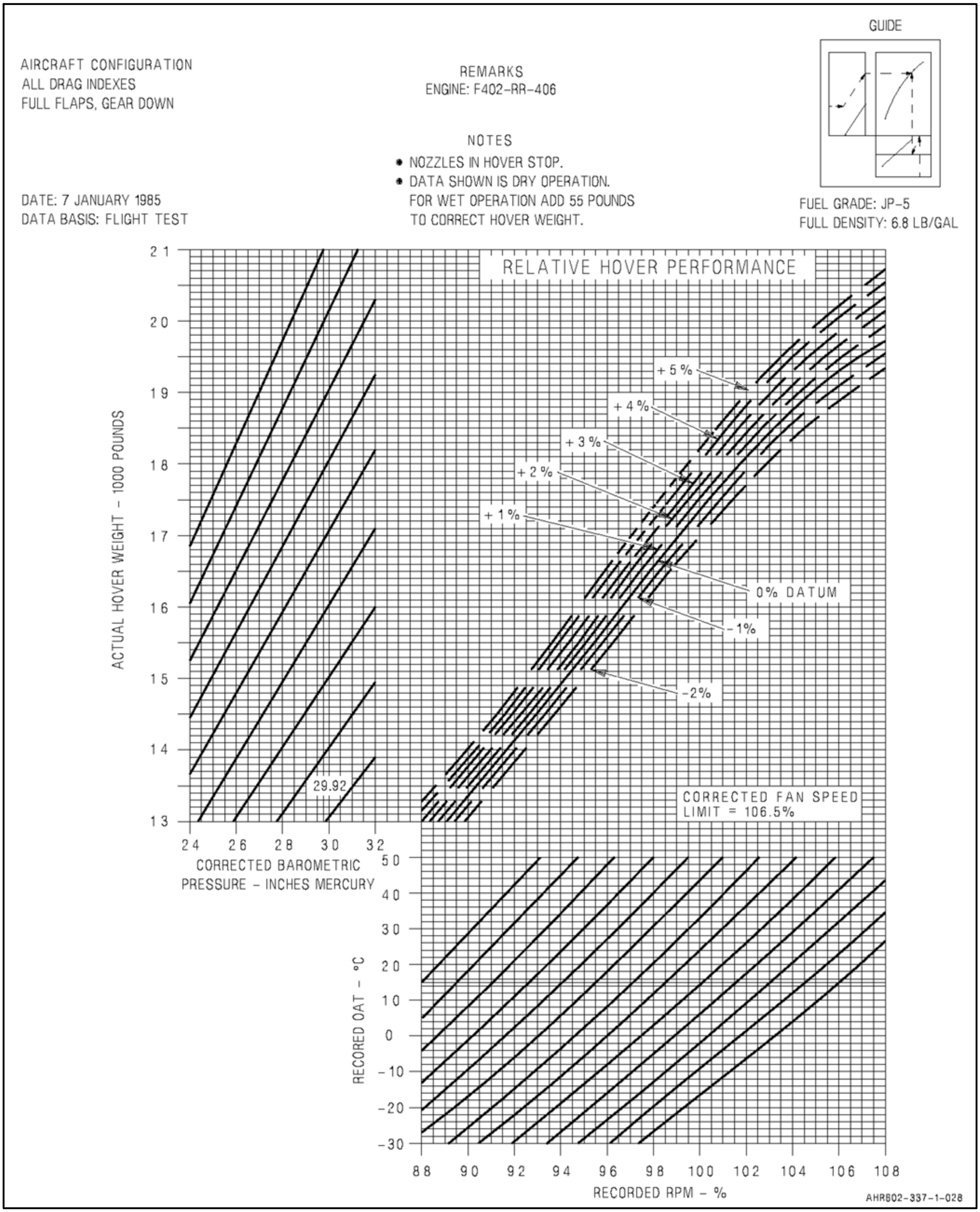


Figure 10-3. Engine RPM Required to Hover, F402-RR-406 Engine

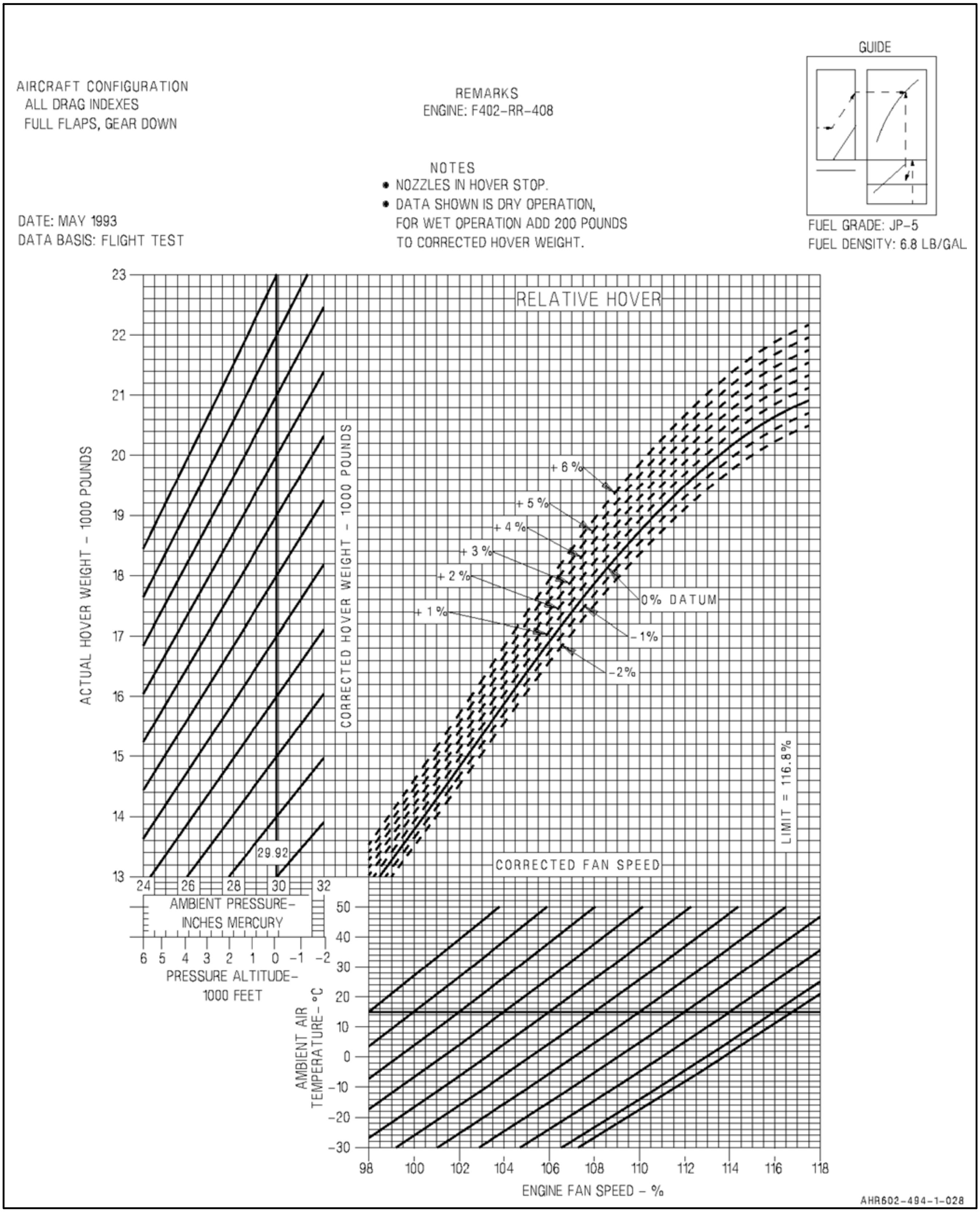


