NAVAIR 01-F14AAD-1

NATOPS FLIGHT MANUAL NAVY MODEL

F-14D

AIRCRAFT

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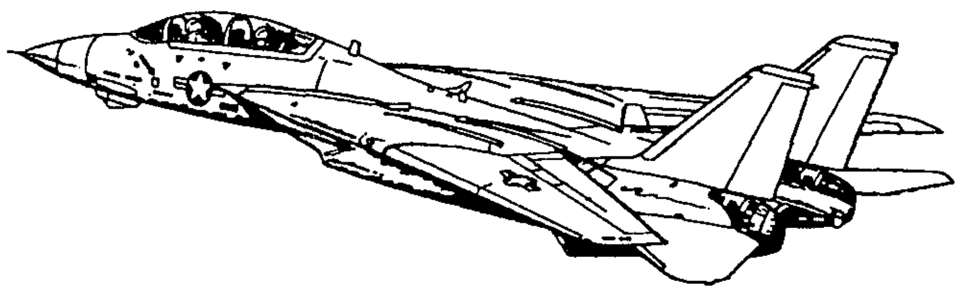

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DEPARTMENT OF THE NAVY
CHIEF OF NAVAL OPERATIONS
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1 February 1997

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 OPNAVINST 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.

DENNIS V. McGINN
Rear Admiral, U.S. Navy
Director, Air Warfare

INTERIM CHANGE SUMMARY

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 through 8	Previously incorporated

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
9	Dual Compressor Stall Warnings
10	Dual Compressor Stall/Engine Flameout Warnings
11	APX-100 AUDIO/LIGHT/OUT Switch
12	Conference Review Advance Change Items
13	Flap and Slat Asymmetry Procedure
14	Modifies Information and Procedures for Spoiler Malfunctions
15	Changes F-14 Currency Requirements
16	Modifies Information and Procedures for On-Deck Emergency Egress

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

RAAUZYUW RUENAAA0187 2471749-UUUU--RUENCGU.
ZNR UUUUU
R 041749Z SEP 01 ZYB
FM CNO WASHINGTON DC//N789J3//
TO ALL TOMCAT AIRCRAFT ACTIVITIES
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RHMFIUU/NAVOPMEDINST PENSACOLA FL//06//
BT
UNCLAS SECTION 01 OF 03
MSGID/GENADMIN/N789J//
SUBJ/INTERIM CHANGES TO F-14ABD AIRCRAFT NATOPS FLIGHT PUBLICATIONS/
SAFETY OF FLIGHT//
REF/A/DOC/NAVAIR 01-F14AAA-1/YMD:19970201//
REF/B/DOC/NAVAIR 01-F14AAP-1/YMD:19970201//
REF/C/DOC/NAVAIR 01-F14AAD-1/YMD:19970201//
REF/D/DOC/NAVAIR 01-F14AAA-1B/YMD:19970201//
REF/E/DOC/NAVAIR 01-F14AAP-1B/YMD:19970201//
REF/F/DOC/NAVAIR 01-F14AAD-1B/YMD:19970201//
REF/G/LTR/VF-101/YMD:20010719//
NARR/REF A IS NAVAIR 01-F14AAA-1 (F-14A NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 W/CHG-1 01FEB97. REF B IS NAVAIR 01-F14AAP-1 (F-14B NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 W/CHG-1 01FEB97. REF C IS NAVAIR 01-F14AAD-1 ((F-14D NATOPS FLIGHT MANUAL (NFM)). REF D IS NAVAIR 01-F14AAA-1B (F-14A NATOPS POCKET CHECKLIST (PCL)) DTD 15MAY95 W/CHG-1 01FEB97. REF E IS NAVAIR 01-F14AAP-1B ((F-14B NATOPS POCKET CHECKLIST (PCL)) DTD 15MAY95 W/CHG-1 01FEB97. REF F IS NAVAIR 01-F14AAD-1B ((F-14D NATOPS POCKET CHECKLIST (PCL)). REF G IS VF-101 LTR 3711 SER 20/1479; SUBJ: F-14 NATOPS REVIEW CONFERENCE REPORT.//
RMKS/1. THIS IS INTERIM CHANGE (IC) NUMBER 148 TO REF A (F-14A NFM), IC NUMBER 46 TO REF B (F-14B NFM), IC NUMBER 26 TO REF C (F-14D NFM), IC NUMBER 104 TO REF D (F-14A PCL), IC NUMBER 30 TO REF E (F-14B PCL), AND IC NUMBER 15 TO REF F (F-14D PCL).
2. SUMMARY. THIS IC MSG DIRECTS ENTRY OF THE ADVANCE CHANGE ITEMS FROM THE 19-22JUN01 F-14A/B/D NATOPS REVIEW CONFERENCE WHICH MODIFY EMERGENCY PROCEDURES FOR DOUBLE GENERATOR FAILURE, UNCOMMANDED ROLL AND/OR YAW, AND SPOILER MALFUNCTION/SPOILER STUCK UP IN REFS A THROUGH F.
3. CHANGE REFS A, B, AND C, WITH ALL PREVIOUS IC'S INCORPORATED, AS FOLLOWS:
A. LIST OF ACRONYMS AND ABBREVIATIONS.
(1) DELETE: NA
(2) ADD (INSERT) ABBREVIATION FOR INBOARD ON PAGE 46 OF REF A, AND ON PAGE 44 OF REFS B AND C, RESPECTIVELY, AS FOLLOWS:
INBD. INBOARD.
(3) ADD (INSERT) ABBREVIATION FOR OUTBOARD ON PAGE 47 OF REF A, AND ON PAGE 46 OF REFS B AND C, RESPECTIVELY, AS FOLLOWS:
OUTBD. OUTBOARD.
B. DOUBLE GENERATOR FAILURE:
(1) DELETE:
REF A (F-14A NFM), DFCS SUPPLEMENT, PAGE 14-4X,
PARAGRAPH 14.7.2 (DOUBLE GENERATOR FAILURE),
REF B (F-14B NFM), DFCS SUPPLEMENT, PAGE 14-4X,

PARAGRAPH 14.7.2 /(DOUBLE GENERATOR FAILURE), AND/OR
REF C (F-14D NFM), DFCS SUPPLEMENT, PAGE 14-4X,
PARAGRAPH 14.7.2 (DOUBLE GENERATOR FAILURE):

(2) ADD (REPLACE WITH) IN EACH NFM:

14.7.2 DOUBLE GENERATOR FAILURE.

1. BOTH GENERATOR SWITCHES -- CYCLE.
   WHEN OPERATING ON EMERGENCY GENERATOR, THE FOLLOWING IMPORTANT SYSTEMS ARE INOPERATIVE:
   A. EMERGENCY FLIGHT HYDRAULICS.
   B. OUTBOARD SPOILER MODULE AND EMERGENCY FLAPS ACTIVATION.
   C. OBOGS CONCENTRATOR HEATER (F-14D ONLY) (OBOGS MAY STILL FUNCTION AT A REDUCED, BUT ADEQUATE LEVEL).
2. IF TEMPORARY LOSS OF COMBINED SYSTEM PRESSURE CAUSES EMERGENCY GENERATOR TO SHIFT TO 1-KVA MODE:
   EMERG GENERATOR SWITCH -- CYCLE.

   CAUTION

   A SHIFT TO 1-KVA MODE WILL CAUSE LOSS OF ALL DFCS FUNCTIONS AND SPOILERS WITHOUT ILLUMINATION OF CAUTION LIGHTS. IF THE 5-KVA MODE IS REGAINED, A MASTER RESET WILL BE REQUIRED TO REGAIN SAS, SPOILER, AUTHORITY STOP, AND ARI FUNCTIONS.

   NOTE

   DFCS SYNCHRONIZATION CAN TAKE UP TO 2 SECONDS FOLLOWING A POWER INTERRUPT. IF THE MASTER RESET PUSHBUTTON IS DEPRESSED DURING THE SYNCHRONIZATION TIME, AN ADDITIONAL DEPRESSION OF THE MASTER RESET PUSHBUTTON WILL BE REQUIRED TO RESTORE SPOILER FUNCTIONALITY.
3. LAND AS SOON AS PRACTICABLE.

C. UNCOMMANDED ROLL AND/OR YAW:

(1) DELETE:

REF A (F-14A NFM), CHAPTER 14, PAGE 14-31, PARAGRAPH 14.12.1 (UNCOMMANDED ROLL AND/OR YAW),
REF B (F-14B NFM), CHAPTER 14, PAGES 14-33 AND 14-34, PARAGRAPH 14.12.1 (UNCOMMANDED ROLL AND/OR YAW), AND/OR
REF C (F-14D NFM), CHAPTER 14, PAGE 14-37, PARAGRAPH 14.12.1 (UNCOMMANDED ROLL AND/OR YAW):

(2) ADD (REPLACE WITH) IN EACH NFM:

14.12.1 UNCOMMANDED ROLL AND/OR YAW.

NOTE

IF UNCOMMANDED ROLL AND/OR YAW OCCURS DURING HIGH-AOA MANEUVERING (ABOVE 15 UNITS), ASSUME DEPARTURE FROM CONTROLLED FLIGHT AND APPLY APPROPRIATE DEPARTURE AND/OR SPIN RECOVERY PROCEDURES.

NOTE

FAILURES THAT MAY CAUSE UNCOMMANDED ROLL AND/OR YAW INCLUDE, BUT ARE NOT LIMITED TO:
A. ENGINE FAILURE.
B. STUCK UP SPOILER.
C. ASYMMETRIC FLAPS AND/OR SLATS.

D. UNCOMMANDED DIFFERENTIAL STABILIZER AND/OR RUDDER AUTOMATIC FLIGHT CONTROL SYSTEM INPUTS CAUSED BY ABNORMAL POWER TRANSIENTS.

E. HARDOVER RUDDER.

1. IF FLAP TRANSITION:
   FLAP HANDLE -- PREVIOUS POSITION.
2. RUDDER AND STICK -- OPPOSITE ROLL/YAW.

NOTE

FOR SPOILER MALFUNCTION, USE LATERAL STICK AS PRIMARY LATERAL CONTROL AND RUDDER ONLY AS NEEDED TO MAINTAIN BALANCED FLIGHT.

3. AOA -- BELOW 12 UNITS.
4. DOWNWING ENGINE -- MAX THRUST (IF REQUIRED).
5. MASTER RESET PUSHBUTTON -- DEPRESS.

NOTE

DFCS SYNCHRONIZATION CAN TAKE UP TO 2 SECONDS FOLLOWING A POWER INTERRUPT. IF THE MASTER RESET PUSHBUTTON IS DEPRESSED DURING THE SYNCHRONIZATION TIME, AN ADDITIONAL DEPRESSION OF THE MASTER RESET PUSHBUTTON WILL BE REQUIRED TO RESTORE SPOILER FUNCTIONALITY.

6. ROLL SAS -- ON.
7. ROLL TRIM -- OPPOSITE STICK (IF REQUIRED).
8. OUT OF CONTROL BELOW 10,000 FEET AGL -- EJECT.
9. CONTROL REGAINED -- CLIMB AND INVESTIGATE FOR THE FOLLOWING:
   A. FLAP AND SLAT ASYMMETRY.
   B. SAS MALFUNCTION.

NOTE

SAS FAILURE MAY CAUSE UNCOMMANDED ROLL AND/OR YAW, EVEN WITHOUT ILLUMINATION OF THE ASSOCIATED LIGHTS.

   C. SPOILER MALFUNCTION.
   D. HARDOVER RUDDER.
   E. STRUCTURAL DAMAGE.
10. SLOW-FLY AIRCRAFT TO DETERMINE CONTROLLABILITY AT 10,000 FEET AGL MINIMUM.

D. SPOILERS CAUTION LIGHT/SPOILER MALFUNCTION/SPOILER STUCK UP:

(1) DELETE:

REF A (F-14A NFM), DFCS SUPPLEMENT, PAGE 14-15X AND 14-16X, PARAGRAPH 14.12.11.3 (SPOILERS CAUTION LIGHT/ SPOILER MALFUNCTION/SPOILER STUCK UP),

REF B (F-14B NFM), DFCS SUPPLEMENT, PAGES 14-15X AND 14-16X, PARAGRAPH 14.12.9.3 (SPOILERS CAUTION LIGHT/SPOILER MALFUNCTION/SPOILER STUCK UP), AND/OR

REF C (F-14D NFM), DFCS SUPPLEMENT, PAGES 14-17X AND 14-18X, PARAGRAPH 14.12.7.3 (SPOILERS CAUTION LIGHT/SPOILER MALFUNCTION/SPOILER STUCK UP):

(2) ADD (REPLACE WITH) AS PARAGRAPH 14.12.11.3 IN F-14A NFM, AS PARAGRAPH 14.12.9.3 IN F-14B NFM, AND/OR AS PARAGRAPH 14.12.7.3 IN F-14D NFM):

14.12.11.3 SPOILERS CAUTION LIGHT/SPOILER MALFUNCTION/ SPOILER STUCK UP.

CAUTION

IF THE CURRENT CONFIGURATION IS ACCEPTABLE FOR LANDING, CAREFUL CONSIDERATION SHOULD BE GIVEN BEFORE DEPRESSING MASTER RESET WHEN A SPOILER ACTUATOR MECHANICAL MALFUNCTION IS SUSPECTED. A DEPLOYED SPOILER THAT RESULTED FROM DFCS COMPUTERS DROPPING OFF LINE IS NOT CONSIDERED A MECHANICAL FAILURE.

NOTE

USE LATERAL STICK AS PRIMARY CONTROL AND RUDDER ONLY AS NEEDED TO MAINTAIN BALANCED FLIGHT.

NOTE

SUBSEQUENT DEPRESSION OF THE MASTER RESET PUSHBUTTON MAY CLEAR FAILURE UNTIL SPOILER IS COMMANDED TO MOVE AGAIN.

1. **MASTER RESET PUSHBUTTON -- DEPRESS.**

NOTE

DFCS SYNCHRONIZATION CAN TAKE UP TO 2 SECONDS FOLLOWING A POWER INTERRUPT. IF THE MASTER RESET PUSHBUTTON IS DEPRESSED DURING THE SYNCHRONIZATION TIME, AN ADDITIONAL DEPRESSION OF THE MASTER RESET PUSHBUTTON WILL BE REQUIRED TO RESTORE SPOILER FUNCTIONALITY.

IF FAILURE REMAINS/REOCCURS:

2. **AVOID ABRUPT LATERAL CONTROL MOVEMENTS AND HIGH ROLL RATES.**

CAUTION

WITH WINGS FORWARD OF 62 DEGREES, EXCESSIVE HORIZONTAL TAIL DIFFERENTIAL MAY CAUSE SEVERE STRUCTURAL DAMAGE.

IF SPOILER(S) FAIL DOWN:

3. **PERFORM CONTROLLABILITY CHECK PROCEDURE, PARAGRAPH 14.11.7.**

IF SPOILER(S) REMAIN UP OR FLOATING, OR IF CONTROL UNSATISFACTORY WITH FLAPS DOWN:

NOTE

ANY SINGLE, FULLY-DEFLECTED, FAILED-UP SPOILER IS CONTROLLABLE EVEN WITH FLAPS DOWN IF THE REMAINING SPOILERS ARE OPERATING. WITH MULTIPLE FAILURES, AIRCRAFT CONFIGURATION IS THE CRITICAL FACTOR. WITH FLAPS DOWN, ROLL CONTROL USING LATERAL STICK ALONE MAY BE IMPOSSIBLE. HOWEVER, WITH FLAPS UP, ADEQUATE ROLL CONTROL TO REGAIN WINGS LEVEL FLIGHT IS AVAILABLE WITH USE OF LATERAL STICK ALONE. CHOICE OF FLAP POSITION FOR LANDING AND CV RECOVERY/DIVERT DECISION SHOULD BE MADE FOLLOWING A CONTROLLABILITY CHECK.

4. **PERFORM CONTROLLABILITY CHECK PROCEDURE, PARAGRAPH 14.11.7, USING MANEUVERING FLAP/SLAT (PREFERRED) OR NO-FLAP CONFIGURATION ONLY.**

NOTE

IF CONTROLLABILITY IS UNSUITABLE FOR LANDING APPROACH DUE TO COMPLETE LOSS OF SPOILERS,

CONSIDERATION MAY BE GIVEN TO ATTEMPTING A POWER ON RESET IN AN ATTEMPT TO REGAIN AT LEAST ONE SPOILER SET. SEE DFCS FOR PROCEDURES (F-14A PARAGRAPH 14.12.11.4, F-14B PARAGRAPH 14.12.9.4, AND F-14D PARAGRAPH 14.12.7.4).

IF CONTROLLABILITY SATISFACTORY:

5. PERFORM MANEUVER FLAP/SLAT OR NO-FLAP STRAIGHT-IN APPROACH AT OR ABOVE MINIMUM CONTROL AIRSPEED.

IF CONTROLLABILITY STILL UNSATISFACTORY:

WARNING

WITH BOTH INBD AND OUTBD SPOILER CONTROL CB'S PULLED, ALL OPPOSING SPOILER CONTROL WILL BE LOST.

CAUTION

MARGINAL CONTROL OR LOSS OF CONTROL MAY BE EXPERIENCED DUE TO REMOVAL OF A SPOILER SET WITH MULTIPLE FAILURES PRESENT.

NOTE

IT MULTIPLE FAILED-UP SPOILER PANELS RESULT IN UNSATISFACTORY HANDLING QUALITIES REGARDLESS OF FLAP POSITION, AN ATTEMPT MAY BE MADE TO FAIL THE PANELS DOWN BY REMOVING POWER VIA THE CORRESPONDING SPOILER CONTROL CB'S. THIS MAY TAKE AS LONG AS 60 SECONDS, AND RESULT IN A MARGINAL CONTROL SITUATION OR A LOSS OF CONTROL SITUATION BECAUSE POWER TO THE OTHER SPOILERS HAS BEEN REMOVED. THEREFORE, IT SHOULD BE CONSIDERED ONLY AS A LAST RESORT.

5. SPOILER CONTR CB FOR AFFECTED PAIR -- PULL
(7G9 FOR INBD, 8C5 FOR OUTBD IN F-14A/B),
(8G9 FOR INBD, 9C5 FOR OUTBD IN F-14D).

IF UNCONTROLLABLE ROLL, OR NO IMPROVEMENT IN CONTROLLABILITY:

6. SPOILER CONTR CB (AFFECTED SPOILER) -- RESET.
7. MASTER RESET PUSHBUTTON -- DEPRESS.
   FUNCTIONALITY LOST FROM CYCLING SPOILER CONTROL CB WILL NOT BE REGAINED UNTIL THE MASTER RESET PUSHBUTTON IS DEPRESSED.
8. IF UNSUITABLE FOR LANDING,PERFORM CONTROLLED EJECTION.

IF CONTROLLABILITY IMPROVES:

9. PERFORM STRAIGHT-IN APPROACH IN BEST CONFIGURATION WITH CB(S) OUT.

NOTE

OUTBOARD SPOILER POSITION INDICATORS WILL INDICATE DOWN WITH CB 8C5 (F-14A/B) OR 9C5 (F-14D) PULLED.

NOTE

WITH CB'S 7G9 AND 8C5 (F-14A/B) OR 8G9 AND 9C5 (F-14D) PULLED, GROUND ROLL BRAKING IS NOT AVAILABLE. RESET ON LANDING ROLLOUT IF DESIRED.

4. CHANGE REFS D, E, AND F, WITH ALL PREVIOUS IC'S INCORPORATED, AS FOLLOWS:

A. DOUBLE GENERATOR FAILURE:

(1) DELETE:
REF D (F-14A PCL), PAGE 24, DOUBLE GENERATOR FAILURE PROCEDURE,
REF E (F-14B PCL), PAGE 26, DOUBLE GENERATOR FAILURE PROCEDURE, AND/OR
REF F (F-14D PCL), PAGE 38, DOUBLE GENERATOR FAILURE PROCEDURE:
(2) ADD (REPLACE WITH) IN EACH PCL AS CONTAINED IN PARAGRAPH 3.B(2) ABOVE, EXCEPT OMIT PROCEDURE PARAGRAPH NUMBER.
B. UNCOMMANDED ROLL AND/OR YAW:
(1) DELETE:
REF D (F-14A PCL), PAGE 47, UNCOMMANDED ROLL AND/OR YAW PROCEDURE,
REF E (F-14B PCL), PAGE 57, UNCOMMANDED ROLL AND/OR YAW PROCEDURE, AND/OR
REF F (F-14D PCL), PAGE 71, UNCOMMANDED ROLL AND/OR YAW PROCEDURE:
(2) ADD (REPLACE WITH) IN EACH PCL AS CONTAINED IN PARAGRAPH 3.C(2) ABOVE, EXCEPT:
(A) OMIT PROCEDURE PARAGRAPH NUMBER, AND
(B) OMIT NOTES THAT PRECEDE STEP 1.
C. SPOILERS CAUTION LIGHT/SPOILER MALFUNCTION/SPOILER STUCK UP:
(1) DELETE:
REF D (F-14A PCL), PAGES 48 AND 49, SPOILERS CAUTION LIGHT/ SPOILER MALFUNCTION/SPOILER STUCK UP,
REF E (F-14B PCL), PAGES 58, 58A, AND 59, SPOILERS CAUTION LIGHT/SPOILER MALFUNCTION/SPOILER STUCK UP), AND/OR
REF F (F-14D PCL), PAGES 72, 72A, AND 73, SPOILERS CAUTION LIGHT/SPOILER MALFUNCTION/SPOILER STUCK UP:
(2) ADD (REPLACE WITH) IN EACH PCL AS IN PARAGRAPH 3.D(2) ABOVE, EXCEPT:
(A) OMIT PROCEDURE PARAGRAPH NUMBER,
(B) REPLACE PARAGRAPH 14.11.7 (CONTROLLABILITY CHECK) REFERENCES IN STEPS 3 AND 4 WITH "PAGE 46" IN F-14A PCL, "PAGE 56" IN F-14B PCL, AND "PAGE 70" IN F-14D PCL, AND
(C) REPLACE PARAGRAPH 14.12.7 (DFCS POR) REFERENCE IN STEP 4 NOTE WITH "PAGES 46A THROUGH 46C" IN F-14A PCL, "PAGES 56A THROUGH 56C" IN F-14B PCL AND "PAGES 70A THROUGH 70C" IN F-14D PCL.

5. CONTACT VF-101 F-14A/B/D NATOPS PROGRAM MANAGER, LT GREG KNEPPER, AT DSN 433-5147 OR COMM (757)433-5147, FAX DSN 433-4368 OR (757)433-4368, OR E-MAIL KNEPPERGD@VF101.NAVY.MIL IF REF G OR REPLACEMENT PAGES ARE REQUIRED. NAVAIR 4.1.1.1 POC IS LCDR SCOTT PORTER, AT DSN 757-7017 OR COMM (301)757-7017, OR EMAIL PORTERSD@NAVAIR.NAVY.MIL.

6. THIS MESSAGE AND ALL OTHER NATOPS INTERIM CHANGES WILL BE POSTED ON THE NATEC WEBSITE, WWW.NATEC.NAVY.MIL, WITHIN 15 DAYS OF THE RELEASE OF THIS MESSAGE. IF UNABLE TO VIEW THIS MESSAGE AT THE NATEC WEBSITE, PLEASE INFORM THE CNO NATOPS OFFICE AT DSN 288-5797 OR COMM (202)433-5797.//

BT

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ZNR UUUUU
R 051758Z APR 01 ZYB ZYW
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RMKS/RMKS/1. THIS IS INTERIM CHANGE (IC) NUMBER 147 TO REF A (F-14A NFM),
IC NUMBER 103 TO REF B (F-14A PCL), IC NUMBER 45 TO REF C (F-14B NFM), IC NUMBER 29 TO REF D (F-14B PCL), IC NUMBER 25 TO REF E (F-14D NFM), AND IC NUMBER 14 TO REF F (F-14D PCL).
2. SUMMARY. ADDS RUDDER HARDOVER PROCEDURE, REVISES CONTROLLABILITY CHECK PROCEDURE, AND MODIFIES UNCOMMANDED ROLL AND/OR YAW PROCEDURE IN REFS A THROUGH F.
3. CHANGE REF A (F-14A NFM), REF B (F-14B NFM), AND REF C (F-14D NFM) AS FOLLOWS:
A. CHAPTER 14, F-14A PAGES 14-29 AND 14-30/F-14B PAGES 14-32 AND 14-33/F-14D PAGES 14-35 AND 14-36, PARAGRAPH 14.11.7 CONTROLLABILITY CHECK:
   (1) DELETE EXISTING PARAGRAPH.
   (2) ADD (INSERT) REPLACEMENT PARAGRAPH:
14.11.7 CONTROLLABILITY CHECK. THERE ARE SEVERAL MALFUNCTIONS THAT MAY SIGNIFICANTLY AFFECT THE HANDLING CHARACTERISTICS IN THE CRUISE AND LANDING CONFIGURATIONS. THESE MALFUNCTIONS INCLUDE, BUT ARE NOT LIMITED TO:
    A. SPOILER MALFUNCTION*
    B. FLAP/SLAT ASYMMETRY*
    C. STRUCTURAL DAMAGE
    D. UNCOMMANDED SAS INPUTS*
    E. RUDDER MALFUNCTION (HARDOVER)*
    F. WING SWEEP ASYMMETRY*
    G. JAMMED FLIGHT CONTROLS
    H. (DFCS ONLY) ARI FAILURE*
* THESE MALFUNCTIONS, WHICH HAVE UNIQUE NATOPS PROCEDURES SPECIFIC

TO A PARTICULAR FAILURE MODE, SHOULD BE PERFORMED BEFORE BEGINNING A CONTROLLABILITY CHECK.

NATOPS PROCEDURES CANNOT ACCOUNT FOR EVERY POTENTIAL MALFUNCTION. IT IS ABSOLUTELY IMPERATIVE THAT THE AIRCREW THOROUGHLY AND SAFELY EVALUATE THE DEGRADED HANDLING CHARACTERISTICS OF THE DAMAGED OR MALFUNCTIONING AIRCRAFT PRIOR TO CONTINUED FLIGHT AND LANDING. THIS CHECK DOES NOT TAKE PRIORITY OVER EXISTING EMERGENCY PROCEDURES.

UPON ENCOUNTERING A PROBLEM THAT ALTERS THE HANDLING QUALITIES OF THE AIRCRAFT, THE AIRCREW SHOULD REALIZE THAT THE AIRCRAFT MAY NO LONGER BE A STABLE AIRFRAME, ESPECIALLY IN THE LANDING CONFIGURATION. IN ADDITION, THE FLIGHT CHARACTERISTICS MAY RAPIDLY DEGRADE OR EVEN BECOME UNCONTROLLABLE WHEN NORMAL CONFIGURATION CHANGES ARE INTRODUCED OR DURING AIRSPEED CHANGES. INCREASED AWARENESS OF FLIGHT PARAMETERS SHOULD PREVAIL FOLLOWING A MALFUNCTION UNTIL THE AIRCRAFT IS SAFELY ON DECK.

EVEN THOUGH THE AIRCRAFT MAY POSSESS SIGNIFICANTLY DIFFERENT OR EVEN HAZARDOUS FLYING QUALITIES, THE PILOT AND RIO HAVE NUMEROUS CUES AVAILABLE TO THEM TO WARN OF POTENTIAL PROBLEMS. SOME OF THESE CUES INCLUDE:

A. TURN NEEDLE AND BALL POSITION
B. AOA
C. BUFFET
D. YAW STRING POSITION
E. FLIGHT CONTROL POSITIONS
F. TRIM SETTINGS
G. ROLL-OFF
H. RATE OF DESCENT

ALL CUES SHOULD BE VERY CLOSELY MONITORED SINCE THEY TELL THE PILOT WHAT THE AIRCRAFT IS DOING OR IS ABOUT TO DO.

STALL/DEPARTURE RECOVERY PROCEDURES AND EJECTION SHOULD BE DISCUSSED PRIOR TO ANY CONTROLLABILITY CHECK. IN THE EVENT OF A STALL/DEPARTURE, NATOPS PROCEDURES SHOULD BE APPLIED IMMEDIATELY. IF DURING FLAP/SLAT TRANSITION, FOLLOW UNCOMMANDED ROLL/YAW PROCEDURES. A RAPID INCREASE IN AIRSPEED CAN BE ATTAINED THROUGH JUDICIOUS USE OF FORWARD STICK AND MILITARY POWER.

AFTER A THOROUGH CONTROLLABILITY CHECK (TO INCLUDE APPROACH AND WAVEOFF/BOLTER PERFORMANCE AND FLIGHT CHARACTERISTICS), THE AIRCREW MUST MAKE THE DECISION AS TO WHETHER THE AIRCRAFT CAN BE SAFELY LANDED ABOARD THE CARRIER OR SHOULD BE DIVERTED.

WARNING

IF AIRCRAFT STALLS OR DEPARTS IN DIRTY CONFIGURATION, IMMEDIATELY UNLOAD AND PLACE THROTTLES AT MILITARY. DO NOT RAISE FLAPS UNTIL RECOVERED. (IF DURING FLAP/SLAT TRANSITION, FOLLOW UNCOMMANDED ROLL/YAW PROCEDURES.)

WARNING

A CONTROLLABILITY CHECK REQUIRES THE TOTAL ATTENTION AND AWARENESS OF THE AIRCREW. THE AIRCREW MUST BE PREPARED TO ENCOUNTER UNUSUAL HANDLING CHARACTERISTICS, SINCE THE AERODYNAMIC PROPERTIES OF THE AIRCRAFT MAY BE SIGNIFICANTLY CHANGED. STALL SPEED AS WELL AS FLIGHT AND GROUND HANDLING CHARACTERISTICS MAY BE DRASTICALLY DIFFERENT FROM NORMAL.

NOTE

IF FLIGHT CONTROL MALFUNCTION IS DUE TO UNCOMMANDED STAB AUG TRANSIENTS, SPOILER MALFUNCTION, FLAP/SLAT ASYMMETRY, RUDDER MALFUNCTION (HARDOVER), AND/OR WINGSWEEP MALFUNCTIONS; PERFORM APPLICABLE EMERGENCY PROCEDURE(S) AS NECESSARY BEFORE BEGINNING A CONTROLLABILITY CHECK.

1. CLIMB TO 10,000 FEET AGL MINIMUM.
2. OBTAIN VISUAL CHECK IF POSSIBLE.
3. DECELERATE GRADUALLY TO 200 KNOTS IF FEASIBLE.
4. DIRTY AIRCRAFT, ONE CONFIGURATION CHANGE AT A TIME, WHILE FLYING STRAIGHT AND LEVEL.

NOTE

LANDING GEAR SHOULD BE LOWERED BEFORE FLAPS. DO NOT LOWER ARRESTING HOOK UNTIL LANDING GEAR IS CONFIRMED DOWN AND LOCKED.

5. IF FLAPS ARE LOWERED, DO SO INCREMENTALLY AND BE ALERT FOR A FLAP/SLAT ASYMMETRY.
6. IF MANEUVER FLAPS ARE USED FOR LANDING APPROACH: WING SWEEP DRIVE NO. 1 AND WG SWP DR NO. 2 / MANUV FLAP CB'S -- PULL (LE1 AND LE2 FOR F-14A/B; LD1 AND LE1 FOR F-14D).

NOTE

FAILURE TO PULL WING SWEEP DRIVE CIRCUIT BREAKERS (LE1 AND LE2 FOR F-14A/B; LD1 AND LE1 FOR F-14D) COULD RESULT IN INADVERTENT MANEUVER DEVICE RETRACTION OR WING SWEEP DURING APPROACH.

NOTE

WINGSWEEP WARNING, WINGSWEEP ADVISORY, AND FLAP CAUTION LIGHTS WILL ILLUMINATE WITH BOTH WING SWEEP DRIVE CIRCUIT BREAKERS PULLED (LE1 AND LE2 FOR F-14A/B; LD1 AND LE1 FOR F-14D).

7. USE DIFFERENTIAL THRUST, IF REQUIRED, TO ACHIEVE ACCEPTABLE FLIGHT CHARACTERISTICS.
8. SLOW-FLY AIRCRAFT TO DETERMINE APPROACH HANDLING CHARACTERISTICS, INCLUDING TURNS.
9. FLY SIMULATED APPROACH TO EVALUATE LINEUP CORRECTIONS, POWER CHANGES, AND WAVEOFF/BOLTER PERFORMANCE AND FLIGHT CHARACTERISTICS.
10. FOR LANDING, USE MINIMUM SAFE CONTROL SPEED, BUT NO SLOWER THAN OPTIMUM AOA.
11. IF PERFORMANCE AND FLIGHT CHARACTERISTICS DICTATE THAT A CV LANDING IS NOT POSSIBLE -- DIVERT.
12. IF DIVERTING WITH A FLIGHT CONTROL MALFUNCTION -- MAKE AN ARRESTED LANDING, IF POSSIBLE.

NOTE

IF NORMAL LANDING ROLLOUT IS ATTEMPTED, FLAP HANDLE SHOULD BE CHECKED DOWN ON DECK WITH SPOILER BRAKE SELECTED TO ENABLE FULL GROUND ROLL BRAKING AUTHORITY.

13. IF DIRECTIONAL CONTROLLABILITY IS IN QUESTION:
    A. SHOREBASED ARRESTED LANDING SHOULD BE FLOWN TO TOUCHDOWN AT OR JUST PRIOR TO ARRESTING GEAR.
    B. USE A LANDING SIGNAL OFFICER IF POSSIBLE.
    C. IF ARRESTING GEAR NOT ENGAGED AND PERFORMANCE AND FLIGHT CHARACTERISTICS PERMIT, EXECUTE WAVEOFF/TOUCH-AND-GO, IF POSSIBLE.
    D. EXPECT DIRECTIONAL EXCURSIONS DURING WAVEOFF/BOLTER, ARRESTED LANDING, OR LANDING ROLLOUT.
    E. NOSEWHEEL STEERING SHOULD NOT BE ENGAGED IF RUDDER PEDAL

AUTHORITY IS RESTRICTED.

F. USE RUDDER, LATERAL STICK, AND/OR DIFFERENTIAL BRAKING TO OPPOSE ANY DIRECTIONAL EXCURSIONS DURING NORMAL LANDING ROLLOUT.

G. BRIEF RUNWAY DEPARTURE PRIOR TO LANDING AND IDENTIFY ANY OBSTRUCTIONS IN CLOSE PROXIMITY TO RUNWAY.

B. CHAPTER 14, PARAGRAPH 14.12.1 UNCOMMANDED ROLL AND/OR YAW, F-14A NFM PAGE 14-31/F-14B NFM PAGE 14-33/F-14D NFM PAGE 14-37, F-14B FAILURE D AND F-14A/D FAILURE E:

(1) DELETE "FROM YAW SAS (19 DEG)", SO PARAGRAPH READS:
"D. RUDDER HARDOVER." (FOR F-14B), OR "E. RUDDER HARDOVER." (FOR F-14A/D).

(2) ADD: NA

C. CHAPTER 14, F-14A NFM PAGE 14-33/F-14B NFM PAGE 14-35/F-14D NFM PAGE 14-38, AFTER RUDDER AUTH LIGHT PARAGRAPH:

(1) DELETE: NA

(2) ADD (INSERT) RUDDER HARDOVER PROCEDURE AS PARA 14.12.8A IN F-14A NFM, AS PARA 14.12.7A IN F-14B NFM, AND AS PARA 14.12.5A IN F-14D NFM:

14.12.8A/7A/5A (NUMBER AS APPROPRIATE) RUDDER HARDOVER. A RUDDER HARDOVER WILL RESULT IN A SINGLE FULLY DEFLECTED (OVER 30 DEGREES, PEGGED ON COCKPIT INDICATOR) INBOARD OR OUTBOARD RUDDER WITH POSSIBLE RESTRICTED OPPOSING "GOOD" RUDDER AUTHORITY AND A FLIGHT HYDRAULIC FAILURE. RUDDER TRIM AND RUDDER PEDAL AUTHORITY MAY ALSO BE RESTRICTED. THIS PROCEDURE ONLY APPLIES TO A TRUE RUDDER HARDOVER FAILURE, NOT A YAW SAS HARDOVER FAILURE WHICH WILL BE MANIFESTED BY BOTH RUDDERS BEING DEFLECTED UP TO 9.5 DEGREES WITH MECHANICAL RUDDER AUTHORITY STILL AVAILABLE. A YAW SAS HARDOVER SHOULD BE EASILY CONTROLLED WITH RUDDER TRIM AND THE AVAILABLE MECHANICAL RUDDER. IN CRUISE CONFIGURATION ABOVE 15 UNITS ANGLE OF ATTACK, A DEPARTURE FROM CONTROLLED FLIGHT MAY OCCUR WITH A RUDDER HARDOVER. UPRIGHT DEPARTURE/SPIN RECOVERY PROCEDURES MAY NOT FULLY RECOVER THE AIRPLANE, AND IT MAY BE NECESSARY TO PERFORM UNCOMMANDED ROLL/YAW PROCEDURES.

WARNING

WITH ZERO FLIGHT HYDRAULIC PRESSURE, ENSURE HYDRAULIC TRANSFER PUMP IS SECURED AS SOON AS POSSIBLE. IN THE EVENT OF HYDRAULIC MALFUNCTION, REFER TO APPROPRIATE HYDRAULIC EMERGENCY PROCEDURE AND EXECUTE APPROPRIATE STEPS IN PARALLEL AS REQUIRED.

AFTER COMPLETION OF UNCOMMANDED ROLL/YAW PROCEDURES:

1. CONFIRM RUDDER HARDOVER VIA COCKPIT INDICATOR AND/OR RIO/WINGMAN VISUAL INSPECTION.

NOTE

RESTRICTION OF AUTHORITY, IF ANY, OF OPPOSING "GOOD" RUDDER MAY BE DETERMINED BY REFERENCE TO THE COCKPIT INDICATOR.

2. IF CARRIER BASED, DIVERT TO AN AIRFIELD WITH SHORT FIELD ARRESTING GEAR.
3. PERFORM CONTROLLABILITY CHECK PROCEDURE.

NOTE

EXPECT ROLL AND YAW OSCILLATIONS DURING THROTTLE AND CONTROL MOVEMENTS. UNDESIRABLE AIRSPEED INCREASE MAY OCCUR DUE TO DIFFERENTIAL THRUST. AIRSPEED CONTROL MAY ALSO BE INFLUENCED BY FLAP POSITION AND PILOT WORKLOAD. SPECIFICALLY, EVALUATE

THE EFFECTS OF ANY REQUIRED DIFFERENTIAL THRUST ON LINEUP CORRECTIONS, WAVEOFF/BOLTER PERFORMANCE, AND FLIGHT CHARACTERISTICS.

NOTE

SIMULATION HAS INDICATED THAT FULL FLAP SETTING COMBINED WITH SEVERELY RESTRICTED OPPOSING RUDDER RESULTS IN MORE PRONOUNCED ROLL AND YAW OSCILLATIONS.

4. DURING CRUISE, USE DIFFERENTIAL THRUST, RUDDER, LATERAL STICK, AND RUDDER TRIM TO RELIEVE PILOT WORKLOAD AND CONTROL FORCES. USE LATERAL TRIM AS NECESSARY.

WARNING

IF JETTISON IS REQUIRED, CONSIDERATION SHOULD BE GIVEN TO KEEPING THE WING STATIONS SYMMETRIC AND AVOIDING AFT C.G. CONDITIONS.

NOTE

IT IS UNKNOWN WHAT THE FUEL CONSUMPTION WILL BE IN THIS CONFIGURATION. THEREFORE, FUEL QUANTITY MUST BE CLOSELY MONITORED. RECOMMEND USING GEAR UP, FLAPS DOWN, SINGLE ENGINE BINGO CHARTS. FUEL IMBALANCE MAY OCCUR DURING PROLONGED FLIGHT WITH HIGHER DEMANDS ON ONE ENGINE. USE FEED SWITCH TO MINIMIZE FUEL SPLIT.

5. IF NO SUITABLE DIVERT AVAILABLE AND AIRCRAFT SUFFICIENTLY CONTROLLABLE FOR CV APPROACH, ATTEMPT CV ARRESTED LANDING.

NOTE

RECOMMEND PRACTICE APPROACH TO CV, FUEL PERMITTING.

6. IF NO SUITABLE DIVERT AVAILABLE AND CONTROLLED CV APPROACH IS IN QUESTION, PERFORM A CONTROLLED EJECTION.

PRIOR TO LANDING:

WARNING

CONTROLLABILITY OF A RUDDER HARDOVER AIRBORNE IS NO INDICATION OF THE ABILITY TO MAINTAIN DIRECTIONAL CONTROL ON DECK. UPON TOUCHDOWN,EXPECT THE AIRCRAFT TO EXPERIENCE UNCONTROLLABLE DIRECTIONAL EXCURSIONS POTENTIALLY DEPARTING THE LANDING AREA/RUNWAY.

NOTE

ENSURE FAMILIARITY WITH LANDING CONSIDERATIONS OF CONTROLLABILITY CHECK PROCEDURES.

NOTE

SIMULATION INDICATED THAT BANK ANGLE CONTROL WAS ENHANCED BY LEADING LATERAL STICK INPUTS WITH DIFFERENTIAL THRUST.

7. LATERAL TRIM - NEUTRALIZE

NOTE

THE USE OF LATERAL TRIM TO REDUCE STICK FORCES DURING ACTUAL APPROACH AND LANDING SHOULD BE AVOIDED AS THIS REDUCES THE SPOILER DEFLECTION AVAILABLE FOR ROLL CONTROL.

8.(F-14B/D ONLY) ASYM THRUST LIMITER SW -- OFF (IF REQUIRED)

WARNING

ASYMMETRIC THRUST LIMITER SHOULD ONLY BE DISABLED IF REQUIRED TO ASSIST/MAINTAIN CONTROL. (F-14B/D ONLY)

9./8. PERFORM ARRESTED LANDING.

WARNING

USE ONLY OPPOSING THROTTLE FOR WAVEOFF/BOLTER.

CAUTION

IF RUDDER PEDAL AUTHORITY IS RESTRICTED, NOSEWHEEL STEERING SHOULD NOT BE ENGAGED UPON LANDING ROLLOUT.

(3) RENUMBER RUNAWAY STABILIZER TRIM PROCEDURE, PARA 14.12.7.2 IN F-14B NFM AS NEW PARA 14.12.7B, AND PARA 14.12.5.2 IN F-14D NFM AS NEW PARA 14.12.5B. (NO RENUMBERING OF RUNAWAY STABILIZER TRIM PROCEDURE IN F-14A NFM IS NECESSARY).

(4) NOTE THAT PARAGRAPHS NUMBERED AS, FOR EXAMPLE, 14.12.7A AND 14.12.7B ARE NOT SUBORDINATE TO 14.12.7, BUT FALL BETWEEN 14.12.7 AND 14.12.8 AT THE SAME LEVEL. THIS IS DONE TO AVOID RENUMBERING PARAGRAPHS 14.12.8 AND SUBSEQUENT AT THIS TIME. RENUMBERING OF THE SUBSEQUENT PARAGRAPHS WILL OCCUR DURING PRODUCTION OF THE NEXT REVISION OR CHANGE TO EACH PUBLICATION.

4. CHANGE REFS D (F-14A PCL), REF E (F-14B PCL), AND REF F (F-14D PCL) AS FOLLOWS:

A. F-14A PAGE 46 / F-14B PAGE-56 / F-14D PAGE 70, CONTROLLABILITY CHECK PROCEDURE:

(1) DELETE EXISTING PROCEDURE.

(2) ADD (INSERT) REPLACEMENT PROCEDURE:

CONTROLLABILITY CHECK.

IT IS ABSOLUTELY IMPERATIVE THAT THE AIRCREW THOROUGHLY AND SAFELY EVALUATE THE DEGRADED HANDLING CHARACTERISTICS OF DAMAGED OR MALFUNCTIONING AIRCRAFT PRIOR TO CONTINUED FLIGHT AND LANDING. THIS CHECK DOES NOT TAKE PRIORITY OVER EXISTING EMERGENCY PROCEDURES.

WARNING

IF AIRCRAFT STALLS OR DEPARTS IN DIRTY CONFIGURATION, IMMEDIATELY UNLOAD AND PLACE THROTTLES AT MILITARY. DO NOT RAISE FLAPS UNTIL RECOVERED. (IF DURING FLAP/SLAT TRANSITION, FOLLOW UNCOMMANDED ROLL/YAW PROCEDURES.)

WARNING

A CONTROLLABILITY CHECK REQUIRES THE TOTAL ATTENTION AND AWARENESS OF THE AIRCREW. THE AIRCREW MUST BE PREPARED TO ENCOUNTER UNUSUAL HANDLING CHARACTERISTICS SINCE THE AERODYNAMIC PROPERTIES OF THE AIRCRAFT MAY BE SIGNIFICANTLY CHANGED. STALL SPEED AS WELL AS FLIGHT AND GROUND HANDLING CHARACTERISTICS MAY BE DRASTICALLY DIFFERENT FROM NORMAL.

NOTE

IF FLIGHT CONTROL MALFUNCTION IS DUE TO UNCOMMANDED STAB AUG TRANSIENTS, SPOILER MALFUNCTION, FLAP/SLAT ASYMMETRY, RUDDER MALFUNCTION (HARDOVER), AND/OR WINGSWEEP MALFUNCTIONS; PERFORM APPLICABLE EMERGENCY PROCEDURE(S) AS NECESSARY BEFORE BEGINNING A CONTROLLABILITY CHECK.

1. CLIMB TO 10,000 FEET AGL MINIMUM.
2. OBTAIN VISUAL CHECK IF POSSIBLE.
3. DECELERATE GRADUALLY TO 200 KNOTS IF FEASIBLE.
4. DIRTY AIRCRAFT, ONE CONFIGURATION CHANGE AT A TIME, WHILE FLYING STRAIGHT AND LEVEL.

NOTE

LANDING GEAR SHOULD BE LOWERED BEFORE FLAPS. DO NOT LOWER ARRESTING HOOK UNTIL LANDING GEAR IS CONFIRMED DOWN AND LOCKED.

5. IF FLAPS ARE LOWERED, DO SO INCREMENTALLY AND BE ALERT FOR A FLAP/SLAP ASYMMETRY.
6. IF MANEUVER FLAPS ARE USED FOR LANDING APPROACH: WING SWEEP

DRIVE NO. 1 AND WG SWP DR NO. 2 / MANUV FLAP CB'S -- PULL (LE1 AND LE2 FOR F-14A/B; LD1 AND LE1 FOR F-14D).

NOTE

FAILURE TO PULL WING SWEEP DRIVE CIRCUIT BREAKERS (LE1 AND LE2 FOR F-14A/B; LD1 AND LE1 FOR F-14D) COULD RESULT IN INADVERTENT MANEUVER DEVICE RETRACTION OR WING SWEEP DURING APPROACH.

NOTE

WINGSWEEP WARNING, WINGSWEEP ADVISORY, AND FLAP CAUTION LIGHTS WILL ILLUMINATE WITH BOTH WING SWEEP DRIVE CIRCUIT BREAKERS PULLED (LE1 AND LE2 FOR F-14A/B; LD1 AND LE1 FOR F-14D).

7. USE DIFFERENTIAL THRUST, IF REQUIRED, TO ACHIEVE ACCEPTABLE FLIGHT CHARACTERISTICS.
8. SLOW-FLY AIRCRAFT TO DETERMINE APPROACH HANDLING CHARACTERISTICS, INCLUDING TURNS.
9. FLY SIMULATED APPROACH TO EVALUATE LINEUP CORRECTIONS, POWER CHANGES, AND WAVEOFF/BOLTER PERFORMANCE, AND FLIGHT CHARACTERISTICS.
10. FOR LANDING, USE MINIMUM SAFE CONTROL SPEED, BUT NO SLOWER THAN OPTIMUM AOA.
11. IF PERFORMANCE AND FLIGHT CHARACTERISTICS DICTATE THAT A CV LANDING IS NOT POSSIBLE -- DIVERT.
12. IF DIVERTING WITH A FLIGHT CONTROL MALFUNCTION -- MAKE ARRESTED LANDING, IF POSSIBLE.

NOTE

IF NORMAL LANDING ROLLOUT IS ATTEMPTED, FLAP HANDLE SHOULD BE CHECKED DOWN ON DECK WITH SPOILER BRAKE SELECTED TO ENABLE FULL GROUND ROLL BRAKING AUTHORITY.

13. IF DIRECTIONAL CONTROLLABILITY IS IN QUESTION:
    A. A SHOREBASED ARRESTED LANDING SHOULD BE FLOWN TO TOUCHDOWN AT OR JUST PRIOR TO THE ARRESTING GEAR.
    B. USE LSO IF POSSIBLE.
    C. IF ARRESTING GEAR NOT ENGAGED AND PERFORMANCE AND FLIGHT CHARACTERISTICS PERMIT, EXECUTE WAVEOFF/TOUCH-AND-GO, IF POSSIBLE.
    D. EXPECT DIRECTIONAL EXCURSIONS DURING WAVEOFF/BOLTER, ARRESTED LANDING, OR LANDING ROLLOUT.
    E. NOSEWHEEL STEERING SHOULD NOT BE ENGAGED IF RUDDER PEDAL AUTHORITY IS RESTRICTED.
    F. USE RUDDER, LATERAL STICK, AND/OR DIFFERENTIAL BRAKING TO OPPOSE ANY DIRECTIONAL EXCURSIONS DURING NORMAL LANDING ROLLOUT.
    G. BRIEF RUNWAY DEPARTURE PRIOR TO LANDING AND IDENTIFY ANY OBSTRUCTIONS IN CLOSE PROXIMITY TO THE RUNWAY.

B. F-14A PAGE 56 /F-14B PAGE 66 /F-14D PAGE 80, AFTER RUDDER AUTH LIGHT PROCEDURE:
   (1) DELETE: NA
   (2) ADD (INSERT) NEW PROCEDURE:

RUDDER HARDOVER.

A RUDDER HARDOVER WILL RESULT IN A SINGLE FULLY DEFLECTED (OVER 30 DEGREES, PEGGED ON COCKPIT INDICATOR) INBOARD OR OUTBOARD RUDDER WITH POSSIBLE RESTRICTED OPPOSING "GOOD" RUDDER AUTHORITY AND A FLIGHT HYDRAULIC FAILURE. RUDDER TRIM AND RUDDER PEDAL AUTHORITY MAY ALSO BE RESTRICTED.

WARNING

WITH ZERO FLIGHT HYDRAULIC PRESSURE, ENSURE HYDRAULIC TRANSFER PUMP SWITCH IS SECURED AS SOON AS POSSIBLE. IN THE EVENT OF HYDRAULIC MALFUNCTION, REFER TO APPROPRIATE HYDRAULIC EMERGENCY PROCEDURE AND EXECUTE APPROPRIATE STEPS IN PARALLEL AS REQUIRED.

AFTER COMPLETION OF UNCOMMANDED ROLL/YAW PROCEDURES:

1. CONFIRM RUDDER HARDOVER VIA COCKPIT INDICATOR AND/OR RIO/WINGMAN VISUAL INSPECTION.

NOTE

RESTRICTION OF AUTHORITY, IF ANY, OF OPPOSING "GOOD" RUDDER MAY BE DETERMINED BY REFERENCE TO THE COCKPIT INDICATOR.

2. IF CARRIER BASED, DIVERT TO AN AIRFIELD WITH SHORT FIELD ARRESTING GEAR.
3. PERFORM CONTROLLABILITY CHECK PROCEDURE.

NOTE

EXPECT ROLL AND YAW OSCILLATIONS DURING THROTTLE AND CONTROL MOVEMENTS. UNDESIRABLE AIRSPEED INCREASE MAY OCCUR DUE TO DIFFERENTIAL THRUST. AIRSPEED CONTROL MAY ALSO BE INFLUENCED BY FLAP POSITION AND PILOT WORKLOAD. SPECIFICALLY, EVALUATE THE EFFECTS OF ANY REQUIRED DIFFERENTIAL THRUST ON LINEUP CORRECTIONS, WAVEOFF/BOLTER PERFORMANCE, AND FLIGHT CHARACTERISTICS.

NOTE

SIMULATION HAS INDICATED THAT FULL FLAP SETTING COMBINED WITH SEVERELY RESTRICTED OPPOSING RUDDER RESULTS IN MORE PRONOUNCED ROLL AND YAW OSCILLATIONS.

4. DURING CRUISE, USE DIFFERENTIAL THRUST, RUDDER, LATERAL STICK, AND RUDDER TRIM TO RELIEVE PILOT WORKLOAD AND CONTROL FORCES. USE LATERAL TRIM AS NECESSARY.

WARNING

IF JETTISON IS REQUIRED, CONSIDERATION SHOULD BE GIVEN TO KEEPING THE WING STATIONS SYMMETRIC AND AVOIDING AFT C.G. CONDITIONS.

NOTE

IT IS UNKNOWN WHAT THE FUEL CONSUMPTION WILL BE IN THIS CONFIGURATION. THEREFORE, FUEL QUANTITY MUST BE CLOSELY MONITORED. RECOMMEND USING GEAR UP, FLAPS DOWN, SINGLE ENGINE BINGO CHARTS. FUEL IMBALANCE MAY OCCUR DURING PROLONGED FLIGHT WITH HIGHER DEMANDS ON ONE ENGINE. USE FEED SWITCH TO MINIMIZE FUEL SPLIT.

5. IF NO SUITABLE DIVERT AVAILABLE AND AIRCRAFT SUFFICIENTLY CONTROLLABLE FOR A CV APPROACH, ATTEMPT CV ARRESTED LANDING.

NOTE

RECOMMEND PRACTICE APPROACH TO CV, FUEL PERMITTING.

6. IF NO SUITABLE DIVERT AVAILABLE AND CONTROLLED CV APPROACH IN QUESTION, PERFORM A CONTROLLED EJECTION.

PRIOR TO LANDING:

WARNING

CONTROLLABILITY OF A RUDDER HARDOVER AIRBORNE IS NO INDICATION OF THE ABILITY TO MAINTAIN DIRECTIONAL CONTROL ON DECK. UPON TOUCHDOWN, EXPECT THE AIRCRAFT TO EXPERIENCE UNCONTROLLABLE DIRECTIONAL EXCURSIONS POTENTIALLY DEPARTING THE LANDING AREA/

RUNWAY.

NOTE

ENSURE FAMILIARITY WITH LANDING CONSIDERATIONS OF CONTROLLABILITY CHECK PROCEDURES.

NOTE

SIMULATION INDICATED THAT BANK ANGLE CONTROL WAS ENHANCED BY LEADING LATERAL STICK INPUTS WITH DIFFERENTIAL THRUST.

7. LATERAL TRIM -- NEUTRALIZE

NOTE

THE USE OF LATERAL TRIM TO REDUCE STICK FORCES DURING ACTUAL APPROACH AND LANDING SHOULD BE AVOIDED AS THIS REDUCES THE SPOILER DEFLECTION AVAILABLE FOR ROLL CONTROL.

8. (F-14B/D ONLY) ASYM THRUST LIMITER SW -- OFF (IF REQUIRED)

WARNING

(F-14B/D ONLY) ASYMMETRIC THRUST LIMITER SHOULD ONLY BE DISABLED IF REQUIRED TO ASSIST/MAINTAIN CONTROL.

9./8. PERFORM ARRESTED LANDING.

WARNING

USE ONLY OPPOSING THROTTLE FOR WAVEOFF/BOLTER.

CAUTION

IF RUDDER PEDAL AUTHORITY IS RESTRICTED, NOSEWHEEL STEERING SHOULD NOT BE ENGAGED UPON LANDING ROLLOUT.

5. VF-101 POC IS F-14A/B/D NATOPS PROGRAM MANAGER, LT GREG KNEPPER, AT DSN 433-4322 OR COMM (757)433-4322, FAX DSN 433-4368 OR (757)433-4368, OR E-MAIL KNEPPERGD@VF101.NAVY.MIL. NAVAIR 4.1.1.1 POC IS LCDR JOE MCKEE, AT DSN 757-7011 OR COMM (301)757-7011, OR EMAIL MCKEEJR@NAVAIR.NAVY.MIL.//

BT

PAAUZYUW RUENAAA4544 1612054-UUUU--RUENNSN.
ZNR UUUUU
P R 091944Z JUN 00 ZYB
FM CNO WASHINGTON DC//N889//
TO ALL TOMCAT AIRCRAFT ACTIVITIES
INFO RUDJABF/NAVWARCOL NEWPORT RI//213//
RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
BT
UNCLAS //N03711//
MSGID/GENADMIN/N889//
SUBJ/INTERIM CHANGES (IC'S) TO F-14B AND F-14D AIRCRAFT NATOPS FLIGHT /PUBLICATIONS//
REF/A/DOC/NAVAIR/01FEB97//
REF/B/DOC/NAVAIR/01FEB97//
REF/C/DOC/NAVAIR/01FEB97//
REF/D/DOC/NAVAIR/01FEB97//
REF/E/MSG/CNO/311705ZMAY00//
NARR/REF A IS NAVAIR 01-F14AAP-1 (F-14B NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 W/CHG-1 01FEB97. REF B IS NAVAIR 01-F14AAP-1F (F-14B NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL)). REF C IS NAVAIR 01-F14AAD-1 (F-14D NATOPS FLIGHT MANUAL (NFM)). REF D IS NAVAIR 01-F14AAD-1F (F-14D NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL)). REF E ISSUED DFCS IC'S AS F-14B NFM IC 42, F-14B FCFCL IC 9, F-14D NFM IC 22, AND F-14D FCFCL IC 2.//
RMKS/1. THIS IS IC NUMBER 44 TO REF A (F-14B NFM), IC NUMBER 10 TO REF B (F-14B FCFCL), IC NUMBER 24 TO REF C (F-14D NFM), AND IC NUMBER 3 TO REF D (F-14D FCFCL).
2. SUMMARY. EXPANDS FUNCTIONAL CHECKFLIGHT ENGINE RUNUP CHECK PROCEDURES IN REFS A THROUGH D (F-14B AND F-14D NFM'S AND FCFCL'S). THESE CHANGES HAVE ALREADY BEEN INCORPORATED INTO PMCF CARDS FOR DFCS AIRCRAFT AS PART OF REF E. THEREFORE, CHANGES CONTAINED IN THIS MSG NEED BE MADE ONLY TO F-14B AND F-14D AIRCRAFT PUBS WITH AFCS, AND SHALL NOT BE INCORPORATED INTO F-14B AND F-14D NATOPS PUBS WITH DFCS. IF NATOPS PUBS HAVE REF E INCORPORATED, RETAIN THIS IC MSG, BUT HOLD ENTRY OF IC'S IN THIS MSG IN ABEYANCE AND MAKE ENTRY ON EACH PUB INTERIM CHANGE SUMMARY PAGE AS "ALREADY INCORPORATED BY CNO 311705Z MAY00".
3. CHANGE REF A (F-14B NFM), CHAPTER 10, PAGES 10-11 AND 10-12, PARAGRAPH 10.3.5 ENGINE RUNUP, STEP 48 AS FOLLOWS:
A. DELETE STEP 48.
B. ADD (INSERT) REPLACEMENT STEP:
AB 48. ENGINE RUNUP -- CHECK.

WARNING

ENGINE CHECKS SHALL NOT BE PERFORMED IN TENSION AND SHALL BE PERFORMED WITH THE SHUTTLE FORWARD OF THE LAUNCH BAR.

CAUTION

SHIPBOARD USE OF MRT AND MINIMUM AB IS RESTRICTED TO A MAXIMUM OF 30 SECONDS TO PREVENT DAMAGE TO THE JBD. JBD COOL DOWN REQUIRES BOTH THROTTLES AT IDLE FOR 30 SECONDS, AND MAY BE NECESSARY DURING THESE CHECKS.

CAUTION

ABOARD SHIP, EXCESSIVE ASYMMETRIC THRUST MAY DAMAGE THE HOLDBACK BAR.

A. VERIFY HOOK STOWED AND RATS LIGHT OUT.
B. BOTH ENGINE MODES -- SEC.
C. BOTH THROTTLES -- MIL.
NOTE ACCELERATION TIME (LESS THAN 10 SECONDS).

NOTE

ASHORE, CHECKS MUST BE PERFORMED WITH THE OPPOSING ENGINE AT IDLE FOR THE BRAKES TO HOLD.

D. BOTH ENGINE MODES -- PRIMARY.
RECORD ENGINE PARAMETERS (READ IN FOUR COLUMNS).

ENGINE PARAMETER	LEFT ENGINE	RIGHT ENGINE	LIMITS
NOZ POSITION (PERCENT) (AT MIL)	. . .	. . .	3 TO 10 - NOMINAL (CLOSED)
OIL (PSI)	. . .	. . .	25 TO 65
RPM (PERCENT)	. . .	. . .	95 TO 104 NOMINAL (107.7 MAXIMUM)
EGT (DEGREES C)	. . .	. . .	935
FF (PPH)	. . .	. . .	9,000 TO 12,000

E. HOOK -- DOWN.
VERIFY RATS LIGHT AND 3 TO 6 PERCENT RPM DECAY.
F. RIGHT THROTTLE -- MIN AB.
VERIFY RPM INCREASES 3 TO 6 PERCENT.
G. RIGHT THROTTLE -- MIL.
H. LEFT THROTTLE -- MIN AB.
VERIFY RPM INCREASES 3 TO 6 PERCENT.
I. LEFT THROTTLE -- MIL.
J. THROTTLE MODE SWITCH -- MAN.
K. BOTH THROTTLES -- IDLE.
L. THROTTLE MODE SWITCH -- BOOST.
M. HOOK -- UP.
VERIFY STOWED AND RATS LIGHT OUT.
N. PERFORM AICS PROGRAMMER RESET.
O. BOTH THROTTLES -- MIL.
P. FLIGHT CONTROL WIPEOUT -- PERFORM.

4. CHANGE REF B (F-14B FCFCL), PAGES 1-10 AND 1-11, ENGINE RUNUP, STEP 48 AS IN PARAGRAPHS 3.A AND 3.B ABOVE.
5. CHANGE REF C (F-14D NFM), CHAPTER 10, PAGES 10-11 AND 10-12, PARAGRAPH 10.3.5 ENGINE RUNUP, STEP 51, AS FOLLOWS:
A. DELETE STEP 51.
B. ADD (INSERT) STEP 51 TO READ THE SAME AS IN STEP 48 IN PARAGRAPH 3.B ABOVE.
6. CHANGE REF D (F-14D FCFCL), PAGES 1-11 AND 1-12, ENGINE RUNUP, STEP 51, AS FOLLOWS:
A. DELETE STEP 51.
B. ADD (INSERT) STEP 51 TO READ THE SAME AS IN STEP 48 IN PARAGRAPH 3.B ABOVE.
7. REFS A THROUGH E ARE AVAILABLE FOR REFERENCE ON THE NATEC WEB SITE, WWW.NATEC.NAVY.MIL. IF REQUIRED, THE NSATS DFCS PACKAGES ARE AVAILABLE FROM THE VF-101 F-14A/B/D AIRCRAFT NATOPS PROGRAM MANAGER, LT DOUG THIEN, AT DSN 433-4322 OR COMM (757) 433-4322, FAX DSN 433-5667 OR (757) 433-5667, OR E-MAIL F14MODELMANAGER@AOL.COM.//
BT

PAAUZYUW RUENAAA4384 1522109-UUUU--RUENNSN.
ZNR UUUUU
P R 311944Z MAY 00 ZYB
FM CNO WASHINGTON DC//N889//
TO ALL TOMCAT AIRCRAFT ACTIVITIES//
INFO RUDJABF/NAVWARCOL NEWPORT RI//213//
RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
BT
UNCLAS //N03711// SECTION 01 OF 02
MSGID/GENADMIN/N889//
SUBJ/INTERIM CHANGES (IC'S) TO F-14 AIRCRAFT NATOPS FLIGHT PUBLICATIONS//
REF/A/DOC/NAVAIR/01FEB97//
REF/B/DOC/NAVAIR/01FEB97//
REF/C/DOC/NAVAIR/01FEB97//
REF/D/DOC/NAVAIR/01FEB97//
REF/E/DOC/NAVAIR/01FEB97//
REF/F/DOC/NAVAIR/01FEB97//
REF/G/DOC/VF-101/16MAR99//
REF/H/MSG/CNO/122040ZSEP97//
NARR/REF A IS NAVAIR 01-F14AAA-1 (F-14A NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 W/CHG-1 01FEB97. REF B IS NAVAIR 01-F14AAA-1B (F-14A NATOPS POCKET CHECKLIST (PCL)) DTD 15MAY95 W/CHG-1 01FEB97. REF C IS NAVAIR 01-F14AAP-1 (F-14B NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 W/CHG-1 01FEB97. REF D IS NAVAIR 01-F14AAP-1B (F-14B NATOPS POCKET CHECKLIST (PCL)) DTD 15MAY95 W/CHG-1 01FEB97. REF E IS NAVAIR 01-F14AAD-1 (F-14D NATOPS FLIGHT MANUAL (NFM)). REF F IS NAVAIR 01-F14AAD-1B (F-14D NATOPS POCKET CHECKLIST (PCL)). REF G IS VF-101 LTR 3711 SER 0326; SUBJ: F-14 NATOPS CONFERENCE REPORT. REF H ISSUED IC 32 TO REF C (F-14B NFM) AND IC 23 TO REF D (F-14B PCL).//
RMKS/1. THIS IS IC NUMBER 146 TO REF A (F-14A NFM), IC NUMBER 102 TO REF B (F-14A PCL), IC NUMBER 43 TO REF C (F-14B NFM), IC NUMBER 28 TO REF D (F-14B PCL), IC NUMBER 23 TO REF E (F-14D NFM), AND IC NUMBER 13 TO REF F (F-14D PCL).
2. SUMMARY. ISSUES REF G ADVANCE CHANGE ITEMS FROM THE F-14A/B/D AIRCRAFT NATOPS REVIEW CONFERENCE HELD IN NOV98 INTO REFS A THROUGH F. ALL CHANGES CONTAINED IN THIS MSG AFFECT ONLY AIRCRAFT WITH AFCS INSTALLED, AND DO NOT APPLY TO AIRCRAFT WITH DFCS. THESE CHANGES SHOULD NOT BE INCORPORATED IF AIRCRAFT FLOWN DO NOT HAVE DFCS INCORPORATED SINCE THE DFCS CHANGES WILL DELETE ANALOG FLIGHT CONTROL SYSTEM (AFCS) INFORMATION IN SUBJECT PUBS. IF UNIT'S AIRCRAFT HAVE DFCS INCORPORATED, RETAIN THIS IC MSG, BUT HOLD ENTRY OF THESE IC'S IN ABEYANCE, AND MAKE ENTRY ON EACH PUB INTERIM CHANGE SUMMARY PAGE AS "AFCS - NOT APPLICABLE TO DFCS AIRCRAFT".
3. CHANGE REF A (F-14A NFM), CHAPTER 14, AS FOLLOWS:
A. PAGE 14-32, PARAGRAPH 14.12.5.2 BOTH PITCH OR BOTH ROLL STAB LIGHTS:
   (1) BETWEEN PARAGRAPH TITLE AND CAUTION WHICH PRECEDES STEP 1:
      (A) DELETE: NA
      (B) ADD (INSERT):

WARNING

CONDITIONS PERMITTING, TROUBLESHOOTING SHOULD NOT BE CONDUCTED BELOW 5,000 FEET AGL.

(2) AFTER STEP 5 (PITCH CMPTR AC CB (LB1) OR ROLL CMPTR AC CB (LA1)) -- CYCLE):

(A) DELETE: NA

(B) ADD (INSERT):

WARNING

CYCLING BOTH PITCH AND ROLL AC COMPUTER CB'S SIMULTANEOUSLY MAY RENDER BOTH THE INBOARD AND OUTBOARD SPOILERS INOPERATIVE.

B. PAGE 14-35, PARAGRAPH 14.12.11.1 SPOILER MALFUNCTION/SPOILER STUCK UP:

(1) BETWEEN PARAGRAPH TITLE AND STEP 1:

(A) DELETE FIRST NOTE:

NOTE

SPOILERS CAUTION LIGHT WILL NOT ILLUMINATE WITH SPOILER FLR ORIDE SWITCHES IN THE ORIDE POSITION.

(B) ADD (REPLACEMENT) FIRST NOTE:

NOTE

SPOILERS CAUTION LIGHT WILL ILLUMINATE ONLY IF ANY SET OF SPOILERS HAVE FAILED DOWN TO THE MINUS 4-1/2 DEGREES POSITION.

(2) STEP 3:

(A) DELETE STEP 3:

3. COUNTER ROLL WITH AT LEAST 1 INCH OF LATERAL STICK.

(B) ADD (REPLACE WITH):

3. IF UNCOMMANDED ROLL IS ENCOUNTERED:
COUNTER ROLL WITH AT LEAST 1 INCH OF LATERAL STICK.

(C) RETAIN NOTE WHICH FOLLOWS STEP 3.

C. PAGE 14-38, PARAGRAPH 14.12.16.1 AUTOPILOT LIGHT:

(1) DELETE AUTOPILOT LIGHT PROCEDURE.

(2) ADD (REPLACE) WITH:

14.12.16.1 AUTOPILOT LIGHT

WARNING

CONDITIONS PERMITTING, TROUBLESHOOTING SHOULD NOT BE CONDUCTED BELOW 5,000 FEET AGL.

1. MASTER RESET -- DEPRESS.

IF LIGHT REMAINS ILLUMINATED:

2. PITCH AND ROLL CMPTR AC CIRCUIT BREAKERS -- CYCLE (LB1, LA1).

WARNING

CYCLING BOTH PITCH AND ROLL AC COMPUTER CB'S SIMULTANEOUSLY MAY RENDER BOTH THE INBOARD AND OUTBOARD SPOILERS INOPERATIVE.

4. CHANGE REF B (F-14A PCL), AS FOLLOWS:

A. PAGE 48, SPOILER MALFUNCTION/SPOILER STUCK UP:

(1) BETWEEN PROCEDURE TITLE AND STEP 1:

(A) DELETE FIRST NOTE:

NOTE

SPOILERS CAUTION LIGHT WILL NOT ILLUMINATE WITH SPOILER FLR ORIDE SWITCHES IN THE ORIDE POSITION.

(B) ADD (INSERT) REPLACEMENT FIRST NOTE:

NOTE

SPOILERS CAUTION LIGHT WILL ILLUMINATE ONLY IF ANY SET OF SPOILERS HAVE FAILED DOWN TO THE MINUS 4-1/2 DEGREES

POSITION.

(2) STEP 3:

(A) DELETE STEP 3:

3. COUNTER ROLL WITH AT LEAST 1 INCH OF LATERAL STICK.

(B) ADD (REPLACE WITH):

3. IF UNCOMMANDED ROLL IS ENCOUNTERED:
COUNTER ROLL WITH AT LEAST 1 INCH OF LATERAL STICK.

(C) RETAIN NOTE WHICH FOLLOWS STEP 3.

B. PAGE 54, PITCH OR ROLL STAB AUG -- BOTH PITCH OR BOTH ROLL STAB LIGHTS:

(1) BETWEEN PROCEDURE TITLE AND CAUTION WHICH PRECEDES STEP 1:

(A) DELETE: NA

(B) ADD (INSERT):

WARNING

CONDITIONS PERMITTING, TROUBLESHOOTING SHOULD NOT BE CONDUCTED BELOW 5,000 FEET AGL.

(2) AFTER STEP 5:

(A) DELETE: NA

(B) ADD (INSERT) WARNING:

WARNING

CYCLING BOTH PITCH AND ROLL AC COMPUTER CIRCUIT BREAKERS SIMULTANEOUSLY MAY RENDER BOTH THE INBOARD AND OUTBOARD SPOILERS INOPERATIVE.

C. CHANGE PAGE 70, FOLLOWING CADC LIGHT NOTE AND GLOVE VANE LIGHT PROCEDURES:

(1) DELETE: NA

(2) ADD (INSERT) AUTOPILOT LIGHT PROCEDURE AS PROVIDED IN PARAGRAPH 3.C(2) ABOVE, EXCEPT OMIT PARAGRAPH NUMBER.

5. CHANGE REF C (F-14B NFM), CHAPTER 14, AS FOLLOWS:

A. PAGE 14-34, PARAGRAPH 14.12.5.2 BOTH PITCH OR BOTH ROLL STAB LIGHTS:

(1) BETWEEN PARAGRAPH TITLE AND CAUTION WHICH PRECEDES STEP 1:

(A) DELETE: NA

(B) ADD (INSERT) WARNING WITH TEXT AS PROVIDED IN PARAGRAPH 3.A(1)(B) ABOVE.

(2) BETWEEN STEPS 5 AND 6:

(A) DELETE: NA

(B) ADD (INSERT) WARNING WITH TEXT AS IN PARAGRAPH 3.A(2)(B) ABOVE.

B. PAGE 14-37, PARAGRAPH 14.12.9.1 SPOILER MALFUNCTION/SPOILER STUCK UP (CURRENT TEXT WAS INCORPORATED BY IC 32 (REF H PARAGRAPH 5.F(1) AND 5.F(2) ABOVE)):

(1) BETWEEN PARAGRAPH TITLE AND STEP 1, REPLACE FIRST NOTE AS IN PARAGRAPHS 3.B(1)(A) AND 3.B(1)(B) ABOVE.

(2) IN STEP 3, REPLACE STEP 3 AS IN PARAGRAPHS 3.B(2)(A) THROUGH 3.B(2)(C) ABOVE.

C. PAGE 14-40, PARAGRAPH 14.12.14.1 AUTOPILOT LIGHT:

(1) DELETE AUTOPILOT LIGHT PROCEDURE.

(2) ADD (INSERT) REPLACEMENT PROCEDURE AS IN PARAGRAPH 3.C(2) ABOVE.

6. CHANGE REF D (F-14B PCL), AS FOLLOWS:

A. PAGES 58 AND 59, SPOILER MALFUNCTION/SPOILER STUCK UP (CURRENT TEXT WAS INCORPORATED BY IC 23 (REF H PARAGRAPHS 6.B(1) AND 6.B(2)

ABOVE:
(1) BETWEEN PROCEDURE TITLE AND STEP 1, REPLACE FIRST NOTE AS IN PARAGRAPHS 4.A(1)(A) AND 4.A(1)(B) ABOVE.
(2) IN STEP 3, REPLACE STEP 3 AS IN PARAGRAPHS 4.A(2)(A) THROUGH 4.A(2)(C) ABOVE.

B. PAGES 64 AND 65, PITCH OR ROLL STAB AUG -- BOTH PITCH OR BOTH ROLL STAB LIGHTS:
(1) BETWEEN PROCEDURE TITLE AND CAUTION WHICH PRECEDES STEP 1:
(A) DELETE: NA
(B) ADD (INSERT) WARNING WITH TEXT AS PROVIDED IN PARAGRAPH 4.B(1)(B) ABOVE.
(2) BETWEEN STEPS 5 AND 6:
(A) DELETE: NA
(B) ADD (INSERT) WARNING WITH TEXT AS IN PARAGRAPH 4.B(2)(B) ABOVE.

C. PAGE 80, AFTER CADC LIGHT PROCEDURE:
(1) DELETE: NA
(2) ADD (INSERT) AUTOPILOT LIGHT PROCEDURE AS PROVIDED IN PARAGRAPH 3.C(2) ABOVE, EXCEPT OMIT PARAGRAPH NUMBER.

7. CHANGE REF E (F-14D NFM), CHAPTER 14, AS FOLLOWS:

A. PAGE 14-38, PARAGRAPH 14.12.3.2 BOTH PITCH OR BOTH ROLL STAB LIGHTS:
(1) BETWEEN PARAGRAPH TITLE AND CAUTION WHICH PRECEDES STEP 1:
(A) DELETE: NA
(B) ADD (INSERT) WARNING WITH TEXT AS PROVIDED IN PARAGRAPH 3.A(1)(B) ABOVE.
(2) BETWEEN STEPS 5 AND 6:
(A) DELETE: NA
(B) ADD (INSERT) WARNING WITH TEXT AS IN PARAGRAPH 3.A(2)(B) ABOVE.

B. PAGE 14-40, PARAGRAPH 14.12.7.1 SPOILER MALFUNCTION/SPOILER STUCK UP:
(1) BETWEEN PARAGRAPH TITLE AND STEP 1, REPLACE FIRST NOTE AS IN PARAGRAPHS 3.B(1)(A) AND 3.B(1)(B) ABOVE.
(2) IN STEP 3, REPLACE STEP 3 AS IN PARAGRAPHS 3.B(2)(A) THROUGH 3.B(2)(C) ABOVE.

C. PAGE 14-44, PARAGRAPH 14.12.13 AUTOPILOT LIGHT
(1) DELETE AUTOPILOT LIGHT PROCEDURE.
(2) ADD (INSERT) REPLACEMENT PROCEDURE AS IN PARAGRAPH 3.C(2) ABOVE.

8. CHANGE REF F (F-14D PCL), AS FOLLOWS:

A. PAGE 72, SPOILER MALFUNCTION/SPOILER STUCK UP:
(1) BETWEEN PROCEDURE TITLE AND STEP 1, REPLACE FIRST NOTE AS IN PARAGRAPHS 4.A(1)(A) AND 4.A(1)(B) ABOVE.
(2) IN STEP 3, REPLACE STEP 3 AS IN PARAGRAPHS 4.A(2)(A) THROUGH 4.A(2)(C) ABOVE.

B. PAGES 78 AND 79, PITCH OR ROLL STAB AUG -- BOTH PITCH OR BOTH ROLL STAB LIGHTS:
(1) BETWEEN PROCEDURE TITLE AND CAUTION WHICH PRECEDES STEP 1:
(A) DELETE: NA
(B) ADD (INSERT) WARNING WITH TEXT AS PROVIDED IN PARAGRAPH 4.B(1)(B) ABOVE.
(2) BETWEEN STEPS 5 AND 6:

(A) DELETE: NA
(B) ADD (INSERT) WARNING WITH TEXT AS IN PARAGRAPH 4.B(2)(B) ABOVE.

C. PAGE 93, AUTOPILOT LIGHT PROCEDURE:
(1) DELETE: NA
(2) ADD (INSERT) AUTOPILOT LIGHT PROCEDURE AS PROVIDED IN PARAGRAPH 3.C(2) ABOVE, EXCEPT OMIT PARAGRAPH NUMBER.

9. REF G DISTRIBUTED TO CONCERNED NATOPS ADVISORY GROUP MEMBERS, F-14 SQUADRONS, AND REVIEW CONFERENCE ATTENDEES. NATOPS PROGRAM MANAGER IS ALSO PREPARING REPLACEMENT PAGES FOR DISTRIBUTION TO FLEET UNITS. IF REF C OR REPLACEMENT PAGES REQUIRED, CONTACT VF-101 F-14A/B/D NATOPS PROGRAM MANAGER, LT DOUG THIEN, AT DSN 433-4322 OR COMM (757)433-4322, FAX DSN 433-5667 OR (757)433-5667, OR E-MAIL F14MODELMANAGER@AOL.COM.//

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ZNR UUUUU
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TO ALL TOMCAT AIRCRAFT ACTIVITIES
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REF/D/DOC/NAVAIR/01FEB97//
REF/E/DOC/NAVAIR/01FEB97//
REF/F/DOC/NAVAIR/01FEB97//
REF/G/DOC/NAVAIR/01FEB97//
REF/H/DOC/NAVAIR/01FEB97//
REF/I/DOC/NAVAIR/01FEB97//
REF/J/DOC/NSATS/UNDATED//
REF/K/DOC/NSATS/UNDATED//
REF/L/DOC/NSATS/UNDATED//
NARR/REF A IS NAVAIR 01-F14AAA-1 (F-14A NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 W/CHG-1 01FEB97. REF B IS NAVAIR 01-F14AAA-1B (F-14A NATOPS POCKET CHECKLIST (PCL)) DTD 15MAY95 W/CHG-1 01FEB97. REF C IS NAVAIR 01-F14AAA-1F (F-14A NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL)). REF D IS NAVAIR 01-F14AAP-1 (F-14B NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 W/CHG-1 01FEB97. REF E IS NAVAIR 01-F14AAP-1B (F-14B NATOPS POCKET CHECKLIST (PCL)) DTD 15MAY95 W/CHG-1 01FEB97. REF F IS NAVAIR 01-F14AAB-1F (F-14B NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL)). REF G IS NAVAIR 01-F14AAD-1 (F-14D NATOPS FLIGHT MANUAL (NFM)). REF H IS NAVAIR 01-F14AAD-1B (F-14D NATOPS POCKET CHECKLIST (PCL)). REF I IS NAVAIR 01-F14AAD-1F (F-14D NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL)). REF J IS NSATS DFCS CHANGE 1 TO F-14A NATOPS PUBS. REF K IS NSATS DFCS CHANGE 1 TO F-14B NATOPS PUBS. REF L IS NSATS DFCS CHANGE 1 TO F-14D NATOPS PUBS.//
RMKS/1. THIS IS IC NUMBER 145 TO REF A (F-14A NFM), IC NUMBER 100 TO REF B (F-14A PCL), IC NUMBER 8 TO REF C (F-14A FCFCL), IC NUMBER 42 TO REF D (F-14B NFM), IC NUMBER 27 TO REF E (F-14B PCL), IC NUMBER 9 TO REF F (F-14B FCFCL), IC NUMBER 22 TO REF G (F-14D NFM), IC NUMBER 12 TO REF H (F-14D PCL), AND IC NUMBER 2 TO REF I (F-14D FCFCL).
2. SUMMARY. ISSUES NSATS DIGITAL FLIGHT CONTROL SYSTEM (DFCS) CHANGES FOR INCORPORATION INTO F-14A, F-14B AND F-14D NATOPS PUBS. THESE CHANGES SHOULD NOT BE INCORPORATED IF AIRCRAFT FLOWN DO NOT HAVE DFCS INCORPORATED SINCE THE DFCS CHANGES WILL DELETE ANALOG FLIGHT CONTROL SYSTEM (AFCS) INFORMATION IN SUBJECT PUBS. IF UNIT'S AIRCRAFT DO NOT HAVE DFCS INCORPORATED, RETAIN THIS IC MSG, BUT HOLD ENTRY OF THESE IC'S IN ABEYANCE UNTIL UNIT AIRCRAFT HAVE DFCS

INCORPORATED AND MAKE ENTRY ON EACH PUB INTERIM CHANGE SUMMARY PAGE AS "DFCS - ENTRY HELD IN ABEYANCE UNTIL INCORPORATION OF DFCS INTO UNIT'S AIRCRAFT".
3. CHANGE REF A (F-14A NFM) BY ENTERING REF J NSATS DFCS F-14A CHANGE 1 NFM CHANGES AS IC 145 IF UNIT AIRCRAFT INCORPORATE DFCS.
4. CHANGE REF B (F-14A PCL) BY ENTERING REF J NSATS F-14A DFCS CHANGE 1 PCL CHANGES AS IC 100 IF UNIT AIRCRAFT INCORPORATE DFCS.
5. REF C (F-14A FCFCL) IS SUPERSEDED BY REF J NSATS DFCS F-14A CHANGE 1 FCFCL AS IC 8 IF UNIT AIRCRAFT INCORPORATE DFCS. REF J NSATS AIRCREW ACCEPTANCE AND FLEET AIRCREW ACCEPTANCE FCFCLS ARE ALSO APPROVED FOR USE DURING DFCS ACCEPTANCE CHECKS AS APPROPRIATE.
6. CHANGE REF D (F-14B NFM) BY ENTERING REF K NSATS DFCS F-14B CHANGE 1 NFM CHANGES AS IC 42 IF UNIT AIRCRAFT INCORPORATE DFCS.
7. CHANGE REF E (F-14B PCL) BY ENTERING REF K NSATS F-14B DFCS CHANGE 1 PCL CHANGES AS IC 27 IF UNIT AIRCRAFT INCORPORATE DFCS.
8. REF F (F-14B FCFCL) IS SUPERSEDED BY REF K NSATS DFCS F-14B CHANGE 1 FCFCL AS IC 9 IF UNIT AIRCRAFT INCORPORATE DFCS. REF K NSATS AIRCREW ACCEPTANCE AND FLEET AIRCREW ACCEPTANCE FCFCLS ARE ALSO APPROVED FOR USE DURING DFCS ACCEPTANCE CHECKS AS APPROPRIATE.
9. CHANGE REF G (F-14D NFM) BY ENTERING REF L NSATS DFCS F-14D CHANGE 1 NFM CHANGES AS IC 22 IF UNIT AIRCRAFT INCORPORATE DFCS.
10. CHANGE REF H (F-14D PCL) BY ENTERING REF L NSATS F-14D DFCS CHANGE 1 PCL CHANGES AS IC 12 IF UNIT AIRCRAFT INCORPORATE DFCS.
11. REF I (F-14D FCFCL) IS SUPERSEDED BY REF L NSATS DFCS F-14D CHANGE 1 FCFCL AS IC 2 IF UNIT AIRCRAFT INCORPORATE DFCS. REF L NSATS AIRCREW ACCEPTANCE AND FLEET AIRCREW ACCEPTANCE FCFCLS ARE ALSO APPROVED FOR USE DURING DFCS ACCEPTANCE CHECKS AS APPROPRIATE.
12. REFS J, K AND L DISTRIBUTED TO CONCERNED NATOPS ADVISORY GROUP MEMBERS AND UNITS BY SEPCOR. NATOPS PROGRAM MANAGER HAS ALSO PREPARED AND IS DISTRIBUTING REPLACEMENT PAGES TO FLEET UNITS. IF REFS J, K, AND/OR L REQUIRED, CONTACT VF-101 F-14A/B/D NATOPS PROGRAM MANAGER, LT DOUG THIEN, AT DSN 433-4322 OR COMM (757)433-4322, FAX DSN 433-5667 OR (757)433-5667, OR E-MAIL F14MODELMANAGER@AOL.COM.//
BT

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TO ALL TOMCAT AIRCRAFT ACTIVITIES
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
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NARR/REF A IS NAVAIR 01-F14AAA-1 (F-14A NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 CHG-1 01FEB97. REF B IS NAVAIR 01-F14AAP-1 (F-14B NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY97 CHG-1 01FEB97. REF C IS NAVAIR 01-F14AAD-1 (F-14D NATOPS FLIGHT MANUAL (NFM)) DTD 01FEB97.//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 143 TO REF A (F-14A NFM), INTERIM CHANGE NUMBER 41 TO REF B (F-14B NFM), AND INTERIM CHANGE NUMBER 21 TO REF C (F-14D NFM).
2. SUMMARY. PROVIDES ADDITIONAL DISCUSSION OF CATAPULT TAKEOFF PROCEDURES, FLIGHT CHARACTERISTICS AND RIO RESPONSIBILITIES DURING NIGHT/IFR CATAPULT LAUNCHES.
3. CHANGE REF A (F-14A NFM), CHAPTER 8, PAGE 8-3, PARA 8.4.2 CATAPULT LAUNCH, AS FOLLOWS:
A. IN FIRST PARAGRAPH, AFTER FOURTH SENTENCE, "WHEN A TURNUP SIGNAL IS RECEIVED....AND THE RIO IS READY.":
   (1) DELETE: NA
   (2) ADD:
   THE RIO MAY SELECT THE AVIA DISPLAY PRIOR TO LAUNCH TO PROVIDE ADDITIONAL INFORMATION DURING INITIAL FLYAWAY. HOWEVER, THE VSI AND AOA INFORMATION DISPLAYED ON THE AVIA IS PARTICULARLY SUSCEPTIBLE TO LAG AND INACCURACIES, AND SHOULD BE USED ONLY AS A SECONDARY SOURCE OF INFORMATION. THE RIO'S PRIMARY SCAN SHOULD BE AIRSPEED, ALTITUDE AND ATTITUDE FROM THE CONVENTIONAL INSTRUMENTS.
B. AFTER FIRST PARAGRAPH:
   (1) DELETE CAUTION.
   (2) ADD:

WARNING

FAILURE TO ALLOW THE CONTROL STICK TO MOVE AFT DURING THE CATAPULT STROKE WILL RESULT IN DEGRADED PITCH RATE AND EXCESSIVE SINK OFF THE BOW.

CAUTION

CATAPULT LAUNCH WITH A PARTIALLY FILLED EXTERNAL TANK IS NOT AUTHORIZED.

C. SECOND PARAGRAPH:
   (1) DELETE SECOND PARAGRAPH, INCLUDING THE THREE SIGNALS SUBPARAGRAPHS.
   (2) ADD:
   THE F-14 MUST BE FLOWN OFF THE CATAPULT BY THE PILOT. AT SHUTTLE RELEASE, THE ENERGY STORED IN THE NOSE STRUT IS RELEASED, ROTATING THE AIRCRAFT TO THE INITIAL FLYAWAY ATTITIDE OF APPROXIMATELY 12-15 DEGREES NOSE-UP ON THE VDI AND HUD. THE AIRCREW SHOULD PLAN AND TRIM FOR THE STANDARD

EXCESS ENDSPEED OF 15 KNOTS UNLESS NOTIFIED OTHERWISE. LOWER EXCESS ENDSPEED THAN ANTICIPATED AND/OR A LOWER PITCH TRIM SETTING THAN RECOMMENDED WILL REQUIRE THE PILOT TO USE AFT STICK AT THE END OF THE CATAPULT STROKE TO ESTABLISH AND MAINTAIN THE DESIRED CLIMBOUT PITCH ATTITUDE OF 10 DEGREES. HIGHER ENDSPEED THAN EXPECTED AND/OR A HIGHER PITCH TRIM SETTING THAN RECOMMENDED WILL REQUIRE THE PILOT TO STOP THE ROTATION AT 10 DEGREES WITH SLIGHT FORWARD STICK. WHILE ROTATING TO THE FLYAWAY ATTITUDE, THE FLIGHTCREW WILL FEEL THE AIRCRAFT SETTLE APPROXIMATELY 5 FEET BEFORE COMMENCING A CLIMB. FOR CATAPULT LAUNCHES WITH EXCESS ENDSPEED LESS THAN 15 KNOTS, THE AOA WILL RISE ABRUPTLY TO 17 UNITS AND THEN GRADUALLY DECREASE AS AIRSPEED INCREASES DURING THE FLYAWAY.

AIRCREW COORDINATION IS PARTICULARLY CRITICAL IN THIS REGIME, SINCE THE AIRCREW MUST ENSURE THAT INITIAL FLYAWAY PARAMETERS ARE MAINTAINED WHILE REMAINING ALERT FOR ANY ABNORMAL LAUNCH CHARACTERISTICS AND ENGINE MALFUNCTIONS. HIGH ENDSPEED AND/OR SINGLE-ENGINE FLYAWAY WITH TRIM SETTINGS ABOVE 2 DEGREES MAY REQUIRE SIGNIFICANT FORWARD STICK PRESSURE. IN ALL CONFIGURATIONS, THE USE OF AFTERBURNER AND/OR LEVEL RAPID ACCELERATION WILL REQUIRE REDUCED NOSE TRIM SETTINGS. THE RIO SHALL SCAN AIRSPEED, ALTITUDE AND ATTITUDE TO CONFIRM A POSITIVE RATE OF CLIMB. THE AVIA DISPLAY MAY BE USED TO PROVIDE ADDITIONAL INFORMATION (AOA AND POSITIVE RATE OF CLIMB) DURING THE INITIAL FLYAWAY, THOUGH, THE VSI AND AOA INFORMATION DISPLAYED ON THE AVIA IS PARTICULARLY SUSCEPTIBLE TO LAG AND INACCURACIES, AND SHOULD BE USED ONLY AS A SECONDARY SOURCE OF INFORMATION.

WHEN AN AIRCRAFT IS LAUNCHED IN AFTERBURNER, THE FOLLOWING DAY SIGNALS AND RESPONSES ARE USED:

1. CATAPULT OFFICER GIVES TWO-FINGER TURNUP SIGNAL; PILOT ADVANCES POWER TO MIL.
2. WHEN AIRCRAFT IS AT MIL POWER, CATAPULT OFFICER RESPONDS WITH FIVE FINGERS (OPEN HAND HELD TOWARD PILOT); PILOT SELECTS MAX POWER.
3. PILOT CHECKS INSTRUMENTS, POSITIONS HIMSELF, THEN SALUTES THE CATAPULT OFFICER.
4. WHEN AIRCRAFT IS AT MAX POWER AND PILOT HAS SALUTED, CATAPULT OFFICER TOUCHES AND THEN RAISES HAND FROM FLIGHT DECK TO SIGNAL FOR CATAPULT TO BE FIRED.

ADDITIONAL CONSIDERATIONS EXIST FOR NIGHT/IFR CATAPULT LAUNCHES. AIRCRAFT ACCELERATION AND THE LACK OF EXTERNAL VISUAL CUES WILL CAUSE THE AIRCREW TO SENSE THAT THE NOSE IS HIGHER THAN ACTUAL AND CAN RESULT IN SPATIAL DISORIENTATION. UNDER THESE CONDITIONS, A VIGILANT INSTRUMENT SCAN IS REQUIRED TO ENSURE THAT THE PROPER ATTITUDE IS MAINTAINED THROUGHOUT THE LAUNCH AND SUBSEQUENT CLIMBOUT. THE AIRCREW SHOULD ALSO BE ALERT FOR POWER TRANSIENTS, WHICH CAN TEMPORARILY DISABLE THE PILOT'S PRIMARY ATTITUDE DISPLAY (VDI) DURING AND AFTER THE CATAPULT STROKE, AND REQUIRE TRANSITION TO THE STANDBY GYRO FOR ATTITUDE INFORMATION.

4. CHANGE REF B (F-14B NFM), CHAPTER 8, PAGE 8-3, PARA 8.4.2, CATAPULT LAUNCH:

A. CAUTION AFTER FIRST PARAGRAPH:

(1) DELETE TEXT "BECAUSE OF SURGE LOAD CONSIDERATIONS" AT END OF

CAUTION.

(2) ADD: NA

B. THIRD (LAST) PARAGRAPH:

(1) DELETE THIRD PARAGRAPH.

(2) ADD:

THE F-14 MUST BE FLOWN OFF THE CATAPULT BY THE PILOT. AT SHUTTLE RELEASE, THE ENERGY STORED IN THE NOSE STRUT IS RELEASED, ROTATING THE AIRCRAFT TO THE INITIAL FLYAWAY ATTITIDE OF APPROXIMATELY 12-15 DEGREES NOSE-UP ON THE VDI AND HUD. THE AIRCREW SHOULD PLAN FOR THE STANDARD EXCESS ENDSPEED OF 15 KNOTS, UNLESS NOTIFIED OTHERWISE. LOWER EXCESS ENDSPEED THAN ANTICIPATED OR A LOWER PITCH TRIM SETTING THAN RECOMMENDED WILL REQUIRE THE PILOT TO USE BACKSTICK AT THE END OF THE CATAPULT STROKE TO CAPTURE AND MAINTAIN THE DESIRED CLIMBOUT PITCH ATTITUDE OF 10 DEGREES. HIGHER ENDSPEED THAN EXPECTED OR A HIGHER PITCH TRIM SETTING THAN RECOMMENDED WILL REQUIRE THE PILOT TO STOP THE ROTATION AT 10 DEGREES WITH SLIGHT FORWARD STICK. WHILE ROTATING TO THE FLYAWAY ATTITUDE, THE FLIGHTCREW WILL FEEL THE AIRCRAFT SETTLE APPROXIMATELY 5 FEET BEFORE COMMENCING A CLIMB. FOR CATAPULT LAUNCHES WITH EXCESS ENDSPEED LESS THAN 15 KNOTS, THE AOA WILL RISE ABRUPTLY TO 17 UNITS AND THEN GRADUALLY DECREASE AS AIRSPEED INCREASES DURING THE FLYAWAY. AIRCREW COORDINATION IS PARTICULARLY CRITICAL IN THIS REGIME, SINCE THE AIRCREW MUST ENSURE THAT INITIAL FLYAWAY PARAMETERS ARE MAINTAINED WHILE REMAINING ALERT FOR ANY ABNORMAL LAUNCH CHARACTERISTICS AND ENGINE MALFUNCTIONS. HIGH ENDSPEED AND/OR SINGLE-ENGINE FLYAWAY WITH TRIM SETTINGS ABOVE 2 DEGREES MAY REQUIRE SIGNIFICANT FORWARD STICK PRESSURE. IN ALL CONFIGURATIONS, THE USE OF AFTERBURNER AND/OR LEVEL RAPID ACCELERATION WILL REQUIRE REDUCED NOSE TRIM SETTINGS. THE RIO SHALL SCAN AIRSPEED, ALTITUDE AND ATTITUDE TO CONFIRM A POSITIVE RATE OF CLIMB. THE AVIA DISPLAY MAY BE USED TO PROVIDE ADDITIONAL INFORMATION (AOA AND POSITIVE RATE OF CLIMB) DURING THE INITIAL FLYAWAY, THOUGH, THE VSI AND AOA INFORMATION DISPLAYED ON THE AVIA IS PARTICULARLY SUSCEPTIBLE TO LAG AND INACCURACIES, AND SHOULD BE USED ONLY AS A SECONDARY SOURCE OF INFORMATION. THE RIO'S PRIMARY SCAN SHOULD BE AIRSPEED, ALTITUDE AND ATTITUDE FROM THE CONVENTIONAL INSTRUMENTS.

ADDITIONAL CONSIDERATIONS EXIST FOR NIGHT/IFR CATAPULT LAUNCHES. AIRCRAFT ACCELERATION AND THE LACK OF EXTERNAL VISUAL CUES WILL CAUSE THE AIRCREW TO SENSE THAT THE NOSE IS HIGHER THAN ACTUAL AND CAN RESULT IN SPATIAL DISORIENTATION. UNDER THESE CONDITIONS A VIGILANT INSTRUMENT SCAN IS REQUIRED TO ENSURE THAT THE PROPER ATTITUDE IS MAINTAINED THROUGHOUT THE LAUNCH AND SUBSEQUENT CLIMBOUT. THE AIRCREW SHOULD ALSO BE ALERT FOR POWER TRANSIENTS, WHICH CAN TEMPORARILY DISABLE THE PILOT'S PRIMARY ATTITUDE DISPLAY (VDI) DURING AND AFTER THE CATAPULT STROKE, AND REQUIRE TRANSITION TO THE STANDBY GYRO FOR ATTITUDE INFORMATION.

5. CHANGE REF C (F-14D NFM), CHAPTER 8, PAGE 8-4, PARA 8.4.2, CATAPULT LAUNCH:

A. DELETE THIRD (LAST) PARAGRAPH.

B. ADD:

THE F-14 MUST BE FLOWN OFF THE CATAPULT BY THE PILOT. AT

SHUTTLE RELEASE, THE ENERGY STORED IN THE NOSE STRUT IS RELEASED, ROTATING THE AIRCRAFT TO THE INITIAL FLYAWAY ATTITIDE OF APPROXIMATELY 12-15 DEGREES NOSE-UP ON THE VDI AND HUD. THE AIRCREW SHOULD PLAN FOR THE STANDARD EXCESS ENDSPEED OF 15 KNOTS, UNLESS NOTIFIED OTHERWISE. LOWER EXCESS ENDSPEED THAN ANTICIPATED OR A LOWER PITCH TRIM SETTING THAN RECOMMENDED WILL REQUIRE THE PILOT TO USE BACKSTICK AT THE END OF THE CATAPULT STROKE TO CAPTURE AND MAINTAIN THE DESIRED CLIMBOUT PITCH ATTITUDE OF 10 DEGREES. HIGHER ENDSPEED THAN EXPECTED OR A HIGHER PITCH TRIM SETTING THAN RECOMMENDED WILL REQUIRE THE PILOT TO STOP THE ROTATION AT 10 DEGREES WITH SLIGHT FORWARD STICK. WHILE ROTATING TO THE FLYAWAY ATTITUDE, THE FLIGHTCREW WILL FEEL THE AIRCRAFT SETTLE APPROXIMATELY 5 FEET BEFORE COMMENCING A CLIMB. FOR CATAPULT LAUNCHES WITH EXCESS ENDSPEED LESS THAN 15 KNOTS, THE AOA WILL RISE ABRUPTLY TO 17 UNITS AND THEN GRADUALLY DECREASE AS AIRSPEED INCREASES DURING THE FLYAWAY.

AIRCREW COORDINATION IS PARTICULARLY CRITICAL IN THIS REGIME, SINCE THE AIRCREW MUST ENSURE THAT INITIAL FLYAWAY PARAMETERS ARE MAINTAINED WHILE REMAINING ALERT FOR ANY ABNORMAL LAUNCH CHARACTERISTICS AND ENGINE MALFUNCTIONS. HIGH ENDSPEED AND/OR SINGLE-ENGINE FLYAWAY WITH TRIM SETTINGS ABOVE 2 DEGREES MAY REQUIRE SIGNIFICANT FORWARD STICK PRESSURE. IN ALL CONFIGURATIONS, THE USE OF AFTERBURNER AND/OR LEVEL RAPID ACCELERATION WILL REQUIRE REDUCED NOSE TRIM SETTINGS. THE RIO SHALL SCAN A REPEAT OF THE PILOT'S HEADS UP DISPLAY AND ASSOCIATED STANDBY FLIGHT INSTRUMENTS TO ENSURE THE CORRECT FLYAWAY CONDITIONS ARE MET (AIRSPEED, ALTITUDE AND ATTITUDE).

ADDITIONAL CONSIDERATIONS EXIST FOR NIGHT/IFR CATAPULT LAUNCHES. AIRCRAFT ACCELERATION AND THE LACK OF EXTERNAL VISUAL CUES WILL CAUSE THE AIRCREW TO SENSE THAT THE NOSE IS HIGHER THAN ACTUAL AND CAN RESULT IN SPATIAL DISORIENTATION. UNDER THESE CONDITIONS, A VIGILANT INSTRUMENT SCAN IS REQUIRED TO ENSURE THAT THE PROPER ATTITUDE IS MAINTAINED THROUGHOUT THE LAUNCH AND SUBSEQUENT CLIMBOUT. //

BT

PTAUZYUW RUENAAA7311 3221825-UUUU--RULSTGP.
ZNR UUUUU
P R 181806Z NOV 98 ZYB PSN 667712M29
FM CNO WASHINGTON DC//N889//
TO ALL TOMCAT AIRCRAFT ACTIVITIES//
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RULSTGP/COMNAVWARDEVCOM DIV WASHINGTON DC//NATOPS//
BT
UNCLAS //N03711//
MSGID/GENADMIN/N889//
SUBJ/INTERIM CHANGE TO F-14D AIRCRAFT NATOPS FLIGHT MANUAL//
REF/A/DOC/NAVAIR/01FEB97//
REF/B/MSG/CNO WASH DC/231304ZOCT98//
NARR/REF A IS NAVAIR 01-F14AAD-1 (F-14D NATOPS FLIGHT MANUAL (NFM)), AND REF B IS INTERIM CHANGE NUMBER 19 (EJECTION SEAT AIRCREW WEIGHTS) TO REF A.//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 20 TO REF C (F-14D NFM).
2. SUMMARY. CORRECTS ERROR IN IC 19 (REF B) TO F-14D NFM (REF A). REF B INCORRECTLY REPLACED THE FIRST THREE SENTENCES OF FIRST PARAGRAPH OF PARA 2.38.1. THIS MESSAGE RESTORES ORIGINAL WORDING OF THE FIRST PARAGRAPH AND CHANGES THE SECOND PARAGRAPH.
3. CHANGE REF A (F-14D NFM), CHAPTER 2, PAGE 2-243, PARAGRAPH 2.38.1 EJECTION SEAT, AS FOLLOWS:

A. FIRST PARAGRAPH OF PARAGRAPH 2.38.1. IF IC 19 NOT YET INCORPORATED INTO FIRST PARAGRAPH, PROCEED TO PARAGRAPH 3.B BELOW. IF IC 19 ALREADY INCORPORATED INTO FIRST PARAGRAPH, PROCEED AS FOLLOWS:

   (1) DELETE FIRST THREE SENTENCES, AS FOLLOWS:

      AFTER EJECTION HAS BEEN INITIATED, TWO PITOT HEADS MOUNTED NEXT TO THE PARACHUTE CONTAINER ARE DEPLOYED. AIRSPEED AND ALTITUDE ARE PROVIDED TO THE BATTERY-OPERATED ELECTRONIC SEQUENCER MOUNTED UNDER THE PARACHUTE CONTAINER. THE SEQUENCER USES THE INFORMATION TO DETERMINE THE RELEASE TIME FOR THE DROGUE BRIDLES, THE DEPLOYMENT TIME FOR THE PARACHUTE, AND RELEASE TIME FOR THE HARNESS LOCKS.

   (2) ADD (INSERT):

      THE NACES SEAT (FIGURE 2-126) IS PROVIDED WITH A ROCKET-DEPLOYED 6.5 METER (20-FOOT), AEROCONICAL, STEERABLE PARACHUTE THAT IS PACKED WITH A RIBBON EXTRACTION DROGUE IN A CONTAINER BEHIND THE SEAT OCCUPANT'S HEAD. THE SEAT BUCKET HOLDS THE SURVIVAL KIT AND ALSO HAS THE SEAT FIRING HANDLE AND OTHER OPERATING CONTROLS. THE PARACHUTE RISERS ATTACH TO THE CREWMWMBER'S TORSO HARNESS BY MEANS OF SEAWATER-ACTIVATED RELEASE SWITCHES.

B. SECOND PARAGRAPH:

   (1) DELETE THIRD SENTENCE:

      THE SEQUENCER, WHICH ALSO RECEIVES STATIC PRESSURE, USES THE INFORMATION TO DETERMINE THE PROPER SEQUENCING OF DEPLOYMENT OF THE SEAT DROGUE AND PARACHUTE AND RELEASE OF THE HARNESS LOCKS.

   (2) ADD (INSERT) REPLACEMENT THIRD SENTENCE:

      THE SEQUENCER USES THE INFORMATION TO DETERMINE THE RELEASE TIME FOR THE DROGUE BRIDLES, THE DEPLOYMENT TIME FOR THE PARACHUTE, AND RELEASE TIME FOR THE HARNESS LOCKS.//

BT

PTAUZYUW RUENAAA6845 2961414-UUUU--RULSTGP.
ZNR UUUUU
P R 231304Z OCT 98 ZYB PSN 532084M22
FM CNO WASHINGTON DC//N889//
TO ALL TOMCAT AIRCRAFT ACTIVITIES
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RULSTGP/COMNAVWARDEVCOM DIV WASHINGTON DC//NATOPS//
BT
UNCLAS //N03711//
MSGID/GENADMIN/N889//
SUBJ/INTERIM CHANGES TO F-14 AIRCRAFT NATOPS FLIGHT MANUALS//
REF/A/DOC/NAVAIR/01FEB97//
REF/B/DOC/NAVAIR/01FEB97//
REF/C/DOC/NAVAIR/01FEB97//
NARR/REF A IS NAVAIR 01-F14AAA-1 (F-14A NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 WITH CHG-1 01FEB97, REF B IS NAVAIR 01-F14AAP-1 (F-14B NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 WITH CHG-1 01FEB97, AND REF C IS NAVAIR 01-F14AAD-1 (F-14D NATOPS FLIGHT MANUAL (NFM)).//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 142 TO REF A (F-14A NFM), INTERIM CHANGE NUMBER 40 TO REF B (F-14B NFM), AND INTERIM CHANGE NUMBER 19 TO REF C (F-14D NFM).
2. SUMMARY. ADDS WARNINGS ABOUT EJECTION SEAT INJURY RISKS TO
PAGE 02 RUENAAA6845 UNCLAS
EACH NFM.
3. CHANGE REF A (F-14A NFM), AS FOLLOWS:
A. CHAPTER 2, PAGE 2-159, PARAGRAPH 2.35 EJECTION SYSTEM, WARNING AFTER SECOND PARAGRAPH:
   (1) DELETE: NA
   (2) ADD (INSERT) NEW FIRST BULLET INTO WARNING:

WARNING

REGARDLESS OF THE GRU-7A EJECTION SEAT LIMITATIONS, ANY PERSON WHOSE NUDE BODY WEIGHT IS BELOW 136 POUNDS OR ABOVE 213 POUNDS IS SUBJECT TO INCREASED RISK OF INJURY FROM EJECTION.

B. CHAPTER 16, PAGES 16-1 AND 16-3, PARAGRAPH 16.1.1 EJECTION ENVELOPE, SECOND PARAGRAPH AND ITEMS:
   (1) DELETE SECOND PARAGRAPH AND ITEMS 1 THROUGH 3.
   (2) ADD (INSERT) WARNING WITH TEXT:

THE ESCAPE SYSTEM WILL FUNCTION UP TO 0.9 IMN OR 600 KIAS, WHICHEVER IS GREATER. HOWEVER, HUMAN LIMITATIONS ARE MORE RESTRICTIVE, AS INDICATED BELOW:

WARNING

REGARDLESS OF THE GRU-7A EJECTION SEAT LIMITATIONS, ANY PERSON WHOSE NUDE BODY WEIGHT IS BELOW 136 POUNDS OR ABOVE 213 POUNDS IS SUBJECT TO INCREASED RISK OF INJURY FROM EJECTION.

1. ZERO TO 250 KIAS - SAFE EJECTION (INJURY IMPROBABLE)
2. 250-600 KIAS - HAZARDOUS EJECTION (APPRECIABLE FORCES ARE EXERTED UPON THE BODY, MAKING INJURY PROBABLE)
3. ABOVE 600 KIAS - EXTREMELY HAZARDOUS EJECTION (EXCESSIVE FORCES ARE EXERTED UPON THE BODY, MAKING SERIOUS INJURY OR DEATH HIGHLY PROBABLE)

C. CHAPTER 16, PAGE 16-2, FIGURE 16-1 EJECTION SEAT LIMITATIONS:
   (1) DELETE: NA
   (2) AT TOP OF PAGE BETWEEN FIGURE TITLE "COMMAND DUAL EJECTION" AND NOTE, ADD:
   GRU-7A EJECTION SEAT(S)

(3) BELOW "EJECTION SEAT - HUMAN FACTORS LIMITATIONS" GRAPH, ADD:
(BULLET) THIS INFORMATION WAS EXTRAPOLATED USING THE GRU-7A QUALIFICATION WEIGHTS.
(BULLET) THE GRU-7A WAS QUALIFIED FOR USE BY MALE AVIATORS WITH NUDE WEIGHTS FROM 136 LB TO 213 LB.
(BULLET) THE HUMAN FACTOR LIMITATIONS ARE FOR HIGH SPEED AERODYNAMIC LOADS ONLY.

D. CHAPTER 16, PAGE 16-3, PARAGRAPH 16.1.1.1 EJECTION AT GROUND LEVEL/ON DECK:
(1) DELETE FIRST THREE PARAGRAPHS.
(2) ADD (INSERT):

16.1.1.1 EJECTION AT GROUND LEVEL/ON DECK. THE GRU-7A EJECTION SEAT IS DESIGNED FOR ZERO-ZERO EJECTION CAPABILITY FOR A MAXIMUM NUDE CREWMEMBER WEIGHT OF 213 POUNDS. AIRCREW ABOVE 213 POUNDS NUDE WEIGHT HAVE AN INCREASED RISK OF INJURY DUE TO AN INADEQUATE PARACHUTE RECOVERY ALTITUDE. AT THE MAXIMUM NUDE WEIGHT OF 213 POUNDS, THE MARGIN OF SAFETY IS VERY NARROW BELOW 50 KTAS. TAILWIND AND AIRCRAFT DECELERATION ALSO CONTRIBUTE TO INCREASED INJURY RISK.

FOR AIRCREW BELOW 136 POUNDS, THE ZERO-ZERO EJECTION PARACHUTE RECOVERY ALTITUDE IS INCREASED. HOWEVER, LIGHT-WEIGHT AIRCREW OCCUPANTS BELOW 136 POUNDS NUDE WEIGHT ARE SUBJECTED TO HIGHER LOADS AS AIRSPEED INCREASES, ESPECIALLY AT AIRSPEEDS GREATER THAN 450 KIAS. THE EJECTION SEAT BECOMES LESS STABLE AND DECELERATION FORCES DURING DROGUE CHUTE DEPLOYMENT BECOME MORE SEVERE. ANALYSIS HAS SHOWN THAT LOWERING THE SEAT PRIOR TO EJECTING INCREASES SEAT STABILITY DURING A HIGH SPEED EJECTION.

(3) RETAIN OLD LAST PARAGRAPH.

4. CHANGE REF B (F-14B NFM), AS FOLLOWS:

A. CHAPTER 2, PAGE 2-152, PARAGRAPH 2.35 EJECTION SYSTEM, WARNING AT TOP OF PAGE:
(1) DELETE: NA
(2) ADD (INSERT) NEW FIRST BULLET INTO WARNING:

WARNING

REGARDLESS OF THE GRU-7A EJECTION SEAT LIMITATIONS, ANY PERSON WHOSE NUDE BODY WEIGHT IS BELOW 136 POUNDS OR ABOVE 213 POUNDS IS SUBJECT TO INCREASED RISK OF INJURY FROM EJECTION.

B. CHAPTER 16, PAGE 16-1, PARAGRAPH 16.1.1 EJECTION ENVELOPE, SECOND PARAGRAPH AND ITEMS:
(1) DELETE SECOND PARAGRAPH AND ITEMS 1 THROUGH 3.
(2) ADD (INSERT) WARNING WITH TEXT:

THE ESCAPE SYSTEM WILL FUNCTION UP TO 0.9 IMN OR 600 KIAS, WHICHEVER IS GREATER. HOWEVER, HUMAN LIMITATIONS ARE MORE RESTRICTIVE, AS INDICATED BELOW:

1. ZERO TO 250 KIAS - SAFE EJECTION (INJURY IMPROBABLE
2. 250-600 KIAS - HAZARDOUS EJECTION (APPRECIABLE FORCES ARE EXERTED UPON THE BODY, MAKING INJURY PROBABLE)
3. ABOVE 600 KIAS - EXTREMELY HAZARDOUS EJECTION (EXCESSIVE FORCES ARE EXERTED UPON THE BODY, MAKING SERIOUS INJURY OR DEATH HIGHLY PROBABLE)

C. CHAPTER 16, PAGE 16-2, FIGURE 16-1 EJECTION SEAT LIMITATIONS:
(1) DELETE: NA
(2) AT TOP OF PAGE BETWEEN FIGURE TITLE "COMMAND DUAL EJECTION" AND NOTE, ADD:

GRU-7A EJECTION SEAT(S)

(3) BELOW "EJECTION SEAT - HUMAN FACTORS LIMITATIONS" GRAPH, ADD:
(BULLET) THIS INFORMATION WAS EXTRAPOLATED USING THE GRU-7A QUALIFICATION WEIGHTS.
(BULLET) THE GRU-7A WAS QUALIFIED FOR USE BY MALE AVIATORS WITH NUDE WEIGHTS FROM 136 LB TO 213 LB.
(BULLET) THE HUMAN FACTOR LIMITATIONS ARE FOR HIGH SPEED AERODYNAMIC LOADS ONLY.

D. CHAPTER 16, PAGE 16-3, PARAGRAPH 16.1.1.1 EJECTION AT GROUND LEVEL/ON DECK:
(1) DELETE FIRST THREE PARAGRAPHS.
(2) ADD (INSERT):

16.1.1.1 EJECTION AT GROUND LEVEL/ON DECK. THE GRU-7A EJECTION SEAT IS DESIGNED FOR ZERO-ZERO EJECTION CAPABILITY FOR A MAXIMUM NUDE CREWMEMBER WEIGHT OF 213 POUNDS. AIRCREW ABOVE 213 POUNDS NUDE WEIGHT HAVE AN INCREASED RISK OF INJURY DUE TO AN INADEQUATE PARACHUTE RECOVERY ALTITUDE. AT THE MAXIMUM NUDE WEIGHT OF 213 POUNDS, THE MARGIN OF SAFETY IS VERY NARROW BELOW 50 KTAS. TAILWIND AND AIRCRAFT DECELERATION ALSO CONTRIBUTE TO INCREASED INJURY RISK.

FOR AIRCREW BELOW 136 POUNDS, THE ZERO-ZERO EJECTION PARACHUTE RECOVERY ALTITUDE IS INCREASED. HOWEVER, LIGHT-WEIGHT AIRCREW OCCUPANTS BELOW 136 POUNDS NUDE WEIGHT ARE SUBJECTED TO HIGHER LOADS AS AIRSPEED INCREASES, ESPECIALLY AT AIRSPEEDS GREATER THAN 450 KIAS. THE EJECTION SEAT BECOMES LESS STABLE AND DECELERATION FORCES DURING DROGUE CHUTE DEPLOYMENT BECOME MORE SEVERE. ANALYSIS HAS SHOWN THAT LOWERING THE SEAT PRIOR TO EJECTING INCREASES SEAT STABILITY DURING A HIGH SPEED EJECTION.

(3) RETAIN OLD LAST PARAGRAPH.

5. CHANGE REF C (F-14D NFM), AS FOLLOWS:

A. CHAPTER 2, PAGE 2-243, PARAGRAPH 2.38 EJECTION SYSTEM, WARNING AFTER SECOND PARAGRAPH:
(1) DELETE: NA
(2) ADD (INSERT) NEW FIRST BULLET INTO WARNING:

WARNING

REGARDLESS OF THE SJU-17 EJECTION SEAT LIMITATIONS, ANY PERSON WHOSE NUDE BODY WEIGHT IS BELOW 136 POUNDS OR ABOVE 213 POUNDS IS SUBJECT TO INCREASED RISK OF INJURY FROM EJECTION.