Figure 10-4. Engine RPM Required to Hover, F402–RR–408 Engine

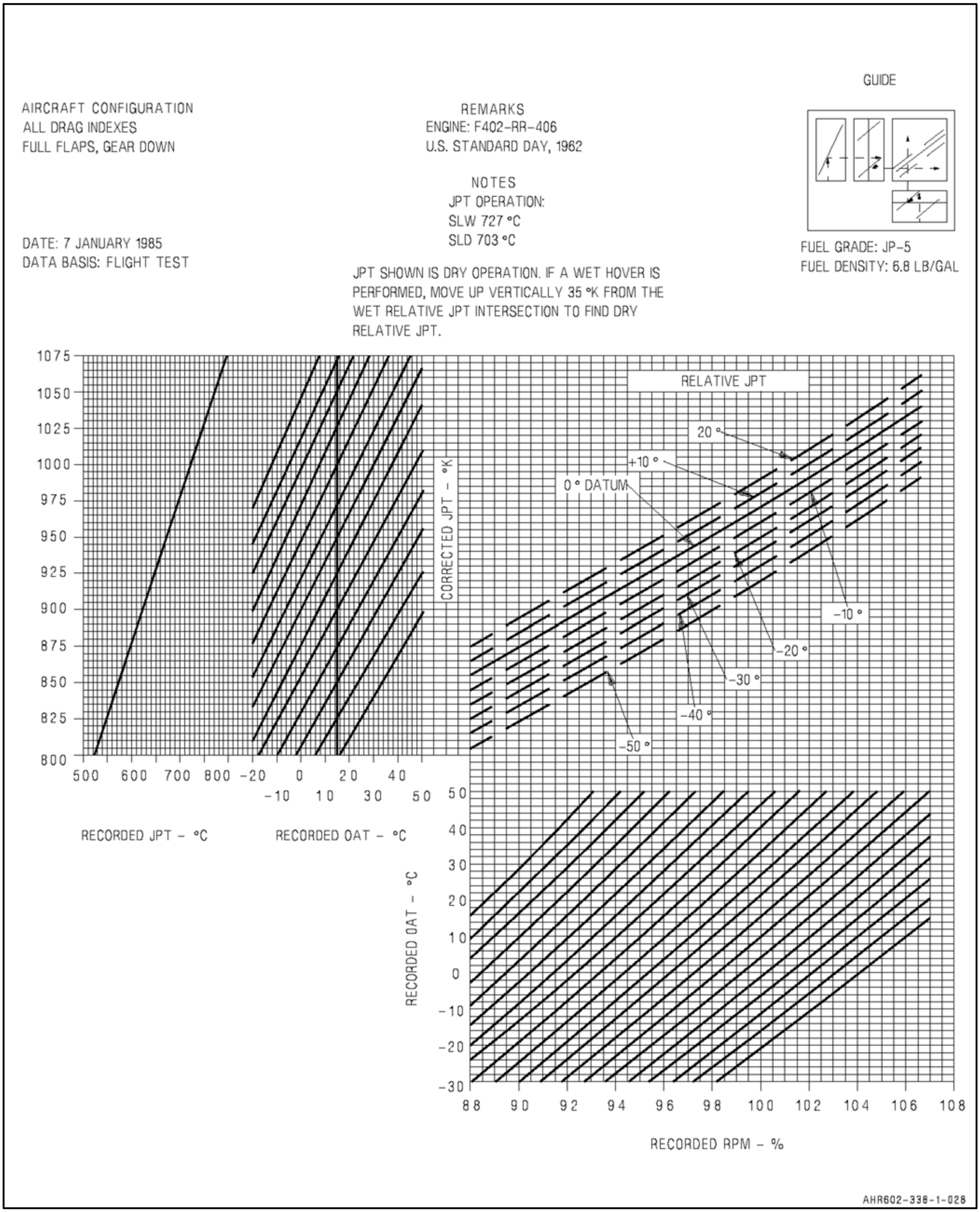


Figure 10-5. JPT in