B. CHAPTER 2, PAGE 2-243, PARAGRAPH 2.38.1 EJECTION SEAT, FIRST PARAGRAPH:
(1) DELETE FIRST THREE SENTENCES.
(2) ADD (INSERT):

AFTER EJECTION HAS BEEN INITIATED, TWO PITOT HEADS MOUNTED NEXT TO THE PARACHUTE CONTAINER ARE DEPLOYED. AIRSPEED AND ALTITUDE ARE PROVIDED TO THE BATTERY-OPERATED ELECTRONIC SEQUENCER MOUNTED UNDER THE PARACHUTE CONTAINER. THE SEQUENCER USES THE INFORMATION TO DETERMINE THE RELEASE TIME FOR THE DROGUE BRIDLES, THE DEPLOYMENT TIME FOR THE PARACHUTE, AND RELEASE TIME FOR THE HARNESS LOCKS.

C. CHAPTER 2, PAGE 2-243, PARAGRAPH 2.38.1.1 SEAT FIRING HANDLE:
(1) DELETE PARAGRAPH.
(2) ADD:

2.38.1.1 SEAT FIRING HANDLE. EJECTION IS INITIATED BY PULLING UP ON THE SEAT FIRING HANDLE ON THE FRONT OF THE SEAT BUCKET BETWEEN THE CREWMEMBERS THIGHS. A PULL FORCE OF 25 TO 40 POUNDS IS REQUIRED TO REMOVE THE FIRING HANDLE FROM ITS

HOUSING. A CONTINUED PULL FORCE OF 30 TO 60 POUNDS IS REQUIRED TO INITIATE EJECTION. THIS ACTION OPERATES LINKAGE THAT WITHDRAWS THE SEARS FROM THE TWO SEAT INITIATOR CARTRIDGES, COMMENCING THE EJECTION SEQUENCE.

D. CHAPTER 2, PAGE 2-248, PARAGRAPH 2.38.1.9 SURVIVAL KIT, THIRD PARAGRAPH:

(1) DELETE FIRST SENTENCE.

(2) ADD (INSERT):

A URT-33C RADIO LOCATOR BEACON IS IN A CUTOUT IN THE LEFT THIGH SUPPORT AND IS CONNECTED TO THE COCKPIT FLOOR BY A STATIC OPERATING CABLE SO THAT IT CAN BE AUTOMATICALLY ACTUATED DURING EJECTION.

E. CHAPTER 2, PAGE 2-250, PARAGRAPH 2.38.4.1 ELECTRONIC SEQUENCING:

(1) DELETE SUBPARAGRAPHS 1 THROUGH 3.

(2) ADD (INSERT):

1. MODE 1 -- THIS IS THE LOW-ALTITUDE, LOW-AIRSPEED MODE. THE BRIDLES ARE RELEASED 0.32 SECONDS AFTER SEAT FIRST MOTION. THE PARACHUTE DEPLOYMENT ROCKET FIRES TO DEPLOY THE PARACHUTE AND THE HARNESS RELEASE SYSTEM OPERATES TO FREE THE OCCUPANT FROM THE SEAT.
2. MODES 2, 3, AND 4 -- THESE MODES ARE FOR LOW TO MEDIUM ALTITUDES. THE SEAT IS DECELERATED BY THE DROGUE AND AFTER A TIME DELAY DETERMINED BY THE ELECTRONIC SEQUENCER THE PARACHUTE DEPLOYMENT ROCKET FIRES TO DEPLOY THE PARACHUTE BEFORE THE DROGUE BRIDLES ARE RELEASED. THE HARNESS RELEASE SYSTEM OPERATES TO FREE THE OCCUPANT FROM THE SEAT.
3. MODE 5 -- THIS MODE IS SELECTED AT HIGH ALTITUDE. THE SEAT (WITH DROGUE BRIDLES CONNECTED) DESCENDS TO 18,000 FEET, WHERE THE BRIDLES ARE RELEASED. THE PARACHUTE DEPLOYMENT ROCKET FIRES TO DEPLOY THE PARACHUTE AND THE HARNESS RELEASE SYSTEM OPERATES TO FREE THE OCCUPANT FROM THE SEAT.

F. CHAPTER 16, PAGES 16-1 AND 16-5, PARAGRAPH 16.1.1 EJECTION ENVELOPE:

(1) DELETE SECOND PARAGRAPH AND ITEMS 1 THROUGH 3.

(2) ADD (INSERT):

WARNING

DURING EJECTION SEAT DEVELOPMENT AND TESTING, THE SJU-17(V)3/A AND SJU-17(V)4/A WERE QUALIFIED FOR USE BY MALE AVIATORS WITH NUDE WEIGHTS FROM 136 POUNDS TO 213 POUNDS. OPERATION OF THE SEAT BY PERSONNEL NOT WITHIN THESE PARAMETERS SUBJECTS THE OCCUPANT TO INCREASED RISK OF INJURY.

1. GENERAL INJURY RISKS:
   A. EJECTION SEAT STABILITY IS DIRECTLY RELATED TO OCCUPANT RESTRAINT. ALL OCCUPANTS SHOULD BE PROPERLY RESTRAINED IN THE SEAT BY THEIR TORSO HARNESS FOR OPTIMUM PERFORMANCE AND MINIMUM INJURY RISK.
   B. INERTIA REEL PERFORMANCE MAY BE DEGRADED FOR OCCUPANTS OUTSIDE OF THE QUALIFIED WEIGHT RANGE. LIGHTER OCCUPANTS MAY BE INJURED DURING THE HAULBACK, AND BOTH LIGHT AND HEAVY OCCUPANTS MAY EXPERIENCE POOR EJECTION POSITIONS, RESULTING IN AN INCREASED RISK OF INJURY DURING EJECTION.
2. INJURY RISKS FOR AVIATORS WITH NUDE WEIGHTS LESS THAN 136 POUNDS:

A. THE CATAPULT WAS DESIGNED FOR THE EJECTION SEAT QUALIFIED WEIGHT RANGE. LIGHTER WEIGHT OCCUPANTS ARE SUBJECT TO A HIGHER RISK OF INJURY FROM THE CATAPULT DUE TO GREATER ACCELERATION.
B. LIGHTER WEIGHT OCCUPANTS ARE AT A GREATER RISK OF INJURY DURING EJECTIONS ABOVE 300 KIAS DUE TO INSTABILITY DURING DROGUE DEPLOYMENT.
C. LIGHTER WEIGHT OCCUPANTS ARE AT A GREATER RISK OF INJURY DURING EJECTIONS NEAR THE UPPER END OF MODE 1 (APPROACHING 300 KIAS) DUE TO HIGH PARACHUTE OPENING SHOCK.

3. INJURY RISKS FOR AVIATORS WITH NUDE WEIGHTS GREATER THAN 213 POUNDS:
A. LARGER OCCUPANTS MAY NOT ATTAIN SUFFICIENT ALTITUDE FOR PARACHUTE FULL INFLATION IN ZERO-ZERO CASES OR AT EXTREMELY LOW ALTITUDES AND VELOCITIES.
B. LARGER OCCUPANTS MAY NOT ATTAIN SUFFICIENT ALTITUDE TO CLEAR THE AIRCRAFT TAIL STRUCTURE.

THE ESCAPE SYSTEM WILL FUNCTION UP TO 0.9 IMN OR 600 KIAS, WHICHEVER IS GREATER. HOWEVER, HUMAN LIMITATIONS ARE MORE RESTRICTIVE AS INDICATED BELOW:

1. ZERO TO 250 KIAS -- SAFE EJECTION (INJURY IMPROBABLE)
2. 250 TO 600 KIAS -- HAZARDOUS EJECTION (APPRECIABLE FORCES ARE EXERTED UPON THE BODY, MAKING INJURY PROBABLE)
3. ABOVE 600 KIAS -- EXTREMELY HAZARDOUS EJECTION (EXCESSIVE FORCES ARE EXERTED UPON THE BODY, MAKING SERIOUS INJURY OR DEATH HIGHLY PROBABLE).

(3) RETAIN OLD LAST PARAGRAPH. //

BT

DEPARTMENT OF THE NAVY
NAVAL AIR SYSTEMS COMMAND
47123 BUSE ROAD, UNIT #IPT
PATUXENT RIVER, MD 20670-1547

IN REPLY REFER TO

3711
Ser AIR-4.3P/7.0098
17 Jul 98

From: Commander, Naval Air Systems Command
To: Distribution

Subj: INTERIM CHANGE TO F-14A/B/D NATOPS PUBLICATIONS

Ref: (a) 01-F-14AAA-1, F-14A NATOPS Flight Manual dtd 15 May 95 with Change 1, 01 Feb 97.
(b) 01-F-14AAP-1, F-14B NATOPS Flight Manual dtd 15 May 95, with Change 1, 01 Feb 97.
(c) 01-F-14AAD-1, F-14D NATOPS Flight Manual dtd 01 Feb 97.

Encl: (1) F-14A Interim NATOPS Change Number 141.
(2) F-14B Interim NATOPS Change Number 39.
(3) F-14D Interim NATOPS Change Number 18.

1. The following F-14 Aircraft Interim NATOPS Changes are hereby issued:

a. F-14A Interim NATOPS Change Number 141 to reference (a).

b. F-14B Interim NATOPS Change Number 39 to reference (b).

c. F-14D Interim NATOPS Change Number 18 to reference (c).

2. Make the following modifications to the F-14A, F-14B, and F-14D NATOPS Manuals:

a. Cross through NATOPS Manual page 4-14 with a pen and write "superseded".

b. Insert change pages 4-14a and 4-14b into the NATOPS Manual from the following enclosures:
(1) F-14A: enclosure (1)
(2) F-14B: enclosure (2)
(3) F-14D: enclosure (3)

c. At the bottom of page 4-15, cross through "figure 2 of 2" with a pen, and write "figure 3 of 3" in its place.

d. Enter the following on page 5, in the front of the appropriate NATOPS Manual,:

	Interim Change Number	Originator/Date	Pages Affected	Remarks/Purpose
F-14A	141	CNASC/17 Jul 98	4-14a/b	Rolling Maneuvering Limits
F-14B	39	CNASC/17 Jul 98	4-14a/b	Rolling Maneuvering Limits
F-14D	18	CNASC/17 Jul 98	4-14a/b	Rolling Maneuvering Limits

Harry P. Lehman

HARRY LEHMAN
By direction

Subj: INTERIM CHANGE TO F-14A/B/D NATOPS PUBLICATIONS

Distribution:
AIR-4.1.1
AIR-4.4.1
COMNAVAIRLANT, NORFOLK, VA (N422C24)
COMNAVAIRPAC, SAN DIEGO, CA (N422CTPL)
NAVAIRPRA, ATSUGI, JA
VF-2 (QA/CTPL)
VF-11 (CTPL UNIT 25504, QATPL)
VF-14 (QA/CTPL)
VF-31 (QA/CTPL)
VF-32 (QA/CTPL)
VF-41 (QA/CTPL)
VF-101 DET KEY WEST (QA/CTPL)
VF-101 (QA/CTPL)
VF-102 (QA/CTPL)
VF-103 (QA/CTPL)
VF-143 (QA/CTPL)
VF-154 (QA/CTPL)
VF-201 (QA/CTPL)
VF-211 (QA/CTPL)
VF-213 (QA/CTPL)
VX-9 DET PT MUGU, CA
SWATSLANT, OCEANA, VA
NAMTRAGRUDET, OCEANA, VA (TECH LIB)
NAESU DET OCEANA, VA
GRUMMAN, ST AUGUSTINE (TECH LIB)
MCDONNELL DOUGLAS, ST LOUIS, MO
XEROX G.E. CO (M/D-T58)
DCMC PACIFIC JAPAN (NIPPI TECH LIB)
NSAWC FALLON, NV (50 QA/CTPL)
NAVTACSUPPACT, WASH NAVY YARD
NAVAL WAR COLLEGE, NEWPORT RI
NAWCAD, PATUXENT RIVER, MD (AIR4.4.7, AMDI BLDG; 5.1.1.1, DATA CNTR)
NAWCWD, CHINA LAKE, CA
NAVY AVIATION SUP OFF, PHILADELPHIA, PA (051341)
NAVWEPTESTRON PT MUGU, CA (562E40E)
NAVAVDEPOT, JACKSONVILLE, FL (3.3.3)
NAVSTRIKE AC TEST SQDN, NAS PATUXENT RIVER, MD
NATESTPILSCH, SY82SYS ENGTEST DIR, NAWCAD PATUXENT RIVER, MD
NAWCAD SETD PATUXENT RIVER, MD (SY040C)
HUGHES, INDIANAPOLIS IN (LIB 064N)
NAWCAD LAKEHURST NJ (4872B696/1PIGA, 7252B1492)
NAWCWD PT MUGU, CA (333000E/DCC)
COMFITWINGLANT, OCEANA, VA
NAVAIRTECHSERVFAC, PHILADELPHIA, PA (2, 3133)
HQ NAIC/GTO, WRIGHT PATTERSON AFB

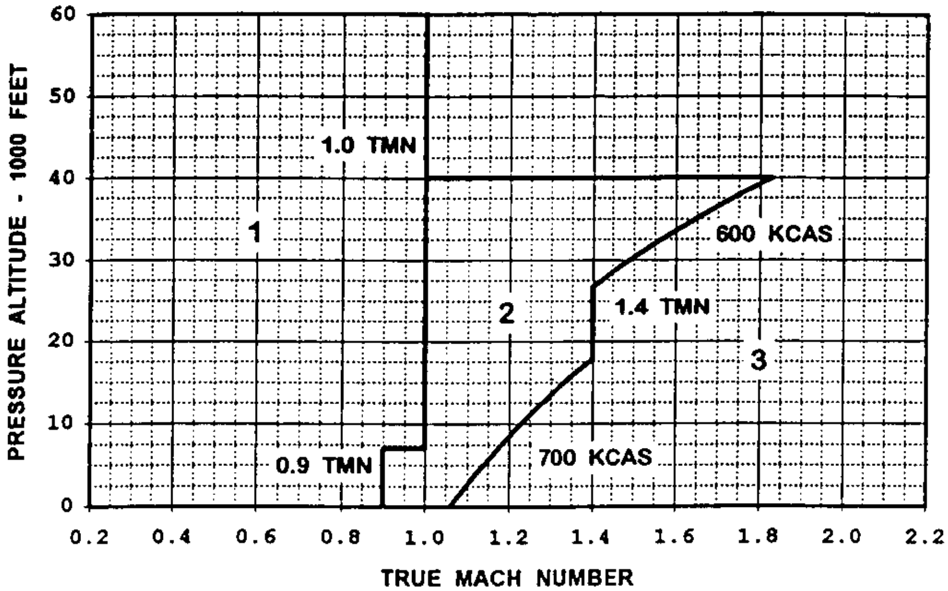
F-14D

INTERIM NATOPS CHANGE #18

(includes F-14D Natops pages 4-14a and 4-14b)

F-14D ROLL SAS ON MANEUVERING ENVELOPE WITHOUT EXTERNAL FUEL TANKS

DATE: SEPTEMBER 1994
DATA BASIS: ESTIMATED FLIGHT TEST



ROLLING MANEUVERS RESTRICTED TO:

REGION 1 - 360° MAXIMUM BANK ANGLE CHANGE AT 1G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1G.
4.0G: ALL CONFIGURATIONS WITH WING-MOUNTED AIM-54.
5.2G: ALL OTHER CONFIGURATIONS (See next sheet for external tanks).

REGION 2 - 360° MAXIMUM BANK ANGLE CHANGE AT 1G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1G (4G MAXIMUM).

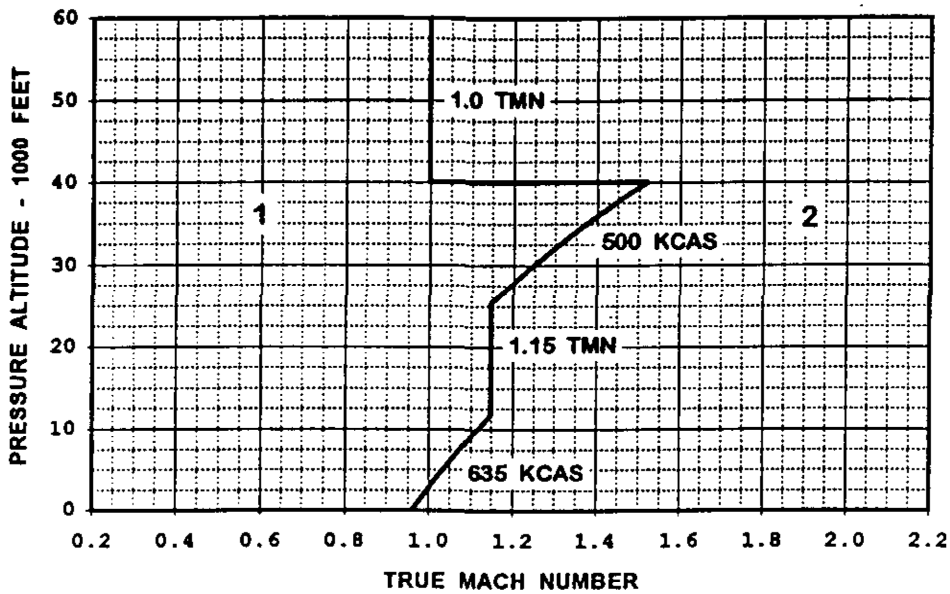
REGION 3 - NO ABRUPT STICK INPUTS.
360° MAXIMUM BANK ANGLE CHANGE AT 1G ONLY.

NOTE: DO NOT EXCEED MAXIMUM ALLOWABLE AIRSPEED FOR STORE CONFIGURATION. NATOPS LIMITS OF FIGURE 4-4 APPLY.

Figure 4-9. Maneuvering Limits — Rolling (Sheet 1 of 3)

F-14D ROLL SAS ON
MANEUVERING ENVELOPE
WITH EXTERNAL FUEL TANKS

DATE: MAY 1998
DATA BASIS: ESTIMATED FLIGHT TEST



ROLLING MANEUVERS RESTRICTED TO:

REGION 1 - 360° MAXIMUM BANK ANGLE CHANGE AT 1G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1G.
4.0G LIMIT : FULL LATERAL STICK ROLLS.

REGION 2 - 360° MAXIMUM BANK ANGLE CHANGE AT 1G.
NO ABRUPT STICK INPUTS.
ROLLING MANEUVERS LIMITED TO COORDINATED TURNS USING MAXIMUM OF 0.5 INCH LATERAL STICK INPUTS.
1.0G DURING ROLLS.

NOTE: DO NOT EXCEED MAXIMUM ALLOWABLE AIRSPEED FOR STORE CONFIGURATION. NATOPS LIMITS OF FIGURE 4-4 APPLY.

Figure 4-9. Maneuvering Limits — Rolling (Sheet 2 of 3)

PTAUZYUW RUENAAA3280 0781546-UUUU--RULSTGP.
ZNR UUUUU
P R 191427Z MAR 98 ZYB PSN 203824M19
FM CNO WASHINGTON DC//N889//
TO ALL TOMCAT AIRCRAFT ACTIVITIES//
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RULSTGP/NAVTACSUPPACT WASHINGTON DC//60//
BT
UNCLAS //N03711//
MSGID/GENADMIN/N889//
SUBJ/INTERIM CHANGES TO F-14 AIRCRAFT NATOPS PUBLICATIONS//
REF/A/DOC/NAVAIR/01FEB97//
AMPN/NAVAIR 01-F14AAA-1 (F-14A NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY95 CHG-1 01FEB97//
REF/B/DOC/NAVAIR/01FEB97//
AMPN/NAVAIR 01-F14AAA-1F (F-14A NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL))//
REF/C/DOC/NAVAIR/01FEB97//
AMPN/NAVAIR 01-F14AAP-1 (F-14B NATOPS FLIGHT MANUAL (NFM)) DTD 15MAY97 CHG-1 01FEB97//
REF/D/DOC/NAVAIR/01FEB97//
AMPN/NAVAIR 01-F14AAP-1F (F-14B NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL))//
REF/E/DOC/NAVAIR/15MAY95//
AMPN/NAVAIR 01-F14AAD-1 (F-14D NATOPS FLIGHT MANUAL (NFM)) DTD 01FEB92 CHG-3 15MAY95//
REF/F/DOC/NAVAIR/01FEB97//
AMPN/NAVAIR 01-F14AAD-1 (F-14D NATOPS FLIGHT MANUAL (NFM))//
REF/G/DOC/NAVAIR/15MAY95//
AMPN/NAVAIR 01-F14AAD-1F (F-14D NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL)) DTD 01FEB92 CHG-3 15MAY95//
REF/H/DOC/NAVAIR/01FEB97//
AMPN/NAVAIR 01-F14AAD-1F (F-14D NATOPS FUNCTIONAL CHECKFLIGHT CHECKLIST (FCFCL))//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 139 TO REF A (F-14A NFM), INTERIM CHANGE NUMBER 7 TO REF B (F-14 FCFCL), INTERIM CHANGE NUMBER 37 TO REF C (F-14B NFM), INTERIM CHANGE NUMBER 8 TO REF D (F-14B FCFCL), INTERIM CHANGE NUMBER 17 TO REFS D AND G (F-14D NFM'S), AND INTERIM CHANGE NUMBER 1 TO REFS G AND H (F-14D FCFCL'S). REFS F AND H ARE CURRENTLY AT PRINTER AND, WHEN DISTRIBUTED, WILL SUPERSEDE REFS E AND G, RESPECTIVELY.
2. SUMMARY. MODIFIES FUNCTIONAL CHECKFLIGHT PROCEDURES IN REFS A THROUGH I. ALPHABETICAL SUFFIXES ARE USED BELOW WITH STEP NUMBERS WHEN INSERTING ADDITIONAL STEPS TO AVOID RENUMBERING SUBSEQUENT STEPS (E.G., STEP 11A INDICATES AN INSERTED STEP WHICH FOLLOWS CURRENT STEP 11 AND WILL BE NUMBERED AS STEP 12 IN NEXT UPDATE OF THE PUBLICATION, WHILE STEP 11.A INDICATES SUBSTEP A OF STEP 11.)
3. CHANGE REF A (F-14A NFM), CHAPTER 10, AS FOLLOWS:
   A. PAGE 10-1, PARAGRAPH 10.2:
      (1) DELETE EXISTING PARAGRAPH.
      (2) ADD:
         10.2 CHECKFLIGHT PROCEDURES. A FLIGHT PROFILE HAS BEEN ESTABLISHED FOR EACH CHECKFLIGHT CONDITION AND IS IDENTIFIED BY THE LETTER CORRESPONDING TO THE PURPOSE FOR WHICH THE CHECKFLIGHT IS BEING FLOWN (A, B, C, AS SHOWN IN

FIGURE 10-1). THE APPLICABLE LETTER IDENTIFYING THE PROFILE PRECEDES EACH ITEM IN THE FUNCTIONAL CHECKFLIGHT CHECKLIST (NAVAIR 01-F14AAA-1F). POSTMAINTENANCE CHECKFLIGHT PROCEDURES ARE SPECIFIC AND ARE TO BE PERFORMED IN CONJUNCTION WITH NORMAL NATOPS OPERATING PROCEDURES (PART III). CHECKFLIGHT PERSONNEL SHALL FAMILIARIZE THEMSELVES WITH THE PROFILE REQUIREMENTS BEFORE EACH FLIGHT. A DAILY INSPECTION IS REQUIRED BEFORE EACH CHECKFLIGHT. AN AIRCRAFT IS CONSIDERED HIGH GROSS WEIGHT FOR PROFILE PURPOSES IF OVER 56,000 POUNDS TOTAL WEIGHT. AIRCREW SHALL BE COGNIZANT OF THE AIRCRAFT'S CONFIGURATION AND THE CUMULATIVE NEGATIVE EFFECTS OF WEAPONS RAILS AND EXTERNAL STORES ON AIRCRAFT STABILITY.

NOTE

SHIPBOARD CONSTRAINTS CAN PRECLUDE COMPLETION OF SOME ITEMS ON THE APPLICABLE FLIGHT PROFILE CHECKLIST.

10.2.1 GENERAL CONDUCT. THOROUGH, PROFESSIONAL CHECKFLIGHTS ARE A VITAL PART OF THE SQUADRON MAINTENANCE EFFORT. CHECK CREWS PERFORM A VALUABLE SERVICE TO THE MAINTENANCE DEPARTMENT BY CARRYING OUT THIS FUNCTION. THE QUALITY OF SERVICE PROVIDED BY CHECK CREWS REFLECTS DIRECTLY IN THE QUALITY OF MAINTENANCE AND SUBSEQUENTLY ENHANCES FLIGHT OPERATIONS. THE COMMANDING OFFICER SHALL ENSURE THAT THOROUGHNESS, PROFESSIONALISM, AND SAFETY ARE OBSERVED THROUGHOUT THE CHECKFLIGHT EVOLUTION AND THAT CHECK CREWS STRICTLY ADHERE TO THE PROFILE CHECKLIST. SAFETY IS A PRIMARY CONSIDERATION DURING ALL CHECKFLIGHTS.

B. PAGE 10-19, PARA 10.3.12, STEP 70 (NEGATIVE ALPHA MCB/FOD CHECK):
   (1) DELETE STEP 70.
   (2) ADD:
       70. DELETED

C. PAGE 10-21, PARA 10.3.12, AFTER STEP 72.M:
   (1) DELETE: NA
   (2) ADD:
       ABC 72A. NEGATIVE ALPHA/MCB/FOD CHECK (20,000 FEET, 300 KIAS).

WARNING

IT IS IMPERATIVE THAT THE PROCEDURES IN THIS CHECK BE FOLLOWED EXACTLY AND NEGATIVE-G MANEUVERING AT HIGH GROSS WEIGHT (OVER 56,000 POUNDS) SHOULD BE AVOIDED BECAUSE OF THE HIGH PROBABILITY OF ENGINE STALLS AND/OR AIRCRAFT DEPARTURES.

NOTE

THIS CHECK VERIFIES THE PROPER OPERATION OF EACH MCB WITH APPROXIMATELY 4 DEGREES NEGATIVE ALPHA AS SENSED BY THE AICS SENSOR PROBES, AND IS RELATIVELY INDEPENDENT ON THE AMOUNT OF NEGATIVE G APPLIED.

A. THROTTLES -- MIL
B. RAISE NOSE TO 10 DEGREES ABOVE HORIZON, ROLL INVERTED (ENSURE WINGS LEVEL).

C. SMOOTHLY APPLY FORWARD STICK PRESSURE (NOT TO EXCEED -1.0 G). MCB TEST LIGHTS SHOULD ILLUMINATE (COORDINATE WITH RIO).
D. CHECK FOR NORMAL ENGINE OPERATION AND FOD OR LOOSE GEAR.
E. RELEASE FORWARD STICK AND PERFORM COORDINATED ROLL TO UPRIGHT WINGS LEVEL ATTITUDE. CHECK MCB TEST LIGHTS OUT AT +1.0 G.

D. PAGE 10-24, PARA 10.4.4, STEP 19 (MCB TEST LIGHTS):
(1) DELETE STEP 19.
(2) ADD:
AB 19. REFUEL PROBE CHECK:
A. MCB TEST LIGHTS -- ILLUMINATED WITH PROBE EXTENDED/OFF WHEN RETRACTED (COORDINATE WITH PILOT).

E. PAGE 10-24, PARA 10.4.5 FIFTEEN THOUSAND-FOOT CHECKS:
(1) DELETE STEPS 23 THROUGH 25.
(2) ADD:
AB 23. ECS CHECK
A. SET WCS SWITCH TO STBY BEFORE PILOT ECS CHECK.
ABC 24. HIGH AOA MACH LEVER/AUTO MAN DEVICES/MCB CHECKS
A. ALPHA COMP CB (7C8) -- IN.
B. CONFIRM ROLL SAS OFF AND THROTTLES IDLE.
C. OBSERVE MANEUVER DEVICES EXTENDED AT 10.5 UNITS AOA.
D. MCB TEST LIGHTS ILLUMINATED AFTER 16 UNITS AOA (COORDINATE WITH PILOT).
E. CONFIRM RPM INCREASE AT 18+/-1 UNITS AOA (GREATER THAN 80 PERCENT).
F. OBSERVE MANEUVER DEVICES RETRACT AT 8 UNITS AOA.
G. ALPHA COMP CB -- OUT.
AB 25. AICS/MCB CHECK
A. AICS CB'S (7E1 AND 7E2) -- PULL.
B. MCB TEST LIGHTS -- ILLUMINATED.
C. AICS CB'S -- RESET.
D. MCB TEST LIGHTS -- OFF.
ABC 25A. STRUCTURAL INTEGRITY CHECK
A. ANTI-G VALVE OPERATION

F. PAGE 10-24, PARA 10.4.6, AFTER STEP 27 (WCS SWITCH -- STBY):
(1) DELETE: NA
(2) ADD:
AB 27A. AT 0.85 IMN WITH THROTTLES LESS THAN MIL, MCB TEST LIGHTS -- CHECK OFF (COORDINATE WITH PILOT).

G. PAGE 10-25, PARA 10.4.7, AFTER STEP 28 (ENGINE INSTRUMENTS) TABLE:
(1) DELETE: NA
(2) ADD:
AB 28A. MACH LEVER AND MCB CHECK
A. MCB TEST LIGHTS -- ILLUMINATED AT IDLE (COORDINATE WITH PILOT).

H. PAGE 10-25, PARA 10.4.7: STEP 32 (MCB TEST LIGHTS):

(1) DELETE STEP 32.

(2) ADD:

32. DELETED

I. RENAME PAGE 10-25, PARA 10.4.8 DESCENT AS:

10.4.8 DESCENT/20,000-FOOT CHECKS

J. PAGE 10-27, PARA 10.4.8, STEP 34 (MCB CHECK):

(1) DELETE ALL.

(2) ADD:

ABC 34. MCB CHECK

A. GUN ARMED POWER CB (8C3) -- PULL (RIO).
B. CONFIRM WEAPONS SELECT -- GUN.
C. CONFIRM MASTER ARM SWITCH -- ON.
D. CONFIRM THROTTLES -- STABILIZED ZONE 2 (APPROXIMATELY 2.4 NOZZLE POSITION).
E. CONFIRM TRIGGER -- SQUEEZE.
F. VERIFY NOZZLE POSITION INCREASE.
G. MCB TEST LIGHTS -- ILLUMINATED. (COORDINATE WITH PILOT)
H. VERIFY NOZZLES RETURN TO THE ORIGINAL POSITION.
I. CONFIRM MASTER ARM SWITCH -- OFF.
J. CONFIRM GUN -- DESELECTED
K. GUN ARMED POWER CB (8C3) -- RESET.

ABC 34A. NEGATIVE ALPHA/MCB/FOD CHECK (20,000 FEET, 300 KIAS)

WARNING

IT IS IMPERATIVE THAT THE PROCEDURES IN THIS CHECK BE FOLLOWED EXACTLY AND NEGATIVE-G MANEUVERING AT HIGH GROSS WEIGHT (OVER 56,000 POUNDS) SHOULD BE AVOIDED BECAUSE OF THE HIGH PROBABILITY OF ENGINE STALLS AND/OR AIRCRAFT DEPARTURES.

NOTE

THIS CHECK VERIFIES THE PROPER OPERATION OF EACH MCB WITH APPROXIMATELY 4 DEGREES NEGATIVE ALPHA AS SENSED BY THE AICS SENSOR PROBES, AND IS RELATIVELY INDEPENDENT ON THE AMOUNT OF NEGATIVE G APPLIED.

A. CONFIRM THROTTLES -- MIL.
B. AFTER PILOT RAISES NOSE TO 10 DEGREES ABOVE HORIZON AND ROLLS INVERTED WINGS LEVEL (NOT TO EXCEED -1.0 G), CONFIRM MCB TEST LIGHTS ILLUMINATED.
C. CHECK FOR FOD OR LOOSE GEAR.
D. AS AIRCRAFT ROLLS UPRIGHT TO WINGS LEVEL ATTITUDE, CHECK MCB TEST LIGHTS OUT AT +1.0 G.

4. CHANGE REF B (F-14A FCFCL) AS FOLLOWS:

A. PART 1, PILOT CHECKLIST:

(1) PAGE 1-19, STEP 70 (NEGATIVE ALPHA MCB/FOD CHECK):

(A) DELETE STEP 70.

(B) ADD:

70. DELETED

(2) PAGE 1-21 AFTER STEP 72.M:
(A) DELETE: NA
(B) ADD STEP 72A (NEGATIVE ALPHA/MCB/FOD CHECK) AS IN PARAGRAPH 3.C(2) ABOVE.

B. PART 2, RIO CHECKLIST:
(1) CHANGE PAGE 2-4, STEP 19 (MCB TEST LIGHTS) AS IN PARAGRAPHS 3.D(1) AND 3.D(2) ABOVE.
(2) CHANGE PAGE 2-5, STEPS 23 THROUGH 25A, AS IN PARAGRAPHS 3.E(1) AND 3.E(2) ABOVE.
(3) PAGE 2-5, AFTER STEP 27 (WCS SWITCH -- STBY):
(A) DELETE: NA
(B) ADD STEP 27A (AT 0.85 IMN WITH THROTTLES....) AS IN PARAGRAPH 3.F(2) ABOVE.
(4) PAGE 2-5, AFTER STEP 28 (ENGINE INSTRUMENTS) TABLE:
(A) DELETE: NA
(B) ADD STEP 28A (MACH LEVER AND MCB CHECK) AS IN PARAGRAPH 3.G(2) ABOVE.
(5) PAGE 2-6, STEP 32 (MCB TEST LIGHTS):
(A) DELETE STEP 32.
(B) ADD:
32. DELETED
(6) PAGE 2-6, DESCENT HEADING (AFTER STEP 32):
(A) DELETE: DESCENT
(B) ADD: DESCENT/20,000-FOOT CHECKS
(7) CHANGE PAGE 2-8, STEP 34 (MCB CHECK), AS IN PARAS 3.J(1) AND 3.J(2) ABOVE.

5. CHANGE REF C (F-14B NFM), CHAPTER 10, AS FOLLOWS:
A. CHANGE PAGE 10-1, PARA 10.2 AS IN PARAS 3.A(1) AND 3.A(2) ABOVE, EXCEPT REPLACE REFERENCE TO 01-F14AAA-1F WITH 01-F14AAP-1F.
B. PAGE 10-20, PARA 10.3.8, STEP 73 (NEGATIVE ALPHA/FOD CHECK):
(1) DELETE STEP 73.
(2) ADD:
73. DELETED
C. PAGE 10-21, PARA 10.3.12, AFTER SUBSTEP 74.F(3):
(1) DELETE: NA
(2) ADD:
ABC 74A. NEGATIVE ALPHA/FOD CHECK (20,000 FEET, 300 KIAS)

WARNING

IT IS IMPERATIVE THAT THE PROCEDURES IN THIS CHECK BE FOLLOWED EXACTLY AND NEGATIVE-G MANEUVERING AT HIGH GROSS WEIGHT (OVER 56,000 POUNDS) SHOULD BE AVOIDED BECAUSE OF THE HIGH PROBABILITY OF AIRCRAFT DEPARTURES.

A. THROTTLES -- MIL.
B. RAISE NOSE TO 10 DEGREES ABOVE HORIZON, ROLL INVERTED (ENSURE WINGS LEVEL).
C. SMOOTHLY APPLY FORWARD STICK PRESSURE (NOT TO EXCEED -1.0 G).
D. CHECK FOR NORMAL ENGINE OPERATION AND FOD OR LOOSE GEAR.
E. RELEASE FORWARD STICK AND PERFORM COORDINATED ROLL TO UPRIGHT WINGS LEVEL

ATTITUDE.

D. RENAME PAGE 10-25, PARA 10.4.8 DESCENT AS:

10.4.8 DESCENT/20,000-FOOT CHECKS

E. PAGE 10-27, AFTER SUBSTEP 26.F:

(1) DELETE: NA

(2) ADD:

ABC 26A. NEGATIVE ALPHA/FOD CHECK (20,000 FEET, 300 KIAS)

WARNING

IT IS IMPERATIVE THAT THE PROCEDURES IN THIS CHECK BE FOLLOWED EXACTLY AND NEGATIVE-G MANEUVERING AT HIGH GROSS WEIGHT (OVER 56,000 POUNDS) SHOULD BE AVOIDED BECAUSE OF THE HIGH PROBABILITY OF AIRCRAFT DEPARTURES.

A. CONFIRM THROTTLES -- MIL.

B. AFTER PILOT RAISES NOSE TO 10 DEGREES ABOVE HORIZON AND ROLLS INVERTED WINGS LEVEL (NOT TO EXCEED -1.0 G), CHECK FOR FOD OR LOOSE GEAR.

6. CHANGE REF D (F-14B FCFCL) AS FOLLOWS:

A. PART 1, PILOT CHECKLIST:

(1) PAGE 1-21, STEP 73 (NEGATIVE ALPHA/FOD CHECK):

(A) DELETE STEP 73.

(B) ADD:

73. DELETED

(2) PAGE 1-23 AFTER SUBSTEP 74.F(3):

(A) DELETE: NA

(B) ADD STEP 74A, (NEGATIVE ALPHA/FOD CHECK) AS IN PARAGRAPH 5.C(2) ABOVE.

B. PART 2, RIO CHECKLIST:

(1) PAGE 2-6, DESCENT HEADING (AFTER STEP 25.C):

(A) DELETE: DESCENT

(B) ADD: DESCENT/20,000-FOOT CHECKS

(2) PAGE 2-7, AFTER SUBSTEP 26.F:

(A) DELETE: NA

(B) ADD STEP 26A (NEGATIVE ALPHA/FOD CHECK) AS IN PARAGRAPH 5.E(2) ABOVE.

7. CHANGE REF E (F-14D NFM DTD 15MAY95), CHAPTER 10, AS FOLLOWS:

A. CHANGE PAGE III-10-1, PARA 10.2 AS IN PARAS 3.A(1) AND 3.A(2) ABOVE, EXCEPT REPLACE REFERENCE TO 01-F14AAA-1F WITH 01-F14AAD-1F.

B. PAGE III-10-11, STEP 68 (NEGATIVE ALPHA/FOD CHECK):

(1) DELETE STEP 68.

(2) ADD:

68. DELETED

C. PAGE III-10-14, AFTER SUBSTEP 77.G(2):

(1) DELETE: NA

(2) ADD:

ABC 77A. NEGATIVE ALPHA/FOD CHECK (20,000 FEET, 300 KIAS)

WARNING

IT IS IMPERATIVE THAT THE PROCEDURES IN THIS CHECK BE FOLLOWED EXACTLY AND NEGATIVE-G MANEUVERING AT HIGH GROSS

WEIGHT (OVER 56,000 POUNDS) SHOULD BE AVOIDED BECAUSE OF THE HIGH PROBABILITY OF AIRCRAFT DEPARTURES.

A. THROTTLES -- MIL.

B. RAISE NOSE TO 10 DEGREES ABOVE HORIZON, ROLL INVERTED (ENSURE WINGS LEVEL).

C. SMOOTHLY APPLY FORWARD STICK PRESSURE (NOT TO EXCEED -1.0 G).

D. CHECK FOR NORMAL ENGINE OPERATION AND FOD OR LOOSE GEAR.

E. RELEASE FORWARD STICK AND PERFORM COORDINATED ROLL TO UPRIGHT WINGS LEVEL ATTITUDE.

D. RENAME PAGE III-10-16, PARA 10.4.9 DESCENT AS:

10.4.9 DESCENT/20,000-FOOT CHECKS

E. PAGE III-10-17, AFTER SUBSTEP 23.E:

(1) DELETE: NA

(2) ADD:

ABC 23A. NEGATIVE ALPHA/FOD CHECK (20,000 FEET, 300 KIAS)

WARNING

IT IS IMPERATIVE THAT THE PROCEDURES IN THIS CHECK BE FOLLOWED EXACTLY AND NEGATIVE-G MANEUVERING AT HIGH GROSS WEIGHT (OVER 56,000 POUNDS) SHOULD BE AVOIDED BECAUSE OF THE HIGH PROBABILITY OF AIRCRAFT DEPARTURES.

A. CONFIRM THROTTLES -- MIL.

B. AS PILOT RAISES NOSE TO 10 DEGREES ABOVE HORIZON AND ROLLS INVERTED TO WINGS LEVEL (NOT TO EXCEED -1.0 G), CHECK FOR FOD AND LOOSE GEAR.

8. WHEN RECEIVED, CHANGE REF F (F-14D NFM DTD 01FEB97), CHAPTER 10, AS FOLLOWS:

A. CHANGE PAGE III-10-1, PARA 10.2 AS IN PARAS 3.A(1) AND 3.A(2) ABOVE, EXCEPT CHANGE REFERENCE TO 01-F14AAA-1F TO 01-F14AAD-1F.

B. PAGE III-10-21, STEP 76 (NEGATIVE ALPHA/FOD CHECK):

(1) DELETE STEP 76.

(2) ADD:

76. DELETED

C. PAGE III-10-22, AFTER SUBSTEP 77.G(2):

(1) DELETE: NA

(2) ADD STEP 77A (NEGATIVE ALPHA/FOD CHECK) AS IN PARA 7.C(2) ABOVE.

D. RENAME PAGE III-10-25, PARA 10.4.9 DESCENT AS:

10.4.9 DESCENT/20,000-FOOT CHECKS

E. PAGE III-10-26, AFTER SUBSTEP 23.E:

(1) DELETE: NA

(2) ADD STEP 23A (NEGATIVE ALPHA/FOD CHECK) AS IN PARA 7.E(2) ABOVE.

9. CHANGE REF G (F-14D FCFCL DTD 15MAY95) AS FOLLOWS:

A. PART 1, PILOT CHECKLIST:

(1) PAGE 1-19, STEP 68 (NEGATIVE ALPHA/FOD CHECK):

(A) DELETE STEP 68.

(B) ADD:

68. DELETED
(2) PAGE 1-24, AFTER SUBSTEP 77.G(2):
(A) DELETE: NA
(B) ADD STEP 77A (NEGATIVE ALPHA/FOD CHECK) AS IN PARA 7.C(2) ABOVE.
B. PART 2, RIO CHECKLIST:
(1) PAGE 2-5, AFTER STEP 22 (ENGINE INSTRUMENTS) TABLE:
(A) DELETE: DESCENT
(B) ADD: DESCENT/20,000-FOOT CHECKS
(2) PAGE 2-6, AFTER SUBSTEP 23.E:
(A) DELETE: NA
(B) ADD STEP 23A (NEGATIVE ALPHA/FOD CHECK) AS IN PARAGRAPH 7.E(2) ABOVE.

10. WHEN RECEIVED, CHANGE REF H (F-14D FCFCL DTD 01FEB97) AS FOLLOWS:
A. PART 1, PILOT CHECKLIST:
(1) PAGES 1-22 AND 1-23, STEP 76 (NEGATIVE ALPHA/FOD CHECK):
(A) DELETE STEP 76.
(B) ADD:
76. DELETED
(2) PAGE 1-23, AFTER SUBSTEP 77.G(2):
(A) DELETE: NA
(B) ADD STEP 77A (NEGATIVE ALPHA/FOD CHECK) AS IN PARA 7.C(2) ABOVE.
B. PART 2, RIO CHECKLIST:
(1) PAGE 2-5, AFTER STEP 22 (ENGINE INSTRUMENTS) TABLE:
(A) DELETE: DESCENT
(B) ADD: DESCENT/20,000-FOOT CHECKS
(2) PAGE 2-6, AFTER SUBSTEP 23.E:
(A) DELETE: NA
(B) ADD STEP 23A (NEGATIVE ALPHA/FOD CHECK) AS IN PARAGRAPH 7.E(2) ABOVE. //

BT

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

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

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION
AFC 793	Standard Central Air Data Computer	30 Sep 94	None
AFC 795	Radar Warning Receiver Modification	30 Sep 94	None
AYC 832	Incorporation of Unmodified OBOGS Monitor	15 May 95	Panel size increased on pilot's right console
AFC 843	BOL Chaff Incorporation	1 Feb 97	5A BOL PWR circuit breakers at 2I9, 2I10

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

CHANGE NUMBER	DESCRIPTION	VISUAL IDENTIFICATION

RECORD OF CHANGES

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

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LIST OF ABBREVIATIONS AND ACRONYMS

A

A/A. Air-to-air.

AAC. Aviation armament change.

AAI. Air-to-air interrogator.

AAW. Antiair warfare.

AB. Afterburner.

ac. Alternating current.

ACC. Aircrew system change.

ACL. Automatic carrier landing.

ACLS. Automatic carrier landing system.

ACM. Air combat maneuver.

ACQ. Acquisition (TCS).

ACS. Automatic channel select.

A/D. Analog-to-digital.

ADAC. Airborne data acquisition computer.

ADF. Automatic direction finder.

ADI. Attitude director indicator.

ADL. Armament datum line.

AEC. Automatic exposure control.

AFB. Airframe bulletin.

AFC. Airframe change.

AFCS. Automatic flight control system.

AFTC. Augmenter fan temperature control.

A/G. Air-to-ground.

AGI. Armament gas ingestion.

AGL. Above ground level.

AGR. Air-to-ground ranging.

AIC. Air inlet control; air intercept control.

AICS. Air inlet control system.

AIM-54. Phoenix missile.

AM. Amplitude modulation.

A/N. Alphanumeric.

AOA. Angle of attack.

AOB. Angle of bank.

APC. Approach power compensator.

APCS. Approach power compensator system.

ARDP. Advance radar data processor.

ARI. Aileron rudder interconnect.

ARSP. Advance radar signal processor.

ASC. Advanced signal converter.

ASE. Allowable steering error.

ASH. Automatic stored heading.

ASPJ. Airborne self-protection jammer.

ASR. Air surveillance radar.

ATDC. Airborne tactical data control.

ATDS. Airborne tactical data system.

ATLS. Asymmetric thrust limiting system.

AVB. Avionic bulletin.

AVC. Avionic change.

AVIA. TID AOA, VV, ILS, and ACLS.

AVTR. Airborne videotape recorder.

AWCS. Airborne weapons control system.

AWL. All-weather landing.

AYC. Accessories change.

B

BARO. Barometric.

BATR. Bullet at target range.

BCD. Binary code decimal.

BDA. Bomb damage assessment.

BDHI. Bearing distance heading indicator.

BER. BIT evaluation report.

BFCM. Backup flight control module.

BIDI. Bidirectional hydraulic pump.

Bingo. Return fuel state.

BIST. Built-in self test.

BIT. Built-in test.

BLS. Basic landing display.

BMT. BIT moving target.

BOL. BOFORS launcher.

Bolter. Hook down, unintentional touch and go.

BOS. Backup oxygen system.

BPS. Beam power supply.

BRU. Bomb rack unit.

BSF. Band suppression filter.

BTOF. Bullet time of flight.

C

CA. Cartridge actuated device.

CADC. Central air data computer.

CAINS. Carrier aircraft inertial navigation system.

CAP. Combat air patrol; computer address panel.

CARQUAL. Carrier qualifications.

CAS. Calibrated airspeed.

CAT. Catapult.

CATCC. Carrier air traffic control center.

CAW. Caution, advisory, warning.

cb. Circuit breaker.

CC. Cubic centimeter.

CCA. Carrier controlled approach.

CCIP. Continuously computed impact point.

CCRS. Command course.

CDI. Course deviation indicator.

CDIR. Camouflage detection infrared.

cg. Center of gravity.

CGTL. Command ground track line.

Charlie time. Expected time over ramp.

CICU. Computer integrated converter unit.

CIPDU. Control indicator power distribution unit.

CIU. Converter interface unit.

CM. Continuous monitor.

CMB. Code matrix box.

CMM. Continuous monitor mode.

CMPTR. Computer.

CNI. Communication-navigation-identification.

COT. Crew operation trainer.

CP. Central processor.

CPS. Controller processor signal unit; cycles per second.

CRT. Cathode ray tube.

CSD. Constant speed drive.

CSS. Control stick steering.

CTVS. Cockpit television sensor.

CV. Aircraft carrier.

CVA. Aircraft carrier approach.

CVS. Course vectoring symbols.

CWI. Continuous-wave illuminator.

D

D/A. Digital-to-analog.

dB. Decibel.

dc. Direct current.

DD. Digital display.

DDP. Digital data processor.

DDPG. Digital data processor group.

DDS. Data display system; digital data system.

DECM. Defensive electronic countermeasures.

DEST. Destination.

DEU. Data entry unit.

DF. Direction finder.

DFM. Dogfight mode.

DG. Directional gyro.

D/L. Data link.

DLC. Direct lift control.

DLS. Data-link transceiver.

DMA. Degraded mode assessment.

DME. Distance measuring equipment.

DPGS. Data processing ground station.

DRO. Destructive readout.

DROT. Degraded range on target.

DSPT. Dynamic steering point.

DSS. Data storage set.

DSU. Data storage unit.

E

EAC. Expected approach clearance time.

EAS. Equivalent airspeed.

ECA. Expanded chaff adapter.

ECM. Electronic countermeasures.

ECS. Environmental control system.

ECU. Electronic control unit.

EED. Electroexplosive devices.

EGT. Exhaust gas temperature.

EIF. Exposure interval factor.

EIG. Engine instrument group.

EMCON. Electronic radiation control.

EMSP. Engine monitoring system processor.

ETA. Estimated time of arrival.

F

FCF. Functional checkflight.

FMA. Familiarization.

FCLP. Field carrier landing practice.

FD. Fault direction.

FEMS. Fatigue engine monitoring system.

FF. Fuel flow.

F/F. Fighter to fighter.

FF/DL. Fighter-to-fighter data link.

FHF. Failure history file.

FI. Fault isolation.

FL. Flight level.

FLC. Film motion compensation.

FLOLS. Fresnel lens optical landing system.

FLRP. Fighter link reference point.

FMC. Fighter mode command; film motion compensation; forward motion correction.

FMI. Flight maintenance indicator.

FMLP. Field mirror landing practice.

FOD. Foreign object damage.

FOV. Field of view.

fpm. feet per minute.

FRL. Fuselage reference line.

FRS. Fleet replacement squadron.

FTCM. Flight test continuous monitoring.

FTJU. Fuel tank jettison unit.

FWD. Forward.

G

G. Guard channel.

g. Gravity.

G/A. Ground to air.

GACH. Gimble angle crosshair.

GCA. *Ground-controlled approach.*

GCI. Ground-controlled intercept.

GCU. Generator control unit; gun control unit.

GHz. Gigahertz.

GSS. Gun scoring system.

GT. Ground track.

H

HDG. Heading.

HEFOE. Hydraulic electric fuel oil engine.

HERO. Hazards of electromagnetic radiation to ordnance.

hot start. A start that exceeds normal starting temperatures.

HSD. Horizontal situation display.

HSI. *Horizontal situation indicator.*

HUD. Heads-up display.

hung start. A start that results in a stagnated rpm and temperature.

I

IAS. Indicated airspeed.

IBIT. Initiated BIT.

ICAO. International Civil Aviation Organization.

ICS. Intercommunications.

IDG. Integrated-drive generator.

IFB. Interference blanker.

IFF. Identification, friend or foe.

IFOV. Instantaneous field of view.

IFR. Instrument flight rules.

IFT. In-flight training.

IFX. IFF transponder.

IGV. Inlet guide vane.

ILCOS. Instantaneous lead computed optical sight.

ILS. Instrument landing system.

IMC. Instrument meteorological conditions.

IMN. Indicated Mach number.

IMU. Inertial measurement unit.

InHg. Inch of Mercury.

INS. Inertial navigation system.

IP. Initial point.

IPF. Interference protection feature.

IR. Infrared.

IRCM. Infrared countermeasures.

IRLS. Infrared line scanner.

IRNR. Infrared not ready.

IRRS. Infrared reconnaissance set.

IRST. Infrared search and track.

IRW. Infrared wide.

ITER. Improved triple ejector rack.

ITS. Integrated trim system.

IU. Interface unit.

J

JAT. Jam angle track.

JTIDS. Joint tactical information distribution system.

K

KCAS. Knots calibrated airspeed.

KCP. Keyer control panel.

KEAS. Knots estimated airspeed.

kHz. Kilohertz.

KIAS. Knots indicated airspeed.

KTS. Knots.

L

LAOT. Low-PRF antenna on target.

LAR. Launch acceptability region.

LARI. Lateral automatic rudder interconnect.

LBA. Limits of basic aircraft.

LCD. Liquid crystal display.

LCOS. Lead computing optical sight.

LE. Leading edge.

LOROP. Long-range oblique photography.

LOS. Line of sight.

LOX. Liquid oxygen.

LPA. Life preserver assembly.

LS. Line scanner.

LSO. Landing signal officer (Paddles).

LTE. Launch to eject.

M

M. Mach.

MAC. Mean aerodynamic chord.

MAD. Magnetic azimuth detector.

MAG VAR. Magnetic variation.

MAN. Manual.

MAS. Missile auxiliary subsystem.

MATS. Missile auxiliary test set.

MAX. Maximum.

MCB. Midcompression bypass.

MCF. Motion compensation factor.

MCM. Monitor control message.

MCS. Mission computer system.

MCT. Memory confidence test.

meatball. Glideslope image of mirror landing system.

MEC. Main engine control.

MER. Multiple ejector rack.

MFD. Multifunction display.

MHz. Megahertz.

MIL. Military.

MITS. Missile interface test set.

MLC. Mainlobe clutter.

MLG. Main landing gear.

MOAT. Missile on aircraft test.

MMGS. Multiple mode gunsight.

MPRU. Missile power relay unit.

MPS. Missile power supply.

MR. Maintenance readout.

MRL. Manual rapid lock-on.

MRT. Military rated thrust.

MSEC. Message security.

MSI. Multistatus indicator.

MSL. Mean sea level.

MSS. Mission support system.

MTDS. Marine tactical data system.

MTM. Magnetic tape memory.

MTP. Master test panel.

MVR. Mission video recorder.

MWOD. Multiple word of day.

N

NACES. Navy aircrew common ejection seat.

NAG. Air-to-ground mode.

NATOPS. Naval air training and operating procedures standardization.

NATSF. Naval Air Technical Services Facility.

NAV GRID. Navigation command and control grid.

NDRO. Nondestructive readout.

NECT. Net entry control terminal.

NFL. Notch filter left.

NFO. Naval flight officer.

NFOV. Narrow field of view.

NFR. Notch filter right.

nm. Nautical miles.

NOTAM. Notice to airmen.

NOZ. Nozzle.

NPG. Network participant group.

NPS. Navigation power supply.

NR. Number.

NRNG. No range.

NSV. Navigation state vector.

NTDS. Naval tactical data system.

NTR. Network time reference.

NWP. Naval warfare publication.

NWPM. Non-write-protected memory.

NWS. Nosewheel streering.

N_1. Low-pressure compressor rotor speed.

N_2. High-pressure compressor rotor speed.

O

OAT. Outside air temperature.

OBC. On-board check.

OBOGS. On-board oxygen generating system.

OFT. Operational flight trainer.

OFP. Operational flight plan.

OSP. Overspeed.

OWF. Overwing fairing.

P

Paddles. Landing signal officer.

PA. Power approach.

PAL. Pilot automatic lock-on.

PAN. Panoramic.

PAP. Precision approach point.

PAR. Precision approach radar.

PC. Pulse compression.

PCD. Precision course direction.

PD. Pulse Doppler.

PDCP. Pilot display control panel.

PDS. Pulse Doppler search.

PDSTT. Pulse Doppler single-target track.

PFPM. Potential flightpath marker.

PGU. Improved round for the M-61 gun (new bullet).

PH. Phoenix missile.

PIO. Pilot-induced oscillation.

PLM. Pilot lock-on mode.

PP. Peak power.

PPC. Powerplant charge.

pph. Pounds per hour.

PPI. Plan position indicator.

PPLI. Precise participant location and identification.

PRI. Primary.

PS. Pulse search.

P_s. Static pressure.

psi. Pounds per square inch.

PSTT. Pulse single-target track.

PSU. Power switching unit.

PT. Engine power trim.

P_t. Total pressure.

PTO. Pilot takeover.

PTP. Point to point.

P_{T7}. Turbine exhaust pressure.

Q

Q. Dynamic pressure.

R

RACH. Radar angle crosshair.

RARI. Rudder automatic rudder interconnect.

RDO. Recovery duty officer.

RDR. Radar.

RDSCU. Radar sensor control unit.

RECON. Reconnaissance.

RF. Radio frequency.

RFCI. Radio frequency/control indicators.

RFI. Radio frequency indicator.

RHA. Recording head assembly.

RIO. Radar intercept officer.

RNAV. Relative navigation.

ROE. Rules of engagement.

ROM. Read-only memory.

ROT. Range on target.

rpm. High-pressure compressor rotor speed (N_2).

RRC. Rounds remaining counter.

RTGS. Real time gunsight.

RTT-I. Round trip timing interrogation.

RWR. Radar warning receiver.

RWS. Range while search.

S

SA. Semiautomatic acquisition mode.

SAHRS. Standard attitude heading reference system.

SAM. Surface-to-air missile.

SAR. Search and rescue.

SAS. Stability augmentation system.

SAT. Simultaneous alignment and test.

SC. Sensor control.

SCADC. Standard central air data computer.

SCP. Sensor control panel.

SDIS. Sensor display indicator set.

SEAM. Sidewinder expanded acquisition mode.

SEAWARS. Seawater-activated release system.

SEC. Single-engine secondary.

SHDG. Stored heading ground align.

SIF. Selective identification feature.

SINS. Ship's inertial navigation system.

SMAL. Single-mode alignment.

SMDC. Shielded mild detonator cord.

SMP. Store management processor.

SMS. Stores management system.

SP. Sparrow missile.

SPAM. Special aid to maintenance.

SPS. Solenoid power supply.

STAB AUG. Stability augmentation.

STBY. Standby.

STN. Source track number.

STT. Single-target track.

SSI. Standard serial interface.

SW. Sidewinder missile.

T

tacan. Tactical air navigation.

TAC DRO. Tactical destructive readout.

TADIL. Tactical digital information link.

TARPS. Tactical air reconnaissance pod system.

TAS. True airspeed.

TBT. Turbine blade temperature.

TCA. Turbine compressor assembly.

TCR. Time code readout.

TCS. Television camera set.

TDRS. Tactical data recording system.

TDMA. Time-division multiple access.

TDS. Tactical data system.

TED. Trailing edge down.

TER. Triple ejector rack.

TEU. Trailing edge up.

TID. Tactical information display.

TIMS. Terminal input messages.

TIT. Turbine inlet temperature.

TLN. Takeoff, landing, navigation.

TMA. Target under missile attack.

TOF. Time of fall.

TOMS. Terminal output messages.

T/R. Transformer-rectifier.

T_S. Static temperature.

T_s. Free air temperature.

TSEC. Transmission security.

T_{T2}. Compressor inlet temperature.

T_{T4}. Compressor discharge temperature.

TV. Television.

TVS. Television search.

TVT. Television track.

TWS. Track while scan.

U

UHF. Ultrahigh frequency.

UHT. Unit horizontal tail.

UTM. Universal test message.

V

V_C. Closing velocity rate.

vC. Computed MAG VAR.

VDI. Vertical display indicator.

VDIG. Vertical display indicator group.

VEC. Vector.

VERT. Vertical.

VFR. Visual flight rules.

Vg/H. Velocity/height.

V/H. Velocity altitude factor (Vg/H).

VID. Visual identification.

VLA. Vertical lever arm.

vM. Manual MAG VAR.

V_{mcg}. Minimum control groundspeed.

VMCU. Voltage monitor control unit.

V_R. Rotation speed.

VSL. Vertical scan lock-on.

VSV. Variable stator vane.

VSWR. Voltage standard wave ratio.

VTR. Videotape recorder.

VV. Vertical velocity.

V_1. Critical engine failure speed.

W

WCS. Weapon control system.

WDIR. Wind direction.

WFOV. Wide field of view.

WOD. Wind over the deck; word of the day.

WOW. Weight on wheels or weight off wheels.

WPM. Weapons program memory.

WRA. Weapons replaceable assembly.

WSPD. Windspeed.

WST. Weapons system trainer.

Y

YY. Geographic reference point for NAV GRID.

PREFACE

SCOPE

This NATOPS flight 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. This manual, together with the supplemental manuals listed below, contains information on all aircraft systems, performance data, and operating procedures required for safe and effective operations. However, it is not a substitute for sound judgment. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. Read this manual from cover to cover. It is your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

NAVAIR 01-F14AAP-1.1 (Performance Charts)

NAVAIR 01-F14AAD-1A (Supplemental)

NAVAIR 01-F14AAD-1B (Pocket Checklist)

NAVAIR 01-F14AAD-1F (Functional Checkflight Checklist)

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

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

Routine change recommendations are submitted directly to the model manager on OPNAV 3710/6 shown on the next page. The address of the model manager of this aircraft is:

Commanding Officer
Fighter Squadron 101
DET MIRAMAR
NAS Miramar, Hangar 3
San Diego, CA 92145

Attn: F-14D Model Manager

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

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NATOPS flight manuals are kept current through an active manual change program. Any corrections, additions, or constructive suggestions for improvement of its content should be submitted by routine or urgent change recommendation, as appropriate.

NATOPS FLIGHT MANUAL INTERIM CHANGES

Flight manual interim changes are changes or corrections to the NATOPS flight manuals. They are issued by CNO or NAVAIRSYSCOM either as printed pages or as a naval message. The Interim Change Summary page is provided as a record of all interim changes. Each manual custodian should check the Interim Change Summary page to see that all interim changes have been incorporated.

CHANGE SYMBOLS

Revised material 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 this 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 that has been adhered to in preparing this manual is as follows:

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

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

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

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

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

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

Recommendation (be specific)

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Justification

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(a) Your Change Recommendation Dated ____________

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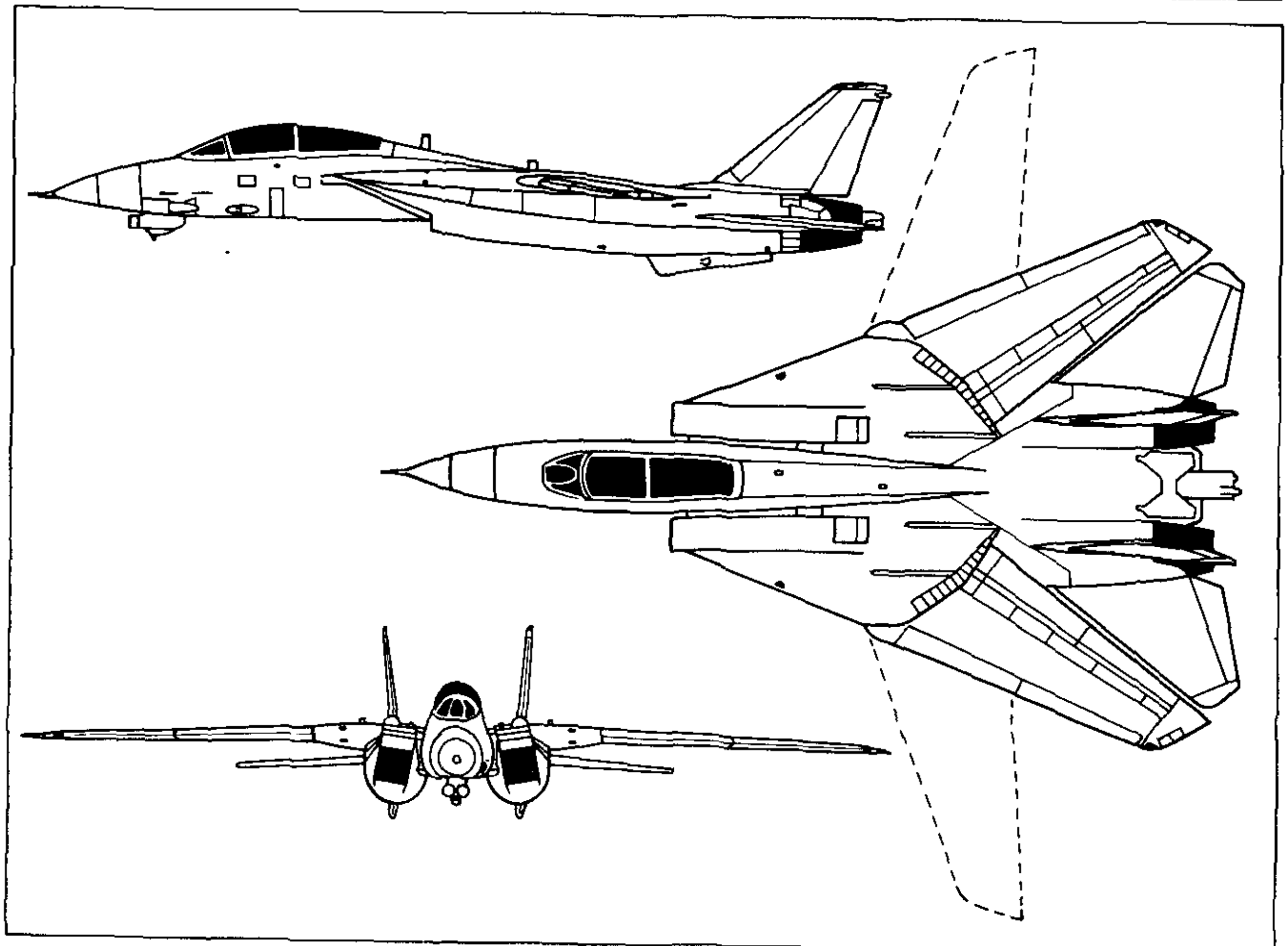
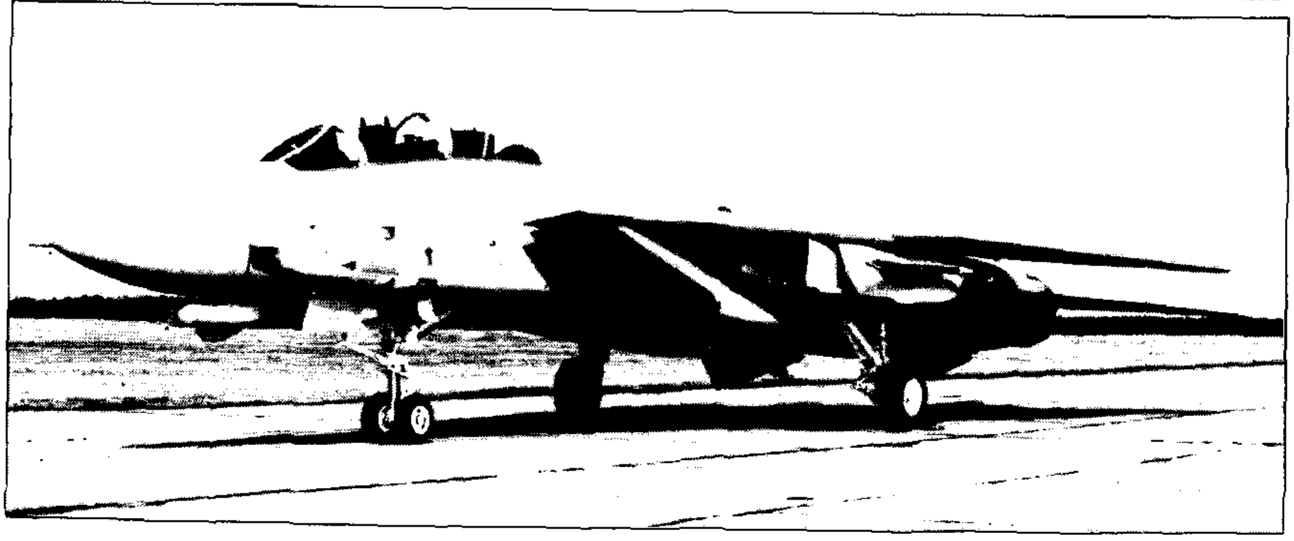
/S/ ____________ MODEL MANAGER | ____________ AIRCRAFT

F-14D TOMCAT





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PART I

The Aircraft

Chapter 1 — Aircraft and Engine

Chapter 2 — Systems

Chapter 3 — Servicing and Handling

Chapter 4 — Operating Limitations

CHAPTER 1

Aircraft and Engine

1.1 AIRCRAFT

The F-14D aircraft is a supersonic, two-place, twin-engine, swing-wing, air-superiority fighter designed and manufactured by Grumman Aerospace Corporation. In addition to its primary fighter role, carrying missiles (Sparrow and/or Sidewinder) and an internal 20-mm gun, the aircraft is designed for fleet air defense (Phoenix missiles) and ground attack (conventional ordnance) missions. Armament and peculiar auxiliaries used only during secondary missions are installed in low-drag, external configurations. Mission versatility and tactical flexibility are enhanced through independent operational capability or integration under existing tactical data systems.

The forward fuselage, containing the flightcrew and electronic equipment, projects forward from midfuselage and wing glove. Outboard pivots in the highly swept wing glove support the movable wing panels, which incorporate integral fuel cells and full-span leading-edge slats and trailing-edge flaps for supplemental lift control. In flight, the wings may be varied in sweep, area, camber, and aspect ratio by selection of any leading-edge sweep angle between 20° and 68°. Wing sweep can be automatically or manually controlled to optimize performance and thereby enhance aircraft versatility. Separate variable-geometry air inlets, offset from the fuselage in the glove, direct primary airflow to two F110-GE-400 dual-axial compressor, turbofan engines equipped with afterburners for thrust augmentation. The displaced engine nacelles extend rearward to the tail section, supporting the twin vertical tails, horizontal tails, and ventral fins. The middle and aft fuselage, which contains the main fuel cells, tapers off in depth to the rear where it accommodates the speedbrake surfaces and arresting hook. All control surfaces are positioned by irreversible hydraulic actuators to provide desired control effectiveness throughout the flight envelope. Stability augmentation features in the flight control system enhance flight characteristics and thereby provide a more stable and maneuverable weapons delivery platform. The tricycle-type, forward-retracting landing gear is designed for nosegear catapult launch and carrier landings. Missiles and external stores are carried from eight hardpoint stations on the center fuselage between the nacelles and under the nacelles and wing glove; no stores are carried on the movable portion of the wing. The fuel system incorporates both in-flight and single-point ground refueling capabilities. Aircraft general dimensions are shown in Figure 1-1. FO-1 shows the general placement of components within the aircraft. A summary of aircraft limitations and characteristics are shown in Figure 1-2. Refer to Chapter 4 for detailed information.

1.1.1 Aircraft Weight.

The basic weight of the aircraft is approximately 43,735 pounds, which includes trapped fuel, oil gun, and pylons. Consult the applicable Handbook of Weight and Balance (NAVAIR 01-1B-40) for the exact weight of any series aircraft.

1.1.2 Cockpit.

The aircraft accommodates a two-main crew that consists of a pilot and RIO in a tandem seating arrangement. To maximize external field of view, stations within the tandem cockpit are prominently located atop the forward fuselage and enclosed by a single clamshell canopy. Integral boarding provisions to the cockpit and aircraft top deck are on the left side of the fuselage. Each crew station incorporates a rocket ejection seat that is vertically adjustable for crew accommodation. A single environmental control system provides conditioned air to the cockpit and electronic bays for pressurization and air-conditioning. Oxygen for breathing is supplied to the crew under pressure from an on-board oxygen generating system with stored gaseous oxygen as backup. The cockpit arrangement provides minimum duplication of control capability, which, of necessity, requires two crewmen for flight.

1.1.2.1 Pilot Cockpit.

The forward station of the cockpit is arranged and equipped for the pilot (FO-3). In addition to three electronic displays for viewing tactical, flight, navigational, and ECM data, the pilot instrument panel also contains armament controls, flight and engine instruments. Engine controls, fuel management, auxiliary devices, autopilot, and communication control panels are on the left console. Display, power, lighting, and environmental controls are on the right console.

1.1.2.2 RIO Cockpit.

The aft station of the cockpit is equipped for the RIO (FO-4). This instrument panel

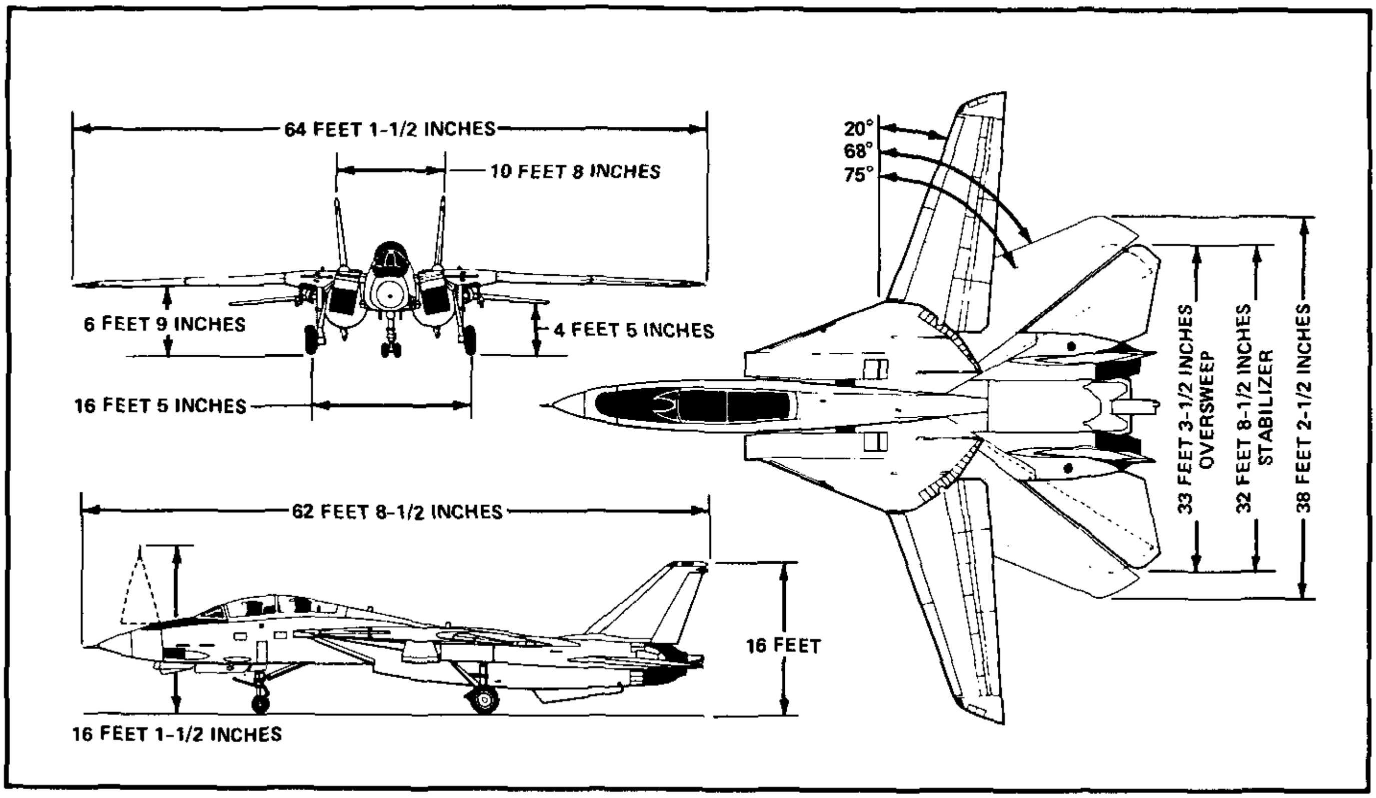

Figure 1-1. Aircraft Dimensions

contains controls and three electronic displays for the radar, tactical, and navigational flight instruments. Armament controls, sensor controls, and communication panels are on the left console. The right console contains a navigational display, data entry unit, ECM controls, data-link controls and lighting, and the IFF panel.

1.1.3 Electronic Nomenclature. Figure 1-3 is an alphabetical listing of the tactical, communication, navigation, flight control, and instruments in the aircraft.

1.1.4 Technical Directives. As technical changes are made to the aircraft, those that affect aircraft operation or pilot and RIO 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:

ACC	Aviation Armament Change
ACC	Aircrew System Change
AFC	Airframe Change
AVB	Avionics Bulletin
AVC	Avionics Change
AYC	Accessories Change.

1.1.5 Block Numbers. The following production block numbers correspond to aircraft serial numbers (BuNo). Selected blocks 85 and 110 are updated to F-14D/ block 170 configuration.

Block No.	Serial No. (BuNo)
160	163412 – 163418
165	163893 – 163904
170	164340 – 164351 and 164599 – 164604
85	159610, 159613, 159600, 159629, 159628, 159619, 159592, 159595, 159603, 159635, 159633, 159018, 159630, 159608, 159631
110	161159, 161158, 161166, 161163, 161154.

F-14D AIRCRAFT CHARACTERISTICS AND LIMITATIONS

Aircraft Dimensions

Length	62'	8.5"
Height (Tail)	16'	0"
Wingspan @ 20° wingsweep	64'	1.5"
Wingspan @ 68° wingsweep	38'	2.5"
Wingspan in oversweep	33'	3.5"
Wing Area	565 sq/ft	

Gross Weights

Empty A/C (w/crew & trapped fuel)	43,735 lbs
Catapult	76,000 lbs
Field takeoff	72,000 lbs
Min descent rate landing (350 fpm)	72,000 lbs
Field landing (***max*** 500 fpm ROD)	60,000 lbs
Carrier/FCLP land	54,000 lbs

T/O & Land Flap/Slat Transition Limits

AOB < 45°
Roll SAS on
Min 200' AGL for flaps/slats up on takeoff
Min 800' AGL for dirty-up
Min 180 kts for retraction of flaps
12 units AOA for all transitions

225 kts	***max*** flap/slat speed
280 kts	***max*** landing gear speed

Landing & Braking

15 kts	***min*** speed for antiskid operation
165 kts	***max*** wheel braking (51.0 k A/C)
190 kts	***max*** tire speed
145 kts	***max*** E-5 engagement speed (69.8 k A/C)
175 kts	***max*** E-28 engagement speed
20 kts	***max*** 90° crosswind component
60 kts	***max*** canopy open

Engine Speeds (RPM)

10%	Ignition system become operative
30 - 46%	Engine crank switch will not engage
20%	***Min*** RPM with throttle at idle
30%	***Max*** RPM with pneumatic starter
30%	RPM must fall below for generator auto-reset
50%	Engine crank switch automatically shuts off
60%	Generator comes on line
50%	Generator light illuminates (if RPM falling)
60%	Ensure engine crank off (ovsp/valve)
62 - 78%	Normal idle
75 - 90%	Auto throttle range
95 - 104%	MIL & above
107.7%	Overspeed (chevrons flash)
110.0%	Engine secures (fuel shutoff)

Starter Cranking Limits

Cross bleed	2 min continuous then 10 min off
Start Cart	5 min continuous then 10 min off

Idle

RPM = 62 - 78%	OIL PRESS = 15 - 45 psi
EGT = 350 - 650°C	NOZ POS = 100%
FF = 950 - 1400 PPH	HYD PRESS = 3000 psi

MIL (and above)

RPM = 95 - 104%	OIL PRESS = 25 - 65 psi
EGT = 780 - 935°C	NOZ POS INFLIGHT:
	MIL = 3 - 10%
	Min AB = 5 - 12%
	Max AB = A/B 60 - 90%

Ground Start Malfunctions

HOT START:	890°C (will normally peak @ 30 - 40% RPM)
HUNG START:	Hung RPM below 63% with rising EGT
WET START:	No lightoff within 20 sec of throttle to IDLE

INST Test

RPM	= 96%
EGT	= 950 ± 10°C (initiates engine overtemp alarm)
FF	= 10,500 pph
AOA	= 18 ± 0.5 UNITS
W/S	= 45 ± 2.5°C
FUEL	= 2,000 ± 200# (all tapes and windows)
LIGHTS:	L and R FUEL LOW

Oil System

Normal Range	25 - 65 psi
Min (stabilized idle)	15 psi
Oil pressure light	on @ 11 psi decreasing off @ 14 psi increasing

Pneumatic Pressure

Min auxiliary canopy (3000 psi)	800 psi
Min normal canopy (3000 psi)	1200 psi
CHS accumulator	1800 psi
FHS accumulator	1800 psi
Min emergency gear preflight	3000 psi
Min emergency gear extension	1800 psi
Wheel brake accumulator (2 gages)	1900 ± 50 psi
Arresting hook dashpot	800 ± 10 psi

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Figure 1-2. Characteristics and Limitations (Sheet 1 of 2)

F-14D AIRCRAFT CHARACTERISTICS AND LIMITATIONS *(continued)*

Fuel System

Aft-Left Tank Group Capacity	5900 - 6200 lbs
Fwd-Right Tank Group Capacity	6300 - 6600 lbs
Max split between cockpit totals	300 lbs
Fuel dump rate	1500 lbs/min
Fuel dump auto shutoff with	4000 lbs remaining
Ground refuel rate @ 50 psi	450 gal/min
In-flight refuel rate @ 57 psi	475 gal/min

Hydraulic System

Normal Hyd. system operating press	3000 ± 100 psi
BIDI activates when one system is	<2100 psi
BIDI output w/3000 psi on good side	2400 - 2600 psi
BIDI shuts off when failed system is	<500 psi for 10 sec
Emer. Flt. Hyd. on if both systems	<2100 psi
Outb'd Spoiler Module electrically inhibited @	62° W/S
Outb'd Spoiler Module depressurized @	65° W/S

Miscellaneous

450	Windmill airstart airspeed required
300	Spooldown airstart airspeed required
250	Rudder authority limits inputs to <10°
400	Rudder authority limits inputs to <9.5°
400/0.9 TMN	Lateral stick inputs limited to 1/4
400	Speedbrake blowback
300	Hook blowback in transit
300/0.8 TMN	***Max*** speed w/ airsource off-o'wing fair
350/1.5 TMN	***Max*** ramdoor airspeed - heat from friction
>0.7 TMN	Coordinate stick and rudder input
>0.5 TMN	No cross controls above
2.4 TMN	Reduce speed light (airframe limit)

Ejection

<350	Ejection Safe
350 - 450	Ejection Hazardous
>450/0.9 TMN	Ejection Extremely Hazardous

External Tank Limits

650	Max below 12,000 ft
700	Max 12 - 25,000 ft
650	Max 25 - 34,000 ft
1.75 TMN	Max above 34,000 ft
1.52 TMN	Max with roll SAS off

In-Flight Refueling

170 - 200	Approach configuration
200 - 300/0.8 TMN	Cruise configuration
400/0.8 TMN	***Max*** IFR probe speed

SAS Stability Augmentation System

CRUISE:	Pitch SAS off ...	None
	Yaw SAS off	1.0 TMN
	Roll SAS off	1.0 TMN (wing mounted AIM-54) 1.52 TMN (EX tank, fuselage AIM-54, A/G stores) 1.6 TMN (all other configurations)
APPROACH:	Pitch SAS off ...	None
	Yaw SAS off	None
	Roll SAS off	not permitted during T/O & Land flap transitions

Prohibited Maneuvers

1. Intentional Spins
2. During AB operations; sustained 0 to -0.5 g flight; flight from -0.5 g to -2.4 g's for more than 10 seconds.
3. At MIL power or less; zero or negative g flight for more than 20 seconds.
4. AIM-9 launch with flaps/slats extended.
5. Fuel dump while in A/B or with S/Bs extended.
6. Dual eng AB takeoff, waveoffs, bolters or cat launches
7. Single eng MAX AB takeoff, waveoff, or cat launches
8. ACLS mode 1/1A approaches
9. Rolling maneuvers with bank angle changes in excess of 360

G Limits

Gear Down Symmetric Limit	0 - 2.0
Gear Down Rolling (coordinated turns only 225 - 280 KTS)	0 - 2.0
Flaps/Slats Down	0 - 2.0
Rolling Limit w/ maneuvering flaps/slats extended (50,000 lb aircraft)	5.2
68,000 lb aircraft symmetric limit	4.6
58,000 lb aircraft symmetric limit	5.5
53,000 lb aircraft symmetric limit	6.0
50,000 lb aircraft symmetric limit	6.5

Figure 1-2. Characteristics and Limitations (Sheet 2 of 2)

TACTICAL	
STANDARD CENTRAL AIR DATA COMPUTER (AIRCRAFT INCORPORATING AFC 793)	CPU-175/A
CENTRAL AIR DATA COMPUTER	CP-1166B/A
CHAFF DISPENSING SET	AN/ALE-39
JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM	AN/ARQ-107
DIGITAL DATA LINK	AN/ASW-27B/C
ELECTRONIC COUNTERMEASURES SET	AN/ALQ-165
FUSE FUNCTION CONTROL SET	AN/AWW-4
GUN CONTROL UNIT	C-11414/AYQ-15
IFF INTERROGATOR SET	AN/APX-76C
IFF TRANSPONDER SET	AN/APX-100(V)
IRSTS	AN/AAS-429XN-1
MISSILE LAUNCHER/BOL CHAFF DISPENSER	LAU-138A/A
INTERFERENCE BLANKER	MX-10666/A
MISSILE POWER SUPPLY	PP-8043/A
PANORAMIC CAMERA	KA-99A
RADAR WARNING SET	AN/ALR-67(V)
SERIAL FRAME CAMERA	KS-87B
STORES MANAGEMENT SET	AN/AYQ-15
MISSION COMPUTERS	AN/AYK-14 9XN-60 PMM
TARPS POD	LA-610
TELEVISION CAMERA SET	AN/AXX-1
RADAR SYSTEM	AN/APG-71 (XN-1)
COMMUNICATION	
CRYPTOGRAPHIC SYSTEM	TSEC/KY-58
INTERCOMMUNICATIONS SYSTEM	LS-460B/AIC
VHF/UHF COMMUNICATIONS SET	AN/ARC-182
NAVIGATION	
AUTOMATIC DIRECTION FINDER	OA-8697/ARD
STANDARD ATTITUDE HEADING REFERENCE SYSTEM	AN/USN-2(V)
INERTIAL NAVIGATION SYSTEM	AN/ASN-139
RADAR ALTIMETER	AN/APN-194(V)
RADAR BEACON AND AUGMENTOR SET	AN/APN-154(V) and R-1623/APN
RECEIVER DECODER GROUP	AN/ARA-63
TACTICAL NAVIGATION SET	AN/ARN-118(V)
MAGNETIC AZIMUTH DETECTOR SET	DSU-4A/A
FLIGHT CONTROL AND INSTRUMENTS	
AIR INLET CONTROL PROGRAMMER	C-8684B/A
APPROACH POWER COMPENSATOR SET	AN/ASN-146
AUTOMATIC FLIGHT CONTROL SET	AN/ASW-47
BEARING DISTANCE HEADING INDICATOR	ID-663D/U
VERTICAL VELOCITY INDICATOR	AAU-18/A
STANDBY AIRSPEED INDICATOR	AVU-30/A
STANDBY COCKPIT ALTIMETER	AAU-39/A
STANDBY COMPASS	AQU-5/A

Figure 1-3. Electronic Nomenclature

CHAPTER 2

Systems

2.1 AIR INLET CONTROL SYSTEM

The purpose of the AICS is to decelerate supersonic air and to provide even, subsonic airflow to the engine throughout the aircraft flight envelope. The AICS consists of two variable-geometry intakes, one on each side of the fuselage at the intersection of the wing glove and fuselage. Intake inlet geometry is varied by three automatically controlled hinged ramps on the upper side of the intakes. The ramps are positioned to decelerate supersonic air by creating a compression field outside the inlet and to regulate the amount and quality of air going to the engine. The rectangular intakes are spaced away from the fuselage to minimize boundary layer ingestion and are highly raked to optimize operation at high angle of attack.

Inlet ramps are positioned by electrohydraulic actuators that respond to fixed schedules in the AICS programmers. Separate programmers, probes, sensors, actuators, and hydraulic power systems provide completely independent operation of the left and right air inlet control systems. Figure 2-1 shows the basic elements of AICS mechanization.

Electrical power for the AICS programmers is provided by the ac and dc essential No. 2 buses. The ramp stow function is powered by the dc essential No. 1 bus. Hydraulic power is supplied individually to the left AICS from the combined hydraulic system and to the right AICS from the flight hydraulic system. The left AICS programmer also functions as a wing-sweep backup computer.

2.1.1 Normal AICS Operations. No pilot control is required during the normal (AUTO) mode of operation. Electronic monitoring in the AICS detects failures that would degrade system operation and performance (refer to AICS BIT). AICS caution lights (L and R INLET, L and R RAMPS) and INLET RAMPS switches are shown in Figure 2-2.

Sectional side views of representative variable geometry inlet configurations scheduled by AICS programmers and descriptive nomenclature are shown in Figure 2-3.

2.1.1.1 Ground and Low-Speed Operation. During ground static and low-speed (Mach <0.35) operation, the inlet ramps are mechanically restrained in the stowed (retracted) position. The predominant airflow is concentrated about the lower lip of the inlet duct and is supplemented by reverse airflow through the fixed bleed door, around the forward lip of the third ramp. As flight speed is increased to 0.35 Mach, hydraulic power is ported to the ramp actuators but the ramps are not scheduled out of the stowed position until Mach 0.5 (see Figure 2-4). The fixed bleed door bleeds low-energy, boundary layer air from the movable ramps.

2.1.1.2 Subsonic and Transonic Speeds. At airspeeds greater than 0.5 Mach, the ramps program primarily as a function of Mach for optimum AICS performance. At transonic speeds, a normal shock wave attaches to the second movable ramp. The third ramp deflects above 0.9 Mach to maintain proper bleed slot height (Δh) for transonic and low-supersonic flight.

At supersonic speeds, four shock waves compress and decelerate the inlet air. The bleed slot removes boundary layer air and stabilizes the shock waves. This design results in substantially higher performance above Mach 2 than simpler inlet designs.

2.1.2 AICS Test. Two types of AICS tests are provided to check the general condition of the AICS and to pinpoint system components causing detected failures: AICS built-in test and on-board check.

2.1.2.1 AICS Built-In Test. BIT in the AICS computer programmer is automatically and continually initiated within the programmer to check AICS components when the programmer is energized.

The operational status of the AICS depends on BIT-detected failures in AICS components. Failures of static or total pressure sensors; ramp No. 1, 2, or 3 positioning; programmer continuous end-to-end BIT; or hydraulic pressure to any of the ramp actuators would seriously degrade AICS performance. Detected failures of these items cause the AICS to automatically transfer to a significantly degraded fail-safe mode of operation, indicated by illumination of an INLET caution light.

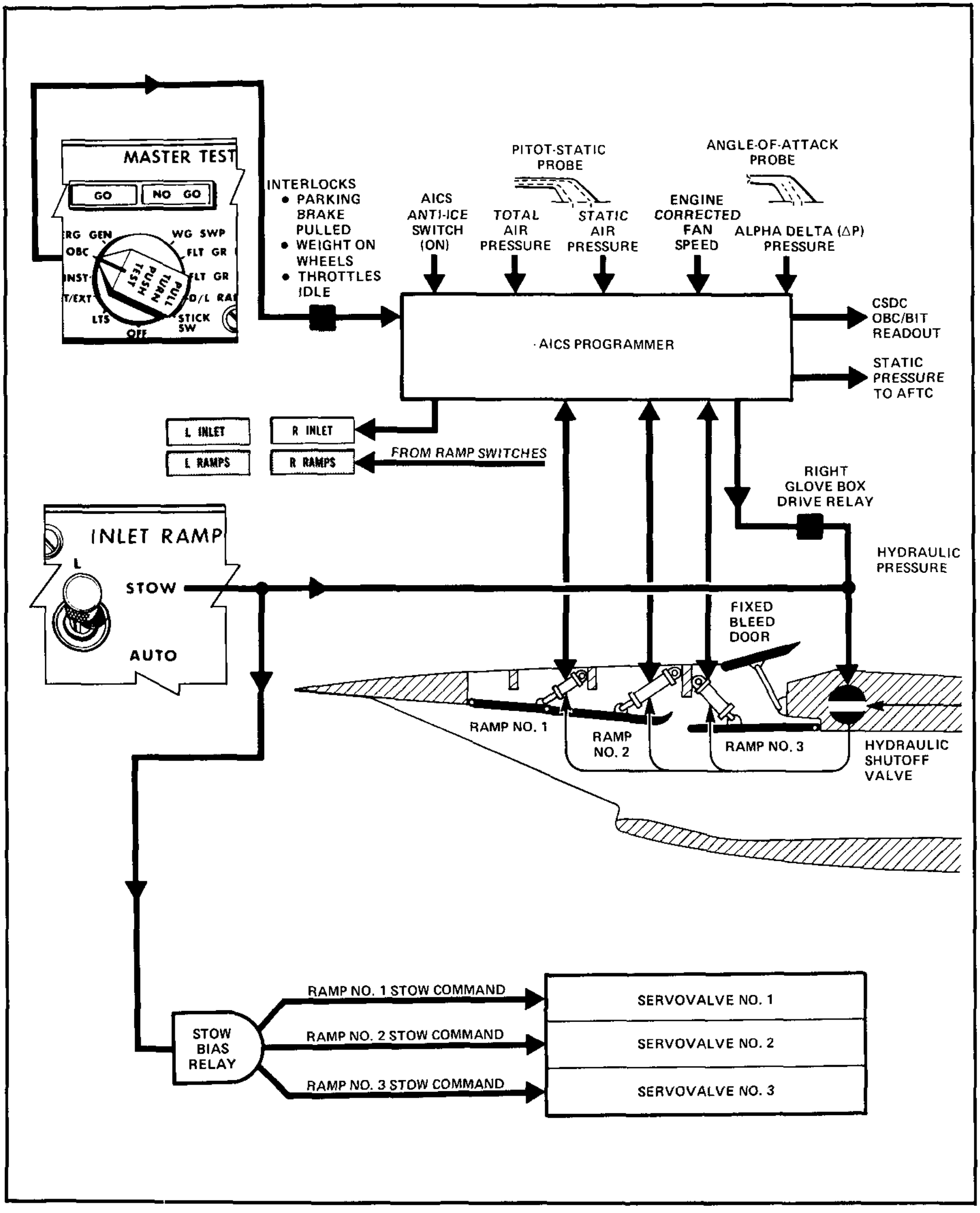
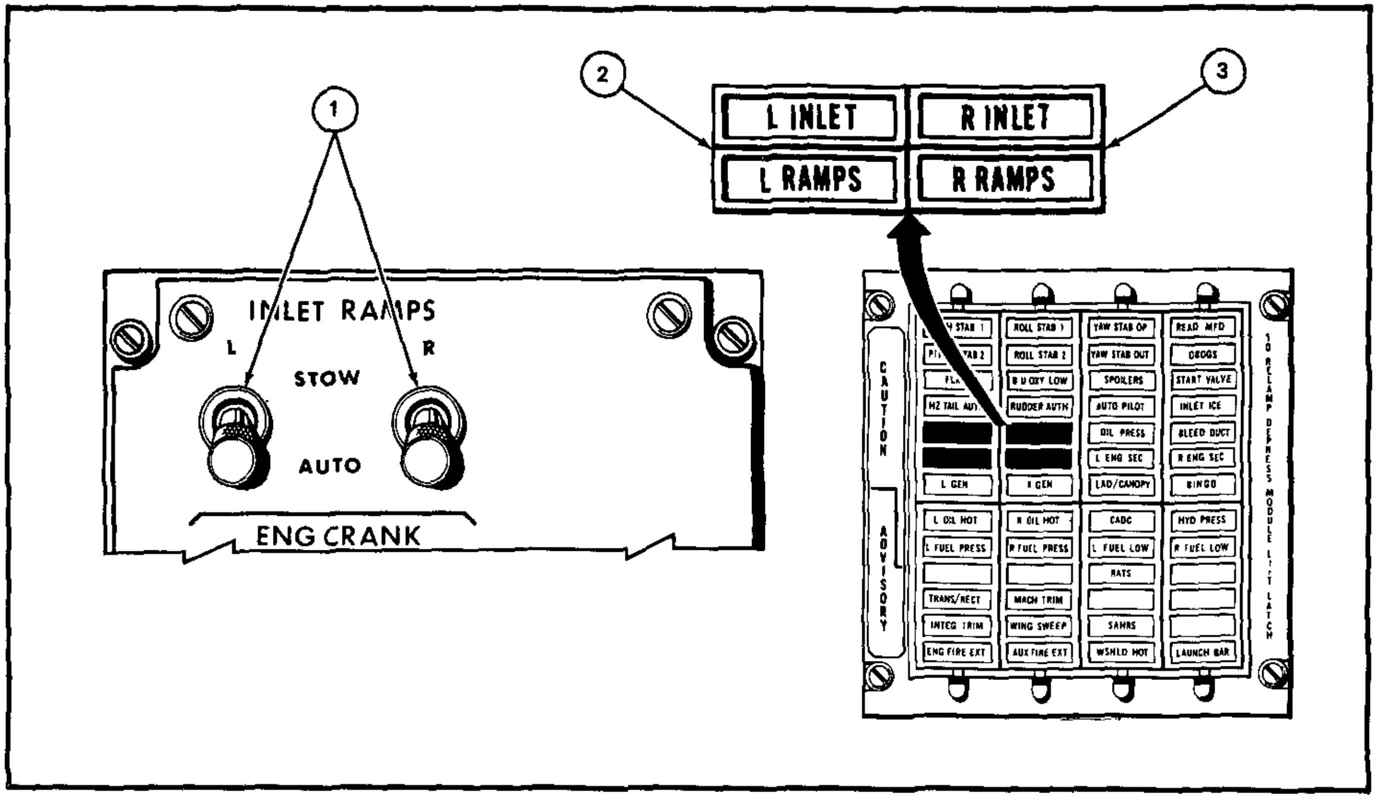


Figure 2-1. Air Inlet Control System



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NOMENCLATURE	FUNCTION
① INLET RAMPS switches	AUTO – Inlet ramp position is determined by the AICS programmer. STOW – Electrically commands the respective inlet ramp actuator to the stow position; opens the appropriate hydraulic shutoff valve. **WARNING** • DO NOT take off with the INLET RAMPS switches in STOW. Hydraulic power is on and may drive the ramps out of the stow locks during certain servocylinder failure modes causing an engine stall. • If wing sweep advisory light illuminates, cycling L AICS circuit breaker (LF1) may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) circuit breakers are pulled.
② RAMPS caution light	Indicates ramps not positioned in either stow or trail locks during critical flight conditions (see figure 2-5).

Figure 2-2. AICS Control and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(3) INLET caution light	Indicates AICS programmer/system failure: Reduce airspeed to Mach 1.2 and check AICS acronym for failure indication. AICS FAILURE Less than Mach 0.5: Ramps should be restrained by actuator stow locks. Greater than Mach 0.5: Ramp movement is restrained by trapped hydraulic pressure and mechanical locks, depending on Mach when INLET light illuminates. Greater than Mach 0.9: Ramp movement is minimized by actuator spool valves and the aerodynamic load profile in this Mach range and a RAMP light should illuminate.

Figure 2-2. AICS Control and Indicators (Sheet 2 of 2)

Detected failures of angle of attack, engine fan speed, or out-of-calibration detection of the difference between P1 and P2 (ΔP), P_s or P_t sensors will cause the AICS to revert to the slightly degraded fail-operational mode of operation. Nominal values of angle of attack, total temperature, or engine fan speed are substituted for the failed values in the AICS programmer, without illumination of an INLET caution light.

In both fail modes of operation, detected failures are continuously registered by the in-flight performance monitoring system and displayed with air inlet control acronyms on the multifunction display and the tactical information display (Figures 2-5 and 2-6).

2.1.2.2 AICS On-Board Check. OBC, initiated by the pilot during poststart or ground maintenance checks, performs a dynamic check of the left and right AICS. In addition to the regular AICS BIT program, sensor calibration checks are made. The status of the programmer electronics and the ramp actuators are checked throughout an altitude and airspeed schedule as psuedopneumatic inputs to the programmer are varied to simulate a flight sequence of maximum airspeed condition and back to static sea level conditions within 65 seconds. This cycles the ramp actuators through their full range, illuminates the ramp lights, exercises the complete AICS for preflight failure detection, and ensures the ramps are in their stow locks. OBC is the only way to ensure stow lock integrity since it verifies the ramps are in the stowed position and then removes ramp hydraulic power. Detected AICS failures are indicated by AIC acronyms or AIC acronym(s) with associated INLET caution light(s) displayed after completion of OBC.

Note

- With INLET RAMP switches in STOW, AICS OBC will fail test and INLET lights will illuminate.
- If the engine enters secondary mode during OBC, the ramps will stow and fail OBC. To reinitiate OBC, select primary mode and reset the AICS.
- An S4 acronym indicates the AICS programmers may be operating on the REV 4 (TF-30/F14A) schedule. As a result, below 25,000 feet at airspeeds greater than 1.1 Mach, unloading the aircraft to less than 1g will reduce inlet stability and may result in inlet buzz and possibly an engine stall. Cycling AICS circuit breakers at a constant subsonic Mach number should eliminate the S4 acronym and reset the programmer to the REV 5 (F-110) schedules.

2.1.3 AICS Failure Modes of Operation. AICS mode of operation following a BIT-detected failure may be either fail-operational mode (Figure 2-5) or fail-safe mode (Figure 2-6).

2.1.3.1 *Fail-Operational.* Failures in the AICS are detected by the AICS programmer, which automatically initiates appropriate corrective action. Mode entry is indicated by the display of a fail-operational AIC acronym. The fail-operational mode results in no significant degradation in AICS operation, and the mission can be continued without any flight restrictions or corrective action by the pilot.

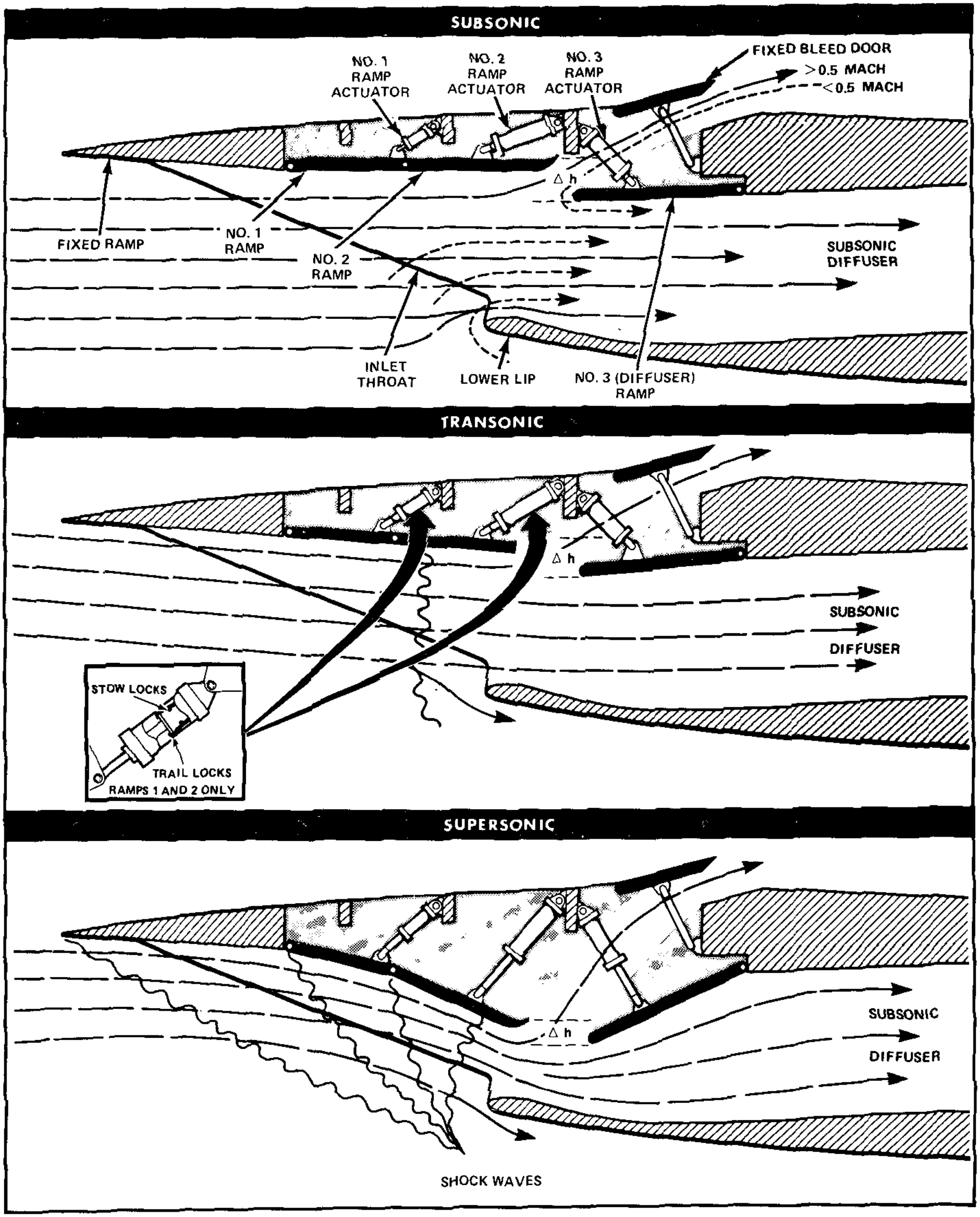


Figure 2-3. Variable-Geometry Inlet Configuration

FLIGHT CONDITION	HYDRAULIC POWER RAMP ACTUATORS	ACTIVATOR POSITION		
		RAMP NO. 1	RAMP NO. 2	RAMP NO. 3
M<0.35	OFF	Mechanically restrained by stow locks in stowed position; electrical stow commands output from AICS programmer.		
M>0.35 to <0.5	ON	Electrical stow commands output from AICS programmer.		
M>0.5 to <2.2	ON	Variable position scheduled by AICS programmer as a function of mach number, corrected engine fan speed, and angle-of-attack. Ramps no. 1 and no. 2 begin positioning at Mach 0.5; ramp no. 3 begins at Mach 0.9.		
M>2.2	ON	Variable position scheduled by AICS programmer as a function of Mach number.		

Figure 2-4. AICS Normal Operating Mode

FAILURE MAINTENANCE READOUT ACRONYM	DETECTED FAILURE	CAUSE	RESULT
AIC S1 (Possible only during OBC)	P_s, P_t, or programmer out of calibration	Limits exceeded.	Ramps may not program during OBC. Reset AICS L and R circuit breakers (LF1, LG1) prior to attempting another OBC.
NONE	Engine fan speed rpm from AFTC.	Loss of engine fan speed signal.	Substitutes 7,300 rpm. Ramps do not program during OBC.
AIC S3	None	None	Mask continuous monitor (CM) so that subsequent AIC acronyms are displayed.
AIC S4	Angle-of-attack or engine fan speed.	Limits exceeded.	IN FLIGHT: Substitutes +2° angle-of-attack or 7,300 rpm.
AIC S4 (During OBC)	Alpha delta pressure sensor out of calibration or engine fan speed.	Limits exceeded. Augmenter fan temperature controller (AFTC) may be in secondary mode.	• Substitutes +2° angle-of-attack value until reset. • Substitutes 7,300 rpm.
AIC A4	Open wire	Open wire	None

Note

AIC symbol has L or R appended (AICL, AICR) to identify on which side failure was detected.

Figure 2-5. Fail-Operational Mode — No INLET Light

FAILURE MAINTENANCE READOUT ACRONYM	DETECTED FAILED	CAUSE	RESULT	
			MACH <0.5	MACH >0.5
AIC P AIC S1 AIC S2	AICS programmer (P) Static pressure (P_s) Total pressure (P_t)	Failed end-to-end BIT Minimum or maximum limits exceeded	Hydraulic shutoff valve remains closed. Ramp actuators remain mechanically restrained within stow locks, provided they failed within stow locks.	Ramp movement is restrained by actuator mechanical locks if failure occurred with ramps within locks. Otherwise ramp(s) move slowly with aero-dynamic loads.
AIC A1 AIC A2 AIC S3	Ramp No. 1 Ramp No. 2 Ramp No. 3	Sustained command and feedback error		
AIC A1, AIC A2, or AIC A3 (INLET caution light eventually illuminates >0.5 Mach)	Hydraulic pressure loss of ramp No. 1, No. 2, or No. 3	Sustained error due to loss of hydraulic pressure		Ramp(s) may move if failure occurred with ramp(s) out of mechanical locks. RAMP light will illuminate.
NONE (No INLET caution light <0.5 Mach)		Loss of hydraulic pressure		

Note

AIC symbol has L or R appended (AICL, AICR) to identify on which side failure was detected.

Figure 2-6. Fail-Safe Mode — INLET Light Illuminated

Note

Transferring to SEC mode will revert the AICS programmers to the REV 4 (TF-30/F14A) schedule because of the loss of the AFTC N_1 speed signal and will display an S4 acronym. Below 25,000 feet and at airspeeds greater than 1.1 Mach, unloading the aircraft to less than 1g will reduce inlet stability and may result in inlet buzz and possible engine stall. To restore full REV 5 (F110/F14B/D) schedule and eliminate S4 acronym following an airborne engine mode reset to PRI, recycle AICS circuit breakers at constant subsonic Mach number.

2.1.3.2 Fail-Safe Mode. The fail-safe mode results in significantly degraded AICS operation. Mode entry is indicated by the display of a fail-safe AIC acronym and illumination of the appropriate INLET caution light. Under these conditions, the AICS programmer provides a shutoff signal to close the ramps' hydraulic shutoff valve. If the hydraulic shutoff valve closes below Mach 0.9, the ramps are normally in a safe configuration (No. 1 and No. 2 ramp within trail locks and No. 3 ramp in stow locks are restrained by trapped hydraulic pressure). Engine operations may be successful below 1.2 Mach in this configuration; however, corrective procedures shall be performed.

Note

Fail-safe operations result in a slight degradation of cruise and excess thrust performance because of the off-optimum configuration.

If the hydraulic shutoff valve closes above Mach 0.9, the ramps are normally in an unsafe configuration and the appropriate RAMPS caution light will accompany the INLET caution light (Figure 2-7). Above Mach 0.9, the No. 3 ramp normally begins programming below the actuator stow lock. When the fail-safe mode is entered above Mach 0.9, the unpowered No. 3 ramp will eventually move and may cause compressor stalls at higher power settings. The aircraft shall be decelerated below 1.2 Mach, and the appropriate INLET RAMPS switch shall be selected to STOW.

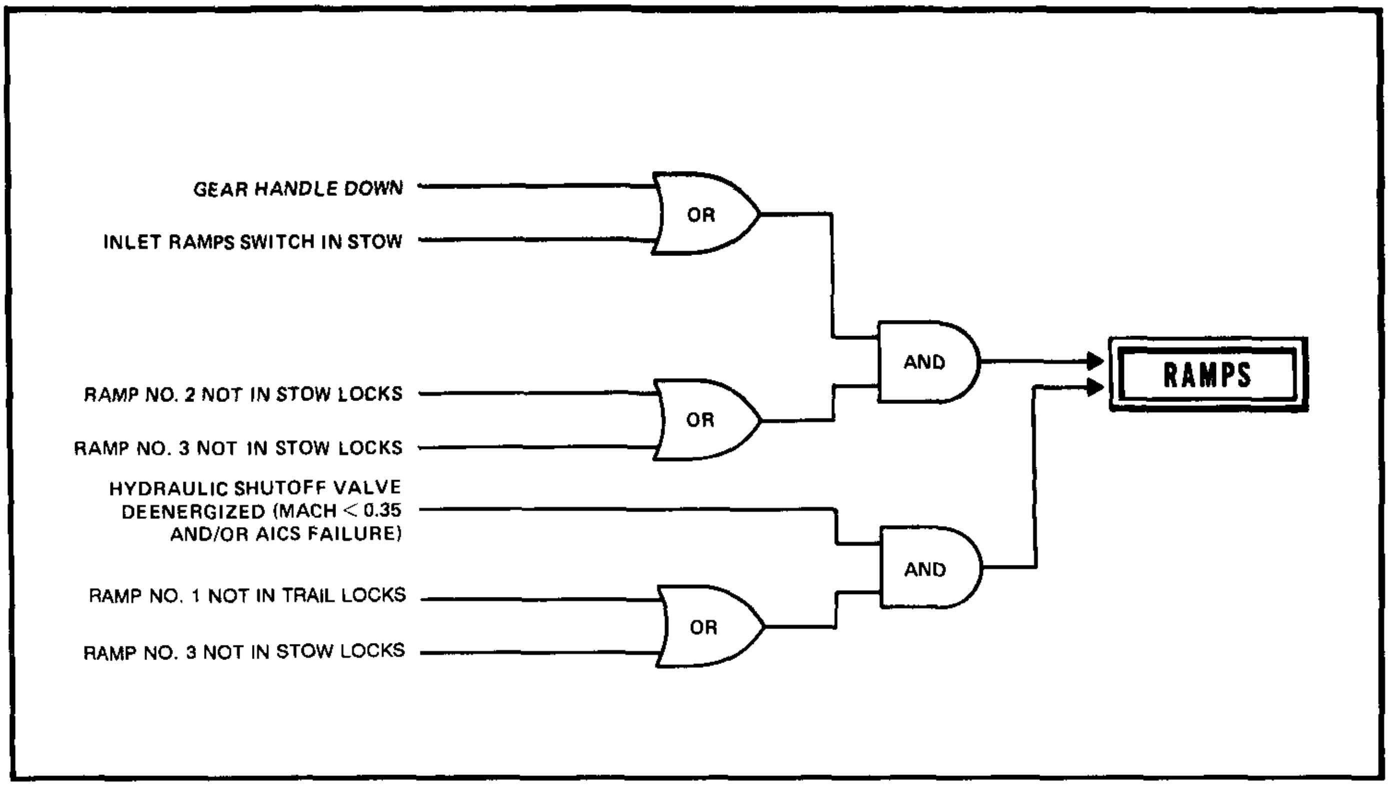


Figure 2-7. Ramp Monitor Logic

CAUTION

Do not select STOW at speeds greater than 1.2 Mach. Compressor stalls may occur because of ramp mispositioning.

2.1.3.3 Stow Mode of Operation. The STOW position of the INLET RAMPS switch commands the appropriate hydraulic shutoff valve to open and provides a direct electrical signal to the ramp actuators, porting hydraulic pressure directly to the retract side of the actuator. When the ramps are retracted to the stow position, the RAMPS light will extinguish and the stow locks should remain engaged even if hydraulic power is subsequently lost. Once in STOW, AICS programmer-detected electronic failures may be reset below Mach 0.5.

2.1.3.4 Hydraulic Shutoff and Dump Inhibit. The AICS hydraulic systems include a hydraulic shutoff valve to control hydraulic system pressure. The hydraulic shutoff valve is normally controlled by the AICS programmer, which removes the hydraulic-on signal below 0.35M or in the event of a programmer failure. The STOW position of the INLET RAMPS switch bypasses the AICS programmer to energize the hydraulic shutoff valve, providing pressure for ramp motion. To ensure hydraulic pressure is shut off, the respective AICS programmer must be deenergized by pulling the circuit breaker (LF1, left or LG1, right) and the INLET RAMPS switch placed in the AUTO position. Whenever the hydraulic shutoff valve closes (i.e., fail-safe mode entry), hydraulic spool valves in the ramp actuators sense the absence of pressure and block the actuator pressure and return ports, causing a hydraulic lock (dump inhibit). This feature reduces ramp movement when an AICS failure occurs and the ramps are not being restrained by mechanical actuator locks. Although dump inhibit prevents the ramp from rapidly extending and causing an engine stall, the ramps will still slowly move. Under normal circumstances, the pilot will have sufficient time to select STOW and prevent an engine stall. F-14A flight test results show that with dump inhibit, the time interval between illumination of a RAMPS caution light and engine stall following an AICS failure was 15 to 40 seconds on the ground at military power, and approximately 50 seconds at 10,000 feet at military power.

2.1.3.5 Ramp Actuator Mechanical Locks/Positioning. In addition to the actuator stow locks, the first and second ramp actuators have another set of latches (trail locks) that prevent further ramp actuator extension after a failure within these trail locks. The actuator stow and trail locks restrain actuator movement in tension only. Hydraulic pressure (500 psi) is required to disengage the lock finger latches.

Safe positioning of the ramp actuators is monitored by the ramp monitor logic shown in Figure 2-5. A RAMPS light should always be accompanied by an INLET light with the landing gear handle UP. With the landing gear handle DOWN, a RAMPS light can be illuminated without an INLET light. The emergency procedure in any case is the same. RAMPS lights will extinguish when a safe configuration is attained.

Note

Following an AICS programmer/ramps failure, the safest configuration results when the ramps are in the stow position. The programmers are disabled by pulling the affected AICS circuit breaker and returning the INLET RAMPS switch to AUTO.

In the event of an engine or hydraulic failure, the following conditions exist with respect to AICS reset:

1. If hydraulic pressure is zero, there is no need to safe the ramps (by stowing ramps, pulling AICS circuit breakers, and returning to AUTO) since selecting STOW will have no effect without hydraulic pressure.

2. If airspeed is less than .35 Mach, there is no need to safe the ramps since hydraulic pressure has already been removed and ramps should be in the stow locks. If the ramps are not in the stow locks, the RAMPS light will illuminate when the landing gear handle is lowered. If the RAMP light does illuminate, then the ramps should be stowed and the AICS programmer reset.