Hover, F402-RR-406 Engine (Sheet 1 of 2)

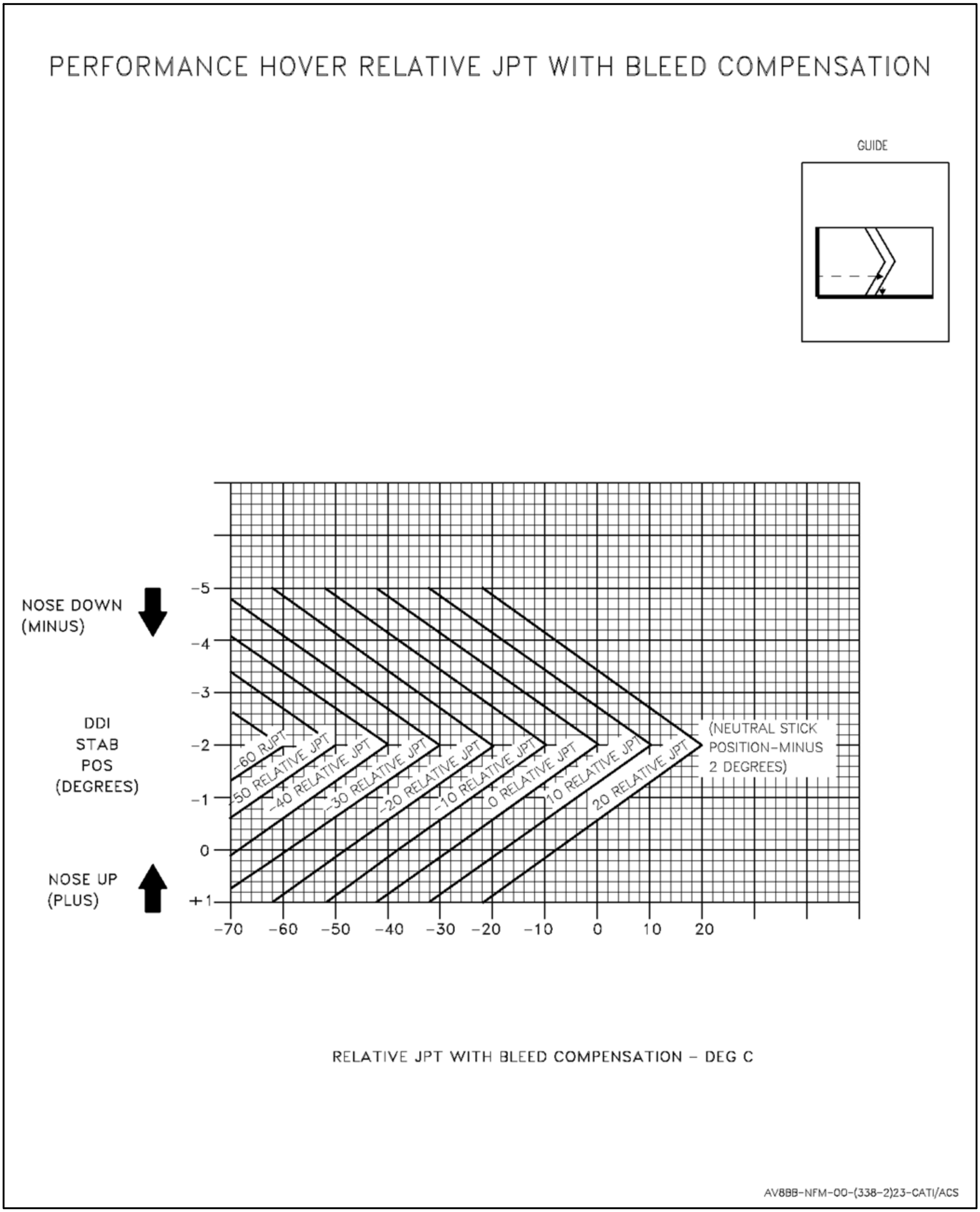


Figure 10-5. JPT in Hover, F402–RR–406 Engine (Sheet 2)