3. If hydraulic pressure is greater than zero and airspeed is greater than .35 Mach, then the ramps should be stowed and the programmer reset after engine failure or a low-hydraulic-pressure situation. This will ensure that if the ramp is out of the stow lock (as is normal above .5 Mach), it will be returned to the stow lock and kept there for landing regardless of subsequent hydraulic or electrical malfunctions.

2.1.3.6 AICS Failure In-Flight Operation. Most AICS failures occurring in flight do not require rapid pilot response because of system design features for fail-safe operation. In flight, the No. 1 and 2 ramps tend to blow back to the stow position or are restrained within the trail locks because of aerodynamic loads. The hydraulic restriction of all ramps during loss of hydraulic power and after fail-safe mode entry, should prevent rapid ramp movement. Internal failure of an actuator, especially the No. 3 ramp actuator, may allow rapid ramp extension and cause engine stall. Additionally, failure to stow the ramps in a reasonable amount of time after INLET light illumination or inability to stow following a hydraulic system failure may result in compressor stalls at high power settings. Engine start attempts may not be successful unless the ramps are stowed (RAMPS caution light extinguished).

2.1.4 AICS Anti-Ice. AICS anti-ice is activated only by selecting ORIDE/ON with the AICS ANTI-ICE switch and airspeed between 0.35 to 0.9 Mach (hydraulic power is available at 0.3 Mach). Above and below these airspeeds the AICS anti-ice is disabled. When the ENG/PROBE anti-ice switch is in AUTO, the AICS anti-ice is off. When AICS anti-ice is activated, the AICS programmer repositions the No. 1 and No. 2 ramps to positions below the No. 3 ramp (Figure 2-8) so that ice will not form above the No. 3 ramp.

2.2 ENGINE

The aircraft is powered by two F110-GE-400 turbofan engines (Figure 2-9) with variable exhaust nozzles and AB augmentation. They are dual-rotor engines consisting of a three-stage fan driven by a two-stage, low-pressure turbine and a mechanically independent, aerodynamically balanced, nine-stage, high-pressure compressor driven by a single-stage, air-cooled high-pressure turbine. Engine operation is automatically regulated and maintained electrically by the augmenter fan temperature control unit and by throttle inputs to the main engine control.

Each engine is slung in a nacelle with the thrust axis laterally offset approximately 4-1/2 feet from the aircraft centerline. The installed static engine thrust at military power is 13,800 pounds and at maximum AB power thrust is 23,600 pounds. Installed engine thrust at maximum AB at 0.9M at sea level is 30,200 pounds. Acceleration time from idle to military power is approximately 4 seconds.

During operation, air entering the engine is directed into the fan, which initially pressurizes the air and directs its flow into the engine core compressor and fan bypass duct. Direction of airflow into the fan is optimized by variable-geometry inlet guide vanes (IGV) and into the compressor by variable geometry stator vanes. The high-pressure compressor further compresses the air through the nine-stage compressor before discharging it into the annular combustion chamber to mix with

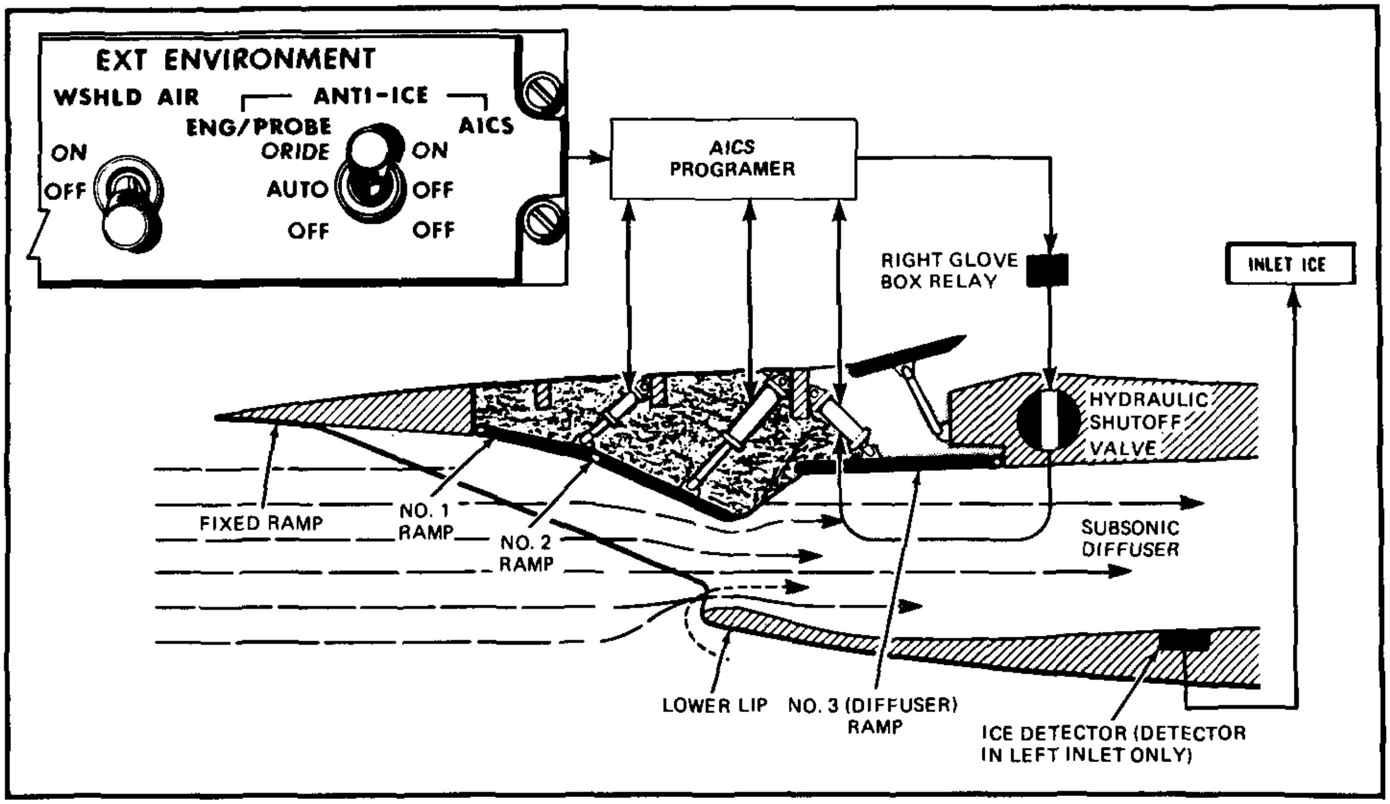


Figure 2-8. AICS Anti-Ice System

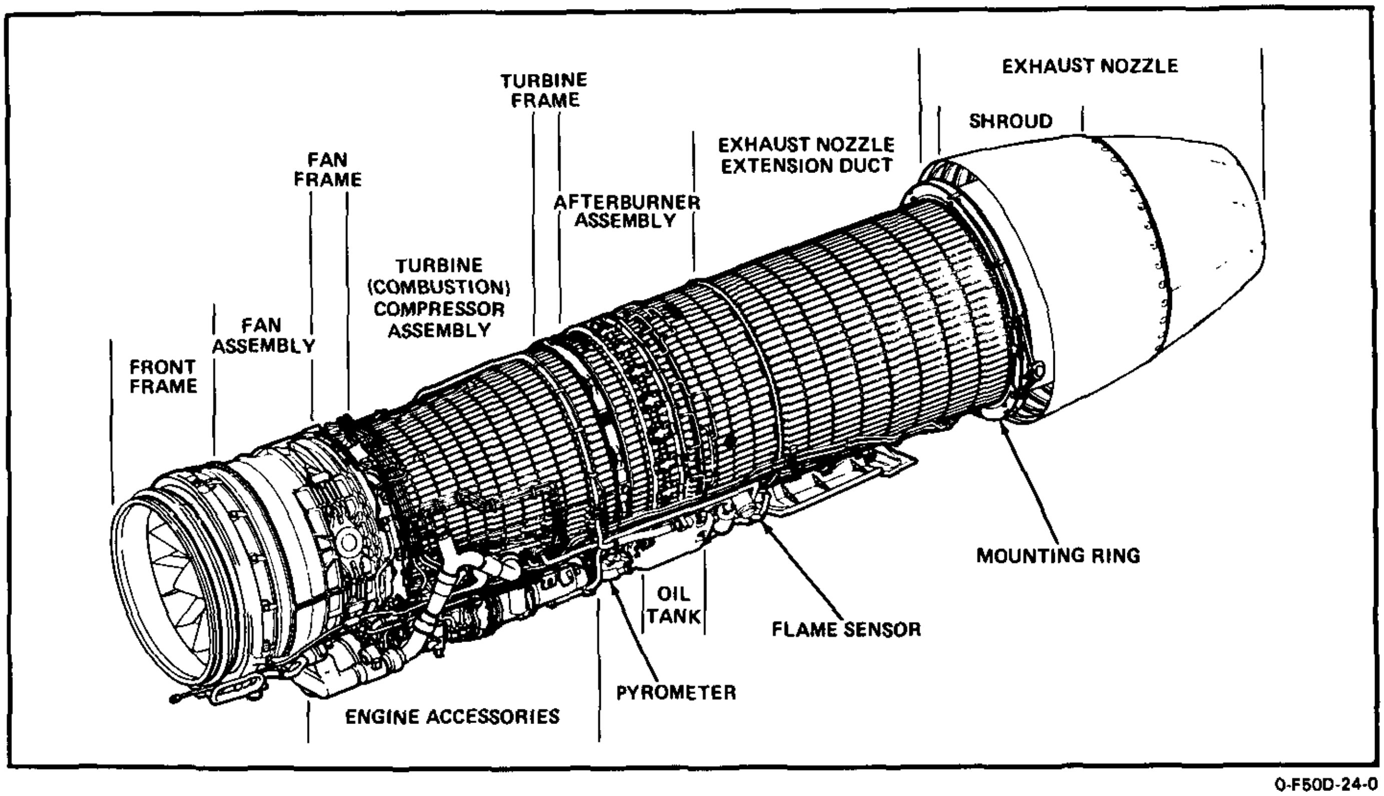


Figure 2-9. F110-GE-400 Engine

fuel from the fuel nozzles. This fuel-air mixture is initially ignited by the main spark igniter in the combustion chamber. As a result of this combustion, expanding gases drive the high- and low-pressure turbines. Power to drive the two accessory gearboxes is obtained from the high-pressure rotor.

From the turbine section, the exhaust gases pass into the section and are mixed with air from the fan bypass duct. During AB operation, fuel is sprayed into this mixed airflow and ignited for additional thrust.

WARNING

During night and/or IFR conditions, the increased acceleration during AB use will result in inner ear disturbances that may cause flightcrew confusion/disorientation. The large amount of light generated by the AB exhaust reflecting around the aircraft will compound this condition. These factors may result in severe aircrew disorientation/vertigo.

2.2.1 Engine Control. The engine is controlled by three units: the hydromechanical main engine control, the electronic augmenter fan temperature control, and the AB fuel control. There are two modes of operation, primary (electronic) and secondary (mechanical), with provisions for automatic and manual switchover to secondary. Manual selection is controlled through the ENG MODE SELECT panel (Figure 2-10). Automatic or manual selection of the secondary mode illuminates an ENG SEC caution light. When one engine reverts to secondary mode, the other engine continues in primary mode. Cycling the ENG MODE SELECT switch may reset the AFTC if the faults are temporary. If the change back to primary mode is successful, the ENG SEC light will go out. Automatic or manual selection of secondary mode is possible throughout the flight envelope. Selection of secondary mode will cause a loss of fan speed signal to the AICS.

CAUTION

SEC mode transfers with throttles in AB above 450 KCAS could result in pop stalls and damage to the IGV linkage.

Note

SEC mode transfer while in AB may result in pop stalls. Nonemergency manual selection of SEC mode on the ground should be performed in basic engine. Nonemergency manual selection of SEC mode airborne should be performed in basic engine with power set above 85-percent rpm.

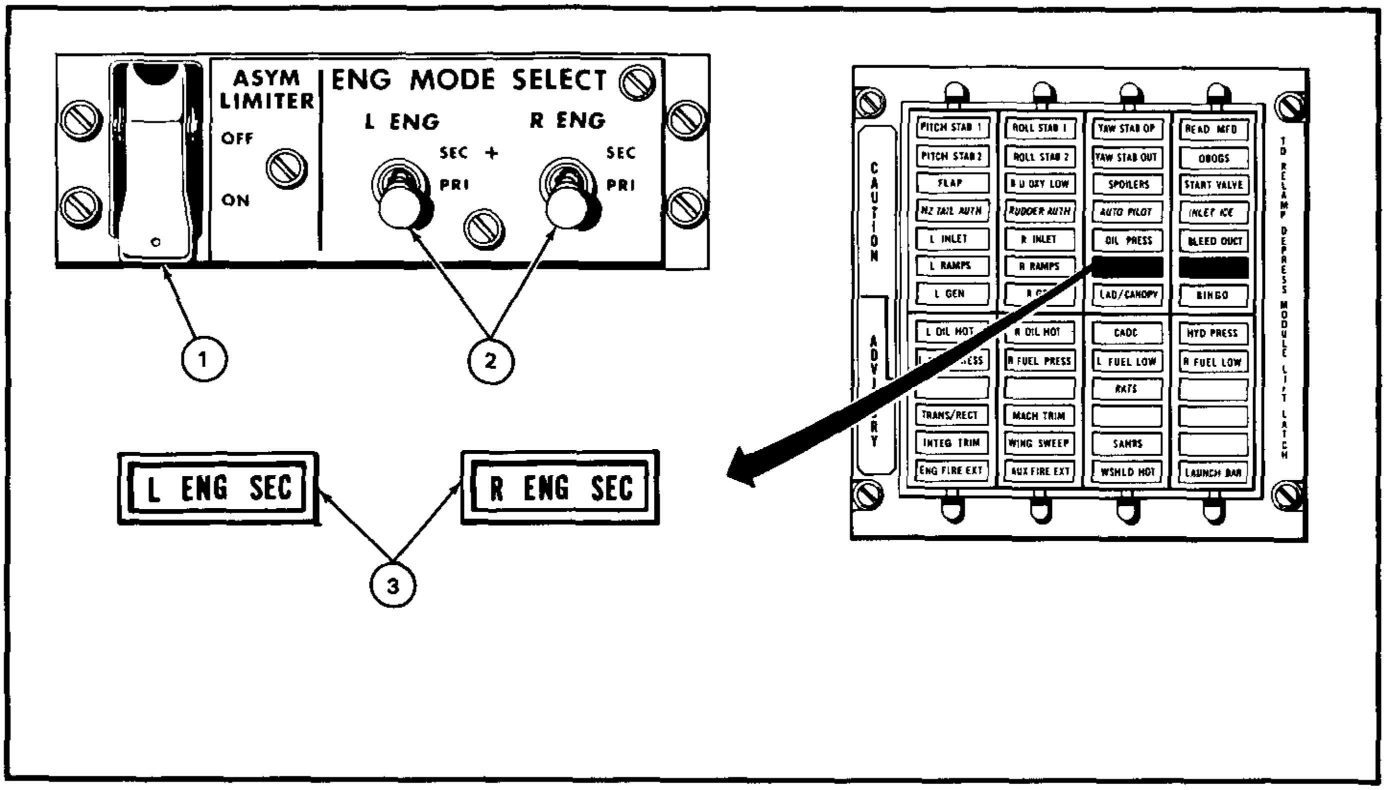
Transferring to SEC mode will revert the AICS programmers to the REV 4 (TF-30/F14A) schedule because of the loss of the AFTC N1 speed signal and will display an OBC AICS - LEFT (RIGHT) and ANGLE OF ATTACK acronym. Below 25,000 feet and at airspeeds greater than 1.1 TMN, unloading the aircraft to less than 1g will reduce inlet stability and may result in inlet buzz and possible engine stall. To restore the full REV 5 (F110/F14B/D) schedule and eliminate the OBC acronym following an airborne engine mode reset to PRI, cycle AICS circuit breakers at constant subsonic Mach number.

2.2.1.1 Main Engine Control. The MEC is a hydromechanical control that provides fuel shutoff, variable stator vane scheduling, and main fuel metering in both primary and secondary modes. The MEC controls fuel flow until 59-percent rpm and provides high-pressure compressor rotor overspeed protection automatically by securing fuel flow to the engine when an overspeed condition of 110 percent is reached.

Note

- To regain engine operation following an automatic engine overspeed shutdown, the throttle must be cycled to OFF then IDLE.
- An overspeed condition in excess of 110 percent will result in momentary loss of rpm indication until N_2 rpm falls below 110 ±.5 percent. EGT and FF indicators will continue to function normally.

2.2.1.2 Augmenter Fan Temperature Control. The AFTC is a modular solid-state electronic device that performs control schedule computations, integration and logic functions, limit control, failure detection, and provides engine core speed (N_2) signal for instrument display and engine fan speed (N_1) signal to the AICS. It also controls the distribution of electrical power to the entire engine electrical and monitoring systems. Figure 2-11 shows the various interface signals used by the AFTC. Normally the CADC supplies Mach number value to the AFTC. If this signal is erroneous, the AFTC assumes a default Mach number value in order to continue operation.



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NOMENCLATURE	FUNCTION
(1) ASYM LIMITER switch	ON – (guarded) Reduces AB thrust asymmetry in the event of AB blowout or if one engine fails to light when commanded to AB. Limits operating engine to minimum AB until other engine attains minimum AB.
	OFF – Either engine may operate at any AB power setting independently of the other engine.
(2) L/R ENG MODE SELECT switch	PRI – Primary mode, AFTC controls main and AB fuel flow, fan inlet guide vanes, nozzle area, and ignition.
	SEC – Secondary mode, main fuel flow is scheduled hydromechanically by the MEC. AB is inhibited.
(3) L/R ENG SEC caution light	Illuminates when the engine is in secondary mode. AB operation is inhibited for engine with light illuminated. AICS on affected engine side reverts to REV 4 (TF-30/F-14A) schedule.

Figure 2-10. ENG MODE SELECT Panel and ENG SEC Lights

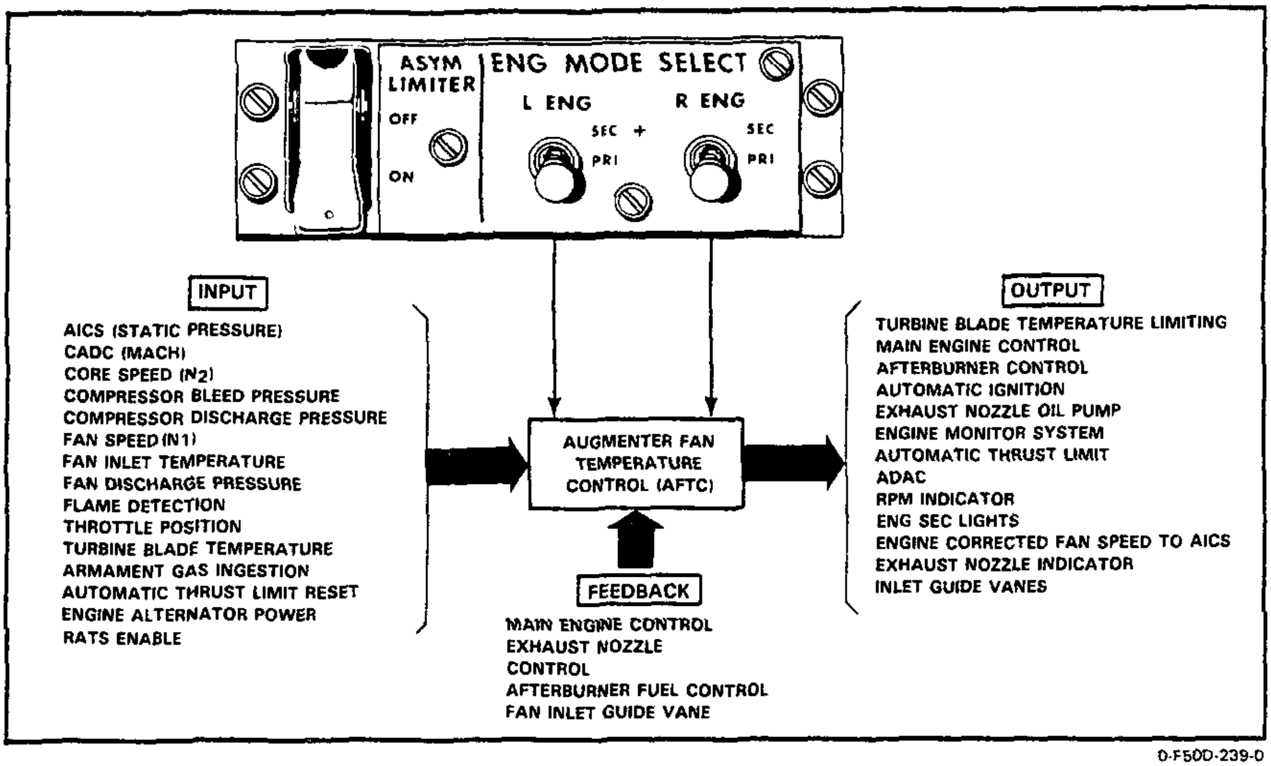

Figure 2-11. AFTC Functiional Relationships

WARNING

The loss of Mach number signal from the CADC results in the loss of both airflow limiting and idle lockup functions of the AFTC. This may result in pop stalls at supersonic speeds (on a cold day) at high power and inlet buzz, resulting in pop stalls at idle power. If this occurs, decel in military power until subsonic.

2.2.1.3 Afterburner Fuel Control. The AFC is controlled by the AFTC for afterburner operation. The AFTC computes AB fuel flow ratios and provides them to the AFC. The AFC converts ratio commands to metered fuel flows into local core and fan AB fuel manifolds. When staging up the AB, local fuel flow is initiated first, followed by core and fan flow last. When staging down, the reverse sequence occurs. Thrust changes are smooth when staging up or down.

2.2.1.4 Primary Mode. In the primary mode, the AFTC controls the MEC, AFC, and AB nozzle hydraulic pump to provide optimum engine operation with unrestricted throttle movement throughout the flight envelope. The AFTC computations are used to control basic engine and AB fuel flow, IGV, and AB nozzle positioning; VSV positioning is controlled by the MEC. The AFTC incorporates independent control schedules that are prioritized so that the optimum amount of fuel flow is provided to the main combustor. At any given time, only one of these schedules is actually in control of fuel flow. The remaining schedules are always active and are calculating the change in fuel flow required (if any) to attain the desired value of their assigned parameter. The selection of the schedule in control is accomplished by a series of minimum and maximum selectors. These selectors control scheduling of the following:

1. Acceleration/deceleration
2. Minimum/maximum compressor discharge pressure
3. Minimum/maximum rpm
4. Fan speed limiting
5. Maximum turbine blade temperature limiting
6. Idle lockup speed.

Other AFTC functions include engine start control, asymmetric thrust limiting, reduced arrestment thrust, automatic relight, and fault detection. Fault detection automatically switches the engine control to the secondary mode in the event of core overspeed, fan speed signal loss, AB nozzle demand full open when not at idle or maximum AB, AFTC power deviations, fuel flow demand full increase or full decrease, fan speed greater than 800 rpm below schedule and not accelerating, or throttle signal error.

2.2.1.4.1 AB Operation (Primary Mode). For AB operational characteristics, refer to Figure 2-12. Unrestricted throttle operation into and out of AB is permitted throughout the flight envelope. During AB operation, rpm, EGT, fuel flow, and nozzle position vary with altitude and airspeed. The nozzle position will also increase as the throttle is transitioned from minimum AB to maximum AB. If an AB blowout occurs, the autorelight feature attempts to reinitiate AB without throttle movement. The engine has reduced AB region of operation at high altitudes and low airspeeds. The automatic AFT control feature, rich stability cutback, reduces or limits the maximum AB fuel flow in this region to prevent AB instabilities (Figure 2-12). Indication of rich stability cutback is a nozzle position of approximately 30 to 50 percent at maximum AB rather than the normal 60 to 70 percent. Also, because of airflow and temperature characteristics, AB light-off characteristics are slower at high altitudes and low airspeeds.

2.2.1.5 Secondary Mode. Basic engine operation in SEC mode is extremely reliable. In the secondary mode, the electronic functions performed by the AFTC are eliminated. The MEC provides complete control of the engine with the exception of fan speed limiting, which is powered by the higher of 28-Vdc aircraft electrical power or engine alternator electrical power. When SEC mode is manually selected or an automatic default to SEC mode occurs, the exhaust nozzle is commanded full closed, the nozzle position indicator goes to the not-powered position (subzero indication), the IGVs are fixed full open, high-energy ignition is continuously energized, AB is inhibited, and idle lockup protection is lost.

In SEC mode, engine stall margin is decreased at low rpm because of IGV positioning. The FEMS engine stall detection circuit is inoperative, but overtemperature warning is still available. A low-level vibration/rumble may be sensed in ground idle operation in secondary mode. This vibration/rumble has no adverse affect on the engine and disappears when the throttle is advanced slightly up to 5-percent rpm increase. Maximum thrust available at military power in SEC mode is depicted in Chapter 14, Figure 14-4.

CAUTION

SEC mode transfers with throttles in AB above 450 KCAS could result in pop stalls and damage to the IGV linkage.

Note

- SEC mode transfer from AB may result in pop stalls. Nonemergency manual selection of SEC mode on the ground should be performed in basic engine. Nonemergency manual selection of SEC mode airborne should be performed in basic engine with power set above 85-percent rpm.
- If the fan speed limiter circuit has failed, engine rollback may occur with selection of SEC mode. In the event of engine rollback, PRI mode must be reselected above 59-percent rpm or flameout will occur and airstart will not be possible.

2.2.1.6 Engine Alternator. Each engine's electrical system is powered by an alternator mounted on the engine aft gearbox. The alternator consists of four windings. Two windings are redundant in providing power to the AFTC and its components. A third winding provides power for both main high-energy ignition and AB ignition. The fourth winding provides power to the engine monitoring system processor (for FEMS), and a signal for the rpm gauge. The last winding is also an alternate source of power for the fan speed limiting circuit. The fan speed limiting circuit may be powered by either the essential No. 2 dc bus or the engine-driven alternator winding, depending on which source has the highest stable output.

If engine alternator power output drops below a preset value, engine control will automatically transfer to SEC mode, illuminating the respective engine SEC light. If the engine reverts to SEC mode as a result of a sheared alternator shaft, engine high-energy ignition will not be available and the engine SEC light will not illuminate. Cockpit indications will be loss of engine rpm and nozzle position indicating below zero. In failure modes, redundant aircraft electrical power will be available for fan overspeed protection.

The engine is completely operable should the aircraft experience a complete electrical failure. The engine operates in either PRI or SEC mode, which can be selected automatically or manually. In case of a complete electrical failure all engine lights and indicators are inoperative.

RICH STABILITY CUTBACK

- REGIONS A, B AND C — UNRESTRICTED THROTTLE MOVEMENT.
- REGION A — FULL AB OPERATION EXPECTED.
- REGION B — TRANSITION REGION, FULL OR REDUCED AB OPERATION IS NORMAL.
- REGION C — REDUCED AB OPERATION EXPECTED (NOZ POS INDICATION 30 — 50 PERCENT).

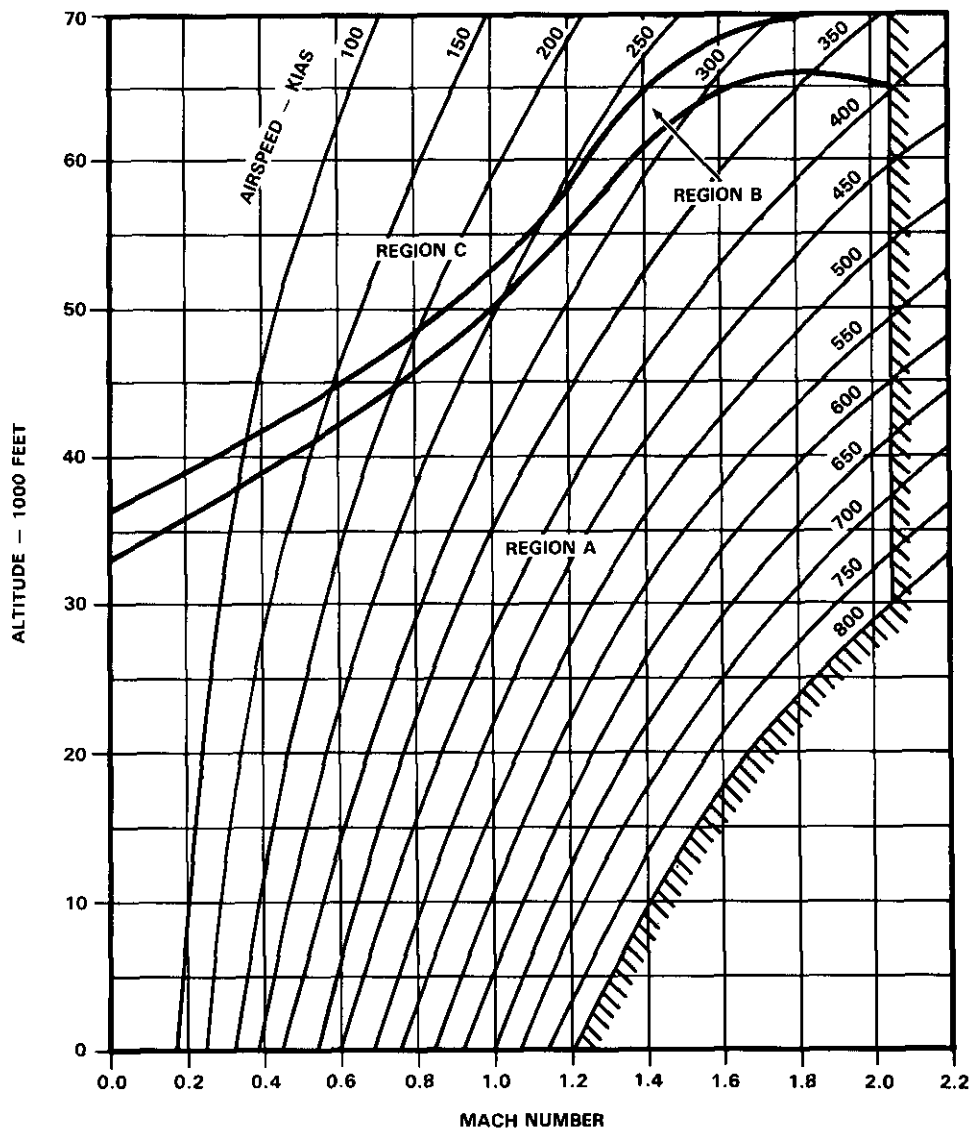

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Figure 2-12. Rich Stability Cutback — F110-GE400 Engine

2.2.1.7 Turbine Blade Temperature (Pyrometer). The pyrometer is a fuel-cooled, photodiode, optical unit that measures infrared radiation from the metal surface of the high-pressure turbine blades. This temperature signal is transmitted to the AFTC and is used to regulate engine fuel flow, which maintains turbine blade temperature within limits. Cockpit indications of turbine blade temperature appear on the MFD.

2.2.1.8 Flame Sensor. The flame sensor is an ultraviolet radiation sensing unit in the AB duct. During AB operation, ultraviolet rays detected through a quartz window activate a gas filled sensor that electrically transmits a flame-present signal to the AFTC. Without this signal, only minimum AB fuel flow is available. AB will be inhibited if the flame sensor fails on. A L/R AUG acronym is displayed in the ENGINE FAULTS block of the MFD engine page.

2.2.1.9 Asymmetric Thrust Limiting. The asymmetric thrust limiting circuit is designed to hold both engines to minimum AB until both ABs are lit off. The AFTC releases the hold on the AB when both engine AB pumps are on and both engines flame sensors are on. Selecting the ASYM LIMITER switch to OFF (guard cover up) overrides the comparison of left and right AB status and allows each AB to operate independently.

WARNING

A malfunctioning or deselected ATLS can greatly increase the magnitude of asymmetric thrust because of engine stall or failure.

2.2.1.10 Reduced Arrestment Thrust System. The RATS is a feature of the AFTC provided to reduce thrust for carrier landings to a level consistent with carrier (CV) wind-over-deck operations. When activated, the AFTC automatically reduces the military power core speed (N_2) by approximately 4.5 percent. This results in an approximate 20- to 25-percent decrease in thrust.

RATS employs two enabling circuits: an engine circuit incorporated within each engine's AFTC, and an aircraft circuit. The engine circuit is enabled by the aircraft circuit via switch closure. Since the engine circuit is a function of the AFTC, it is not available in SEC mode and can be overridden in PRI mode with selection of AB. The aircraft circuit is enabled when weight is placed on either or both main landing gears with the hook handle down or the hook out of the stowed position. The RATS light, located on the pilot advisory panel, illuminates when the aircraft circuit is activated but it is not an indication that the engines are operating at reduced thrust.

Note

The RATS light will be illuminated anytime the aircraft circuit is enabled, even if the engines are operating in SEC mode or the engine circuit has been overridden by selection of AB.

2.2.2 Variable Exhaust Nozzle. Engine exhaust gases at higher thrust settings are discharged through the nozzle throat at sonic velocity and are accelerated to supersonic velocity by the controlled expansion of the gases. Varying nozzle throat area controls fan stall margin, which optimizes performance.

The variable exhaust nozzle is a three-flap, convergent-divergent-type nozzle. Nozzle variation is accomplished by axial movement of four hydraulic actuators mechanically synchronized for geometric stability. These hydraulic actuators use oil from a separate compartment in the engine oil storage tank and are operated by a hydraulic pump that responds to AFTC signals. A failed open nozzle may be caused by an oil leak, but if the leak is in the nozzle system, only a portion of the main engine lube oil will be lost. During basic engine operation, the nozzle area is modulated to a near-closed position, and, in AB, the nozzle area is infinitely variable to a full-open position. The nozzle will go full open airborne with the throttle at IDLE at low altitude and airspeeds (Figure 2-13). A gauge for each engine on the pilot instrument panel next to the engine instruments indicates nozzle position in percentage from 0 to 100. Normal indication for maximum AB is approximately 70 percent.

Note

When AFTC is operating in secondary mode, the nozzle is commanded closed and the exhaust nozzle indicator is inoperative.

With the landing gear handle down, engine at IDLE, and weight off wheels, the nozzle is restricted to a near closed position (maximum 26 percent) to prevent exhaust nozzle flap contact with the deck/hook during landing. Five seconds after weight on wheels, the nozzle resets to full open to reduce idle power during landing rollout and while taxiing. On deck in PRI mode with throttle above IDLE detent, nozzle position varies linearly with throttle position.

2.3 FATIGUE ENGINE MONITORING SYSTEM

2.3.1 FEMS Functional Description. The FEMS is a solid-state electronic system that provides data acquisition, processing, and storage. FEMS information is displayed on the MFDs (Figure 2-14). The system accumulates airframe stress and fatigue data and

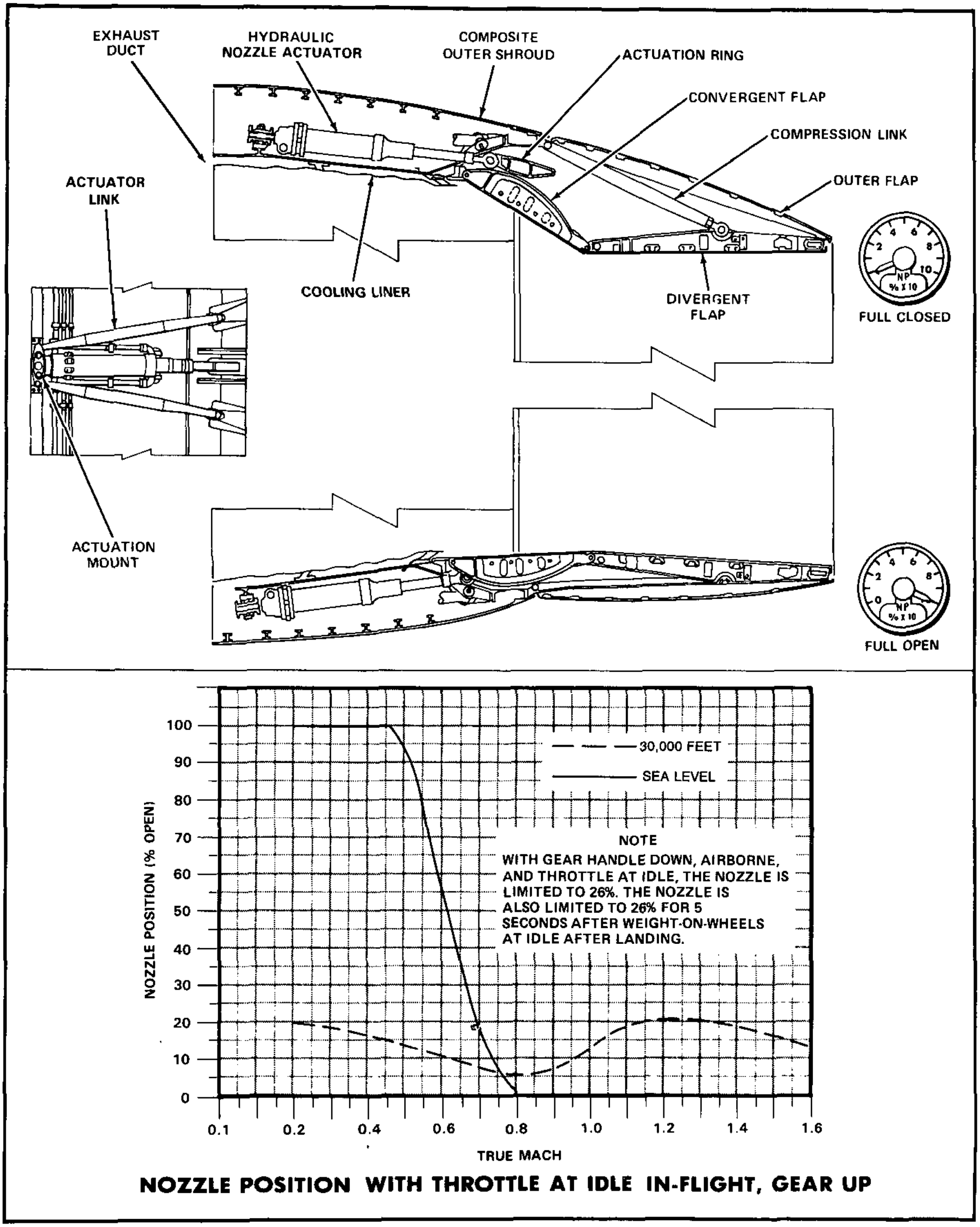

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Figure 2-13. Variable Area Exhaust Nozzle

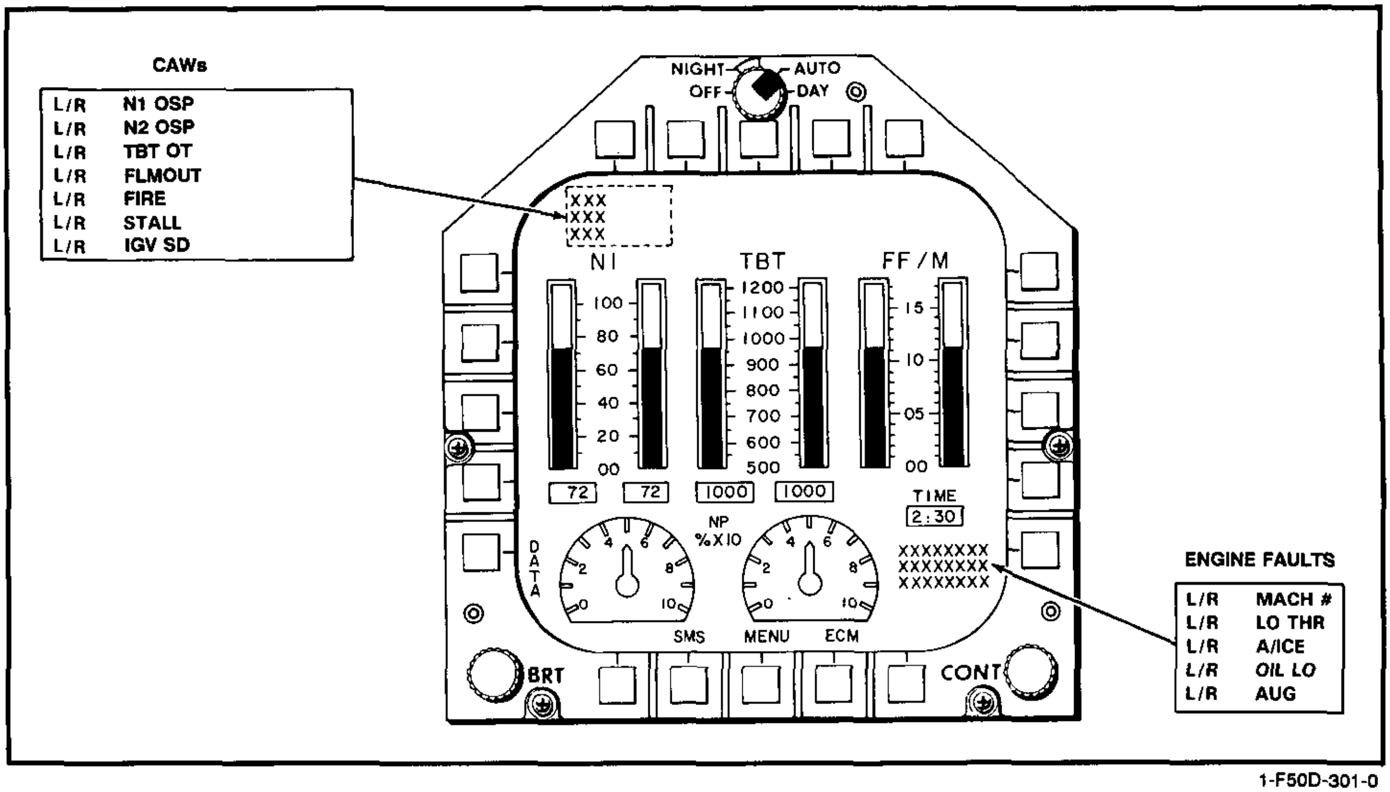

Figure 2-14. FEMS Multifunction Display Configuration

relevant engine performance data, both in flight and on deck, from the engine monitoring system processors. Engine faults detected are isolated to the appropriate WRA or combinations of WRAs and recorded for later transfer to the DPGS for diagnostic analysis, troubleshooting, and appropriate maintenance. The DPGS also computes and stores engine parts life tracking and failure-trending data. This tracking of engine data extends the life and safety of fleet aircraft by permitting maintenance routines at periodic intervals. FEMS also provides a signal to the stall warning system that initiates a 10-second warning tone (identical to overtemperature tone) and illuminates the L or R STALL warning legend on the MFD/HUD indicating an engine stall. FEMS will record aircraft overstress when it determines that normal acceleration has exceeded:

1. 7.5g with landing gear UP and Mach greater than .24
2. 4.5g with landing gear DOWN (as in hard landing)
3. 4.5g when Mach is .24 or less.

The FEMS consists of the following components (see Figure 2-15).

2.3.1.1 Engine Monitoring System Processor. The EMSP is engine mounted and engine powered and converts control system electrical signals from the AFTC into digital format for transmission to the ADAC. It also receives and digitizes other noncontrol system-related data such as anti-icing system status, lube oil level, and lube temperature data for transmission to the ADAC. In addition, the EMSP calculates and stores engine cycle count data, making this data readily available for each serial numbered engine even when the engine is not installed in an aircraft.

EMSP is only operational with the engines in primary mode.

2.3.1.2 Airborne Data Acquisition Computer. The ADAC is the central processor of FEMS and executes airframe and engine fatigue algorithms. The ADAC acquires aircraft data by direct analog and digital inputs. Additional aircraft data received by the ADAC from the CIU to be stored as a result of structural, engine, or other mission events are transferred to the DSS for postflight analysis. In addition, ADAC stores fault code messages, in nonvolatile memory, for display on the FMI. ADAC is powered by the 28-Vdc right main bus.

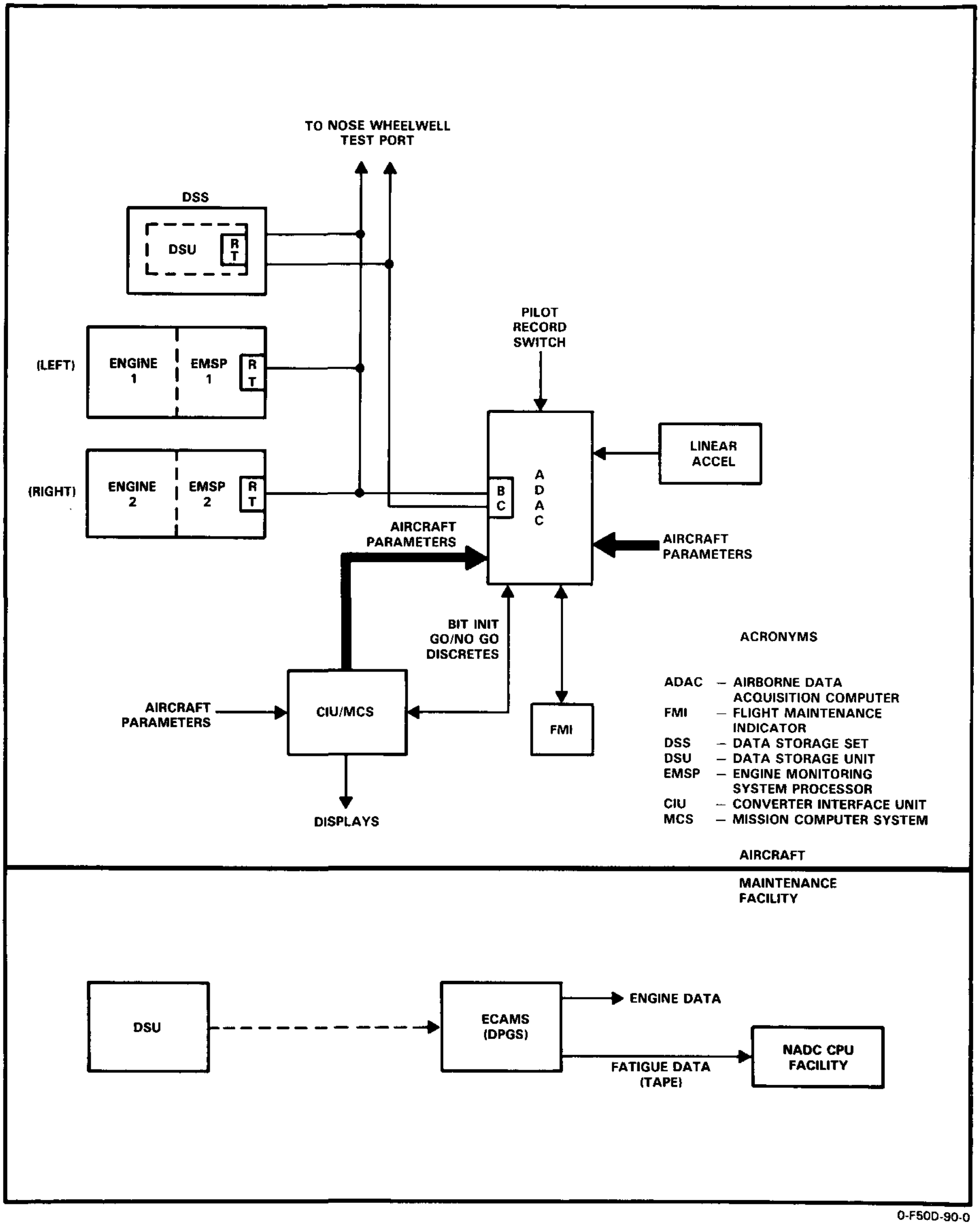

Figure 2-15. Fatigue Engine Monitoring System Diagram

2.3.1.3 Data Storage Set. The DSS, located in the RIO cockpit, and a removable DSU provide automatic preflight entry of JTIDS mission data and in-flight recording of engine data for analysis. Refer to JTIDS Chapter 19. In flight, the MCS transfers engine-related data via the 1553 bus to the DSU for postflight analysis. This data is collected for engine diagnostic purposes and compiled for long-term maintenance records. A fault code on the FMI will alert the maintenance crew when the DSU has reached 80 percent of its capacity for engine data recording. If the DSS is inoperative or is not loaded with a DSU, engine part-life tracking data is maintained only by the EMSP.

2.3.1.4 Flight Maintenance Indicator. The FMI (Figure 2-16) displays to the maintenance crew ADAC data for engine/airframe status. It is mounted in an easily accessible location on the forward bulkhead in the nose wheelwell. After each flight, the FMI FAIL, CAUTION, and/or FLUIDS fault trip indicators will be either black, signifying the absence of a FEMS-detected failure, or white, indicating FEMS detected a failure. The indicators should normally be reset by maintenance personnel prior to flight. With electrical power applied to the aircraft, pressing the STATUS SWITCH button displays either a fault code (if a fault is present) or NONE in the STATUS window. All fault codes may be scrolled line by line by pressing the STATUS SWITCH button once for each line. When no more fault codes are displayed, the display will read END*. When END* is displayed, pressing and holding the CLEAR button changes the display from END* to CLR for approximately 5 seconds followed by NONE, erasing all fault codes.

Note

The FMI is designed to be a maintenance tool only and should not be used as a go/no-go device by aircrew on preflight. Likewise, aircrew should not take it upon themselves to reset the device. Do not press both CLEAR and STATUS SWITCH at the same time. Failure to comply will result in the FEMS onboard clock being altered.

The following is a composite listing of the data automatically recorded in memory for maintenance and displayed in numeric code on the FMI:

1. Fan/core overspeed
2. Decay in core speed or signal out of range
3. Compressor stall
4. Turbine blade temperature limit exceeded or signal out of range

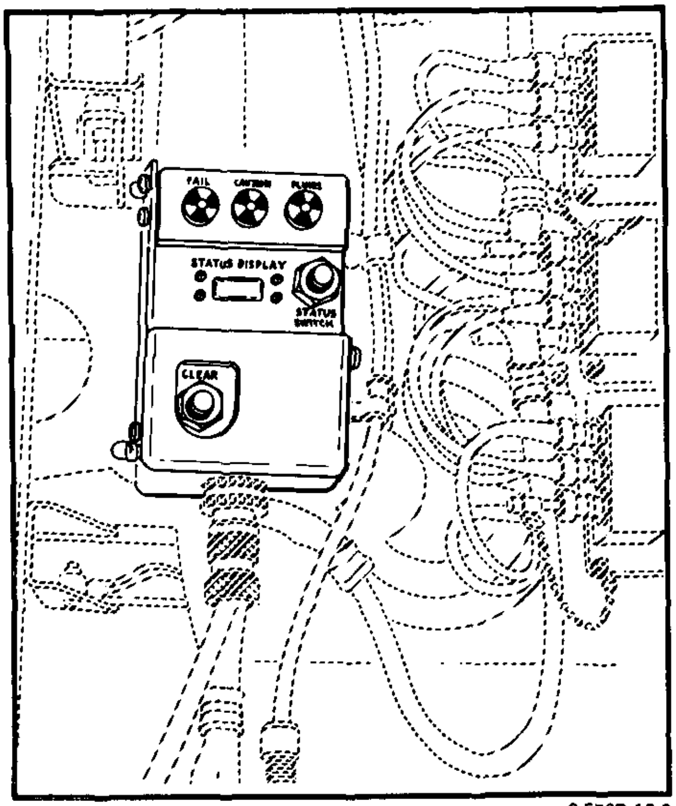

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Figure 2-16. Flight Maintenance Indicator

5. Exhaust nozzle off schedule or signal out of range
6. Fan inlet guide vanes off schedule or signal out of range
7. AB fuel valve operation (dry power)
8. AB fuel schedule fault or signal out of range
9. AB signal on but not selected
10. No AB light-off signal
11. AB blowout
12. Secondary mode operation
13. Pilot-initiated EMS data
14. Anti-icing fault
15. Low oil quantity or signal out of range
16. Oil overtemperature
17. AFTC power out of limits

18. Throttle/AFTC signal fault

19. Mach signal to AFTC fault

20. Aircraft 28-volt supply to AFTC fault

21. EMSP fault

22. ADAC/EMSP interface fault

23. ADAC BIT fault and system failure

24. ADAC battery low

25. Data storage set memory full and requires service

26. Aircraft overstress

27. System DSS

28. ADAC A-6 failure

29. RATS failure.

2.3.2 FEMS Operation. FEMS data acquisition for monitoring engine performance is automatic. However, the pilot may encounter unusual engine behavior of a nature that does not automatically initiate data recording. This data is valuable for diagnosis of the cause of unusual behavior and should be recorded by the pilot by depressing the ENG RCD button on the fuel management panel. Pressing the ENG RCD button momentarily causes 21 seconds of engine data to be recorded: 6 seconds before and 15 seconds after switch initiation. It is important to remember that if a transient problem is to be recorded by FEMS, the ENG RCD button must be activated quickly so the actual event is not missed. Manual recording will not interfere with data automatically saved by the FEMS.

2.3.3 FEMS and OBC. FEMS is checked during OBC preflight and in flight (Class III). It is designated by a FEM acronym. This acronym is displayed at the completion of OBC if FEMS fails its BIT during OBC. Engine-life tracking data is still available through EMSP if FEMS is lost.

2.4 ENGINE FUEL SYSTEM

The engine fuel system, which is identical for each engine, provides motive flow fuel to effect fuel transfer and metered fuel for combustion as a function of pilot throttle commands and numerous engine parameters (Figure 2-17).

2.4.1 Motive Flow Fuel Pump. The motive flow fuel pump is a gear-driven centrifugal pump on each engine accessory gearbox that returns high-pressure fuel to the fuselage and wing tanks to effect normal fuel transfer. Motive flow is used to power the boost pump in the respective sump tank. This fuel continues through control valves to ejector pumps in the fuselage and wing fuel tanks. There is no cockpit control for the motive flow fuel pumps. Failure of one pump illuminates the R or L FUEL PRESS caution light and reduces the rate of fuel transfer but does not inhibit the transfer of fuel from any tank. Motive flow pump failures cause the engine to draw fuel through suction feed. Higher altitudes and decreased ambient pressure result in reduced fuel flow, which may cause engine flameout because of fuel starvation. With a single motive flow fuel pump failure, AB selection above 15,000 feet MSL may cause engine flameout. With failure of both motive flow fuel pumps, high power settings in basic engine may cause flameout above 25,000 feet MSL. If a dual motive flow fuel pump failure occurs, wing fuel will not be available.

2.4.2 Engine Fuel Boost Pump. The engine (total flow) fuel boost pump is an engine-driven centrifugal pump on the aft accessory gearbox that provides boosted pressure and flow from the fuel supply system to meet main and AB fuel requirements. The pump receives fuel at aircraft boost pressure and boosts fuel pressure to levels adequate to operate the engine at all power settings (maximum 40-psi pressure rise). During non-AB operation, some fuel is circulated between AB fuel control and the engine fuel boost pump so that fuel pressure is readily available to the spray bars for AB light-off.

2.4.3 Main Fuel Pump. The main fuel pump is a two-stage pump that receives fuel flow from the engine fuel boost pump. It provides additional fuel pressurization and transmits mechanical-gear-driven power to the MEC from the gearbox.

2.4.4 Main Engine Control. The MEC is a fuel-operated, hydromechanical fuel flow regulator that operates in tandem with the main fuel pump and is capable of operating in two modes. In the primary mode, it meters main fuel flow as commanded by the AFTC and provides VSV scheduling. The secondary mode hydromechanically meters main fuel flow to govern N_2 speed based on pilot throttle commands and provides basic engine control except for AFTC fan speed limiting.

VSVs aerodynamically match high- and low-pressure compressor stages by changing the angle at which airflow enters the compressor rotor blades. The MEC contains the scheduling mechanism and provides fuel pressure to vary VSV positioning. A flexible mechanical cable provides feedback from the compressor stator to the MEC.

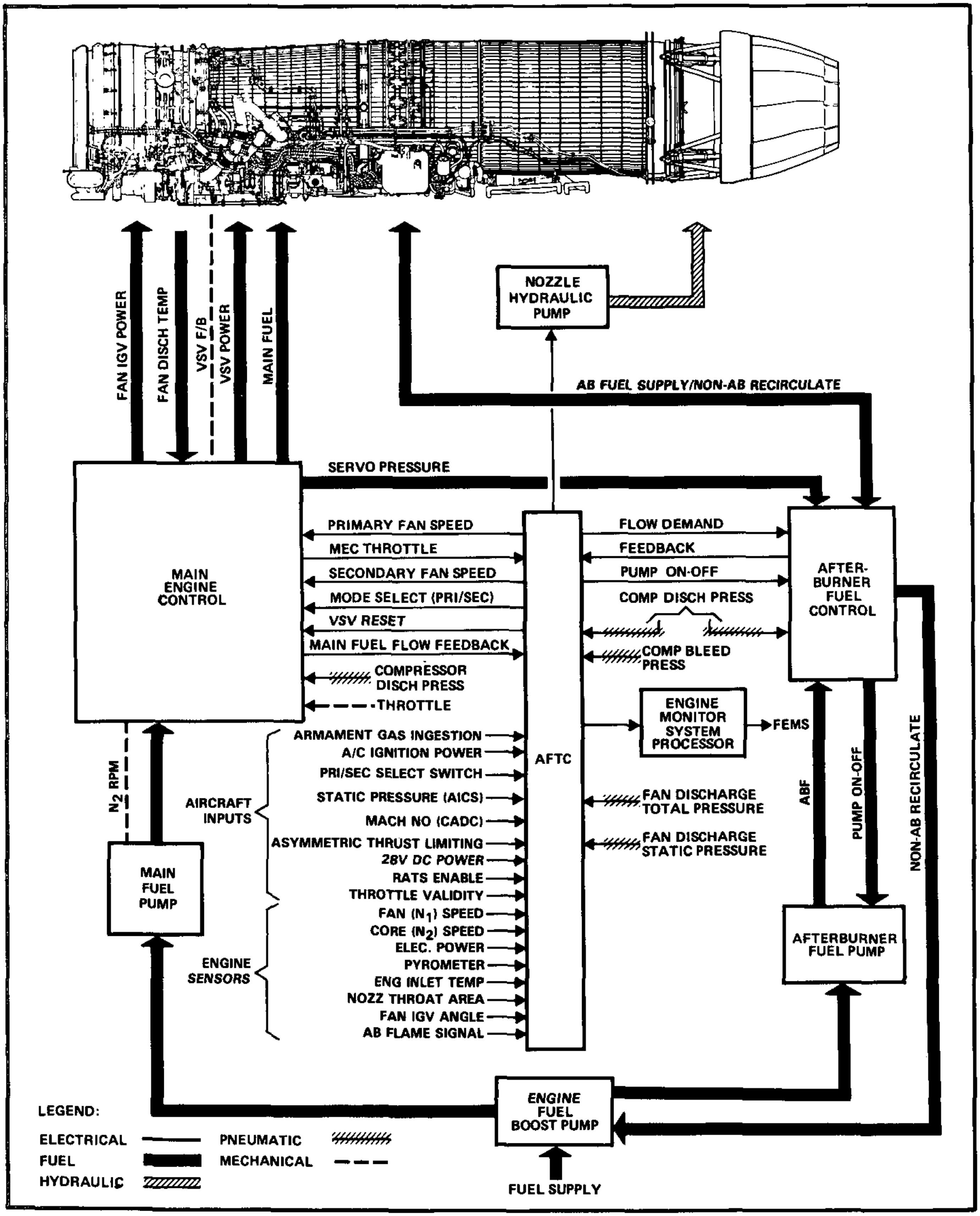

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Figure 2-17. Engine Fuel System

2.4.5 Afterburner Fuel Pump. The AB fuel pump is a centrifugal gear-driven pump that receives fuel from the engine boost pump, increases pressure, and delivers fuel to the AB fuel control. During non-AB operation, fuel is circulated between the AB fuel control and the engine boost pump; the AB fuel pump impeller runs dry with the bearings lubricated by the engine oil system. Failure of an AB fuel pump will result in an AB blowout.

2.4.6 Afterburner Fuel Control. The AB fuel control is a fuel-operated, electrohydromechanical unit that regulates fuel flow in response to AFTC scheduling and compressor discharge pressure. Fuel pressure from the AB fuel control provides on-off signals to the AB fuel pump.

The AB fuel control splits fuel flow into three metered streams (local, core, and fan) on a sequential basis into the AB manifolds for distribution through spraybars in the AB duct. Throttle commands initiate local fuel flow and AB ignition (minimum AB). Once local fuel flow and flame are established, core fuel flow commences. As maximum core fuel flow is established, fan fuel flow commences and increases until maximum AB is achieved. The transitions between local, core, and fan fuel flow are smooth and unnoticed (Figure 2-18). During non-AB operation, fuel flow is circulated through the AB manifolds to prevent thrust lags and surges when AB is initiated.

WARNING

- Zero or negative-g flight longer than 10 seconds in AB or 20 seconds in MIL or less will deplete the fuel sump tanks (cells 3 and 4), resulting in flameout of both engines.
- To prevent engine instability and/or flameout, avoid holding zero or negative g when doing a low-altitude, maximum-thrust acceleration.
- With fuel in feed group below 1,000 pounds, AB operation could result in AB blowout.

Note

Fuel dump operations with either engine in AB are prohibited. The fuel dump mast can be torched.

2.5 THROTTLES

Two throttle levers for regulating engine thrust are on the left console of the forward cockpit. Unrestricted engine operation under independent control is afforded; however, normal symmetric thrust control is provided by collective movement of the throttle levers. Numerous engine control and subsidiary functions are performed by movement of the throttle levers within the full range of travel as shown in Figure 2-19. The forward and aft throw of each throttle lever in the quadrant is restricted by hard detents at the OFF, IDLE, MIL, and MAX (AB) positions. At the OFF and IDLE detents, the throttles are spring loaded to the inboard position. At the MIL detent, the throttles can be shifted outboard to the AB sector or inboard to the basic engine sector of operation by merely overcoming a lateral breakout force. Lateral shifting of the throttles at the MIL detent does not affect engine control. Thus, placement of the throttle outboard at MIL provides a natural catapult detent to prevent unintentional retarding of the throttles during the launch. This, however, does not inhibit the selection of afterburner. The friction control lever on the outboard side of the quadrant permits adjustment of throttle friction to suit individual requirements. With the friction lever in the full aft position, no throttle friction is applied at the quadrant; increased throttle friction is obtained by forward movement of the lever.

A locking pin device prevents the left throttle from moving into the cutoff position when the right throttle is either traversing or at rest on the face of the right-hand idle stop block.

2.5.1 Throttle Control Modes. Manual, boost, and automatic are the three modes of throttle control over engine operation selectable by the THROTTLE MODE switch located outboard of the quadrant on the pilot console. The toggle switch must be lifted out of a detent to select MAN from BOOST or BOOST from MAN. The switch is solenoid held in AUTO upon successful engagement of the automatic mode. A functional schematic of throttle control modes, including system major components, is shown in Figure 2-20. Except for the autothrottle computer and mode control switch, the throttle control system for each engine is completely redundant. Independent engine operation is possible in the manual or boost mode of throttle control; however, full system operation is necessary in the automatic mode since operation under single-engine control is impracticable because of asymmetric thrust considerations.

2.5.1.1 Manual Throttle Mode. The manual throttle is a degraded mode of operation and was designed as a backup system. Because of hysteresis and friction in the manual system, engine rpm may vary from the boost

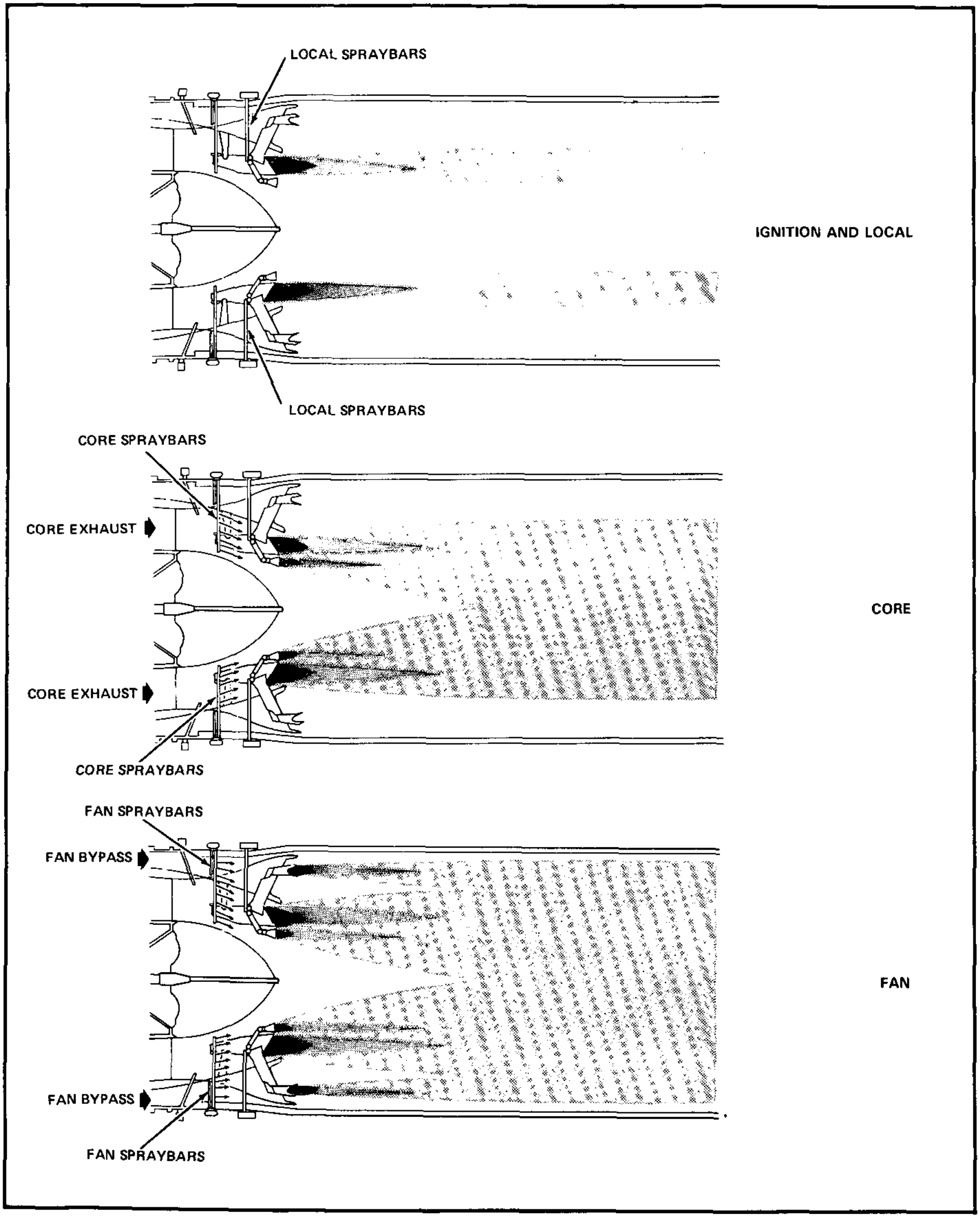

Figure 2-18. Afterburner Fuel Sequencing

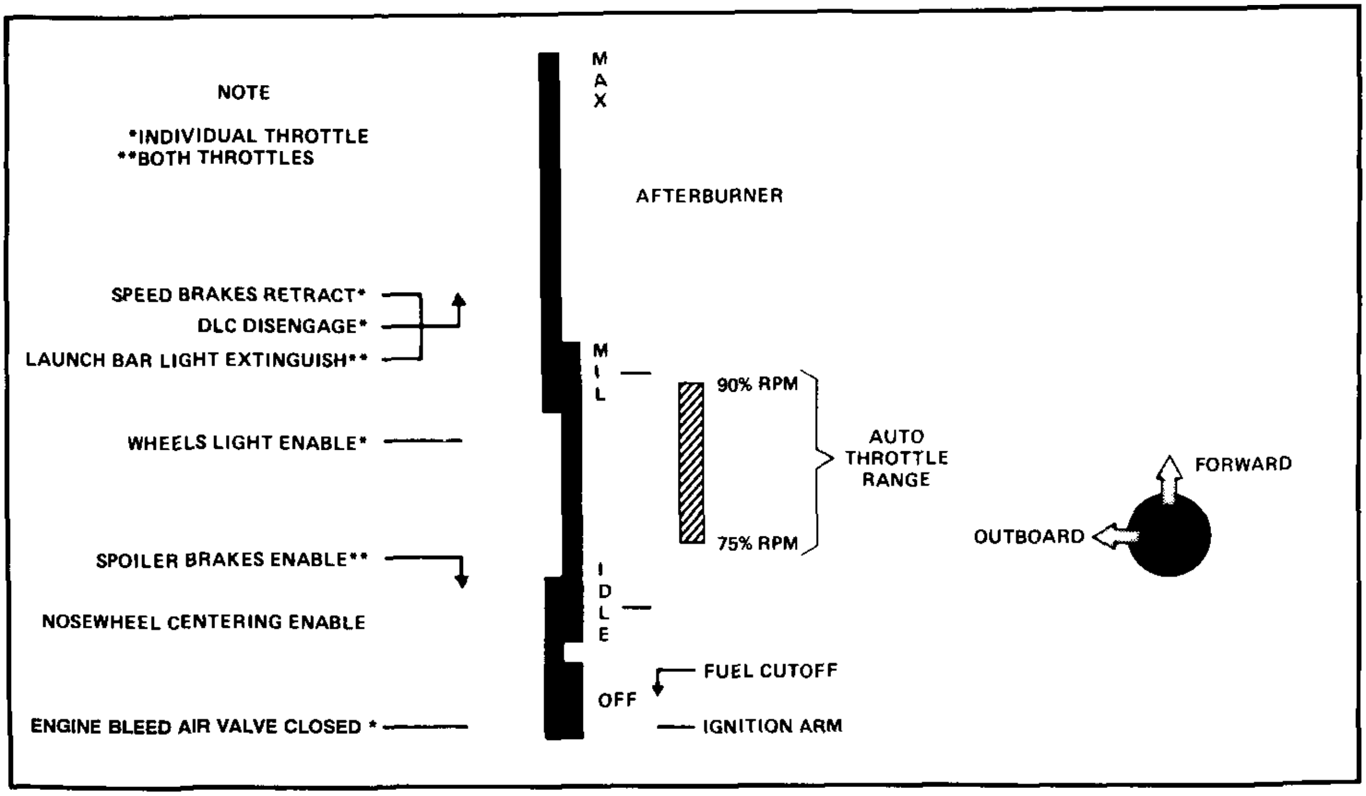

Figure 2-19. Throttle Interlocks

mode at a given throttle position. If an engine fails to secure when the throttle is moved to the OFF position, the throttles have probably reverted to the manual mode and are slightly out of rig. Cycling the throttle switch to MAN and back to BOOST may allow engine shutdown. If shutdown is unsuccessful, then the engine may be secured with the FUEL SHUTOFF handle.

CAUTION

- Engine shutdown at high power settings using the FUEL SHUTOFF handle may result in damage to the aircraft fuel system.

- Engine startup in manual mode may cause tailpipe fires as fuel flow may not be secured.

In the manual mode of operation, movement of each throttle is mechanically transmitted to the respective engine by a push-pull cable and a rack and sector mechanism mounted to the main engine control power lever shaft. An electric clutch in the throttle servoactuator, which is also mounted to the power lever shaft, is disengaged in the manual mode to reduce operating forces.

With the throttle friction lever in OFF, approximately 8 pounds of force per throttle must be applied at the grip to operate the throttles in the IDLE to MAX range.

2.5.1.2 Boost Throttle Mode. The boost mode of throttle is used for normal operations. A force of 2 to 3 pounds at the grip is required to move each throttle throughout its range with the throttle friction lever OFF. Essentially, the boost mode provides electric throttle operation, with the push-pull cables serving as a backup control path. Throttle movement is detected by the throttle position sensor. The signal is resolved in the amplifier to provide positional followup commands to the actuator. Movement of the actuator rotates the engine power lever shaft, which drives the push-pull cable.

If a boost system malfunctions, applying approximately 17 pounds at the throttle grip automatically reverts the throttle control to the manual mode by disengaging the actuator electric clutch. The throttle control reverts to manual mode in 0.25 second. In the event of a boost system malfunction, the throttle MODE switch will remain in the BOOST detent. By manually placing the throttle MODE switch in MAN and then back to BOOST, transient failures in the boost mode can be reset. Additionally, if an actuator seizes, a mechanical clutch in the actuator will slip when a force of approximately 50 pounds is applied at the throttle grip. This

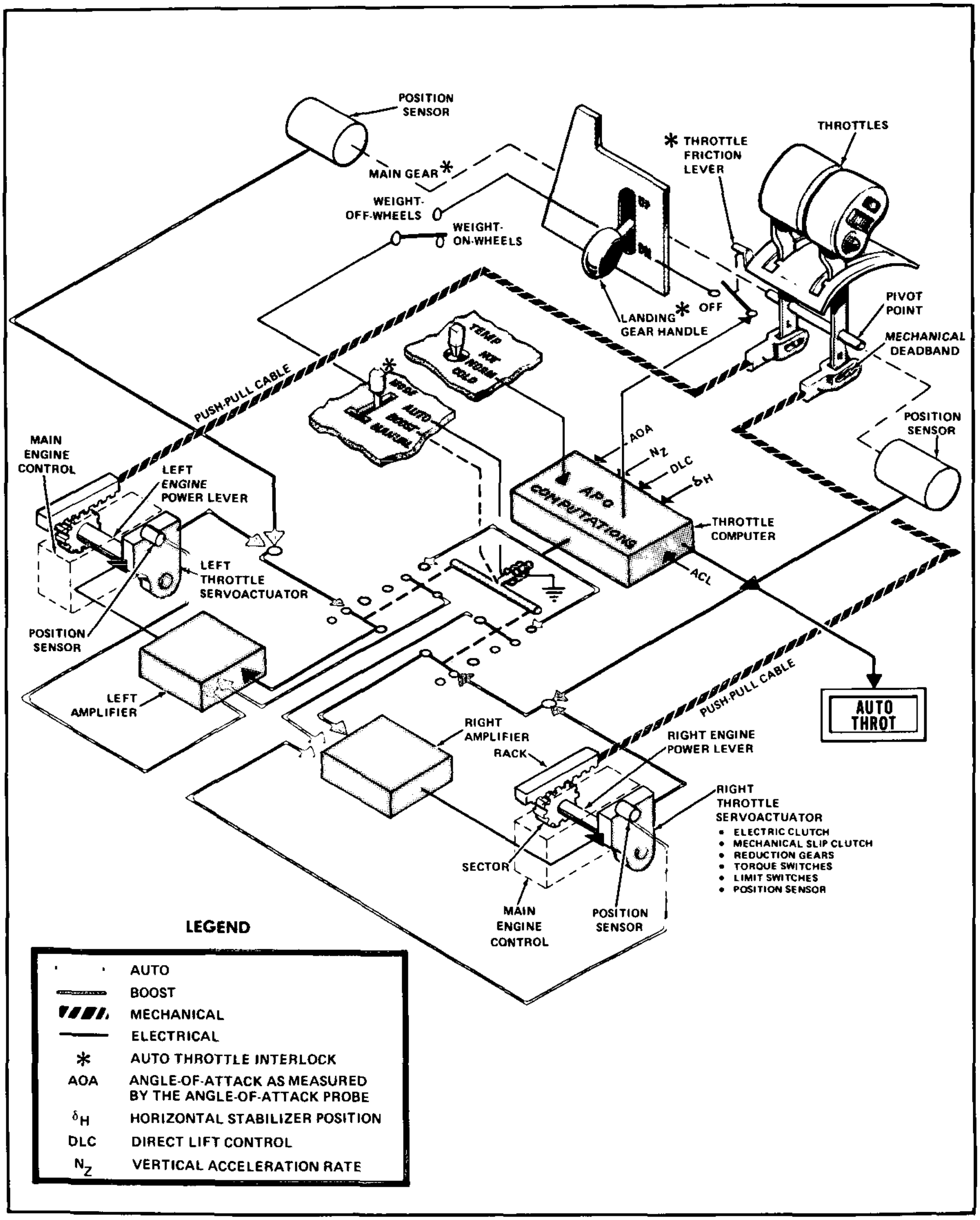

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Figure 2-20. Throttle Control

permits the pilot to override an actuator seizure. There is no visible warning of these anomalies only the noticeable increase in the forces required to manipulate the affected throttle.

2.5.1.3 Approach Power Compensator (Automatic Throttle Mode). The automatic mode of throttle control is a closed-loop system that automatically regulates basic engine thrust to maintain the aircraft at an optimum approach angle of attack for landing. All components of the throttle control system except the throttle position sensor are used in the automatic mode of control. The AOA signal from the AOA probe on the left side of the forward fuselage is the controlling parameter within the autothrottle computer. Additional parameters are integrated within the computer to improve response. The air temperature switch on the pilot left console effects a computer gain change to compensate for pilot preferred reaction rate. In order to engage the autothrottle, throttles must be between 75- to 90-percent rpm with weight off wheels, gear handle down, and throttle friction off. With all conditions met, the throttle MODE switch will be held by an electrical solenoid when placed in AUTO. The throttle control mode automatically reverts to the boost mode upon interruption of any interlock in the system or by manually overriding the throttles with a force of approximately 11 pounds per throttle in either direction. The throttle MODE switch automatically returns to BOOST and the AUTO THROT caution light illuminates for 10 seconds. See Figure 2-21 for autothrottle controls.

The pilot can revert from automatic to boost mode by selecting the CAGE/BRST (UP) position on the CAGE/SEAM switch located on the inboard throttle grip. This provides a smooth throttle override for an automatic-to-boost mode approach, while maintaining a grip on both throttles.

2.5.1.3.1 Autothrottle Test. An automatic check of the autothrottle control system while on deck is accomplished during OBC. Signals to the servoactuators are inhibited during the OBC autothrottle test so that the engines remain at idle thrust. A malfunction is indicated by an APC acronym at the conclusion of OBC.

Rotating the MASTER TEST switch to FLT GR DN and depressing it bypasses the autothrottle weight-on-wheels interlock and an end-to-end check of the autothrottles may be performed on deck. The throttles should be placed at about 80-percent rpm and the THROTTLE MODE switch placed in AUTO. The throttles must be positioned above idle before selecting AUTO to ensure a valid test. Once AUTO is engaged, the control stick should be programmed fore and aft to check for the appropriate power response.

CAUTION

High-power settings may result during aft stick deflection.

If the THROTTLE MODE switch does not remain engaged or the APC does not respond properly to indicated AOA and longitudinal stick movements, a malfunction exists in the autothrottle system.

Depressing and holding the autopilot emergency disengage paddle switch with weight on wheels causes the throttle control system to be placed in the manual mode. If the automatic mode was selected before depressing the paddle switch, the THROTTLE MODE switch will automatically move to BOOST. The THROTTLE MODE switch must be moved from BOOST to MAN while holding the paddle switch depressed if the manual mode is desired after the paddle switch is released.

2.6 ENGINE BLEED AIR

Bleed air is extracted from the high-pressure compressor to perform engine-associated services and to supply high pressure and temperature air for operation of auxiliary equipment. Fifth-stage bleed air supplies hot air for the engine anti-icing system and is used to draw cooling air through the aircraft hydraulic heat exchangers to cool flight and combined fluids and to ventilate the nacelle when weight is on wheels (Figure 2-22). Ninth-stage bleed air supplies hot air to the environmental control system, provides air for crossbleed engine starts, and draws air through the integrated drive generator heat exchanger (ventral fin) when weight is on wheels.

2.6.1 Engine Anti-Ice. The fan IGV and nosedome are susceptible to icing under a wider range of conditions, particularly at static or low speed with high engine rpm, than that which cause ice to form on external surfaces of the airframe. Ice formation at the fan face can restrict engine maximum airflow, which results in a thrust loss, decreased stall margin, and dislodgement of ice, which can damage the compressor. The engine anti-icing system is designed to prevent the formation of ice rather than deice the IGV and nose dome. Hot bleed air (5th stage) is passed through the hollow IGV to the nose dome and is discharged into the engine along the vanes and at the rotor hub. Cockpit control of the engine anti-icing system is effected through the ANTI-ICE switch (Figure 2-23).

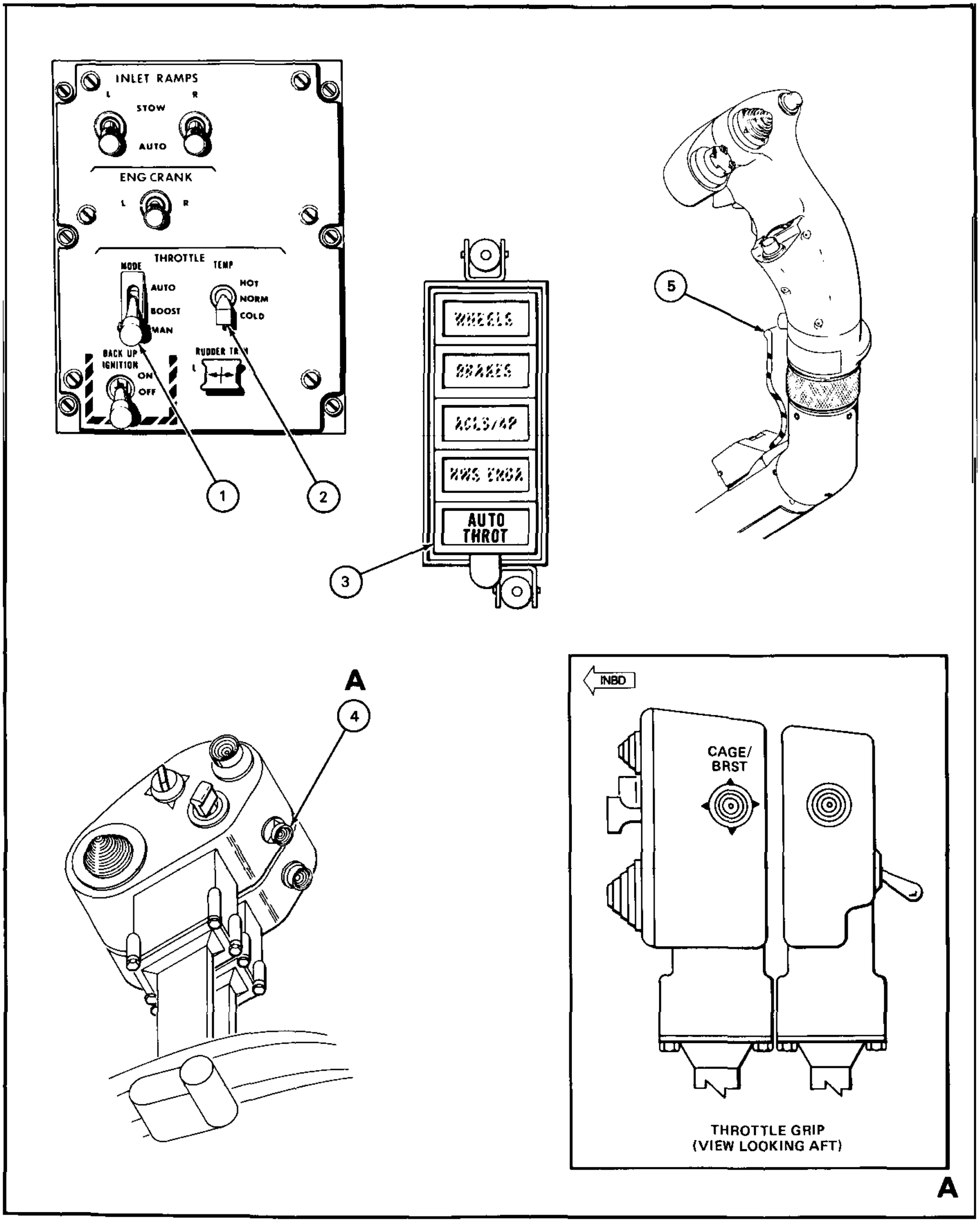

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Figure 2-21. Autothrottle Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(1) THROTTLE MODE switch	AUTO - Engine thrust is automatically regulated to maintain optimum angle of attack for landing by the throttle control computer. BOOST - Normal operating mode. Reduces effort required to move throttles manually with friction control aft. MAN - Movement of each throttle is mechanically transmitted to the respective engine cross-shaft by a push-pull cable.
(2) THROTTLE TEMP switch	Used with the AUTO throttle mode to effect throttle computer gain changes to compensate for pilot preferred reaction rate. HOT - Increases normal throttle computer gain. NORM - Normal throttle computer gain. COLD - Decreases normal throttle computer gain.
(3) AUTO THROT caution light	Auto throttle mode is disengaged. During preflight check, remains illuminated for 10 seconds, then goes off and throttle mode switch automatically returns to BOOST. **Note** If the auto throttle is disengaged by deselecting the throttle MODE switch, the AUTO THROT light will not illuminate.
(4) CAGE/SEAM switch	When in TLN master mode with the THROTTLE MODE switch in AUTO, selecting the CAGE/BRST position on the CAGE/SEAM switch reverts the throttles to the BOOST mode.
(5) Autopilot emergency disengage paddle	Reverts throttle system from AUTO or BOOST mode to MAN mode only while depressed and with weight on wheels.

Figure 2-21. Autothrottle Controls and Indicators (Sheet 2 of 2)

Note

Because of its adverse effects on engine performance, the engine anti-icing system should be used only when icing conditions exist or are anticipated.

During engine start, the engine anti-ice valve remains open to bleed the compressor to prevent engine stall. The valve closes when the engine approaches idle rpm. In flight, the valve is normally closed unless the ANTI-ICE switch is in ORIDE/ON, or AUTO/OFF, when the ice detector probe in the left inlet is activated. Ice accumulation on the ice detector illuminates the INLET ICE caution light. The engine anti-icing control valve on the engine is powered closed (fails open) from the essential dc No. 2 bus through the ENG/PROBE/ANTI-ICE circuit breaker (RG2).

2.6.2 Environmental Control System Leak Detection. Thermal detection circuits are routed in proximity to ECS ducts and components to provide cockpit indications of high-temperature air leaks. Normal air temperatures range from 520 to 1,180 °F inside the bleed air portion of the ECS, and from 400° to 500 °F inside the hot air portion (400 °F manifold).

The entire bleed air portion of the ECS, from engine bleed air shutoff valves to the primary heat exchanger, is monitored by two detection systems. Fire detection circuits monitor the bleed air system from each engine to its respective firewall. When a fire detection circuit

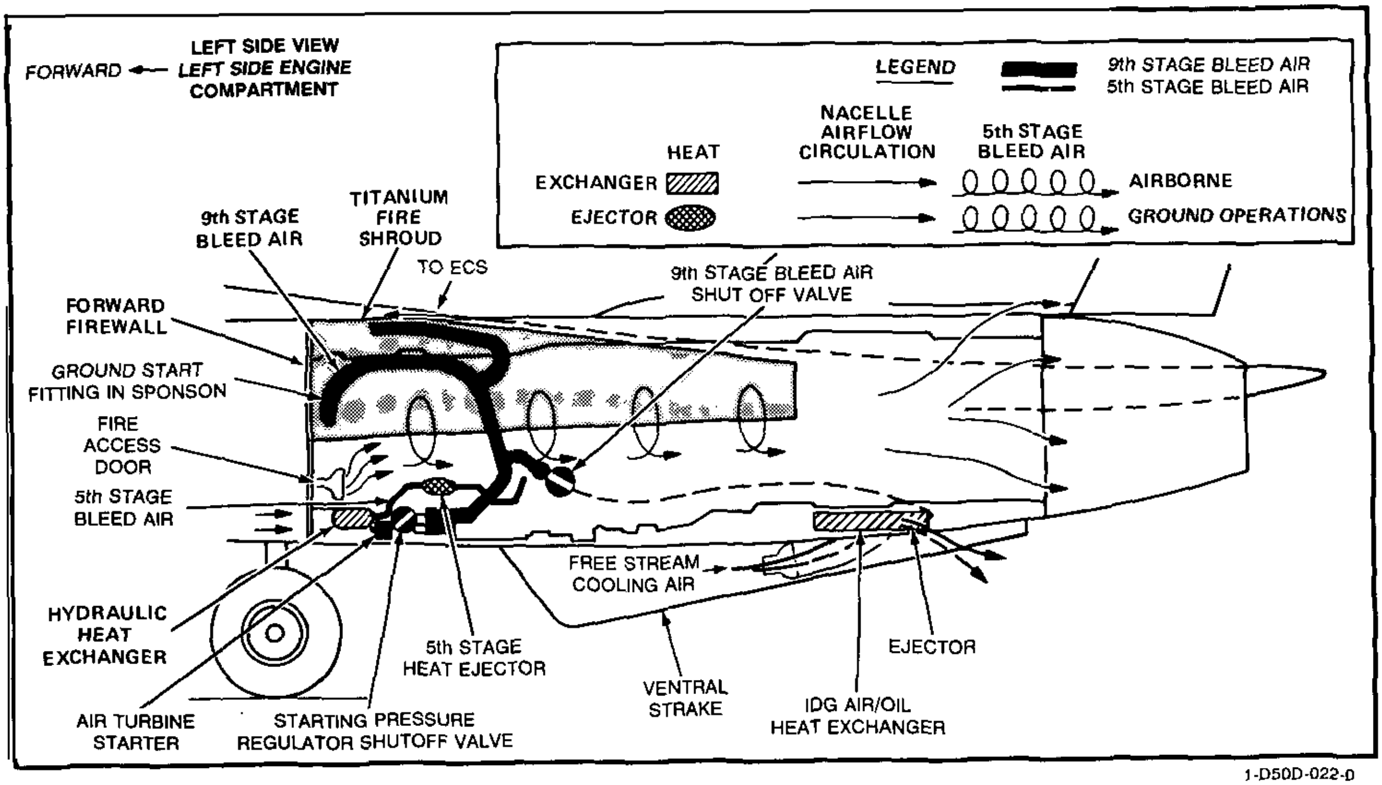


Figure 2-22. Engine Bleed Air/Compartment Ventilation

in an engine compartment senses temperatures above threshold, the appropriate L or R FIRE warning light illuminates (refer to fire detection system). The remainder of the bleed air system, from engine firewalls to the primary heat exchanger, is monitored by bleed air leak-sensing elements. When the bleed air leak-detection circuit detects temperatures in excess of 575 °F, the BLEED DUCT caution light illuminates.

The hot air portion of the ECS is monitored by hot air leak-sensing elements. The hot air system extends from the primary heat exchanger through the 400° manifold to the cockpit floor. When the hot air detection circuit detects temperatures in excess of 255 °F, the BLEED DUCT caution light illuminates.

2.7 ENGINE COMPARTMENT VENTILATION

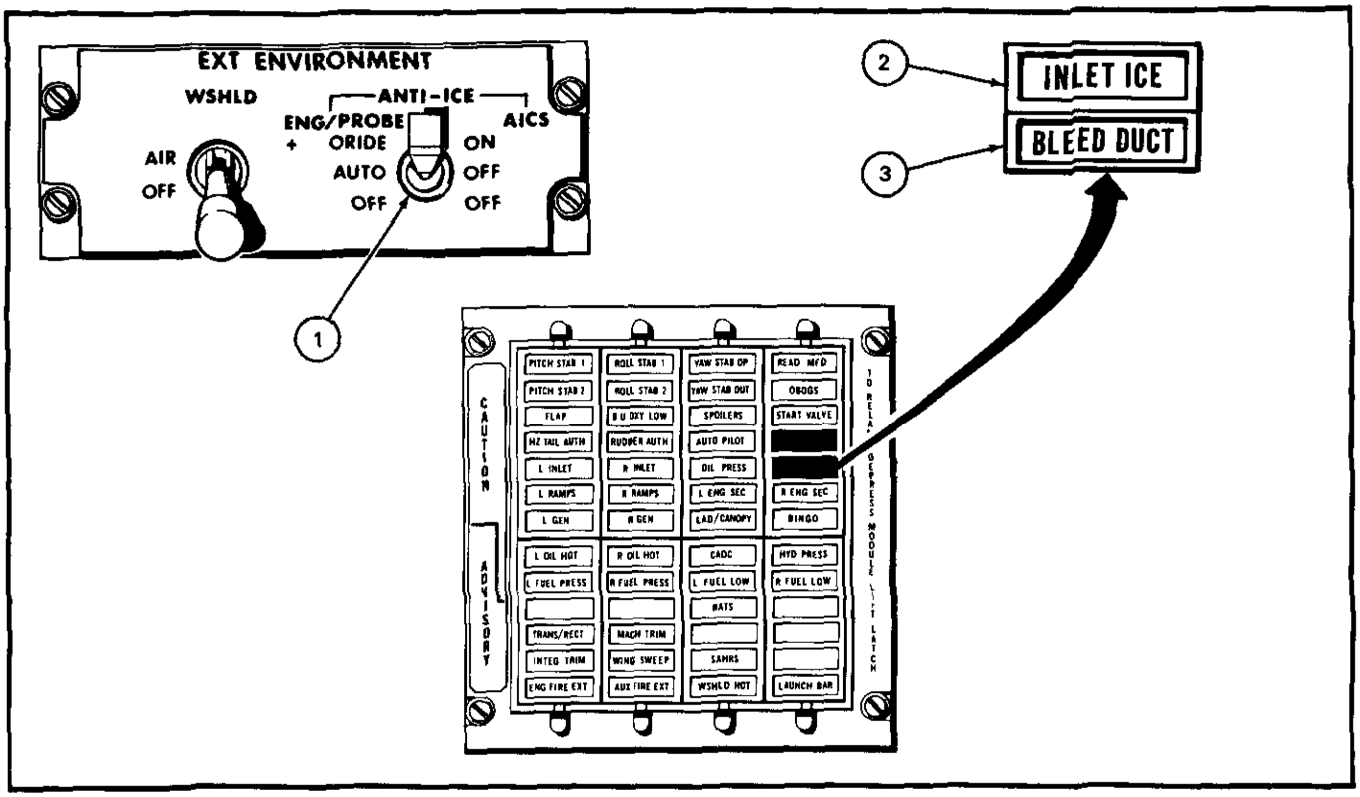
Each engine compartment is completely isolated from the primary air inlet, and the efficiency and cooling of the variable-area exhaust nozzle are not dependent upon nacelle airflow. Therefore, within the bounds of the forward firewall (landing gear bulkhead) and the nozzle shroud, the cooling system for each engine compartment is a separate entity. Cooling requirements for the turbofan engine are minimized by the annular fan bypass duct. Figure 2-22 shows cooling airflow patterns through the engine compartment during ground and flight operations. Two air-cooled heat exchangers are also shown; however, only the hydraulic heat exchanger cooling airflow is associated with engine nacelle cooling. Fire access doors are on the outboard side of the nacelles at the forward end to permit insertion of fire suppressing agents by ground personnel in event of an engine compartment fire.

2.7.1 Engine In-Flight Ventilation. In-flight cooling of the engine compartment is accomplished by nacelle ram-air scoops, circulating boundary-layer air through the length of the compartment and expelling the air overboard through louvered exits, just forward of the engine nozzle shroud.

2.7.2 Engine Ground Ventilation. With weight on wheels, cooling airflow through the engine compartment is induced by the hydraulic heat exchanger ejector in the forward end of the compartment. Air enters through the nacelle ram-air scoop on the left side, passes through the hydraulic heat exchanger, and is discharged into the engine compartment. The air flows through the full length of the nacelle to discharge overboard through a louvered port atop the nacelle on the outboard side of the vertical tail.

2.8 ENGINE IGNITION SYSTEM

There are three electrical ignition circuits, each utilizing a dedicated ignitor, for each engine: main high energy, afterburner, and backup.



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NOMENCLATURE	FUNCTION
(1) ANTI-ICE switch	ORIDE/ON - Overrides ice detector system to turn on INLET ICE caution light, and activate external probe heaters and engine anti-ice. Commands the anti-ice mode to the AICS programmers. AUTO/OFF - When icing is sensed, ice detector activates engine anti-ice system and turns on INLET ICE caution light. External probe heaters activated with weight off wheels. Disables anti-ice mode to AICS programmers. OFF/OFF - Engine anti-ice system and probe heaters shut off. INLET ICE caution light disabled. Disables anti-ice mode to AICS programmers.
(2) INLET ICE caution light	Illuminates when ice accumulates on ice detector with ANTI-ICE switch in AUTO/OFF or if ORIDE/ON is selected. Does not illuminate with switch in OFF/OFF.
(3) BLEED DUCT caution light	Illuminates when bleed air leak sensing elements detect temperatures greater than 575°F between the left and right firewalls, past the primary heat exchanger and up to the right diverter area. An additional sensor, detecting temperatures of 255° or greater, senses from the right diverter area, along the 400° manifold and into the bootstrap turbine compartment.

Figure 2-23. Anti-Ice Control

2.8.1 Main High-Energy Ignition. The main high-energy ignition provides ignition in the combustion chamber for ground and air starts. It is powered by one of the four windings in the engine-driven ac alternator. The AFTC provides logic to control main high-energy ignition automatically. Ignition is available when N_2 rpm is 10 percent or greater and is automatically provided from 10- to 59-percent rpm when the throttle is above cutoff. Ignition is secured 0.5 second after N_2 rpm rises above 59 percent. At rpm above 59 percent, ignition is provided if N_2 deceleration exceeds a 5 percent rpm per second rate. Ignition continues for 20 seconds after N_2 deceleration falls below the 5 percent rpm per second rate. Main high-energy ignition is provided continuously when the engine is in the secondary (SEC) mode.

2.8.2 Afterburner Ignition. The AB ignition provides ignition for AB light-offs, and relights in the event of an AB blowout. It is powered by the same winding in the engine-driven alternator that powers the main energy ignition. The AFTC provides logic to control AB ignition automatically and prevents simultaneous powering of the main high-energy and AB ignitions. In the event of an AB blowout, relight is normally provided within 1.5 seconds. AB ignition is not powered if the engine is in SEC mode.

2.8.3 Backup Ignition. The backup ignition provides ignition in the combustion chamber for ground and air starts when the BACK UP IGNITION switch on the THROTTLE CONTROL panel is set to ON. It is powered by the essential No. 1 ac bus and provides less power than main high-energy ignition. After use, the BACK UP IGNITION switch should be set to OFF. To allow ground checkout of backup ignition, main high-energy ignition is disabled when the BACK UP IGNITION switch is ON and weight is on wheels.

WARNING

The BACK UP IGNITION switch shall be selected to OFF prior to applying external electrical power to prevent ignition of fuel puddled in the engine.

2.9 ENGINE STARTING SYSTEM

Each engine is provided with an air turbine starter that may be pressurized from an external ground starting cart or by crossbleeding high-pressure bleed air from the other engine. Figure 2-24 shows the components associated with the engine start system.

2.9.1 External Airstart. A high-pressure (75 psi) air source and 115 volt, 400 Hz ac power are required for engine start on the deck.

The air hose is connected to the aircraft fitting in the left sponson area, behind the main gear strut. Ground start air is ducted into a central bleed air (9th stage) manifold, which interconnects the air turbine starters on both engines. The air supply to each air turbine starter is pressure regulated (52.5 psi) and controlled by a shutoff and regulating valve at the turbine. Each pneumatic starter is composed of a turbine, gear train, sprag clutch with a speed-sensing device, and an overspeed disengagement mechanism with a shear section. Shutoff valves in the bleed air manifold selectively isolate the other starter, subsidiary bleed lines, and the environmental control system air supply for effecting a start. Maximum engine motoring speed with the pneumatic starter is approximately 30-percent rpm.

2.9.2 Engine Crank. Placing the ENG CRANK switch in either L or R opens the corresponding starter pressure shutoff valve to allow pressurized air to drive the turbine. The ENG CRANK switch, energizes the appropriate shutoff valves to condition the bleed manifold for starting.

2.9.2.1 Engine Crank Switch. The ENG CRANK switch is held in L or R by a holding coil. At approximately 50-percent rpm, a centrifugal cutoff switch closes the turbine shutoff valve and returns the ENG CRANK to the center or off position. A START VALVE caution light illuminates if the starter valve remains in the open position after the ENG CRANK switch automatically returns to the center (off) position.

CAUTION

- If the starter valve does not close during engine acceleration to idle rpm, continued airflow through the air turbine starter could result in catastrophic failure of the starter turbine.
- If the START VALVE caution light illuminates after the ENG CRANK switch is OFF, select AIR SOURCE to OFF to preclude starter overspeed.
- If the ENG CRANK switch does not automatically return to the OFF position by 50 percent, ensure that the ENG CRANK switch is off by 60-percent rpm to avoid starter turbine failure as a result of an inoperative automatic starter cutout.

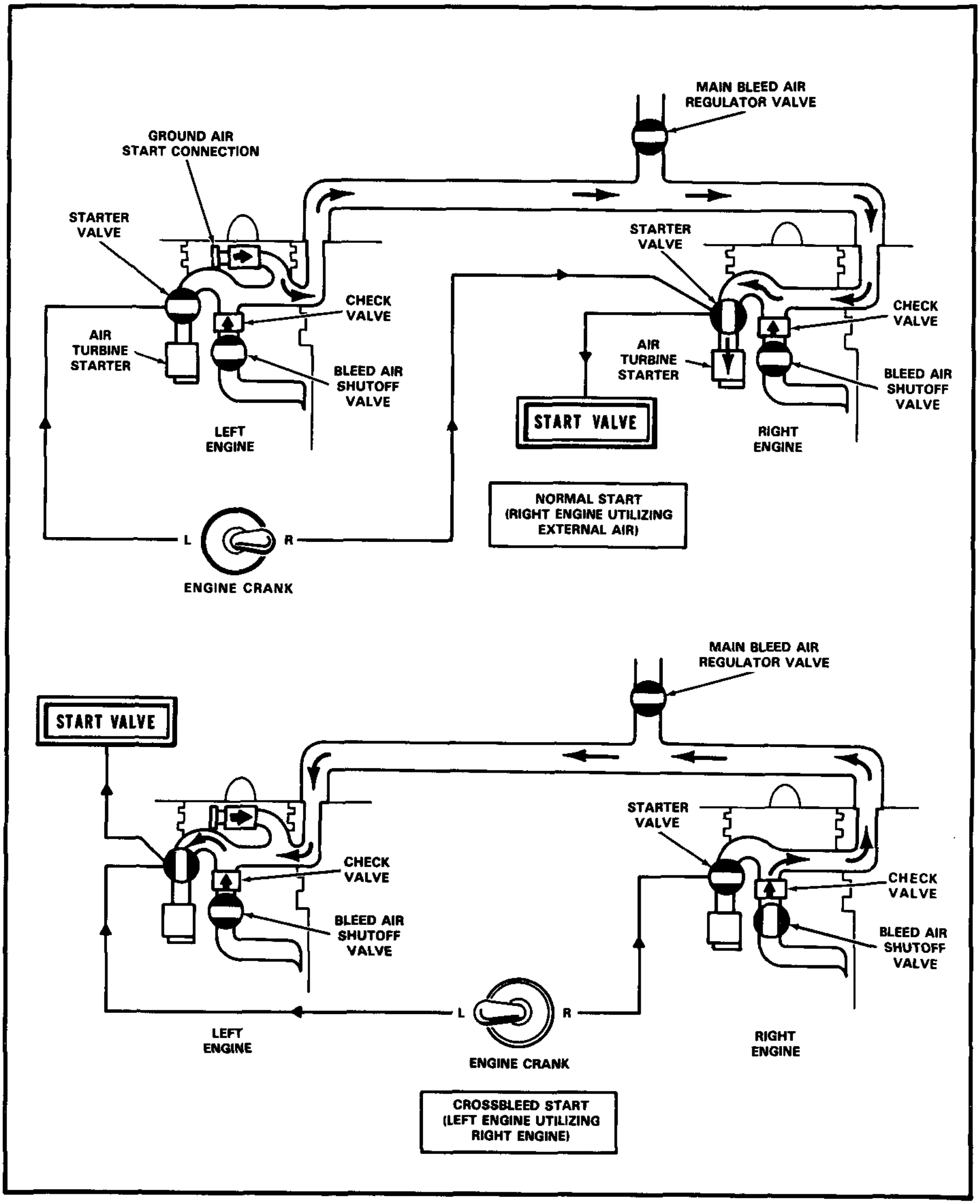

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Figure 2-24. Engine Start System

This action, in turn, resets the bleed air manifold valves to permit 9th-stage bleed air to flow to the environmental cooling system and ejectors in the engine compartment.

Starter cranking limits:

1. Crossbleed — 2 minutes continuous then 10 minutes OFF.

2. Start cart — 5 minutes continuous then 10 minutes OFF.

2.9.3 Crossbleed Start. Engine cranking procedures during a crossbleed start are the same as with a ground start cart. Engine crossbleed start on the ground can be accomplished with the throttle on the operating engine at or above idle rpm. When high-residual EGT (remains from a hot start) and/or throttles are advanced from OFF to IDLE prior to 20-percent rpm, higher than normal EGT readings may occur.

When initiating crossbleed starts with ambient temperature less than 40 °F (4 °C), the starter torque load is increased. Above 80 °F (27 °C), engine bleed air provides less energy potential to the starter turbine. Either extreme can affect engine starting acceleration rates, resulting in hotter-than-normal starts. When crossbleed starting with an operating engine at idle, the operator should be aware of either condition and increase the operating engine rpm in 5-percent increments until normal starting acceleration rate is achieved. Low percentage rpm-to-EGT ratio can increase turbine distress without necessarily exceeding the EGT limit.

When performing an idle crossbleed start, advance the throttles from OFF to IDLE at 20-percent rpm or greater while monitoring EGT. If EGT rises rapidly, advance the operating engine rpm to slightly above idle. The exhaust nozzles start to close when rpm is slightly above idle.

Note

- To prevent possible engine overtemperature during crossbleed and backup ignition start attempts, select AIR SOURCE for the operating engine and return to BOTH after rpm stabilizes at idle or above.

- If attempting a ground restart after a hot start, windmill the engine until EGT is below 250 °C prior to advancing the throttle from OFF to IDLE to avoid a subsequent hot start.

- When attempting a crossbleed or normal ground start, do not attempt to reengage the ENG CRANK switch if the engine is spooling down and rpm is greater than 46 percent. At rpm's of 30- to 46-percent rpm, the ENG CRANK switch may not stay engaged because of normal variations in starter cutout speed.

- The ENG CRANK switch should automatically disengage between 49- to approximately 51-percent rpm during a crossbleed or normal ground start.

2.9.4 Airstarts. AFTC logic provides main high-energy ignition automatically during automatic and manual spooldown, crossbleed, and windmill airstarts. Selecting the BACKUP IGNITION switch to ON provides continuous backup ignition to both engines, and backs up main high-energy ignition during manual spooldown, crossbleed, and windmill airstarts.

2.10 ENGINE OIL SYSTEM

Each engine has a self-contained, dry sump non-pressure regulated oil system that provides filtered oil for lubricating and cooling engine main shaft bearing, oil seals, gearboxes, accessories, and provides a hydraulic medium to operate the engine exhaust nozzles (FO-5).

A storage tank feeds oil to an oil pump that supplies oil under pressure to the forward sump in the engine front hub, the mid sump in the fan hub, the aft sump in the turbine hub, and the inlet and accessory gearboxes. Oil is recovered through scavenging from the sumps and accessory gearboxes, pumped past a chip detector, and cooled in a fuel/oil heat exchanger before returning to the storage tank.

A separate compartment in the storage tank provides oil to the exhaust nozzle hydraulic system. Oil returning from the nozzle to the tank provides auxiliary oil supply to the No. 3 bearing when normal supply is interrupted or during engine spooldown.

The oil system permits engine operation under all flight conditions. During zero- or negative-g flight, oil pressure may decrease to zero but will return to normal when positive-g flight is resumed. Normal oil consumption is 0.03 gallon per operating hour with the maximum being 0.1 gallon per operating hour. Capacity of the oil storage tank is 3.7 gallons, with 2.9 gallons usable. A sight gauge on the side of the storage tank indicates down to a 2-quart-low oil level. The protrusion of a bypass indicator underneath the oil scavenge pump indicates a clogged filter element.

Note

- Engine oil level must be checked within 30 minutes of engine shutdown, otherwise run engine at 80-percent rpm or greater for 10 minutes to ensure proper servicing.

- A failed-open nozzle may indicate an oil leak; however, if the leak is in the nozzle hydraulic circuit, only that portion of the main engine lube oil will be lost.

2.10.1 Oil Cooling. Filtered and scavenged oil is cooled by a fuel/oil heat exchanger. This oil is then used in a heat exchanger to cool the exhaust nozzle oil. A cold-oil bypass valve opens when the heat exchanger pressure differential is 44 psi, because of reduced oil temperature or exchanger blockage, allowing oil flow to bypass the heat exchanger (for example, during cold engine starts).

2.10.2 Oil Pressure Indicators. An oil pressure transmitter in each engine's oil supply line provides a continuous signal to the oil pressure indicator. Another, independent oil pressure switch in each oil supply line activates the OIL PRESS light when either engine's oil pressure decreases to 11 psi. The oil pressure switches and lights receive electrical power from the essential No. 2 ac bus. The OIL PRESS light and oil pressure indicator are independent of each other.

Note

- During cold starts, oil pressure may exceed 65 psi. The 65 psi oil pressure limit should not be exceeded for more than 1 minute.

- Maneuvers that result in zero or negative g's on the engine (such as rapid rolls, pushovers, or bugout maneuvers) may cause oil pressure fluctuations and momentary illumination of the low oil-pressure light.

2.10.3 OIL HOT Caution Lights. The L or R OIL HOT caution light may be illuminated by either high engine oil temperature or by high forward-engine gearbox scavenge oil temperature. The caution lights illuminate when respective engine oil temperature exceeds 300 °F during a temperature increase and go out at 280 °F minimum during a temperature decrease. The caution lights also illuminate when respective forward engine gearbox scavenge temperature exceeds 375 °F during a temperature increase, and go out at 345 °F minimum during a temperature decrease.

2.11 ENGINE INSTRUMENTS

Instruments for monitoring engine operation are on the pilot left knee panel (Figure 2-25). Engine operating parameters are displayed on the engine instrument group which is a single WRA with LCD readouts. The display provides white readout segments and scales on a dark background and is red backlighted for night operations. Left and right engine compressor speed (rpm), EGT, and FF are displayed on the EIG. Adjacent to the EIG are circular instruments for both engine's oil pressure and nozzle position. Takeoff checks at military (MIL) thrust should display evenly matched tapes on corresponding vertical scale instruments and all pointers on the circular instruments should be at the 9-o'clock position. Data on engine operating limits are provided in Chapter 4.

2.11.1 Engine RPM Indicator. The RPM indicators (Figure 2-25) have a range of 0 to 110 percent. The tape display steps in 5-percent increments and the upper segment flashes to indicate rpm increasing at more than 0.4 percent per second from 0- to 60-percent rpm. The tape steps in 1-percent increments when greater than 60-percent rpm. Nominal indications are 62 to 78 percent at idle and 95 to 104 percent at military and above. At 107.7 percent and above, the affected engine(s) exceeded portions of the chevrons will flash at a rate of 2 to 3 flashes per second. At 20-percent rpm a horizontal segment will illuminate giving an indication of proper motoring speed to start the engine. There is an rpm reading for each engine.

Note

An overspeed condition in excess of 110 percent will result in momentary loss of rpm indication until N_2 rpm falls below 110 ±0.5 percent. EGT and FF indicators will continue to function normally.

2.11.2 Exhaust Gas Temperature Indicator. The EGT indicators (Figure 2-25) provide a nonlinear vertical scale with a range of 0 to 1,100 °C. The compressed lower portion has a range of 0 to 600 °C. The expanded upper portion of the scale has a range of 600 to 1,100 °C. The display moves in 50° increments in the compressed portion and 10° increments in the expanded portion of the display. The normal indications are 350 to 650 °C at idle and 780 to 935 °C at MIL and above. Above 940 °C, the affected engine(s) exceeded portions of the chevrons flash. With a reading of 940 °C, the stall warning light and the aural warning tone will be activated signifying an engine overtemperature condition. The tone is present for a maximum of 10 seconds unless the fault clears sooner. There is an EGT reading for each engine.

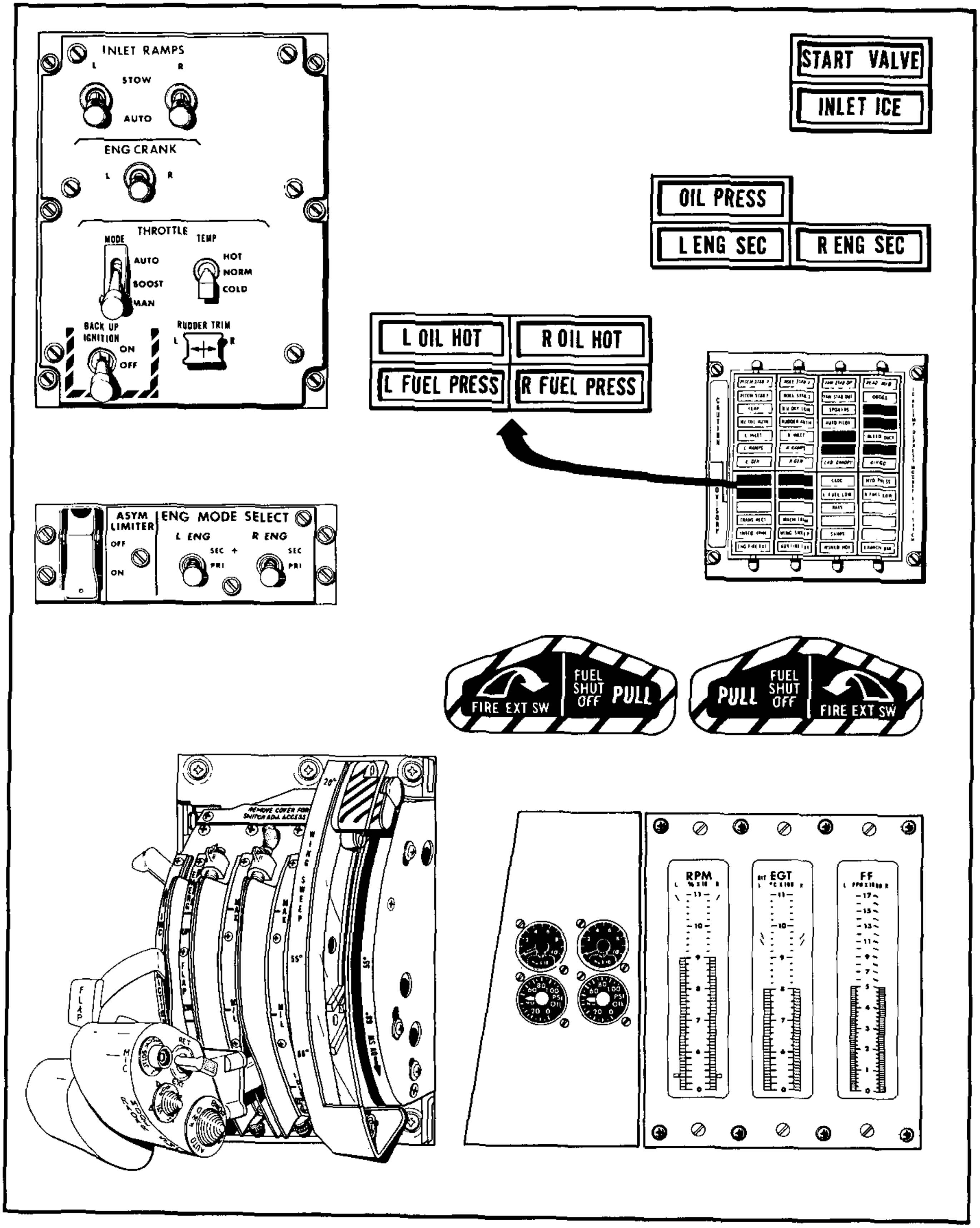

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Figure 2-25. Engine Instruments (F110-GE-400)

2.11.3 Fuel Flow Indicator. The FF indicators have a nonlinear vertical scale, with a range of 0 to 17,000 pph. The expanded lower portion of the scale has a range of 0 to 5,000 pph. The compressed upper portion of the scale ranges from 5,000 to 17,000 pph. The display moves in 100 pph increments in the expanded portion and in 500 pph increments in the compressed portion of the display. Normal indications on deck are 350 pph starting, 950 to 1,400 pph at idle, and approximately 10,100 pph at military and above. The fuel flow reading for each engine indicates only basic engine consumption and does not indicate AB fuel flow.

2.11.4 Engine Instrument Group BIT. A degraded mode of EIG operation is indicated if the BIT segment on the top left side of the EGT indicator illuminates. This means that either the primary or backup microprocessors, or the primary or backup power supply channels (internal to the EIG), have failed. An automatic switch to the operative microprocessor/channel takes place if a failure is detected. The instrument still monitors engine operation and accurately reflects rpm, EGT, and FF. If the input processing circuit fails, the affected scale reading goes to zero.