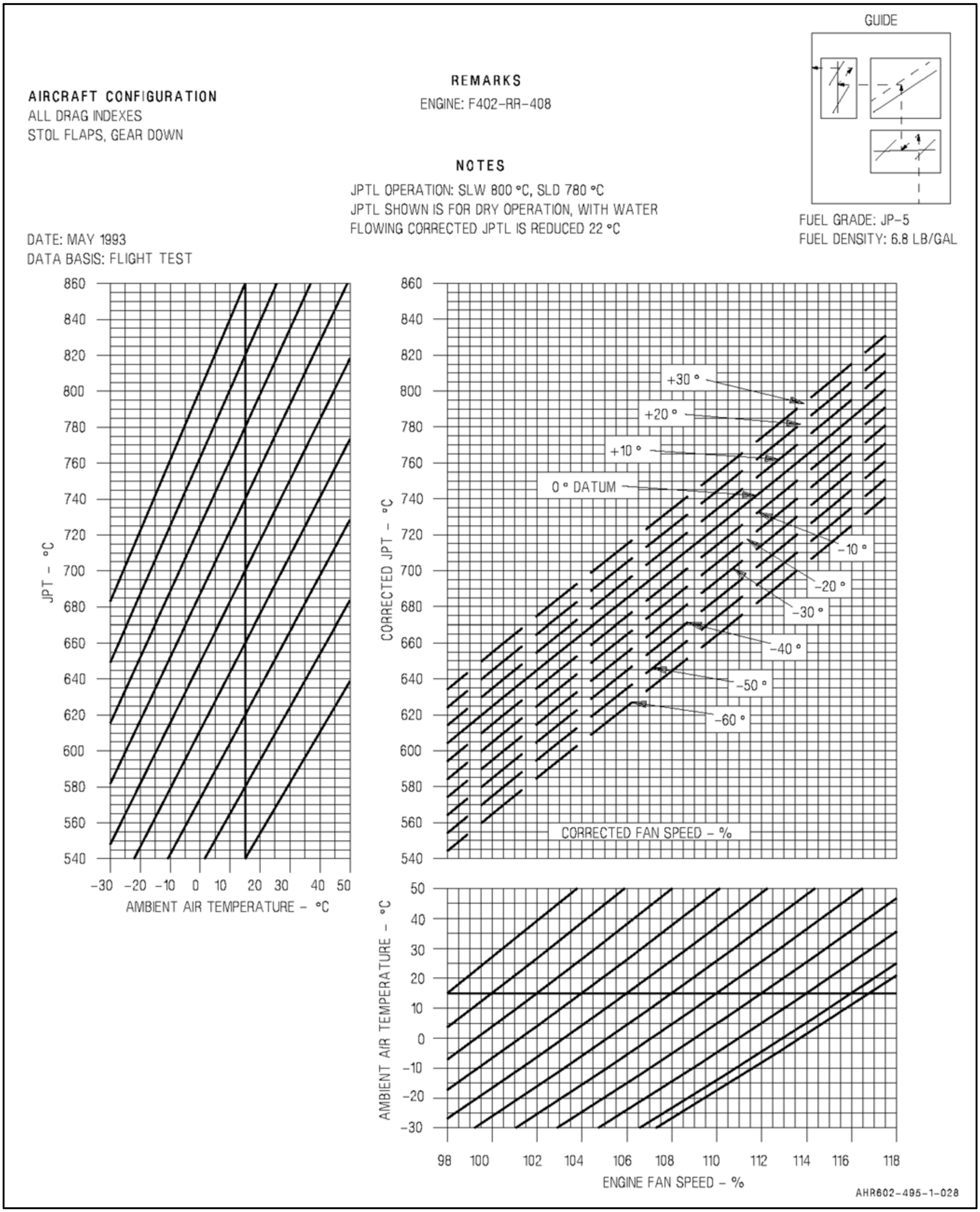


Figure 10-6. JPT in Hover, F402–RR–408 Engine (Sheet 1 of 2)