2.11.5 Engine Instrument Group Self-Test. EIG self-test is selected by the MASTER TEST switch in INST. When master test is selected, all display segments illuminate, scales drive to maximum readings, and warning chevrons (stripes) flash for 5 seconds. BIT segment on the top left side of EGT indicator illuminates. L and R STALL warning acronyms appear on the HUD and MFD and stall warning/overtemp tone is present in pilot earphones for 10 seconds. After 5 seconds, all EIG scales decrease to predetermined values of equal height that correspond to an EGT reading of 950 ±10 °C. If BIT segment remains illuminated, EIG has failed self-test and BIT remains illuminated until self-test is reinitiated. Total self-test time is 15 seconds. If master test is deactivated prior to this, EIG returns to normal mode after the 15-second test. If the MASTER TEST switch remains in INST for more than 15 seconds, the EIG retains equal height readings until master test is deselected.

2.11.6 Engine Oil Pressure Indicator. The engine oil pressure indicators display oil pressure from 0 to 100 psi. Normal oil pressure is 25 to 65 psi and increases in proportion to engine rpm within the pressure limit range. Stabilized idle oil pressure may be a minimum of 15 psi. The OIL PRESS caution light illuminates at 11 psi with decreasing oil pressure and extinguishes at 14 psi with increasing oil pressure. Maximum allowable oil pressure fluctuation is ±5 psi.

2.11.7 Exhaust Nozzle Position Indicator. The nozzle position indicators (Figure 2-25) have a range of 0- to 100-percent open. Normal indications (Figure 2-13) are 100 percent at idle with WOW and vary in flight: 3 to 10 percent at MIL thrust, 5 to 12 percent at MIN AB, and 60 to 90 percent at MAX AB.

Note

When operating engine in SEC mode, the nozzle position indicator is inoperative and indicates below zero. No nozzle position indication is available in SEC mode.

2.11.8 Engine Monitor Display Format. A display of engine parameters (Figure 2-26) can be selected on the MFD by pressing the pushbutton adjacent to the ENG legend on the own-aircraft menu. The display presents N1 (fan speed), TBT (turbine blade temperature), FF/M (fuel flow main engine) or FF/T (fuel flow total, main engine and AB), and NP (exhaust nozzle position). FF/M scale indicates main engine fuel flow and is similar to the fuel flow displayed on the EIG. NP is the same as the nozzle position indicators. Numerical readouts below the N1 and TBT vertical scales digitize the indicated value. The TIME readout below the FF/M vertical scale indicates time in hours and minutes that fuel will last based on current consumption rates. Directly below the TIME readout, engine faults are displayed based on current engine operating conditions of both engines processed by FEMS. If more than three faults exist at the same time, the acronyms will continuously scroll upward. The ten possible acronyms and their definitions are:

1. L MACH # or R MACH # — Mach number signal to designated engine has failed.
2. L LO THR or R LO THR — Designated engine may be producing less than expected thrust.
3. L A/ICE or R A/ICE — Designated engine anti-ice is on or anti-ice valve has failed opposite commanded position.
4. L OIL LO or R OIL LO — Designated engine oil level is approximately two quarts low. Postflight, engine at idle.
5. L AUG or R AUG — Designated AB control system has failed. AB is not available.

Refer to Chapter 12, WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS for the appropriate pilot/RIO response.

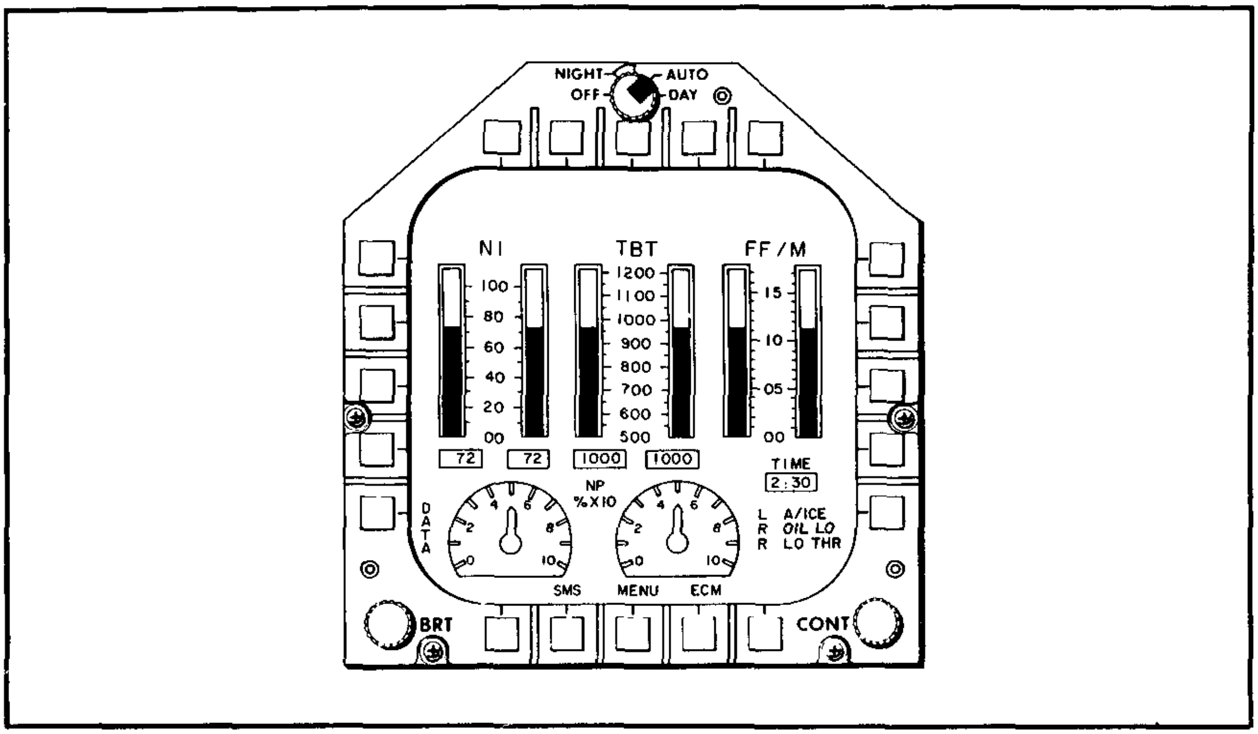

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Figure 2-26. MFD Engine Monitor Display

2.11.9 MFD Engine Caution Legends. In addition to the engine caution lights on the pilot CAUTION/ ADVISORY panel, illumination of the READ MFD caution light indicates that one or more of the following caution legends on the upper left quadrant of the MFD is activated:

1. L N2 OSP or R N2 OSP — Designated engine N_2 overspeed condition.
2. L N1 OSP or R N1 OSP — Designated engine N_1 overspeed condition.
3. L TBT OT or R TBT OT — Designated engine turbine blade overtemperature.
4. L FLMOUT or R FLMOUT — Designated engine flameout.
5. L IGV SD or R IGV SD — Designated engine inlet guide vane off schedule.
6. L STALL or R STALL — Designated engine stall detected (also on HUD).
7. L FIRE or R FIRE — Designated engine fire/ overheat condition in engine nacelle (also on HUD).

Refer to Chapter 12, WARNING/CAUTION/ ADVISORY LIGHTS/DISPLAY LEGENDS for the appropriate pilot/RIO response.

2.11.10 Engine Stall/Overtemperature Warning. An engine stall detection circuit in FEMS monitors each engine. When a stall condition is detected, a L or R STALL warning legend is displayed on the HUD and MFD until the condition is cleared. In addition, an aural warning tone is activated through the pilot ICS for up to 10 seconds. There is no pilot check of the FEMS engine stall detection system.

Note

In SEC mode, FEMS and, therefore, the engine stall detection circuit, is inoperative. However, overtemperature warning is still available and will activate both the STALL warning legends and aural warning tone.

When an overtemperature condition occurs, the EGT display rises above 940 °C, the warning chevrons begin to flash, and a signal from the EGT indicator activates the STALL warning legend and the aural tone. The overtemperature warning system is checked by the pilot during prestart as part of the MASTER TEST check in INST test.

2.12 FIRE DETECTION SYSTEM

The fire detection system provides a cockpit indication of fire or overheating in either engine compartment. There is a separate system for each engine compartment, each consisting of a thermistor-type sensing loop monitored by a transistorized control unit. The system is powered by 28 volts from the essential dc No. 1 bus. Figure 2-27 is a functional schematic of the system.

The sensing loop for each engine compartment consists of a 45-foot continuous tubular element routed throughout the entire length of the engine compartment on both sides above the nacelle door hinge line. The tube sheath, which is clamped in grommets to the engine compartment structure, contains a ceramic-like thermistor material in which are embedded two electrical conductors; one of the conductors is grounded at both ends of the loop. Electrical resistance between two conductors varies inversely as a function of temperature and length, so that heating of less than the full length will require a higher temperature for the resistance to decrease to the alarm point. The L or R FIRE warning lights in the cockpit illuminate when the respective entire sensing loop is heated to approximately 600 °F or when any 6-inch section is heated to approximately 1,000 °F.

The fire alarm output relay to the light is a latching type that remains in the last energized position independent of power interruptions until the fault clears.

False alarms triggered by moisture in the sensing element and connectors or by damage resulting in short circuits or grounds in the sensing element are unlikely because of the system design. Additionally, there is no loss or impairment of fire detector capability from a single break in the sensing element as long as there is no electrical short. With two breaks in the sensing element, the section between the breaks becomes inactive although the remaining segment ends remain active.

Fire detection circuits in the engine compartments detect a leak in the high-temperature duct and illuminate the appropriate FIRE warning light and activate the L FIRE or R FIRE warning legend on the MFD and HUD. The warning legend is a repeat of a discrete from the fire detect system.

2.12.1 Fire Detection Test. An integrity test of the fire detection system can be performed by selection of FIRE DET/EXT on the pilot MASTER TEST switch. The integrity test simultaneously checks the sensing element loops of both engine compartments for continuity

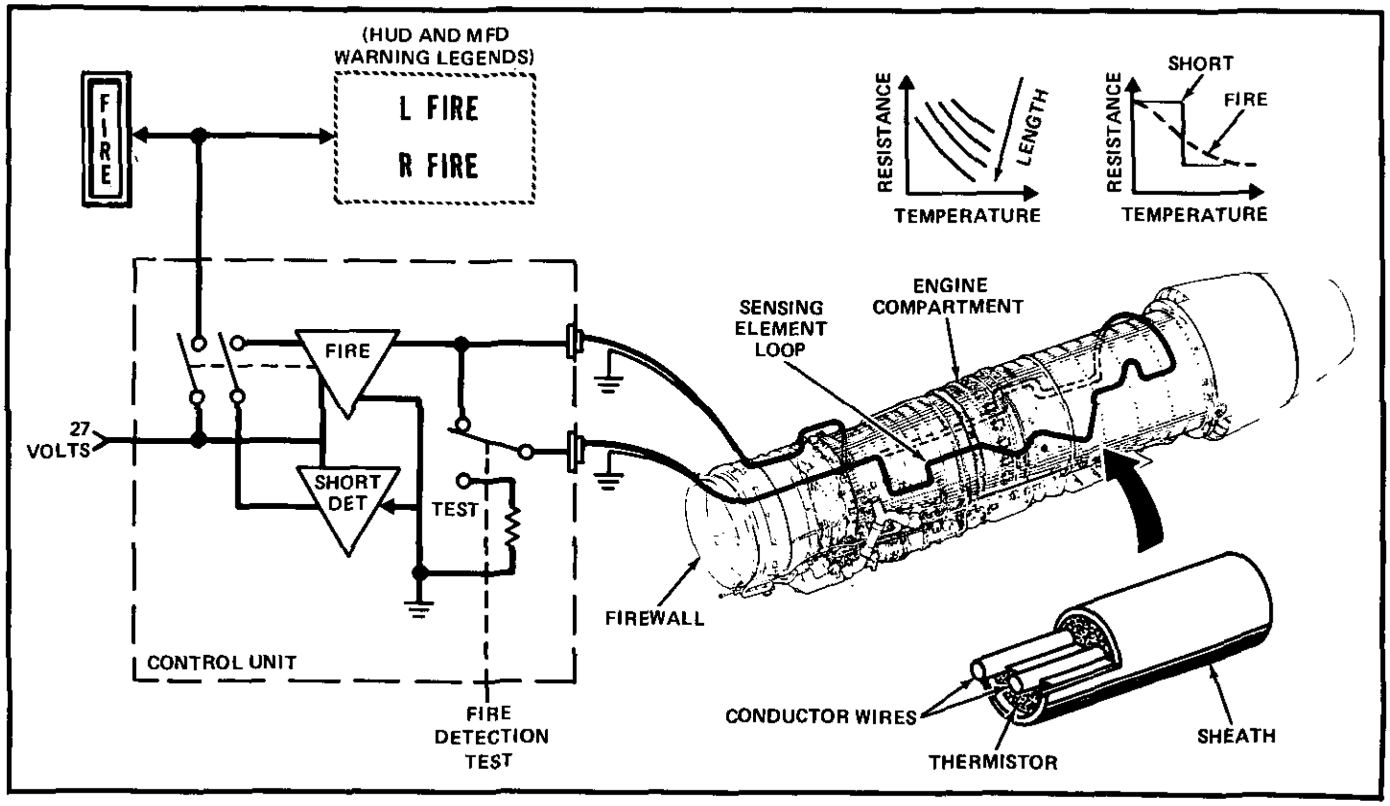

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Figure 2-27. Fire Detection System

and freedom from short circuits, and the fire alarm circuits and FIRE warning lights for proper functioning. Presence of a short circuit or control unit malfunction causes the warning light to remain out. Fire detection test is not available on the emergency generator.

2.13 FIRE EXTINGUISHING SYSTEM

The fire extinguishing system is capable of discharging an extinguishing agent into either engine nacelle and its accessory section. The system consists of two containers of extinguishing agent, piping and nozzles to route and discharge the agent, cockpit switches to activate the system, and advisory lights that alert the flightcrew to a drop in system pressure beyond a predetermined level.

The fire extinguishing agent is a clean, colorless, odorless, and electrically nonconductive gas. It is a low-toxicity vapor that chemically stops the combustion process. It will not damage equipment because it leaves no water, foam, powder, or other residue.

The retention time of an adequate concentration of the extinguishing agent in the engine compartment will determine probability of reignition, and, therefore, the probability of aircraft survival. At high airspeeds, where airflow through the engine compartment is increased, agent retention time is reduced.

The slower the airspeed at the time the extinguisher is fired, the higher the probability of fire extinction and the lower the probability of reignition.

Circuit breaker protection is provided on the RIO essential No. 1 circuit breaker panel by the R FIRE EXT (7C4) circuit breaker and the L FIRE EXT (7C5) circuit breaker.

2.13.1 Fire Extinguisher Pushbuttons. The discharge pushbuttons for the fire extinguishing system are located behind the FUEL SHUT OFF handles. The FUEL SHUT OFF handle for the affected engine must be pulled to make the pushbutton for that engine accessible (see Figure 2-28). If the left or right fire extinguishing pushbutton is activated, the contents of both extinguishing containers are discharged into the selected engine and its accessory section. Since it is a one-shot system, both system advisory lights, ENG FIRE EXT and AUX FIRE EXT, will illuminate and remain illuminated after container pressures drop below a preset level.

2.13.2 Fire Extinguisher Advisory Lights. Two advisory lights are provided to indicate low pressure in the fire extinguishing agent containers. The lights, ENG FIRE EXT and AUX FIRE EXT, illuminate when container pressure drops 90 psi below a nominal pressure of 600 psi at 70 °F (see Figure 2-28).

2.13.3 Fire Extinguisher Test. The fire extinguishing system is tested by raising and rotating the MASTER TEST switch to FIRE DET/EXT and depressing the knob; the FIRE warning lights will illuminate. The fire extinguishing system initiates a self-test indicated by either a GO or NO GO light. If the fire extinguisher test passes, the GO light illuminates; if the NO GO light illuminates or if both or neither GO and NO GO lights illuminate, the system has not tested properly and a failure exists somewhere in the system.

2.14 AIRCRAFT FUEL SYSTEM

The aircraft fuel system normally operates as a split feed system, with the left and aft tanks feeding to the left engine and the right and forward tanks feeding the right engine (refer to FO-6). Except for the external tanks, the system uses motive flow fuel to transfer fuel. The supply of high-pressure fuel from engine-driven motive fuel pumps operates fuel ejector pumps to transfer fuel without the need of moving parts. The system is not dependent on electrical power for normal fuel transfer and feed. Total internal and external fuel quantity indication is provided, with a selective quantity readout for individual tanks. Fuel system management requirements are minimal under normal operation for feed, transfer, dumping, and refueling. Sufficient cockpit control is provided to manage the system under failure conditions. The aircraft fuel system is designed so that all usable fuel will normally be depleted under two- or single-engine operating conditions before an engine flameout occurs from fuel starvation. However, with complete motive flow failure, engine fuel starvation can occur with usable fuel aboard.

Note

All fuel weights in this manual are based on the use of JP-5 fuel at 6.8 pounds per gallon, JP-4 fuel at 6.5 pounds per gallon, or JP-8 fuel at 6.7 pounds per gallon.

2.14.1 Fuel Tankage. Figure 2-29 shows the general fuel tankage arrangement in the aircraft. The fuel supply is stored in eight separate fuselage cells, two wing box cells, two integral wing cells, and (optional loading) two external fuel tanks.

2.14.1.1 Sump Tanks. The engine feed group, consisting of the left and right box-beam tanks and the left and right sump tanks, span the fuselage slightly forward of the mid-center of gravity. Fuel in each box-beam tank gravity flows to its respective sump tank. The sump

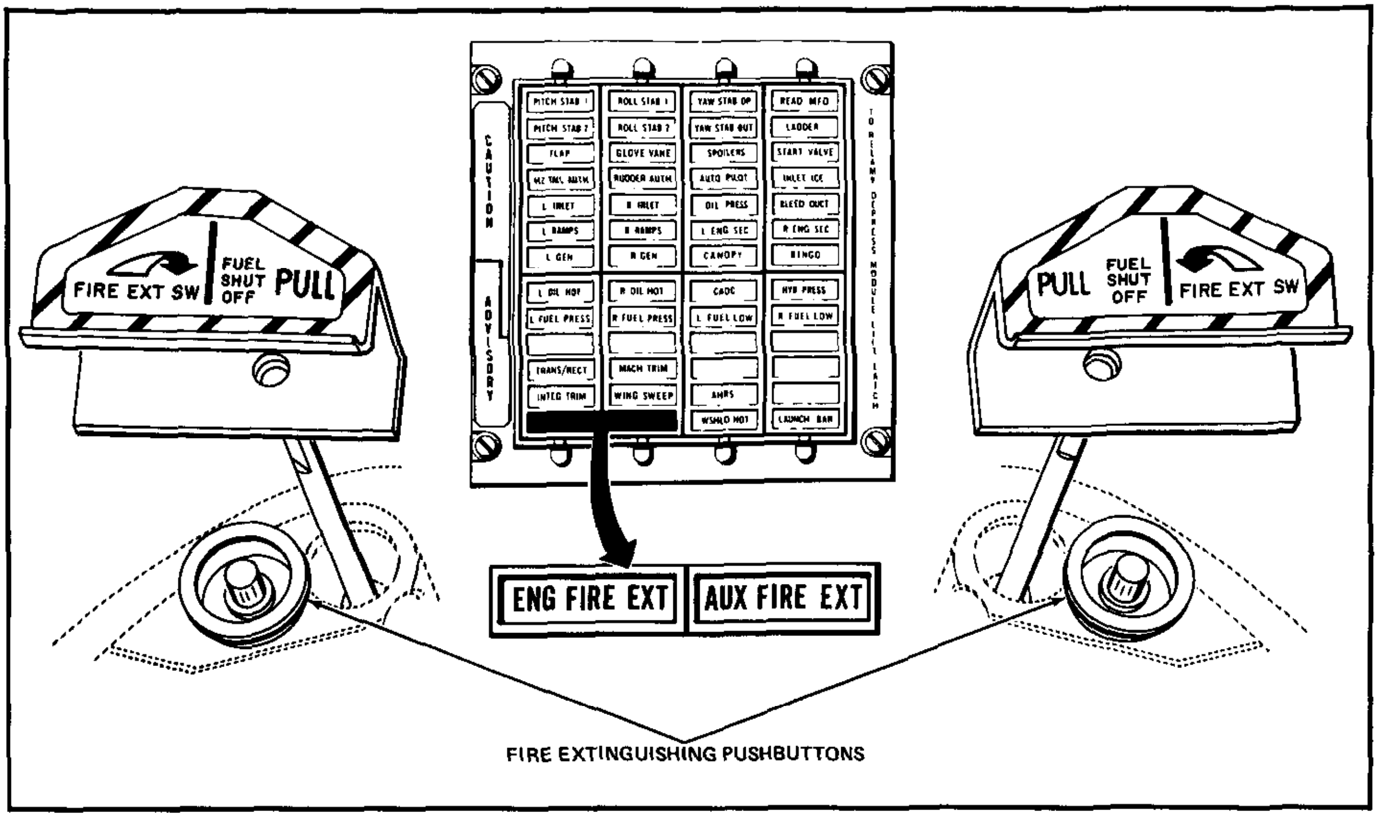

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Figure 2-28. Fire Extinguishing Switches and Advisory Lights

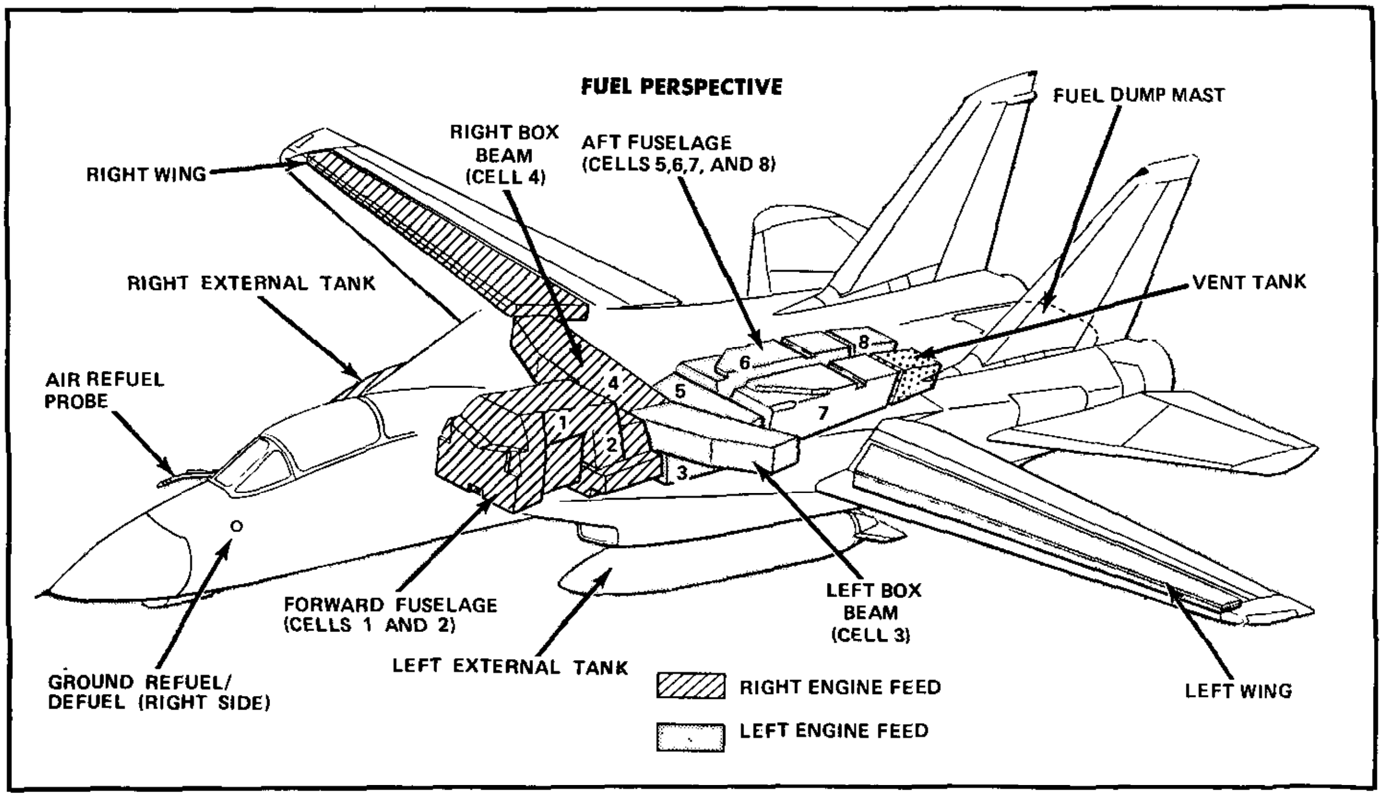

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Figure 2-29. Fuel Tanks

tanks (self-sealing) are directly connected to the box-beam tanks and contain the turbine-driven boost pumps. The feed tanks supply fuel to the engine. A negative-g check valve traps fuel in the feed tank during negative-g flight.

WARNING

- Zero- or negative-g flight longer than 10 seconds in AB or 20 seconds in MIL or less will deplete the fuel sump tanks (cell Nos. 3 and 4), resulting in flameout of both engines.
- AB operation in the zero to negative 0.5g regime may result in air ingestion into the fuel boost pumps, causing possible AB blowout or engine flameout.
- With fuel in feed group below 1,000 pounds, AB operation could result in AB blowout.

Note

AB operation with less than 1,000 pounds in either feed group may illuminate the FUEL PRESS light because of uncovering of the boost pump inlet.

2.14.1.2 Forward Tank. The forward fuselage fuel tank is in the center fuselage, between the inlet ducts and immediately ahead of the feed group. The forward tank is partitioned into two bladder cells (Nos. 1 and 2) that are interconnected by open ports at the top for vent and overflow purposes. Flapper valves at the base provide for forward-to-aft fuel gravity transfer.

2.14.1.3 Aft Tank. The aft fuselage fuel tank group is partitioned into four bladder cells (Nos. 5, 6, 7, and 8) and a vent tank. The forward-most cell in the aft tank group (cell No. 5) lays laterally across the center fuselage. Extending aft are two coffin-shaped tanks that contain two cells (Nos. 6 and 8) on the right side and one cell (No. 7) plus an integral fuel vent tank on the left side. The coffin tanks straddle the center trough area, which contains the control rods. Sparrow missile launchers, and electrical and fluid power lines. All fuel cells in the aft tank group are interconnected by one-way flapper valves at the base for aft-to-forward fuel gravity transfer.

2.14.1.4 Wing Tanks. There are integral fuel cells in the movable wing panels between the front and aft wing spars. Because of the wing-sweep pivot location and the extensive span (20 feet) of the wing tanks, wing fuel loading provides a variable aft cg contribution to the aircraft longitudinal balance as a function of wing-sweep angle. Each wing panel consists of the integral fuel cell, which is designed to withstand loads because of fuel sloshing during catapulting and extreme rolling maneuvers with partial or full wing fuel. Fuel system plumbing (transfer and refuel, motive flow, and vent lines) to the wing tanks incorporate telescoping sealed joints at the pivot area to provide normal operation independent of wing-sweep position.

2.14.1.5 External Tanks. Fuel, air, electrical, and fuel precheck line connectors are under the engine nacelles for the external carriage of two fuel tanks. Check valves in the connectors provide an automatic seal with the tank removed. Although the location is designated as armament station Nos. 2 and 7, no other store is designed to be suspended there so that the carriage of external fuel tanks does not limit the weapon-loading capability of the aircraft. Suspension of the drop tanks and their fuel content has an insignificant effect on the aircraft longitudinal center of gravity, and, even under the most adverse asymmetric fuel condition, the resultant movement can be compensated for by lateral trimming.

CAUTION

See Chapter 4 for external tank limitations.

2.14.2 Fuel Quantity System. The fuel-quantity measurement and indication system provides the flightcrew with a continuous indication of total internal and external fuel remaining, a selective readout for all fuel tanks, independent low-fuel detection, and automatic fuel system control features.

WARNING

To prevent fuel spills from an overfilled vent tank caused by a failed level-control system, set the WING/EXT TRANS switch to OFF if the left tape reading reaches 6,200 pounds or the right tape reading reaches 6,600 pounds. If either fuel tape reading is exceeded, the aircraft shall be downed for maintenance inspection.

Note

Fuel in the vent tank is not gauged.

The quantity measurement system uses dual-element, capacitance-type fuel probes to provide the flightcrew with a continuous display of fuel quantity remaining. Fuel thermistor devices and caution light displays provide a backup FUEL LOW level-indicating system, independent of the capacitance-type gauging system. Additionally, the pilot is provided with a BINGO set capability on the fuel quantity indicator to preset the total quantity level for activation of a BINGO caution light.

Note

Fuel quantity system malfunctions that result in erroneous totalizer readings will invalidate the use of the BINGO caution light.

2.14.2.1 Fuel Quantity Indicators. The pilot and RIO fuel quantity indicators are shown in Figure 2-30 with a definitive breakdown of tape and counter readings. The white vertical tapes on the pilot indicator show fuselage fuel quantity. The left tape indicates fuel quantity in the left feed and aft fuselage; the right tape indicates fuel quantity in the right feed and forward fuselage. The "L" and "R" labeled counters display either feed group, wing tank, or external tank fuel quantity on the side selected using the QTY SEL rocker switch on the fuel management panel. The rocker switch is spring loaded to FEED. The pilot TOTAL quantity display and the RIO display indicate total internal and external fuel.

Note

The RIO fuel quantity indicator is a repeater of the pilot total fuel indicator. The difference between the two should not exceed 300 pounds.

2.14.2.2 FUEL LOW Caution Lights. A L FUEL LOW or R FUEL LOW caution light illuminates with 1,000 ±200 pounds of fuel remaining in the respective feed group. The RIO is provided with a single FUEL LOW caution light that illuminates with one or both of the pilot FUEL LOW caution lights.

Each FUEL LOW caution light is illuminated by two thermistors operating in series. One set of thermistors is in the right box-beam tank and cell No. 2. The other set of thermistors is in the left box-beam tank and cell No. 5. The FUEL LOW light illuminates only if both thermistors operating in series are uncovered.

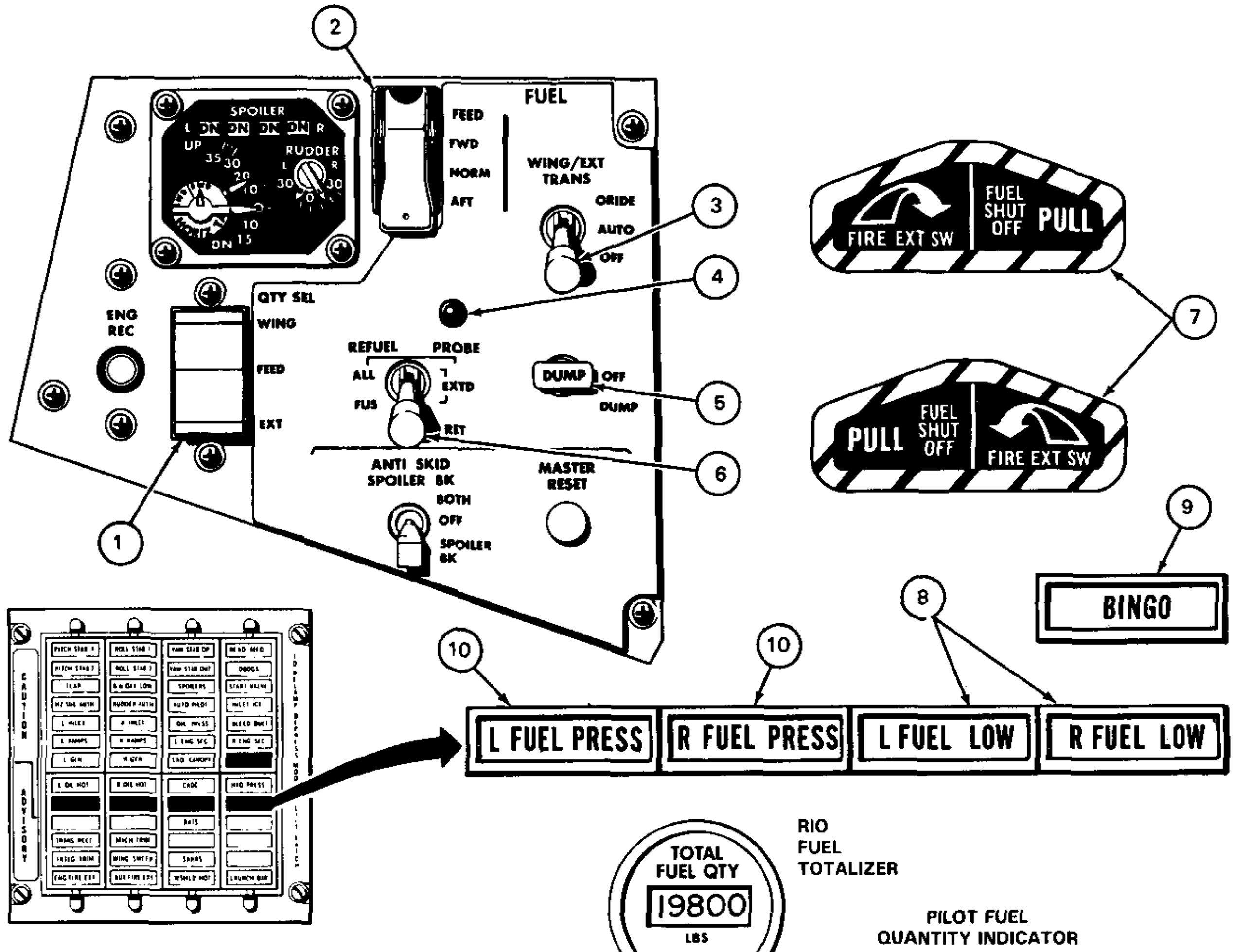
WARNING

- If the thermistors in either cell No. 2 or No. 5 remain covered during a fuel transfer failure, it is possible to partially deplete the sump tank without illuminating the respective FUEL LOW caution light.
- When both FUEL LOW caution lights illuminate, less than 1 minute of fuel is available if both engines are operating in zone five AB.
- If the BINGO CAUTION circuit breaker (8F6) is pulled, the L and R FUEL LOW caution lights will be disabled.

2.14.2.3 Fuel Quantity Indication Test. Actuation of the master test switch in INST causes the fuselage tapes and total and feed/wing/external fuel quantity indicators to drive to 2,000 pounds and illuminates the FUEL LOW caution lights. The test can be performed on the ground or in flight. The test does not check the fuel probes or the thermistors. A test of the BINGO set device can be obtained concurrently with the INST test by setting the BINGO level at greater than 2,000 pounds. In this case, the BINGO caution light will illuminate when the totalizer reading decreases to a value less than the BINGO setting.

2.14.3 Engine Feed. The feed group for each engine is comprised of a box-beam tank and a sump tank. Each box-beam tank holds approximately 1,300 pounds of fuel and is fed from external tank transfer, wing transfer, and fuselage transfer from cell No. 2 or 5. When a box-beam tank is full, excess fuel is returned to the fuselage tanks through an overflow pipe. The sump tanks, which hold approximately 300 pounds of fuel each, are located directly beneath the box-beam tanks and have three sources of fuel (see Figure 2-31 for identification of tank interconnects):

1. Interconnect A or B provides gravity sump from the respective box-beam tank.
2. Interconnect C or D connects the sump tank to its respective fuselage tank (cell No. 4 to cell No. 2/ cell No. 3 to cell No. 5).
3. The sump tank interconnect line and valve E connect the two sump tanks.



TANKS	APPROXIMATE USABLE FUEL	
	GALLONS	POUNDS*
FORWARD FUSELAGE	691	4700
AFT FUSELAGE	648	4400
RIGHT FEED GROUP	235	1600
LEFT FEED GROUP	221	1500
TOTAL FUSELAGE	1795	12,200
INTERNAL WINGS	590	4000
TOTAL INTERNAL	2385	16,200
EXTERNAL TANKS	534	3600
TOTAL CAPACITY	2919	19,800

*WEIGHT BASED ON JP-5 FUEL

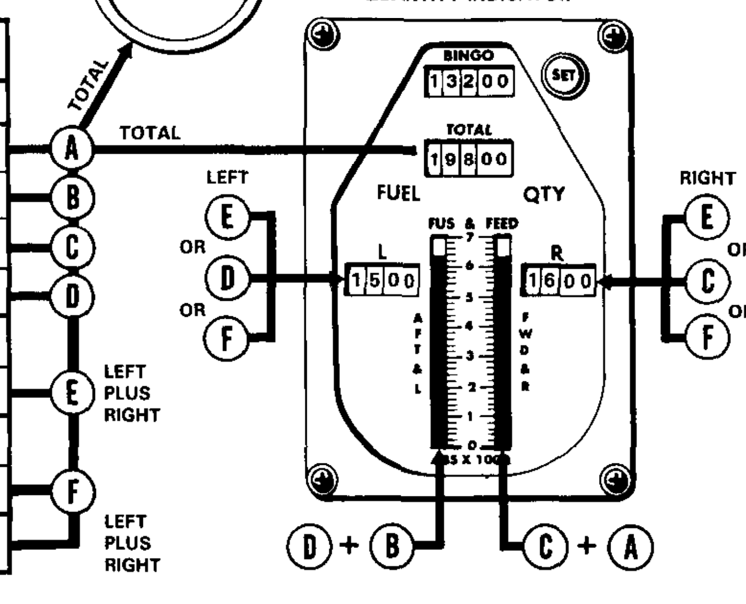


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Figure 2-30. Fuel Controls and Indicators (Sheet 1 of 3)

NOMENCLATURE	FUNCTION	
(1) QTY SEL switch	WING -	Fuel quantity in each wing is displayed on L and R counter of pilot's fuel quantity indicator.
	FEED -	Rocker switch spring returns to FEED when not held in WING or EXT. FEED group fuel quantity displayed on L and R counter of pilot's fuel quantity indicator.
	EXT -	Fuel quantity in each external tank displayed on L and R counter of pilot's fuel quantity indicator.
(2) FEED switch	FWD -	Both engines feed from right and forward tanks. Opens sump tank interconnect valve, box beam vent valves, fuselage motive flow isolation valve, defueling and transfer selector valve, and shuts off motive flow fuel to all aft tank ejector pumps.
	NORM - (guarded position)	Right engine feeds from forward and right tanks. Left engine feeds from aft and left tanks.
	AFT -	Both engines feed from aft and left tanks. Opens sump tank interconnect valve, box beam vent valves, fuselage motive flow isolation valve, defueling and transfer selector valves, and shuts off motive flow fuel to forward tank ejector pumps.
(3) WING/EXT TRANS switch	ORIDE -	*Airborne* - Allows transfer of wing fuel, fuselage tank pressurization, and pressurization and transfer of external tanks with landing gear down, and with electrical malfunction in transfer system. *Weight on Wheels* -Allows transfer of wing and external tank fuel.
	AUTO -	*Airborne* - Normal position. Wing fuel is automatically transferred. Transfer of external fuel and fuselage pressurization is automatic with landing gear retracted. Automatic shut off of wing and external tanks when empty.*Weight on Wheels* -Automatic transfer of wing and external tank fuel cannot be accomplished; switch must be set to ORIDE for wing fuel transfer.
	OFF -	Closes solenoid operated valve to shut off motive flow fuel to wing and also inhibits external tank transfer and fuselage pressurization. Spring return to AUTO when master test switch is actuated in INST, and when either thermistor in cell 2 and 5 is uncovered, when DUMP is selected, and when REFUEL PROBE switch is in ALL EXTD.
(4) In-flight refueling probe transition light	Illuminates whenever probe cavity forward door is open during retraction or extension of probe.	
(5) DUMP switch	OFF -	Dump valve closed.
	DUMP -	Opens a solenoid operated pilot valve, which ports motive flow fuel pressure to open the dump valve and allows gravity fuel dump overboard from cells 2 and 5. Wing and external tank transfer automatically initiated. Dump electrically inhibited with weight on wheels or speed brakes not fully retracted.

Figure 2-30. Fuel Controls and Indicators (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
6 REFUEL PROBE switch	ALL EXTD - Extends refueling probe. Shuts off wing and external tank fuel transfer to permit refueling of all tanks. Returns transfer switch from OFF to AUTO. FUS EXTD - Extends refueling probe. Normal transfer and feed. Used for practice plugins, fuselage-only refueling, or flight with damaged wing tank. RET - Retracts refueling probe.
7 Left and right FUEL SHUT OFF PULL handles	Pulling respective handle manually shuts off fuel to that engine. Push forward resets engine fuel feed shutoff valve to open.
8 L and R FUEL LOW caution lights (Also single light on RIO CAUTION panel.)	Fuel thermistors uncovered in aft and left or forward and right feed group. Illuminates with approximately 1,000 pounds remaining in individual feed group and the respective fuselage tanks empty.
9 BINGO caution light	Illuminates when total fuel quantity indicator reads lower than BINGO counter value.
10 L and R FUEL PRESS caution lights	Indicates insufficient discharge pressure (less than 9 psi) from respective turbine driver boost pump.

Figure 2-30. Fuel Controls and Indicators (Sheet 3 of 3)

The proportion of fuel supplied to each sump tank through the five interconnects (A through E) is a function of the pressure differential existing at each of the interconnects. The interconnect with the highest pressure differential will provide the most fuel. Valve E is commanded open during low-fuel states and during fuel balancing when the FEED switch is selected FWD or AFT.

In a normal sequence, three situations can be defined

1. Situation 1

   a. Fuel in cell Nos. 2 and 5

   b. FEED switch in NORMAL

   c. Normal engine fuel flow (MIL thrust or less).

Under these conditions, the sump tank interconnect valve is closed, and the left and right systems are isolated. The transfer capacity into the box-beam tank exceeds the engine demand, ensuring a full box-beam tank. The pressure head at interconnect A or B created by the higher vertical location of the fuel in the box-beam tank, is greater than that created at interconnect C or D by the fuel in either cell No. 2 or 5. Therefore, fuel to replenish the sump tanks will come from the box-beam tanks through interconnects A and B.

2. Situation 2

   a. Fuel in cell Nos. 2 and 5

   b. FEED switch in NORM

   c. High-engine fuel demands (afterburner).

Under these conditions the sump tank interconnect valve is closed and the left and right systems are isolated. Engine fuel demand can exceed the transfer rate into the box-beam tank. If this occurs, the fuel level in the box-beam tank will start to drop; however the box-beam tanks are not vented, resulting in a pressure drop above the declining fuel level. This reduced pressure lowers the total pressure at A and B, below the pressure at C and D. Therefore, the majority of the fuel to replenish the sump tanks comes directly from fuselage cell Nos. 2 and 5 through interconnects C and D, respectively. The reduction in box-beam tank fuel quantity should not normally

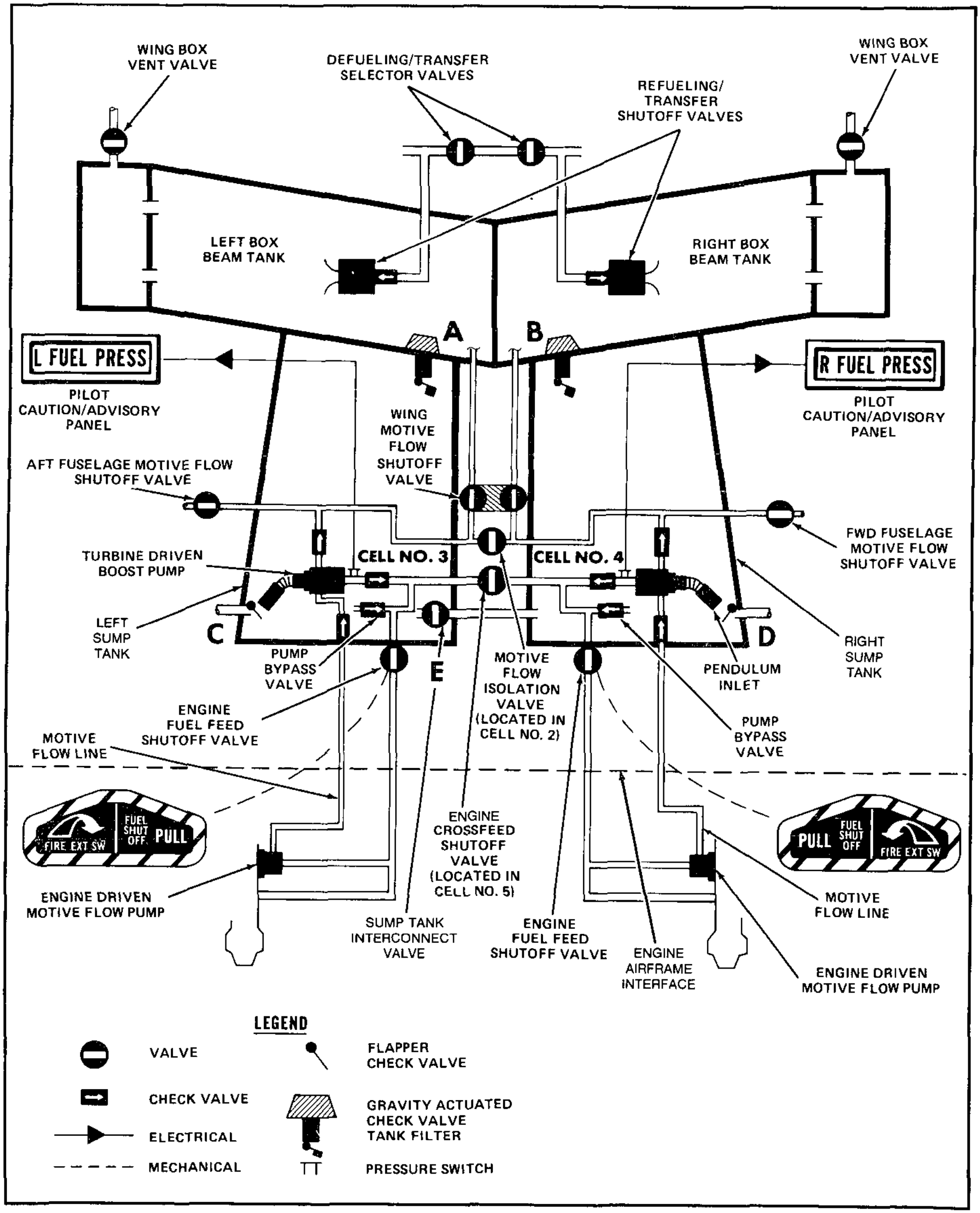

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Figure 2-31. Engine Fuel Feed

result in a feed group quantity indication of less than 1,200 pounds. If the feed groups drop and then hold in the 1,200-pound range during a high-speed dash, the system is working normally.

3. Situation 3

   a. Fuel in either cell No. 2 or 5 has been depleted.

   b. FEED switch in NORM.

   c. Any normal engine demand.

When the low-level thermistor in either cell No. 2 or 5 is uncovered, both box-beam tanks are vented and the sump tank interconnect valve is opened. The two groups become a common system and will seek a common level to equalize the static pressure head. Fuel will flow through the open sump tank interconnect valve only as a function of differential pressure. With open vent valves, the fuel in both box-beam tanks has a positive vent pressure, forcing the fuel into the respective sump tank through interconnect A or B.

Fuel in the sump tank is picked up by the turbine-driven boost pump through a flexible pendulum pickup, boosted to greater than 10 psi, and fed to the engine through the engine feed line. Normally the right boost pump only feeds the right engine and the left boost pump only feeds the left engine; however, the boost pump output lines are connected by a normally closed engine automatic crossfeed valve. If either boost pump output pressure falls below 9 psi, as indicated by the illumination of the appropriate FUEL PRESS caution light, the engine automatic crossfeed valve is commanded open. The engine automatic crossfeed valve allows fuel from the operating boost pump to supply pressurized fuel to the engine on the failed side. The engine automatic crossfeed valve is also opened when either of the low-level thermistors in cell No. 2 or 5 is uncovered; however if equal boost pump pressures exist, negligible flow will occur through the valve.

2.14.3.1 L/R FUEL PRESS Caution Lights. Illumination of the L or R FUEL PRESS caution light results from a malfunction of the boost pump, failure of the motive flow pump, exhaustion of fuel, or fuel flow interruption. With illumination of the caution light, the engine automatic crossfeed valve is commanded open and the fuselage motive flow shutoff valve on the failed side is automatically closed. Because of the reduced pumping and transfer capacity while operating on a single boost pump, afterburner operation is restricted to altitudes below 15,000 feet. Fuel to both engines is supplied from the side with the operating boost pump; therefore a fuel quantity imbalance will result. Use of the FEED switch to balance fuel quantity will override the low-fuel pressure signal to the fuselage motive flow shutoff valve, allowing normal fuel balancing procedures. Illumination of both FUEL PRESS caution lights indicates reduced (<9 psi) or loss of boosted fuel pressure to both engines. Fuel will continue to be supplied by suction feed; however, thrust settings should be minimized and AB used only in emergencies. Suction feed is drawn from an inlet at the bottom of the fuel cell that does not incorporate a flexible pendulum pickup.

CAUTION

With a left or right FUEL PRESS light, flight at zero or negative g should be avoided or engine fuel starvation may result.

With both FUEL PRESS caution lights illuminated, there is a potential that total loss of motive flow pressure has occurred because of both motive flow pumps not functioning. Total loss of motive flow pressure will preclude transfer of any remaining wing fuel or fuel dump and result in total segregation of the FWD/RIGHT and AFT/LEFT systems since motive flow provides the force to open the sump tank interconnect valve. Without motive flow pressure, all fuselage fuel transfer is by gravity, which makes the quantity of usable fuel a function of aircraft attitude. At cruise attitude, approximately 400 pounds of usable fuel will be trapped in the aft fuselage. After illumination of both fuel pressure caution lights, any of the following events indicate that some motive flow pressure is available:

1. Wing fuel transfer

2. With the FEED switch in FWD or AFT and no transfer of external fuel

   a. The feed group of the selected side remains full.

   b. Fuel migration from one side to the other.

2.14.3.2 Engine Fuel Feed During Afterburner Operations. High AB fuel consumption places extreme demands on the engine feed system. In addition, the g forces experienced with AB use, especially during unloaded accelerations (bugouts) and low-g nose-high maneuvering, tend to reduce forward fuel transfer to cell No. 5 and the left engine sump tank (cell No.3). When these conditions are sustained, fuel in cell No. 5 is depleted by both high suction feed through the gravity transfer line (C, Figure 2-32), and by reducing gravity

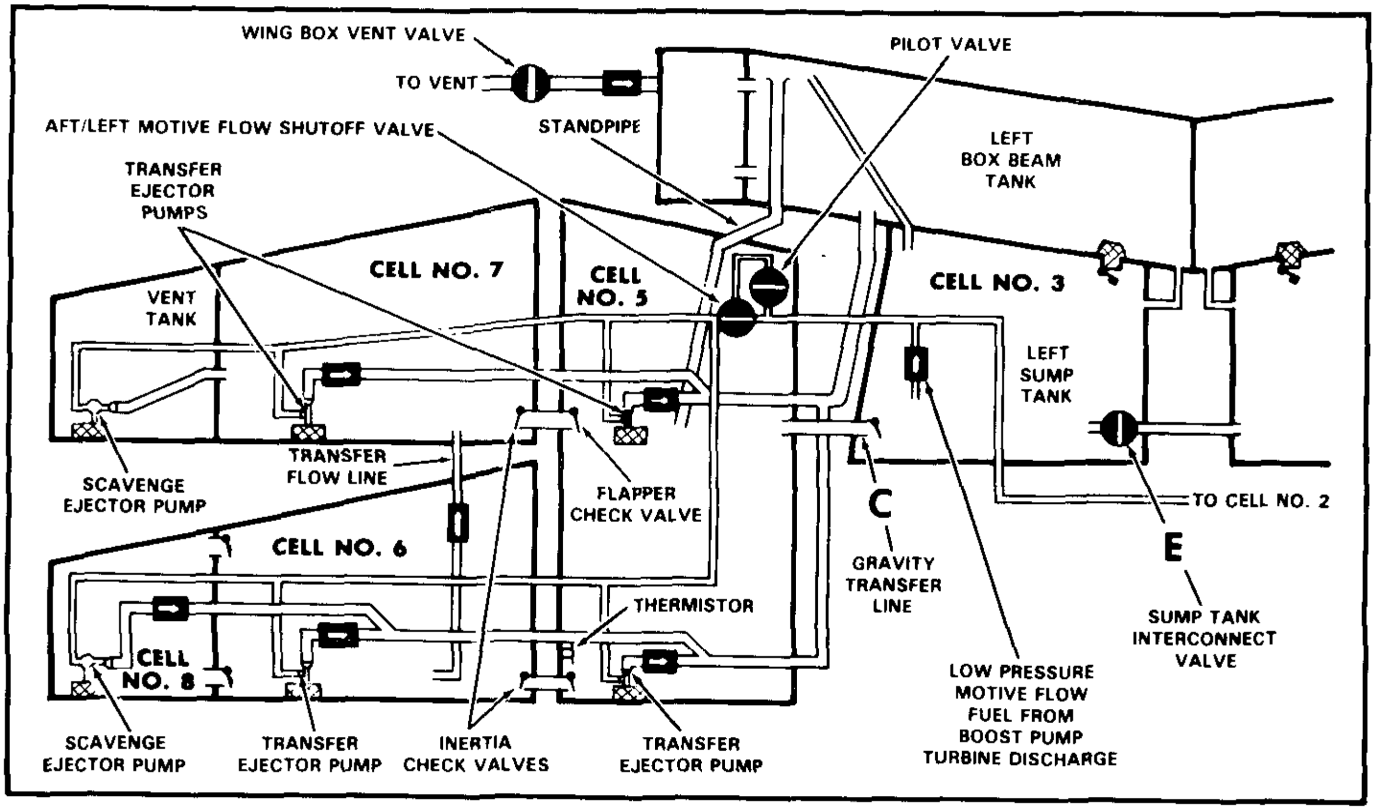

Figure 2-32. Aft Fuselage Fuel Transfer

fuel transfer from cell Nos. 6 and 7. Zero- or low-g (less than 0.5) flight tends to force the fuel remaining in cell No. 5 toward the aft wall of the tank or, at reduced fuel level, uncovers gravity transfer line (C) and allows air to be drawn into the sump tank. Continued zero- or low-g (less than 0.5) maneuvers will aggravate this condition and increase the probability of air ingestion. If air enters the boost pump and engine feed line, the fuel pressure light will illuminate. If the maneuver is continued, the left AB will blow out and subsequent left-engine flameout can occur. Right-engine flameout can follow after left-engine flameout because engine feed crossfeed operation will reduce the effective output of the right boost pump. Aircraft deceleration can further interrupt fuel transfer from cell No. 2 to the right sump through the gravity transfer line (D, Figure 2-33). Once initiated, this sequence can occur rapidly and is independent of total fuel state.

WARNING

- During zero- or negative-g flight, the oil pressure light will normally illuminate and activate the master caution light. Subsequent illumination of a fuel pressure light may go unnoticed, allowing the pilot to continue the maneuver to the point of AB blowout and engine flameout.

- In the presence of a fuel pressure light, fuel demand must be reduced and positive g restored to prevent possible engine flameout.

2.14.3.3 Fuel Shutoff Handles. Individual engine fuel feed shutoff valves in the left and right feed lines at the point of nacelle penetration are connected by control cables to the FUEL SHUT OFF handles on the pilot instrument panel. During normal operation, the handles should remain pushed in so that fuel flow to the engine fuel feed system is unrestricted. If a fire is detected in the engine nacelle, the pilot should pull (approximately 3 or 4 inches) the FUEL SHUT OFF handle on the affected side to stop the supply of fuel to the engine.

CAUTION

Securing the engine at high power settings using the FUEL SHUTOFF handles may result in damage to the aircraft fuel system.

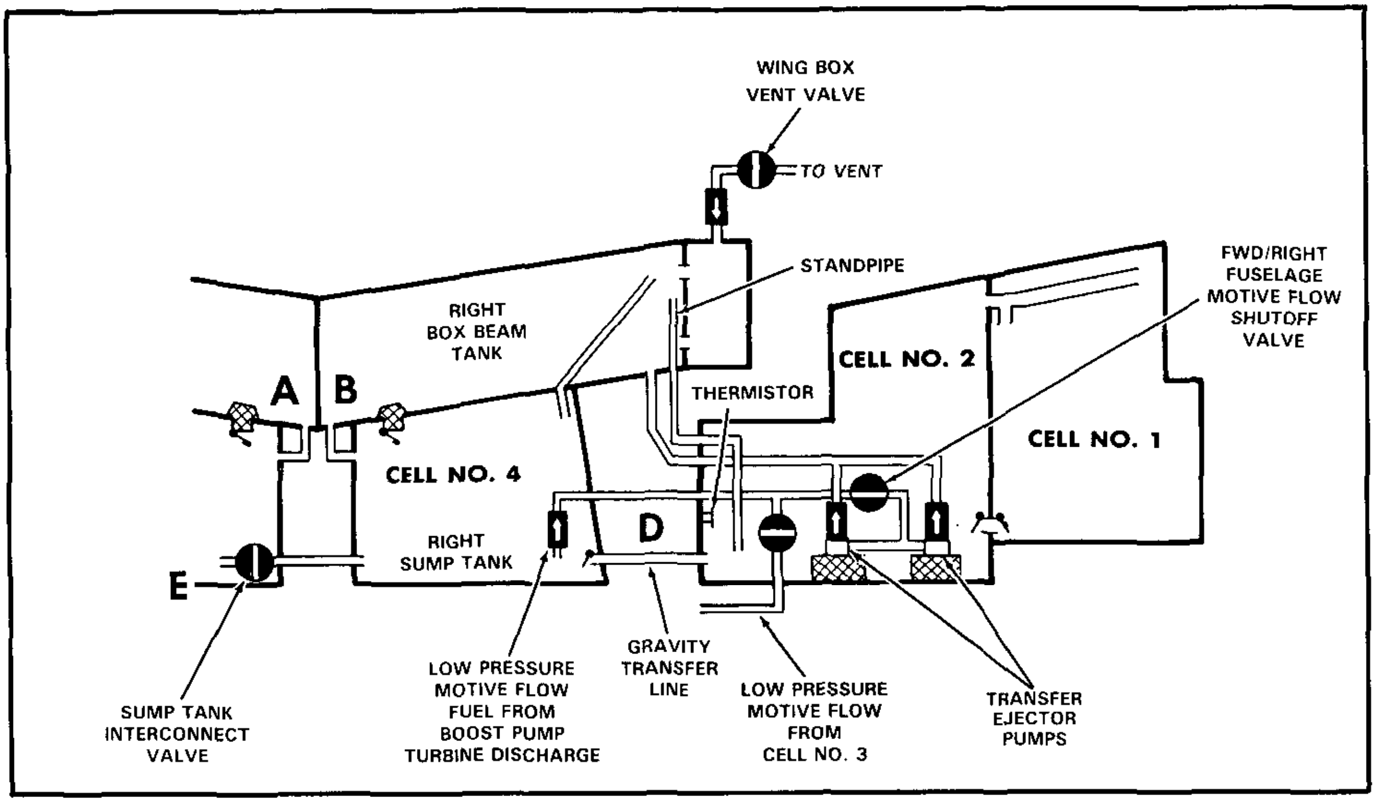

Figure 2-33. Forward Fuselage Fuel Transfer

Note

Engine flameout will occur approximately 4 seconds after the FUEL SHUT OFF handle(s) is pulled with the throttle(s) at MIL. With lower power settings, time to flameout will increase (approximately 30 seconds at IDLE).