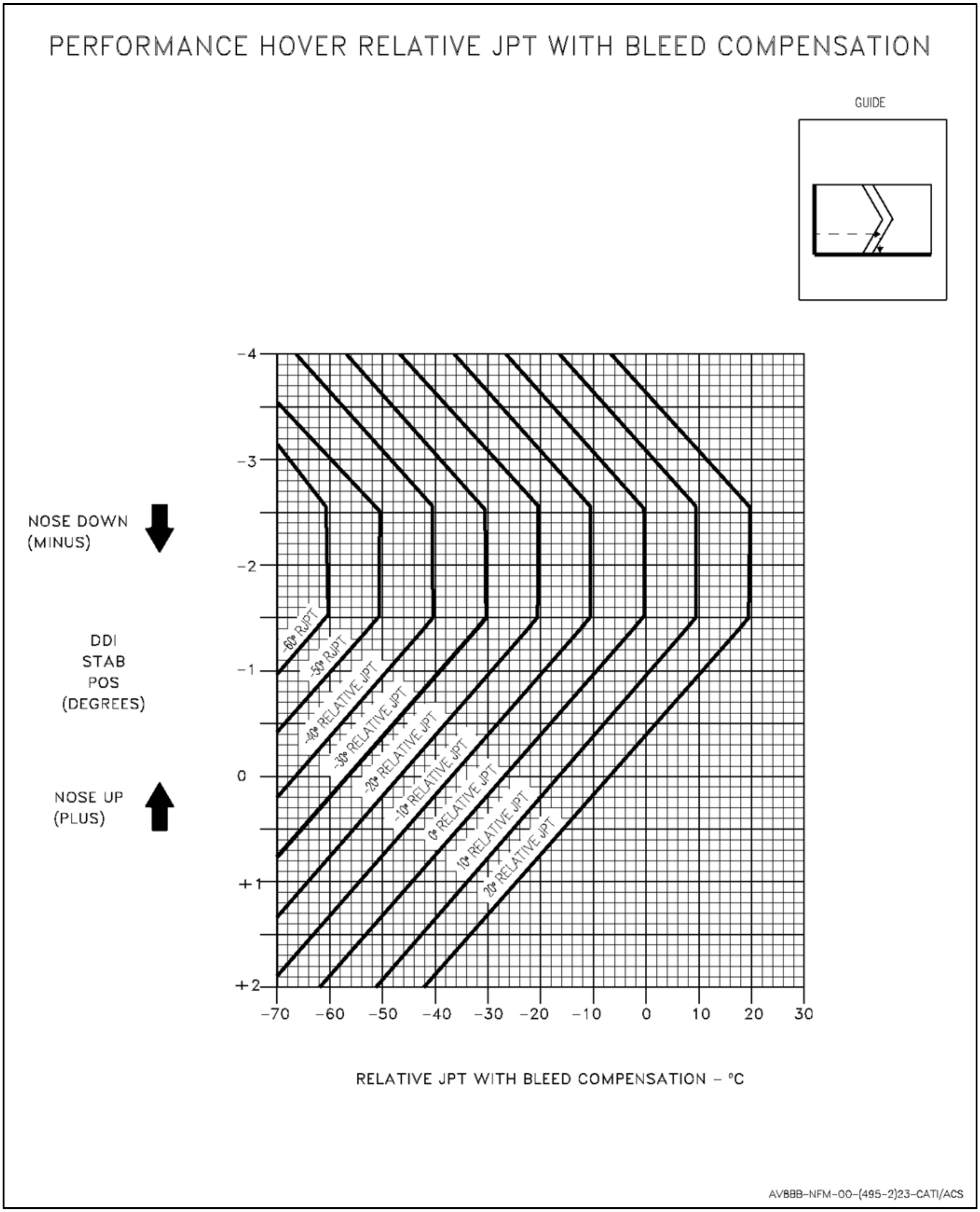


Figure 10-6. JPT in Hover, F402–RR–408 Engine (Sheet 2)

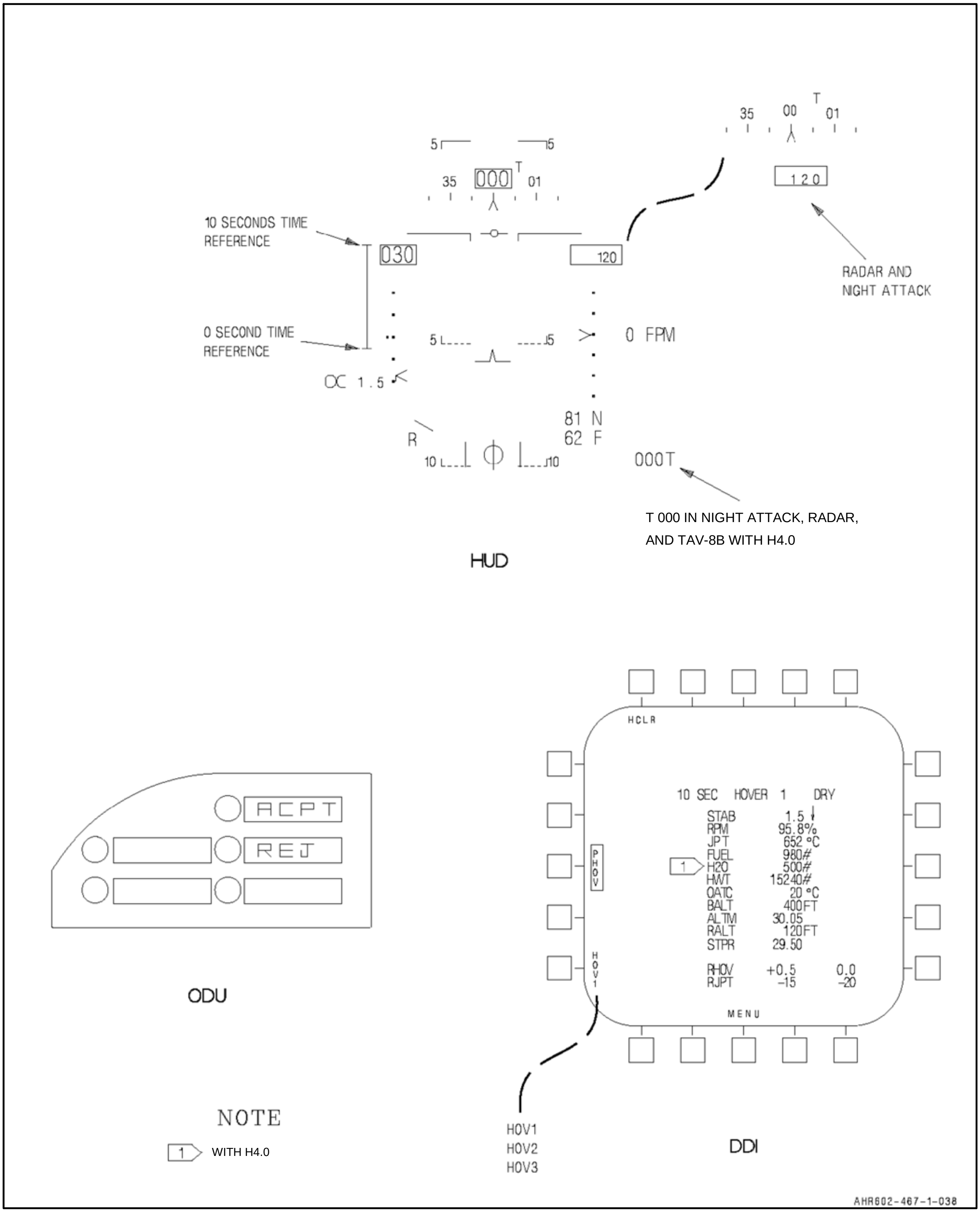


Figure 10-7. Performance Hover Display

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.

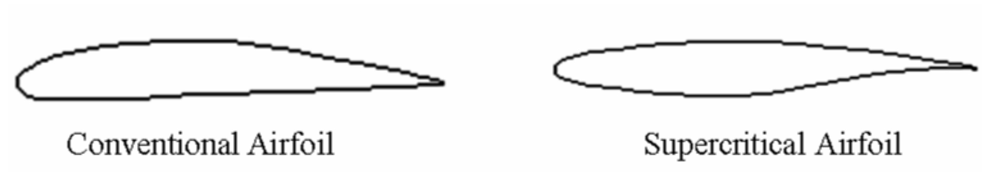


Figure 11-1. Airfoil Differences

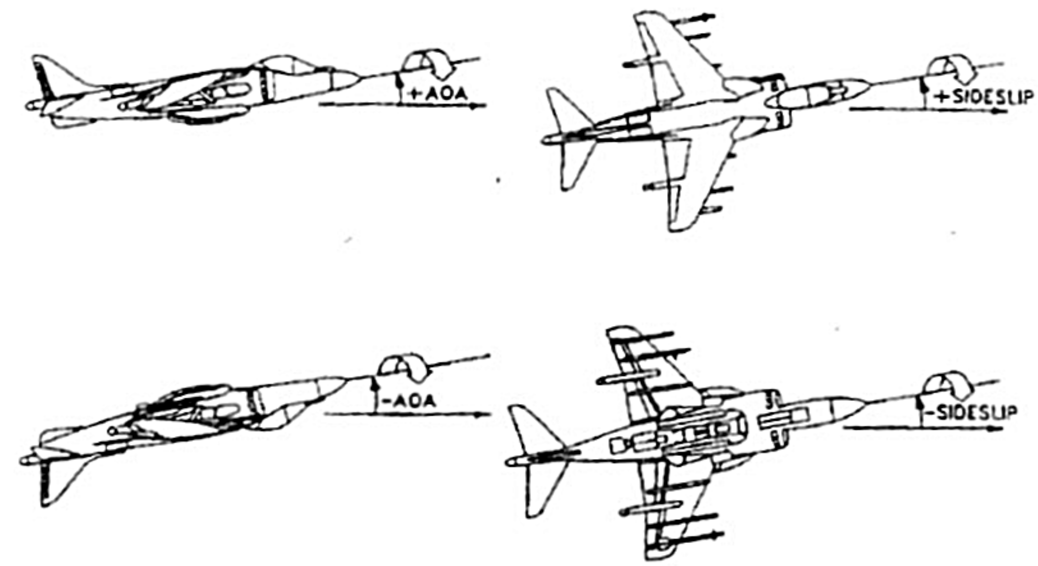


Figure 11-2. Kinematic Coupling

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.

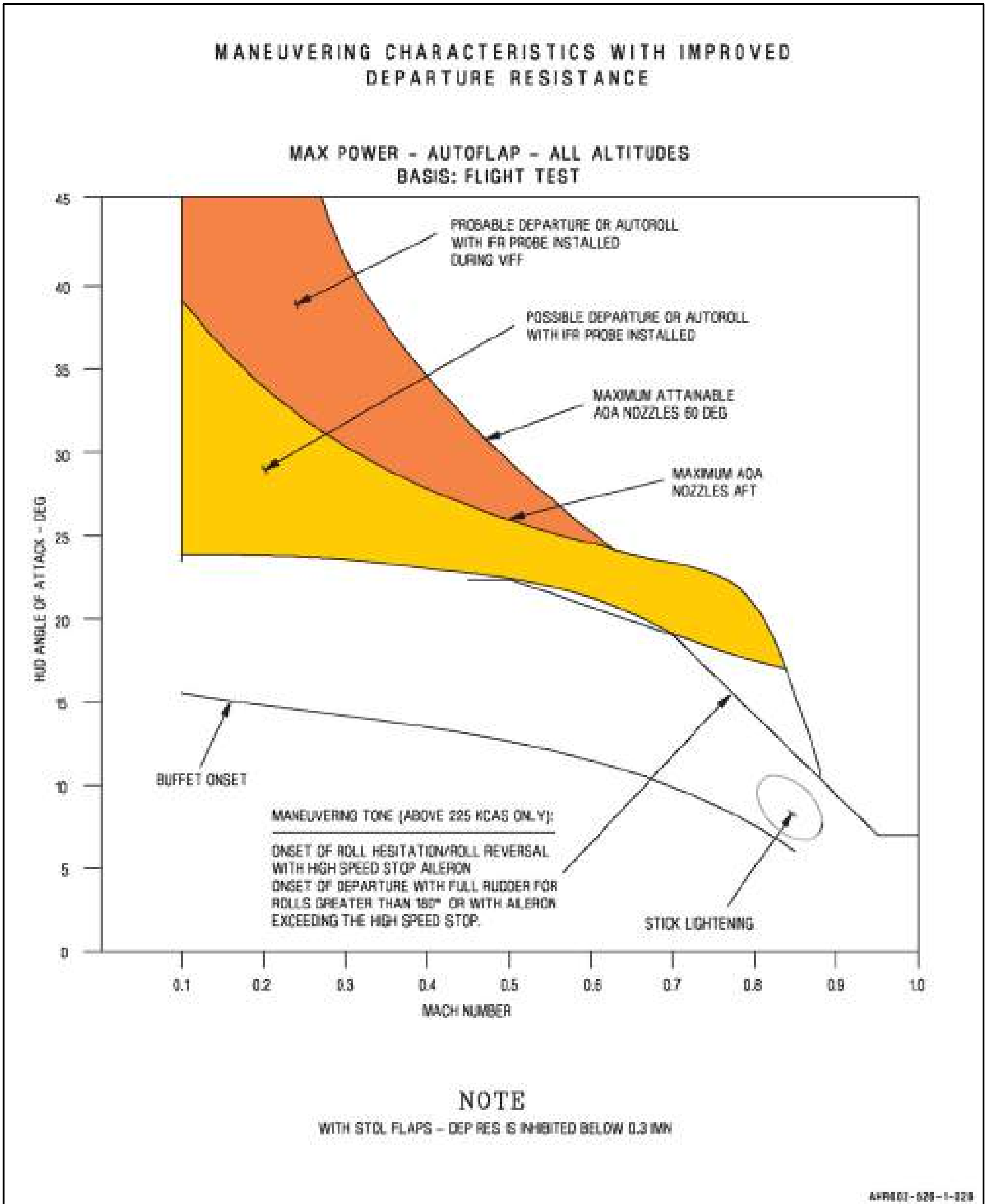


Figure 11-3. Maneuvering Characteristics with 65 Percent LERX

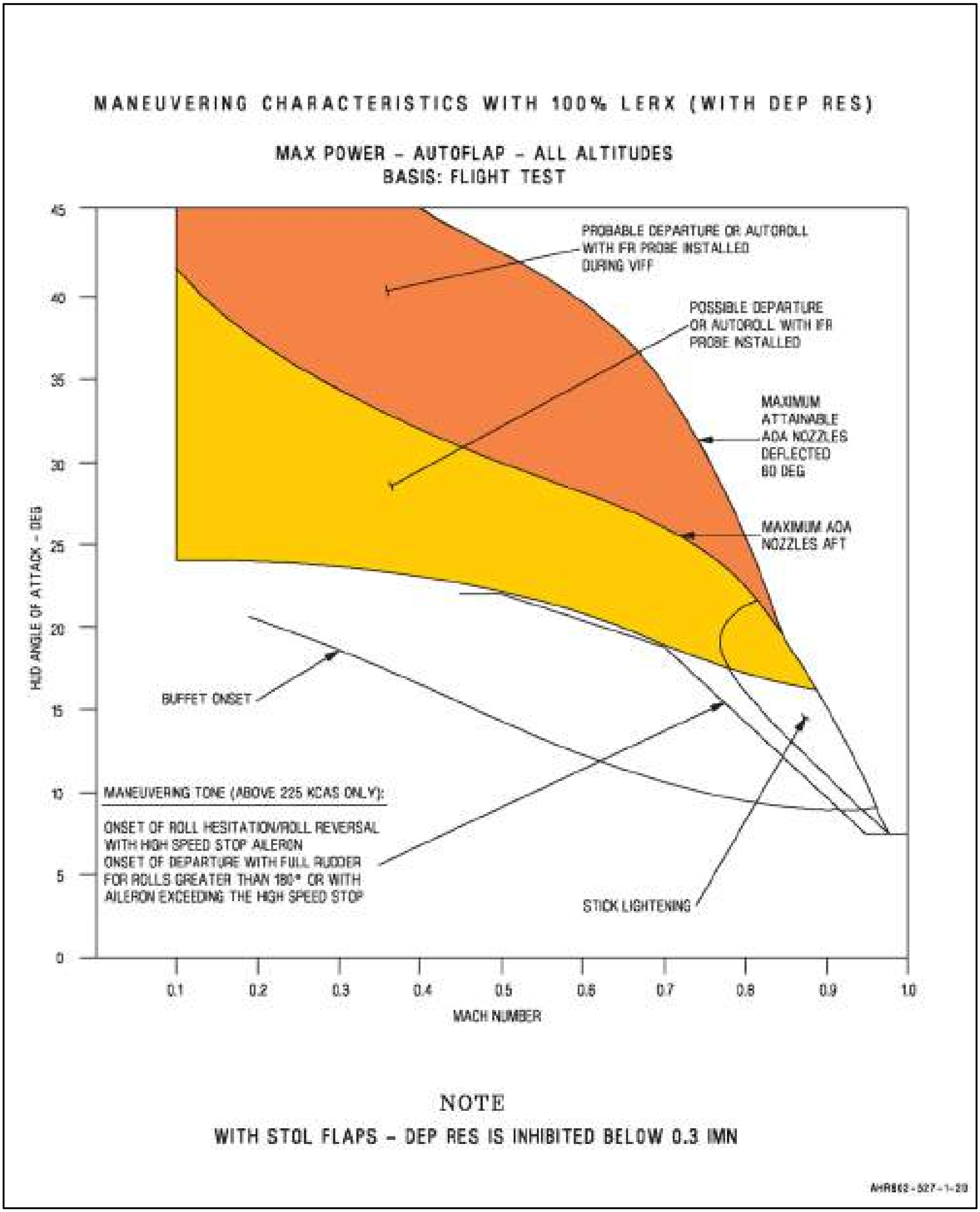
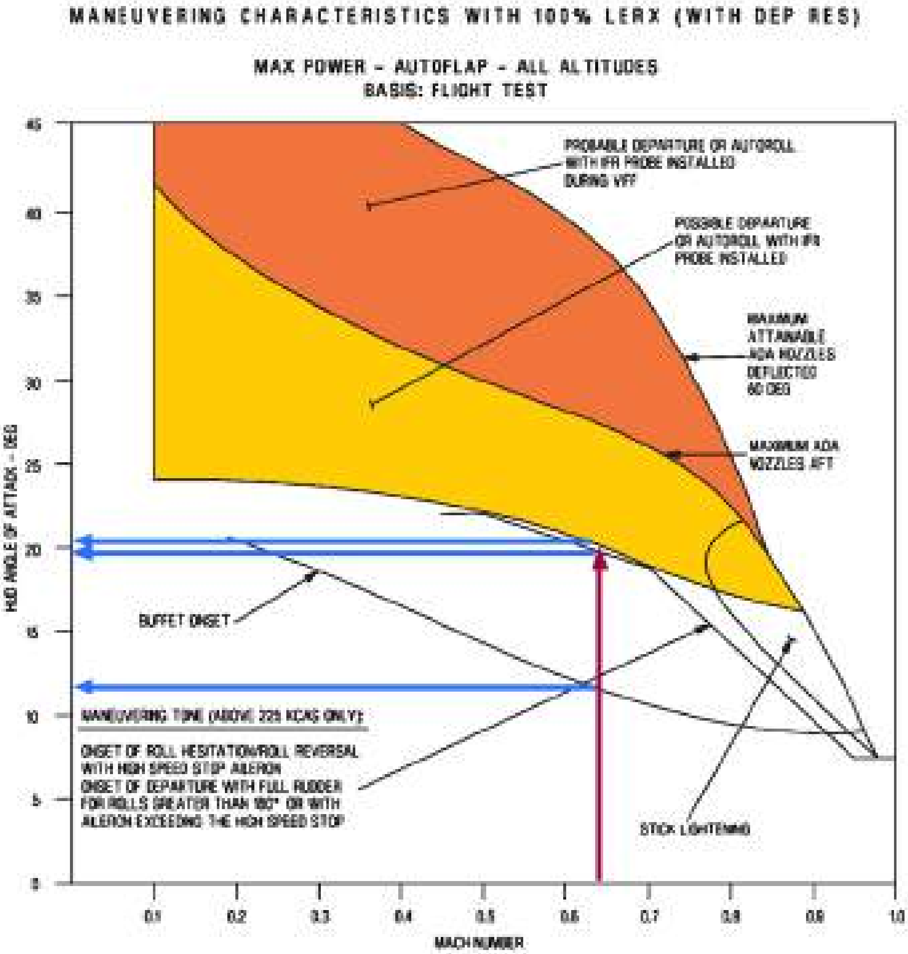


Figure 11-4. Maneuvering Characteristics with 100 Percent LERX



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.

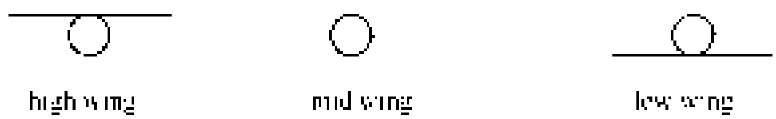
11.4.5 Stability Influences

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.



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.

Geometric Dihedral. This is the "slope" of the wing; positive geometric dihedral contributes to positive dihedral effect.

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