2.14.4 Fuel Transfer

2.14.4.1 Motive Flow Transfer. With the exception of the external tanks, which utilize bleed air, all fuel transfer is accomplished by gravity and motive flow. In motive flow, a relatively small amount of pressurized fuel moves at high speed through ejector pumps, using the venturi effect to induce flow of the transfer fuel. The ejector pumps have no rotating parts or power requirements other than motive flow.

Like other elements of the fuel transfer system, motive flow transfer is initially segregated to right and left. The motive flow pump driven by the right engine provides motive flow and pressure to drive the right boost pump and to run the ejector transfer pumps in the forward fuselage and right wing. The motive flow pump driven by the left engine provides motive flow and pressure to drive the left boost pump and runs the ejector transfer pumps in the aft fuselage and left wing.

The path of the motive flow fuel is essentially the same for either side. Fuel from the engine feed line is pressurized by the engine-driven motive flow pump and initially routed through the boost pump turbine. The motive flow fuel is then routed through its respective transfer system. As the pressurized fuel passes through each ejector pump, it induces transfer fuel to flow along with the motive flow fuel. This combination of fuel eventually is transferred into the respective wing box-beam tank.

There are four valves that control motive flow transfer:

1. Motive flow isolation valve — Normally closed, but when the low-level thermistor in cell Nos. 2 or 5 is uncovered or the FEED switch is out of NORM, the valve is commanded open, providing a path for motive flow fuel from a normally operating side to cross over and power a malfunctioning opposite side.

2. Forward fuselage motive flow shutoff valve — Normally open except when the R FUEL PRESS caution light is illuminated or the FEED switch is in AFT. When the valve is closed, all motive flow transfer in the forward fuselage is shut off. If the valve is closed because of the R FUEL PRESS caution light, positioning the FEED switch to FWD will open the valve.

3. AFT fuselage motive flow shutoff valve — Normally open except when the L FUEL PRESS caution light is illuminated or the FEED switch is in FWD. When the valve is closed, all motive flow transfer in the aft fuselage is shut off. If the valve is closed because of the L FUEL PRESS caution light, positioning the FEED switch to AFT will open the valve.

4. Wing motive flow shutoff valve — The motive flow to each wing passes through separate paths in a single motive flow shutoff valve. The valve is normally open except when:

   a. The WING/EXT TRANS switch is in OFF or in AUTO with both left and right wing thermistors dry.

   b. Weight is on wheels.

   c. The REFUEL PROBE switch is in ALL EXTD.

In any case, the wing motive flow shutoff valve can be commanded open by selecting ORIDE on the WING/EXT TRANS switch.

2.14.4.2 Forward Fuselage Transfer. Fuel in cell No. 1 flows by gravity into cell No. 2 where two motive flow ejector pumps transfer it into the right wing box-beam tank at approximately 18,000 pounds pph. Fuel entering the box-beam tank beyond engine demands overflows through an overflow pipe back into cell No. 2. There is no fuel level control associated with fuselage motive flow transfer; therefore, the fuel will continue to circulate from cell No. 2 into the right box-beam tank and back through the overflow pipe. When the fuel in cell Nos. 1 and 2 is depleted, the motive flow ejector pumps are shut off by their own low-level floats. In the event of failure of the forward fuselage motive flow, the fuel can reach the right sump tank by gravity flow through interconnect D.

2.14.4.3 Aft Fuselage Transfer. Fuel in the aft fuselage is transferred forward by scavenge ejector pumps in cell No. 8 and the vent tank, single ejector pumps in cell Nos. 6 and 7, and two ejector pumps in cell No. 5. All aft motive flow transfer is into the left box-beam tank, producing a rate of approximately 36,000 pph. This flow rate is approximately twice that of the forward fuselage transfer rate because there are more motive flow ejector pumps in the aft transfer system. More fuel tanks and thus more motive flow ejector pumps are required in the aft transfer system than the forward transfer system because of the aircraft structural configuration. Like the forward fuselage, aft fuselage transfer does not have any high-level control associated with it. Excess fuel in the box-beam tank passes through an overflow pipe back into cell No. 5. When cell No. 5 is full, the fuel cascades into cell Nos. 6, 7, and 8. The aft fuselage fuel will continue to circulate until consumed by the engine. When their respective cell is empty, the motive flow ejector pumps will be shutoff by their own low-level floats. The scavenge ejector pumps do not incorporate shutoff floats. In the event of loss of aft fuselage motive flow transfer, fuel may be gravity fed forward to cell No. 5 and eventually to the left sump tank through interconnect C.

2.14.4.4 Wing Transfer. Wing fuel is transferred by two motive flow ejector pumps located in each wing. To prevent overfilling the fuselage, entry of wing fuel into the box-beam tank is controlled by the refueling/transfer shutoff valve. In the forward fuselage, excess fuel overflows through an overflow pipe from the right box-beam tank into cell No. 2, and then cascades into cell No. 1. A high-level pilot valve senses when cell No. 1 is full and sends a signal to close the right refueling/transfer shutoff valve, preventing additional wing fuel from entering. When engine fuel consumption provides room in cell No. 1 for additional fuel, the high-level pilot will signal the refueling/transfer shutoff valve to open. The sequence is identical for the left box-beam tank and aft fuselage with the exception that the high-level pilot valve is located in cell No. 7 and controls the left refueling/transfer shutoff valve (see Figure 2-34 for wing and external tank fuel transfer).

Normally wing fuel can only transfer to the box-beam tank on its respective side, except when the thermistor in either cell No. 2 or 5 is uncovered or the FEED switch is selected FWD or AFT. For either condition, the motive flow isolation valve opens, making motive flow pressure available to either wing from either engine and the two defuel/transfer selector valves open permitting fuel from either wing to transfer to either box-beam tank. Total loss of wing motive flow will preclude transfer of any remaining wing fuel. Failure of either high-level pilot valve or refueling/transfer shutoff valve to the closed position could cause a single-wing transfer failure. Selection of FWD or AFT on the FEED switch opens the defuel/transfer selector valves allowing the trapped wing fuel to transfer to the opposite box-beam fuel tank.

Note

Premature automatic wing motive flow valve shutoff may occur because of formation of air bubbles in the wingtip fuel thermistors. Pilot selection of ORIDE with the WING/EXT TRANS switch will reenable fuel transfer.

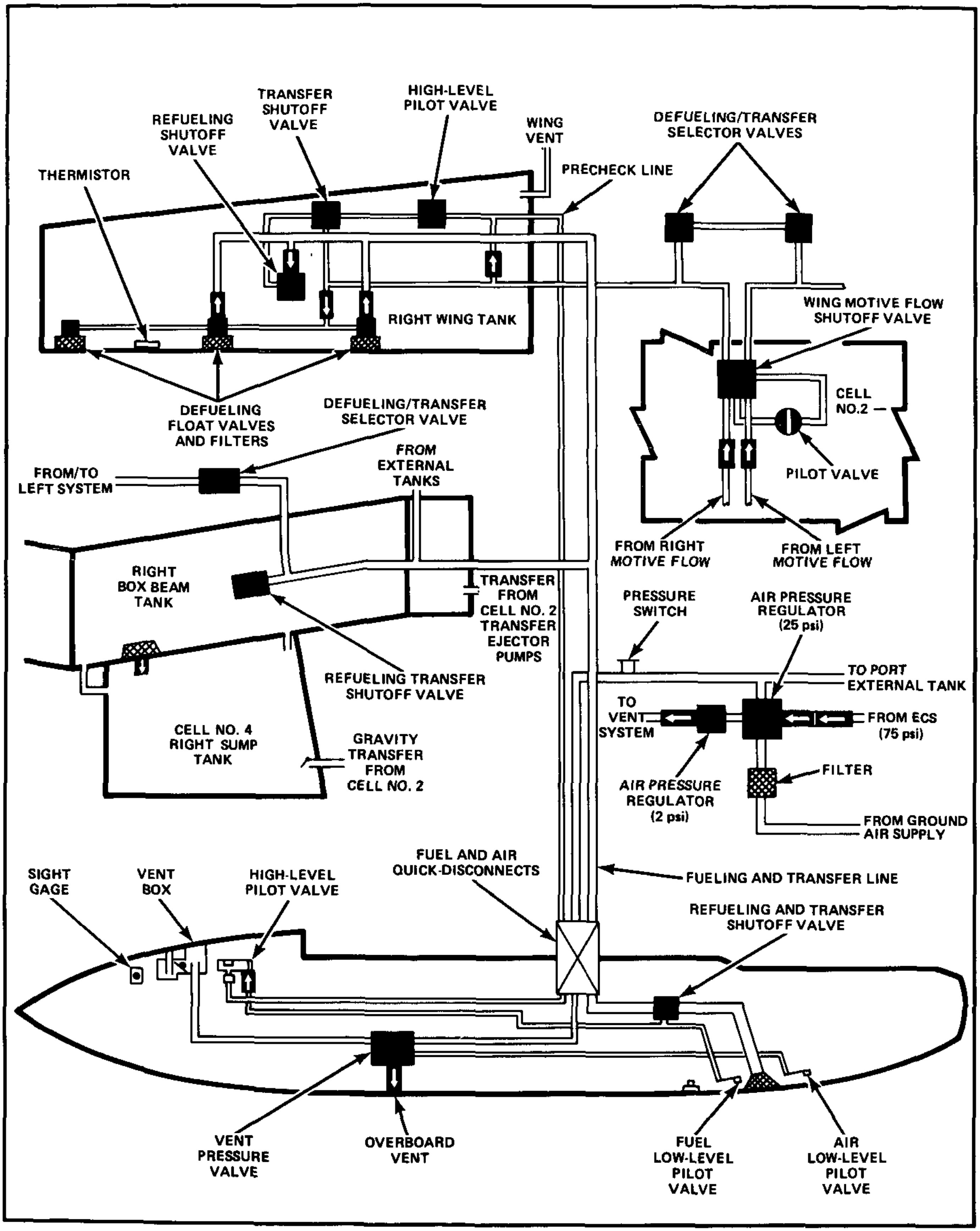

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Figure 2-34. Wing and External Tank Fuel Transfer

Note

- ORIDE transfer should not normally be used unless AUTO transfer fails to complete transfer of wing or external tank fuel. ORIDE use when the wing tanks are dry may allow air to enter the box-beam tanks, reducing the efficiency of gravity transfer to the sump tanks.

- When the thermistor in either cell No. 2 or 5 is uncovered, the WING/EXT TRANS switch will be deenergized from OFF to AUTO. This automatic feature is to ensure all wing and external fuel has been transferred. After 5 seconds, the pilot may reset this switch to OFF.

A weight-on-wheels inhibit function prevents opening of the wing motive flow shutoff valve. To transfer wing fuel during ground operations, the WING/EXT TRANS switch must be set to ORIDE to bypass the weight-on-wheels function.

Activation of fuselage fuel dump automatically initiates wing fuel transfer in sequence after external tank transfer by automatically moving the WING/EXT TRANS switch to AUTO if in OFF. Positioning the REFUEL PROBE switch to ALL/EXTD also releases the solenoid holding the WING/EXT TRANS switch in OFF.

2.14.4.5 External Tank Transfer. External tank transfer is also controlled by the WING/EXT TRANS switch. When external tanks are installed, transfer from the wings and external tanks occurs concurrently. Transfer from the wings and external tanks cannot be accomplished separately; however, the external tanks should complete transfer before the wing tanks. External tank fuel is transferred by bleed air pressure regulated to 25 psi. Maximum transfer rate of each external tank is approximately 45,000 pph. External tank fuel transfer into the fuselage is controlled by the same valves that control wing transfer. Fuselage level is controlled by the refueling/transfer shutoff valves and, until both the defuel/transfer valves are commanded open, external tank fuel can only transfer into the box-beam tank located on the same side of the aircraft.

External tank transfer can be checked on the deck by placing the WING/EXT TRANS switch to ORIDE, or selecting FLT GR UP with the MASTER TEST switch and noting depletion of external tank fuel quantity. In addition, when FLT GR UP is selected, the GO/NO GO light on the MASTER TEST panel is illuminated by a pressure switch in the aircraft pressure line leading to the external tanks and indicates status of line pressure. Since FLT GR UP serves to bypass the landing gear down interlock in the external tank transfer circuit, the WING/EXT TRANS switch may remain in the AUTO (normal) position for this check.

Note

- Verifying tank operation by observing fuel transfer is both time consuming with a full fuselage fuel load and aggravates fuel slosh loads in the external tanks during catapult launch.

- Engine rpm above idle may be required to provide sufficient bleed air pressure for a satisfactory check.

2.14.4.6 Vent Valve Failure. The vent valves in the right and left box-beam tank are always commanded open with the sump tank interconnect valve, making the right and left feed groups a common system. This function occurs when the low-level thermistor in cell No. 2 or 5 is uncovered. To equalize the static pressure head at the interconnect valve, the fuel in the sump tanks will seek a common level. At matched engine demands, each engine will feed from its own side and negligible flow will occur across the sump tank interconnect valve. If a vent valve fails to open, the additional vent pressure on top of the fuel on the vented side creates a pressure differential between the left and right sump tanks and results in migration through the interconnect valve to the side with the inoperative vent valve. Therefore, sump tank replenishment of fuel to the side with the failed vent valve will come primarily from the opposite sump tank because the head pressure at the interconnect valve (E) may be higher than that at interconnects A, B, C, or D (Figure 2-31). A fuel quantity imbalance will occur with the side of the properly operating vent valve decreasing more rapidly than the malfunctioning side. The box-beam tank with the malfunctioning vent valve will eventually vent through the overflow pipe when the respective fuselage tank (cell No. 2 or 5) is empty. If for any reason the fuel is not transferred out of the respective fuselage tank, the imbalance will continue until the vented sump tank fuel quantity is low enough to uncover the interconnect valve and line (256 pounds approximately). This permits venting of the unvented side and permits use of the balance of the fuel in the sump tanks.

Vent valve malfunctions can create disconcerting fuel imbalances. Although engine operation is not affected and all of the fuel in the aircraft is available, AB use should be avoided when low-feed group fuel quantities are indicated. If both engine/boost pumps are operating, there is no advantage in using the cockpit fuel FEED switch to attempt to correct the imbalance. Positions other than NORM may simply aggravate the imbalance.

2.14.5 Fuel Quantity Balancing. Fuel quantity balancing is not normally required prior to completion of wing/external tank transfer or until one fuselage tape drops below 4,500 pounds. The procedure requires use of the FEED switch that opens the sump tank interconnect valve, joining the FWD/R and AFT/L systems. With a high quantity in the FWD/R group, the greater static head pressure, particularly in noseup attitudes, can cause overfilling of the AFT/L group. To prevent this, the FEED switch should be returned to NORM before the AFT/L tape reaches 6,200 pounds.

When the FEED switch is moved to select the high-fuel quantity side, the following occurs:

1 Sump tank interconnect valve opens and provides a fuel path between the right and left tanks.

2. Both box-beam tank vent valves open and provide equal vent pressure on top of the fuel in each box-beam tank, regardless of the fuel level.

3. Fuselage motive flow shut off valve on the non-selected (low-fuel quantity) side closes and terminates the last source of transfer of that fuselage fuel into its respective box-beam tank.

4. Motive flow isolation valve opens and provides path for nonselected side motive flow pressure to reach the opposite side. Thus motive flow transfer should maintain a full box-beam tank on the selected side.

5. Both defuel/transfer selector valves open and permit either wing/external tank to transfer into either wing box-beam tank.

The higher static pressure head created by the full box-beam tank on the selected side results in the nonselected side engine feeding primarily from the sump tank interconnect rather than interconnects A, B, C, or D. With both engines feeding from the fuel in primarily one side, the correction rate of the fuel quantity imbalance is essentially a function of engine demand.

CAUTION

- During AB operations, NORM shall be selected. FWD or AFT could deplete fuel in sump tanks.

- Aircraft attitude will have a significant influence on the direction of fuel movement if FWD or AFT is selected. Nosedown attitude will transfer fuel forward, and noseup attitude will transfer fuel aft.

2.14.6 Fuel Transfer/Feed During Single-Engine Operation. Loss of an engine before the low-level thermistor in either cell No. 2 or 5 is uncovered will terminate all motive flow transfer on the failed side. External tank fuel will continue to transfer if room is available in the failed side fuselage tanks. If no pilot action is taken, the operating engine will feed only from its own side. This will lead to a fuel imbalance that can normally be corrected through the use of the fuel FEED switch. Selecting the high side (inoperative engine side) results in the following:

1. Selected side fuselage motive flow shutoff valve is opened. The valve was commanded closed when the FUEL PRESS caution light illuminated.

2. Operating side fuselage motive flow shutoff valve is closed and stops operating side fuselage fuel transfer into the box-beam tank.

3. Motive flow isolation valve opens. Operating side motive flow pressure now powers the inoperative side. Failed side fuselage fuel will begin transferring into its respective box-beam tank.

4. Sump tank interconnect valve opens and provides a path for the inoperative side fuel to reach the operating engine.

5. Wing box-beam tank vent valves open and equalize the pressure above the fuel in each wing box-beam tank, permitting the higher static pressure created by the full wing box-beam tank on the inoperative side to induce flow through the open sump tank interconnect valve to the operating engine.

6. Both defuel/transfer selector valves open and allow either wing or external tank fuel to transfer into either wing box-beam tank.

If no crew action is taken with the FEED switch, the same fuel system functions are automatically provided when the thermistor in either cell No. 2 or 5 is uncovered. Additional actions that will occur when the cell No. 2 or 5 thermistor is uncovered are:

1. Both right and left fuselage motive flow shutoff valves open, overriding any previous commands to close. Manual override of each valve is still provided through the FEED switch.

2. Engine crossfeed valve receives a redundant command to open. An initial command was provided when the FUEL PRESS caution light illuminated.

3. WING/EXT TRANS switch will automatically go to AUTO if originally in OFF. If desired, OFF can be reselected after 5 seconds.

2.14.6.1 Sump Tank Interconnect Valve Failure. The major fuel system consideration while operating single engine is that the sump tank interconnect valve opens when commanded. This constitutes the only path through which inoperative side fuselage fuel can reach the operating engine. While the probability of an inoperative sump tank interconnect valve is very low, the consequences of a malfunction under single-engine conditions are severe, particularly at landing fuel weights. With a failed closed sump tank interconnect and full fuselage cells on the inoperative side, only the wing fuel on the inoperative side and external fuel can be transferred into the operating side fuselage. Attempts to transfer the fuel from the inoperative side with the FEED switch compound the problem when the motive flow isolation valve and inoperative side motive flow shutoff valve open. Operating side motive flow fuel, pumped through the open motive flow isolation valve to permit inoperative side wing and/or fuselage motive flow transfer cannot be retrieved. Fuel migration is approximately 100 pounds per minute because of wing transfer, and approximately 200 pounds per minute for fuselage transfer. Coupled with a normal engine demand of approximately 100 pounds per minute, a balancing attempt will result in usable fuel in the operative side being depleted at approximately 400 pounds per minute.

Note

Operating side fuel remaining can be protected by pulling the FUEL SHUT OFF handle for the inoperative side and concurrently selecting the operative side on the FEED switch. This will eliminate a potential fuel path across the engine automatic crossfeed valve, through the inoperative sump tank boost pump into the inoperative side.

If the sump tank interconnect is failed closed, the following additional considerations apply:

With the FEED switch selected to the operating side.

1. Wing and external tank fuel from both sides will transfer into the operating side fuselage *if the inoperative side fuselage is full.*

2. If DUMP is selected, wing motive flow is automatically activated; therefore, approximately 100 pounds per minute of fuel available to the operating engine will be lost.

2.14.7 Fuel Dump. Figure 2-35 shows aircraft fuel system components associated with fuel dump operation. Fuel dump standpipes in the forward (cell No. 2) and aft (cell No. 5) fuselage tanks are connected to the fuel dump manifold at the dump shutoff valve. The manifold extends aft to the fuselage boattail. Actuation of the fuel DUMP switch to DUMP supplies power (dc essential No. 2) to open the solenoid-operated pilot valve, which ports motive flow fuel pressure to open the dump shutoff valve with weight off the main landing gear and the speedbrakes retracted.

The fuel DUMP switch circuit is deactivated on deck or with speedbrakes extended. Fuel dump with the speedbrakes extended is inhibited because of the resulting flow field disturbance, which would result in fuel impingement on the fuselage boattail and exhaust nozzles. The speedbrake switch is electrically bypassed during a combined hydraulic system failure, enabling the pilot to dump fuel when the speedbrakes are floating. The electrical bypass is accomplished whenever the combined pressure falls below 500 psi.

CAUTION

The speedbrake/fuel dump interlock does not prevent speedbrakes from being deployed if fuel dump is activated. It only prevents the dumping of fuel if the speedbrakes are already extended.

Note

- The FUEL FEED/DUMP circuit breaker is on the pilot right-knee circuit breaker panel.
- Dump operations with either engine in afterburner should be avoided since the fuel dump mast discharge will be torched.
- After terminating fuel dump, wait approximately 1 minute to allow residual fuel in the fuel dump line to drain before extending speedbrakes or lighting afterburners.

Fuel in the wings and external tanks is dumped by transferring to the fuselage. When the fuselage fuel dump circuit is activated, wing and external tank transfer to the box-beam tanks is automatically initiated. Fuel dump is by gravity flow with a nominal discharge rate of 1,500 pounds per minute. The dump rate is affected by aircraft pitch attitude and total fuselage fuel quantity with discharge flow inhibited at nosedown conditions. The standpipes in the fuel cells control the minimum

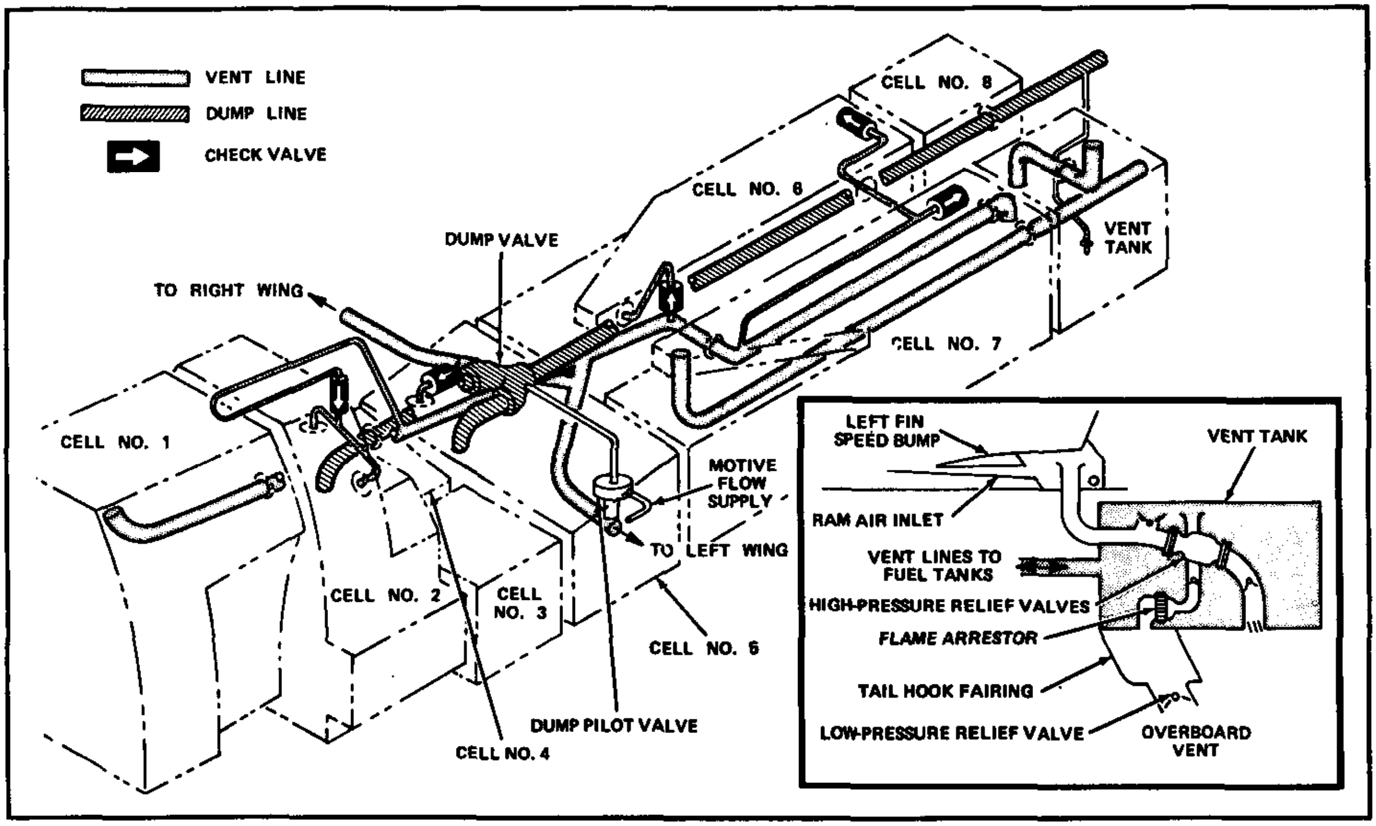


Figure 2-35. Fuel Vent and Dump

fuel dump level in the tanks, which, under normal operations (feed group full), is approximately 4,000 pounds.

2.14.8 Internal Tank Pressurization and Vent. The internal fuel vent system is shown in Figure 2-35. It is an open-vent-type system, pressurized by ram air and engine bleed air from the 25-psi external tank pressure system that is reduced to 1.75 psi by a fuselage pressure regulator and distributed to all tanks through the fuselage vent system. This air is automatically supplied when the landing gear handle is UP or the WING/EXT TRANS switch is in ORIDE. When the WING/EXT TRANS switch is in OFF, the low-pressure bleed air is cut off.

In flight, the vent tank is maintained at a positive pressure up to 2.5 psi maximum. This pressure is fed by connecting lines to all internal tanks. These connecting lines are routed to provide venting to both the forward and aft end of each fuselage tank so it can function as both a climb and dive vent. Venting of the box-beam tanks is controlled by solenoid-operating valves, which when closed, provide suction transfer through the gravity flow paths in cell Nos. 2 and 5 to the sump tanks.

2.14.9 Fueling and Defueling. Figure 2-36 shows the refueling system. The aircraft is equipped with a single-point refueling system, which enables pressure filling of all aircraft fuel tanks from a single receptacle. The receptacle is at the recessed ground refuel and defuel station, behind a quick-access door on the lower right side of the forward fuselage. The maximum refueling rate is 450 gallons per minute at a pressure of 50 psi. Since ground and air refueling connections use a common manifold, the refueling sequence is the same.

Standpipes refuel the aft and forward fuselage tanks by overflow from the left and right box-beam tanks. A high-level pilot valve at the high point of the forward tank shuts off the fuselage refueling valve in the right box-beam tank when the forward tank group is full. Fuel flows from the left box-beam tank to cell No. 5, after which it overflows to the right side, then the left side. A high-level pilot valve at the high point of the left box-beam tank and aft tank (cell No. 7) shuts off the fuselage refueling valve in the left box-beam tank when the aft tank group is full. Individual wing and external tank filling is accomplished by flow through a shutoff valve in each tank.

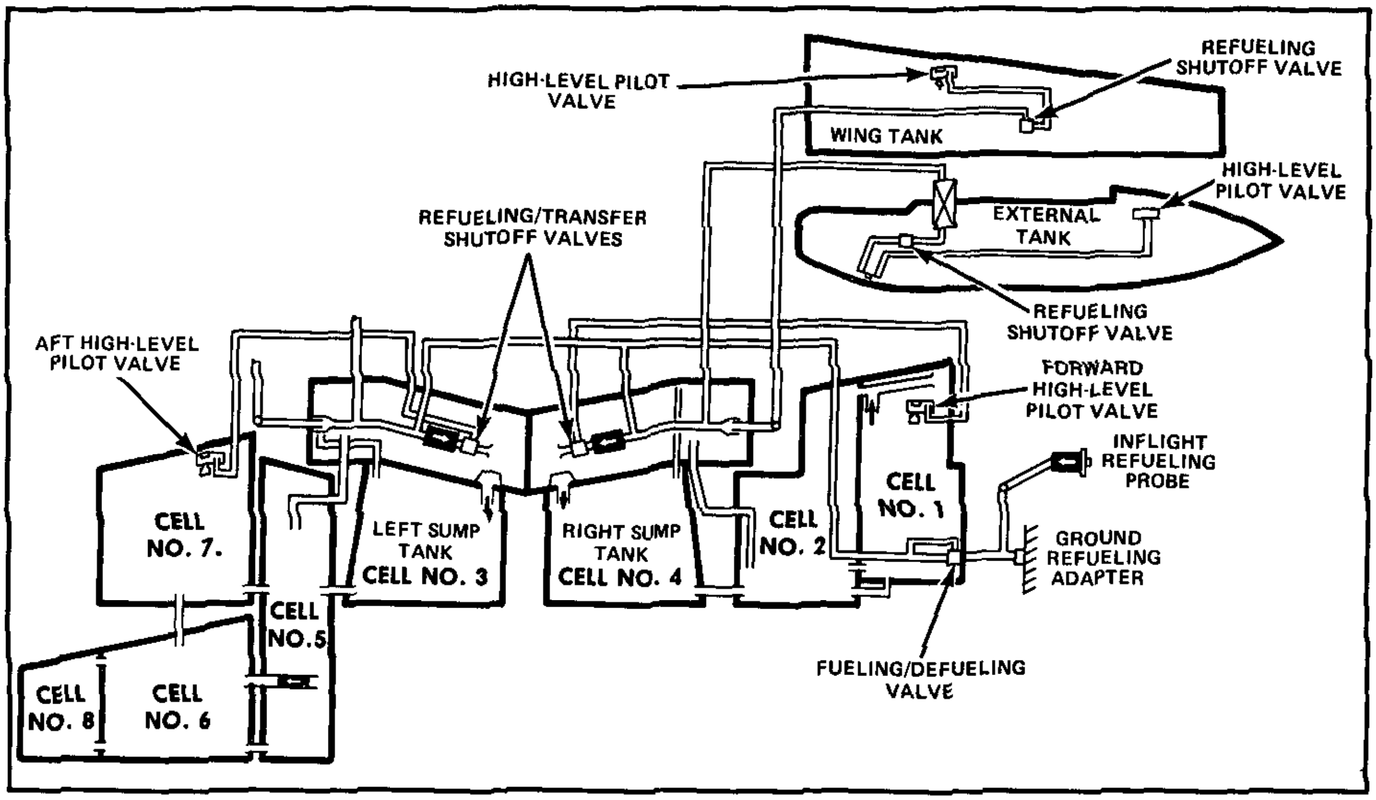


Figure 2-36. Refueling System

CAUTION

Gravity refueling of the aircraft fuel system should be accomplished only under emergency situations. While performing such an operation, avoid introducing contaminants into the fuel tanks or damaging the fuel quantity probes and wiring.

2.14.9.1 Precheck System. Ground refueling control is by two precheck selector valves and a vent pressure gauge adjacent to the refueling receptacle on the ground refuel and defuel panel. The precheck valves functionally test high-level pilot valve operation incident to ground pressure refueling; the valves separately check the pilot valves in the fuselage tanks and the wing and external tanks. In addition to this precheck function, the precheck valves can be used for ground selective refueling of only the fuselage or all tanks. Since the precheck valves, which are manually set by the groundcrew, port pressurized servo fuel to the high-level pilot valves and subsequently to the shutoff valves, no electrical power is necessary on the aircraft to perform ground refueling operations. Additionally, ground refueling control without engines running is completely independent of switch positioning on the fuel management panel. The direct-reading vent pressure indicator monitors pressure in the vent lines. The gauge consists of a pointer on a scale having two bands, one green and one red.

The green band indicates a safe pressure range (0 to 4 psi), and the red band indicates an unsafe range (4 to 8 psi).

CAUTION

During ground refueling operations, the direct-reading vent pressure indicator shall be observed and refueling stopped if pressure indicates in the red band (above 4 psi).

2.14.10 In-Flight Refueling

Note

See paragraph 9.1 for in-flight refueling procedures.

The in-flight refueling system permits partial or complete refueling of the aircraft fuel tanks while in flight. The retractable refueling probe has an MA-2-type nozzle, which is compatible with any drogue-type refueling system. A split refueling system is provided with fuel routed into the left and right box-beam tanks for initial replenishment of sump tank fuel. Selectable fuel management controls dictate the extent of further distribution to the wing tanks, external tanks, and/or fuselage tanks. The maximum refueling rate is approximately 475 gpm at a pressure of 57 psi.

WARNING

To prevent fuel fumes from entering the cockpit through the ECS because of possible fuel spills during in-flight refueling, select L ENG air source.

CAUTION

Maximum airspeed for extension or retraction in flight of the refueling probe is 400 knots (0.8 Mach).

Note

- With the in-flight refueling probe extended, the pilot and RIO altimeter and airspeed and Mach indicators will show erroneous indications because of changes in airflow around the pitot static probes.

- Flight operations with the in-flight refueling probe door removed are not recommended because of the effects of water intrusion, exposure to elements, and structural fatigue to electrical hydraulic hardware assemblies. If operational necessity dictates, the in-flight refueling probe door may be removed to prevent damage, loss, or engine FOD.

- The RUDDER AUTH caution light may illuminate when the in-flight refueling probe is extended. Press the MASTER RESET button to reset the light.

2.14.10.1 In-Flight Refueling Probe. The retractable in-flight refueling probe is in a cavity on the right side of the forward fuselage section, immediately forward of the pilot vertical console panel.

Extension of the refueling probe is provided through redundant circuits by the REFUEL PROBE switch. A hydraulic actuator within the probe cavity extends and retracts the probe. The probe actuator is powered by the combined hydraulic system. It can be extended and retracted by means of the hydraulic handpump in the event of combined system failure.

CAUTION

Loss of combined pressure may indicate impending fluid loss. Without fluid in the combined system return line, the in-flight refueling probe will not extend with the handpump. Early extension of the refueling probe at the first indication of a combined system malfunction is recommended in a carrier environment.

Note

- To extend or retract the refueling probe using the hydraulic handpump requires the refuel probe switch to be placed in EXT or RET (as appropriate), combined system fluid in the return line, and essential dc No. 2 electrical power. With a total loss of combined hydraulic pressure in flight, fluid trapped in the return line/handpump reservoir can be isolated exclusively for refueling probe extension if the landing gear handle is in the up position. Extension of the refueling probe requires approximately 25 cycles of the pump handle.

- Probe retraction is not available if the FUEL P/MOTIVE FLOW ISOL V (P-PUMP) circuit breaker (RG1) is pulled.

2.14.10.2 Refueling Probe Transition Light. The red probe transition light immediately above the REFUEL PROBE switch illuminates whenever the probe cavity forward door is not in the closed position. Since the closed-door position is indicative of both the probe retracted and extended position, the light serves as a probe transition indicator as well as a terminal status indicator. The probe external light illuminates automatically upon probe extension with the EXT LTS master switch ON.

2.14.10.3 In-Flight Refueling Controls. Regardless of fuel management panel switch positioning, at low-fuel states the initial resupply of fuel is discharged into the left and right box-beam tanks. The split refueling system to the left and right engine feed group provides for a relatively balanced cg condition during refueling. Selective refueling of the fuselage or all fuel tanks is provided on the REFUEL PROBE switch with the probe extended. In FUS/EXTD, normal fuel transfer and feed is unaltered. This position is used for practice plug-ins, fuselage-only refueling, or return flight with a damaged wing tank. The ALL/EXTD position shuts off wing and external drop tank transfer to permit the refueling of all tanks.

2.14.11 Hot Refueling. Hot refueling can be accomplished with the refueling probe extended or retracted. If the probe is extended, control of the tanks to be refueled is accomplished in the same manner as during inflight refueling. If the probe is not extended, select WING/EXT TRANS switch to OFF to refuel all tanks. Select ORIDE to refuel the fuselage only.

2.14.12 Automatic Fuel Electrical Controls

2.14.12.1 Automatic Low-Level Wing Transfer Shutoff. A thermistor is located at the low point in each wing cell. When both are uncovered, a discrete electrical signal is generated, and through a control, the wing motive flow shutoff valve is energized and closes, terminating all wing transfer. If either or both thermistors are again submerged, wing transfer resumes.

Failure of this override system could result in a wing transfer failure. Selection of WING/EXT TRANS switch to ORIDE removes all power from the wing motive flow shutoff valve, permitting it to open.

2.14.12.2 Automatic Fuel Low-Level Override. Under normal operating conditions, the forward and right fuselage tank complex is isolated from the aft and left tank. This is necessary for proper longitudinal cg control and battle damage conditions. However, as fuel depletion progresses to the point of sump tank only remaining, it becomes mandatory that the tanks be connected to maintain an equal balance. To accomplish this, two thermistors are located at the low points in cell Nos. 2 and 5, and when either is uncovered (approximately 1,700 to 2,000 pounds per side) the following operations are electrically performed.

1. Sump tank interconnect valve is opened.

2. Motive flow isolation valve is opened.

3. Box-beam vent valves are opened.

4. Engine crossfeed valve is opened.

5. WING/EXT TRANS switch is energized to move from OFF to AUTO. This signal is maintained for 5 seconds.

6. Defuel transfer selector valves are opened.

WARNING

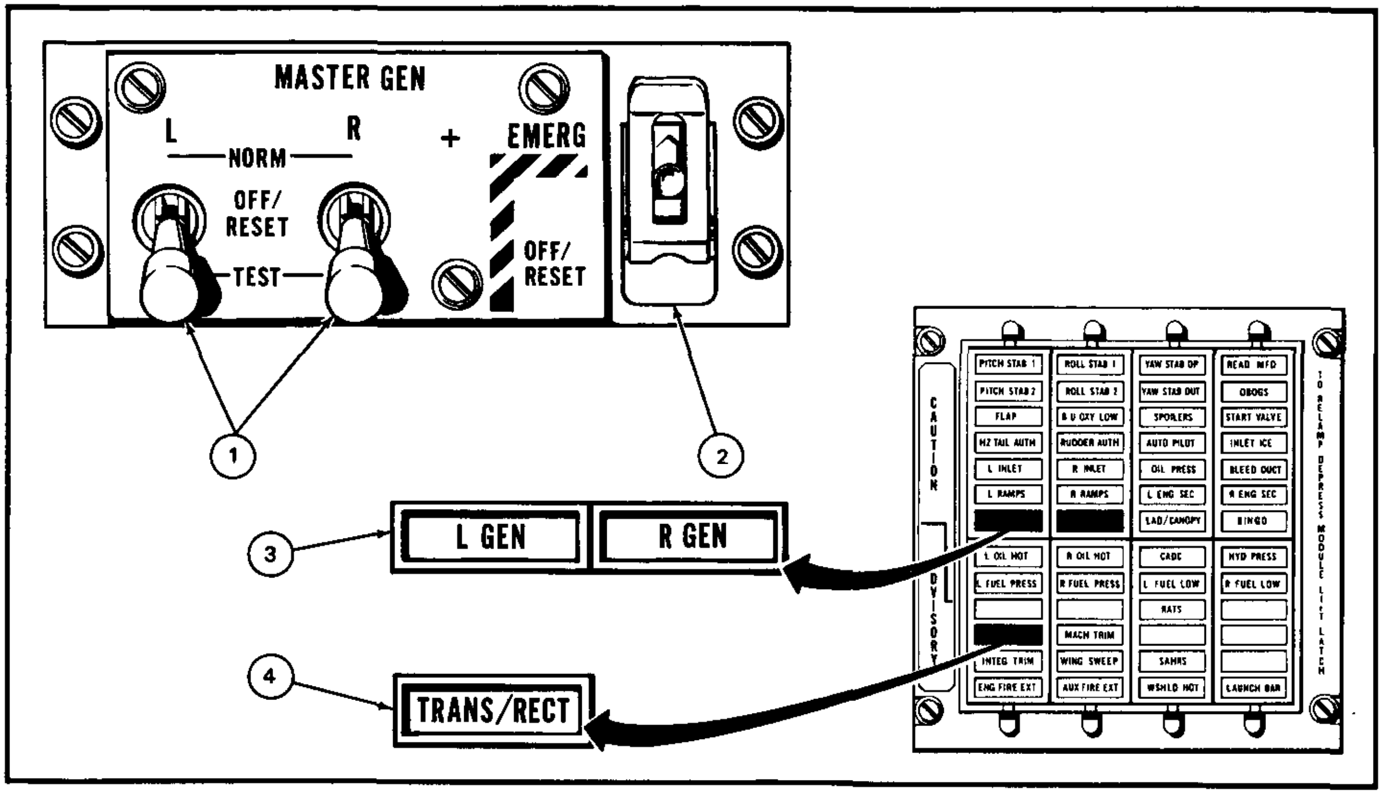
Uncovering either thermistor in cell No. 2 or 5 will only move the WING/EXT TRANS switch from OFF to AUTO but, under no circumstances, will it override a wing transfer failure.

2.15 ELECTRICAL POWER SUPPLY SYSTEM

In normal operation, ac power is supplied by the engine-driven generators. This ac power is converted by two transformer-rectifiers (T/R) into dc power (refer to FO-8). One generator is capable of assuming the full ac power load and one T/R is capable of assuming the full dc power load. Additionally, a hydraulically driven emergency generator provides an independent backup supply of both ac and dc power for electrical operation of essential buses. Ground operation of all electrically powered equipment is provided through the supply of external ac power to the aircraft. Switching between power supply systems is automatically accomplished without pilot action; however, sufficient control is provided for the flightcrew to selectively isolate power sources and distribution in emergency situations. See Figure 2-37 for a functional description of the control switches. All electrical circuits are protected by circuit breakers accessible in flight to the pilot and RIO.

2.15.1 Normal Electrical Operation

2.15.1.1 Main Generators. Two engine-driven, oil-cooled, IDGs produce the normal 115-volt, 400 Hz, three-phase ac electrical power. The normal rated output of each generator is 75 kVA. Each main ac generator is controlled by a separate switch on the pilot MASTER GEN control panel. Indication of a main power supply malfunction is provided by a L GEN and R GEN caution light. The IDG oil system is used for cooling as well as lubricating the IDG. The oil is normally cooled by the IDG air/oil cooler and returned to the constant speed drive for recirculation. When AB is used, additional cooling is provided by the AB fuel/oil cooler before returning to the IDG. Should an excessive amount of heat be developed in an IDG, a thermal (390 °F) actuated device automatically decouples the input shaft from the remainder of the CSD, protecting both the CSD and generator. There are no provisions for recoupling the IDG unit in flight.



NOMENCLATURE	FUNCTION	
(1) MASTER GEN switch (lock lever)	NORM	Connects the generator to the main buses through the line contactor.
	OFF/RESET –	Disconnects generators from the buses. Reset the generator if tripped by an overvoltage, undervoltage, or fault condition.
	TEST –	The generators are energized but are not connected to the buses. Provides a means to analyze a system malfunction indicated by a generator caution light when an attempt to reset a generator is unsuccessful.
(2) EMERG generator switch	NORM –	Safety guard down. Emergency generator is automatically connected to the essential buses if both dc power sources fail.
	OFF/RESET	Safety guard must be lifted. Disconnects the emergency generator from the essential buses. Resets the generator if tripped by an undervoltage or underfrequency condition.
(3) L GEN and R GEN caution lights	GEN caution lights are on the pilot's caution/advisory light panel. Each light is tied to its respective main ac contactor and is powered by the essential bus no. 2. Illumination of the L GEN or R GEN caution light indicates that the corresponding generator is not supplying power due to a fault in the generator, generator control unit, or electrical distribution system.	
(4) TRANS/RECT advisory light	A TRANS/RECT advisory light is on the lower half of the pilot's caution/advisory indicator panel. Illumination of the TRANS/RECT advisory light indicates either a single or dual transformer-rectifier failure has occurred.	

Figure 2-37. Generator Panel

CAUTION

Failure of the weight-on-wheels circuit to the in-flight mode while on the deck will cause the loss of ECS engine compartment air ejector pumps, causing a subsequent IDG disconnect and illumination of the GEN light.

2.15.1.1.1 Generator Control Units. Generator output voltage and frequency are individually monitored by GCUs, that prevent application of internally generated power to the aircraft bus system until the generator output is within prescribed operating limits. With the main generator switch in NORM, the applicable generator is self-excited, so that during the engine start cycle, it automatically comes on the line at approximately 60-percent rpm under normal load conditions. Likewise, during engine shutdown, the GCU automatically trips the generator off the line as the power output decreases below prescribed limits at approximately 55 percent.

During normal operations, the generator control switches remain in NORM continuously. However, subsequent to an engine shutdown, stall, or flameout in flight where the GCU has tripped the generator off the line, the reattainment of normal engine operation will not automatically reset the generator unless the engine speed decreases below about 30-percent N_2 rpm. If a transient malfunction or condition causes the generator to trip, the generator must be manually reset by cycling the applicable generator control switch to OFF/RESET then back to NORM.

When normal reset cannot be accomplished, TEST, on the generator control switch, allows the generator to be excited but not connected to the aircraft buses. In test, a CSD, generator, or GCU failure causes the GEN light to remain illuminated. If the light goes out, the problem is in the distribution system.

2.15.1.2 Transformer-Rectifiers. Two transformer-rectifiers convert internal or external ac power to 28-Vdc power. A single TRANS/RECT advisory light on the pilot advisory panel provides failure indication for one or both transformer-rectifiers. No flightcrew control is exercised over transformer-rectifier operation aside from controlling the ac power supply or circuit breakers for the power converters. The transformer-rectifiers have a rated output of 100 amperes each. Each unit is capable of assuming the complete dc electrical load of the aircraft. Forced air cooling is provided with engines running to dissipate the heat generated by the power converters.

2.15.1.3 External Power. Ground power is applied through a receptacle just aft of the nosegear. The pilot has control over external power application only through hand signals to the plane captain. An external power monitor prevents application of external power that is not within tolerances and disconnects external power from the buses if undervoltage, overvoltage, underfrequency, overfrequency, or phase-reversal occurs. Power can be reapplied to the aircraft by pressing the reset button adjacent to the receptacle, provided it is within prescribed limits. External electrical power is automatically inhibited from HUD, MFD, AICS, APX-76, CADC, and CIU without external air-conditioning connected to the aircraft. When the left generator comes on the line during start, it automatically disconnects external power. Although there is no direct cockpit indication of external power being applied after one generator is operating, the HYD TRANSFER PUMP will not operate if the external power plug is still in the aircraft receptacle.

2.15.2 Electrical Power Distribution. Electrical power is distributed through a series of buses. Under normal operation, the ac generator power distribution is split between the left and right main ac buses. Failure of either main ac generator trips a tie connector to connect both buses to the operative generator. If the bus tie fails to trip when the generator goes bad, the respective transformer-rectifier will not be powered and the indication of this double failure will be a L GEN or R GEN caution light and a TRANS/RECT advisory light. The left and right main ac buses in turn supply ac power directly to the respective transformer-rectifiers, and the left main ac bus also supplies power to both essential ac buses under normal operation.

External power is distributed through the aircraft electrical system in the same manner as main generator power. Like the main ac generators, dc power distribution from the two transformer-rectifiers under normal operations is split between the left and right main dc buses. Failure of either transformer-rectifier trips the respective tie contactor to connect both main dc buses to the operative transformer-rectifier. The TRANS/RECT advisory light provides a direct indication of dc bus tie status. An interruption-free dc bus interconnects the left and right main dc buses to provide a continuous source of dc power with failure of either main ac generator and/or transformer-rectifier. The left main dc bus additionally supplies power to both essential dc buses under normal operations. Power to the AFCS bus is normally supplied from the interruption-free dc bus; however, with an output failure from both transformer-rectifiers, the AFCS bus load is automatically transferred to the essential No. 2 bus. Loss of main dc power automatically activates the emergency generator, which, in turn, trips power transfer relays to change essential ac and dc bus loading from the left main ac and dc buses to the emergency generator, regardless of main generator output status.

2.15.2.1 Circuit Breakers. Individual circuit protection from an overload condition is provided by circuit breakers, which are all located in the cockpits for accessibility in flight. The appropriate circuit breaker will pop out and isolate a circuit that draws too much current, thus preventing equipment damage and a possible fire.

CAUTION

> Popped circuit breakers should not be reset more than once nor held depressed unless the associated equipment is absolutely required by operational necessity. A popped circuit breaker indicates an equipment malfunction or an overload condition. Repeated resets or forced depressions of popped circuit breakers can result in equipment damage and/or serious electrical fire.

Cockpit circuit breaker panels are shown on FO-8 and FO-9. Circuit breakers in the pilot cockpit comprise the majority of those required for essential aircraft systems. The circuit breakers are arranged in rows and are oriented so that the white banded shaft of popped breakers is readily visible for flightcrew surveillance. Panels, rows, and columns of breakers are identified to facilitate breaker location and designation. Placards adjacent to the breakers identify individual circuit breakers by affected components; amperage ratings are indicated on top of each circuit breaker.

2.15.2.1.1 Circuit Breaker Location. The alphanumeric system for locating circuit breakers in the aircraft is as follows.

The panels in the RIO cockpit are labeled 1 through 9 starting left-aft and proceeding clockwise (see Figure 2-38). Thus, panels 1 to 5 are on the RIO's left and panels 6 to 9 are on the RIO's right. The pilot left and right knee panels are designated L and R, respectively.

The first digit in the three-part locator is the alphanumeric that identifies the circuit breaker panel. The second part is a letter and designates the row in which the circuit breaker will be found. The top row is designated A, the next row lower is B, etc. The third part is a number and designates the column in which the circuit breaker will be found. The innermost column of each panel 1, 2, 5, 8, and 9 or aft most column on each panel 3, 4, 6, 7 L and R is designated "1," the next outboard/forward column is 2, etc. Figure 2-38 is an alphanumeric listing of circuit breakers.

Note

- Panel No. 1 row A, the column numbering is different from rows B to J.
- Panel No. 2 rows A to F, the column numbering is different from Rows G to I.

2.15.3 Degraded Electrical Operation

2.15.3.1 Emergency Generator. The emergency generator provides a limited but independent backup source of ac (5 kVA, 115/200 volts) and dc (50 amperes, 28 volts) power for flight-essential components. It is driven by combined hydraulic system pressure.

With the normal combined hydraulic system operation, the emergency generator powers the essential ac and dc No. 1 and No. 2 buses and the AFCS dc bus. Operation of the generator is automatically initiated with the loss of dc left main bus even if other dc buses remain energized. Approximately 1 second elapses from the time of automatic initiation before the generator delivers rated power to flight-essential ac and dc buses.

Pilot control of the emergency generator is through the guarded EMERG switch on the MASTER GEN control panel. With the switch in NORM, the emergency generator is automatically activated when all main ac or dc power is lost. The switch OFF/RESET provides the pilot with the capability of isolating emergency electrical power from the aircraft buses (as in the case of an electrical fire) or resetting the generator.

2.15.3.1.1 Emergency Power Distribution. An emergency generator control unit monitors the emergency generator output. If it senses that the emergency generator cannot supply power within the proper frequency and voltage tolerances, it disconnects the essential ac and dc essential No. 2 and the dc AFCS buses from the emergency generator. It is possible that this could happen if the combined hydraulic system is not operating normally. If combined hydraulic pressure subsequently recovers, the emergency generator switch must be cycled through OFF/RESET and back to NORM to regain the essential No. 2 and AFCS buses.

3F6	26 VAC BUS FDR
3F7	AC ESS BUS NO. 2 FDR PH A
4F1	AC ESS BUS NO. 2 FDR PH B
4F2	AC ESS BUS NO. 2 FDR PH C
2I4	ACM LT/SEAT ADJ/STDY POS LT
3C6	ADF AC
8D6	ADF DC
8B1	AFCS BUS FDR
RC2	AFCS/NOSE WHEEL STEER
LF1	AICS L
2I5	AICS L HTR
8E2	AICS L LKUP PWR/EMER GEN TST
7A6	AICS L RAMP STOW
LG1	AICS R
2I8	AICS R HTR
8E1	AICS R LKUP PWR/ANTI SKID
7A5	AICS R RAMP STOW
RD2	AIR SOURCE CONTROL
8C2	AIR/ANTI ICE CONTR HOOK CONT/ WSHLD
9B6	ALE−39 CHAFF/FLARE DISP
9B5	ALE−39 SEQ 1 & 2 SQUIBS
RB1	ALPHA COMP/PEDAL SHAKER
4F4	ALPHA HTR
2H1	ALR−67 CMPTR
2H3	ALR−67 RCVR PH A
2H6	ALR−67 RCVR PH B
2H9	ALR−67 RCVR PH C
7B6	ALT LOW WARN
9F5	ALR−67 CONTR
9D1	AMC BIT/R DC, TEST
7A3	ANGLE OF ATTACK IND DC
3F3	ANGLE OF ATTK IND AC
4F5	ANL ATTK/TOTAL TEMP HTR
9C2	ANN PNL DIM CONTR
8C1	ANN PNL PWR
9A6	ANT LOCK EXCIT
1C2	ANT SVO HYD PH A
1C4	ANT SVO HYD PH B
1C6	ANT SVO HYD PH C
8C2	ANTI ICE CONTR HOOK CONT/WSHLD/ AIR
8E1	ANTI SKID/R AICS LKUP PWR
2I1	ANTICOLL/SUPP POS/POS LT
RG2	ANTI−ICE/ENG/PROBE
6C3	AN/AWW 4 PH A
6C2	AN/AWW 4 PH B
6C1	AN/AWW 4 PH C
9A2	APG−71 ANT
2G3	APG−71 PUMP PH A
2G6	APG−71 PUMP PH B
2G7	APG−71 PUMP PH C
9A3	APG−71 XMTR DC
1I1	APG−71 XMTR AC
8E6	APN−154
4D6	APX−100 AC
7F7	APX−100 DC
7C2	ARC−182 NO. 1
7C1	ARC−182 NO. 2
8A5	ARMT GAS/L ENG AFT CONT/RAT IND
9A4	ASC
1D2	ASC PH A
1D5	ASC PH B
1D6	ASC PH C
1F1	ASPJ AUG PH A
1F3	ASPJ AUG PH B
1F6	ASPJ AUG PH C
1F2	ASPJ BASIC PH A
1F4	ASPJ BASIC PH B
1F5	ASPJ BASIC PH C
9G5	ASPJ DC
9G6	ASW−27
1J2	ASW−27 AC
LA3	AUTO PITCH DRIVE TRIM
1J1	AUTO THROT AC
9B7	AUTO THROT DC
8G3	AUX FLAP/FLAP CONTR
3B5	BARO ALTM AC
7D3	BARO ALT/TURN SLIP
3D4	BDHI INST PWR/JTIDS/DPG
8E7	BDHI/JTIDS DPG
1B3	BEAM PS
8F6	BINGO CAUTION
8F2	BLEED AIR/L OIL HOT
4B4	BLEED DUCT AC
7A4	BOS CONTR/B/U OXY LOW
9D5	BRAKE ACCUM SOV
7A2	B/U OXY PRESS IND
8A1	CABIN PRESS
8C5	CAN/LAD CAUTION/EJECT CMD IND
LA2	CHAN 1 CADC PH A
LB2	CHAN 1 CADC PH B
LC2	CHAN 1 CADC PH C
LD2	CHAN 2 CADC
3E7	CIU PH A
4E1	CIU PH B
4E2	CIU PH C
3B3	COMB HYD PRESS IND
9F4	COOLING INTLK/GND PWR
8D8	CURSOR CONT/SNSR

Figure 2-38. Circuit Breaker Alphanumeric Index (Sheet 1 of 5)

7B5	DC ESS NO. 1 FDR
8A2	DC ESS NO. 2 FDR
7A7	DC L TEST/RUDDER TRIM
9D1	DC R TEST/AMC BIT
9B2	DD ENABLE/RDP
9I6	DEKI
3A5	DEKI LTS
3F4	DP 1 PH A
4F3	DP 1 PH B
4F6	DP 1 PH C
1G2	DP 2 PH A
1G4	DP 2 PH B
1G6	DP 2 PH C
9G3	DSS
RE1	DUMP/FUEL FEED
9E7	DYHR UNIT
8D4	ECS TEMP CONTR DC
4A3	EIG WHT LTS
9H3	ELECT COOLING
7B2	EMER FLT HYD AUTO
7B1	EMER FLT HYD MAN
9I2	EMER GEN CONTR
8E2	EMER GEN TEST/L AICS LKUP PWR
7E3	EMER JETT #1
7E2	EMER JETT #2
RC1	ENG ANTI−ICE VALVES
7D5	ENG INST NO. 1
7D4	ENG INST NO. 2
8A5	ENG L AFT CONT/ARMT GAS/RATS IND
3A3	ENG L BACKUP IGN
3B1	ENG L OIL PRESS
8A4	ENG R AFT CONT/EXAHUST NOZZLE
3A4	ENG R BACKUP IGN
3B2	ENG R OIL PRESS
8D1	ENG OIL COOL
8D3	ENG SEC
8F10	ENG STALL TONE
RF1	ENG START
RG2	ENG/PROBE/ANTI−ICE
8A4	EXHAUST NOZZLE/R ENG AFT CONT
8G10	EXT LT CONTR
9D2	FEMS
7C7	FIRE L DET LT
7C5	FIRE L EXT
7C6	FIRE R DET LT
7C4	FIRE R EXT
8G3	FLAP CONTR/AUX FLAP
3D6	FLAP IND/TAIL/RUDDER
RA2	FLAP/SLAT CONTR SHUT−OFF
9B6	FLARE DISP/ALE−39 CHAFF
LC1	FLT CONTR AUTH AC
RF2	FLT CONTR AUTH DC
2A1	FLT HYD BACKUP PH A
2C1	FLT HYD BACKUP PH B
2E1	FLT HYD BACKUP PH C
3B4	FLT HYD PRESS IND
3A2	FORM LT/TAXI
RE1	FUEL FEED/DUMP
8F7	FUEL LOW CAUTION
RD1	FUEL MGT PNL
8F1	FUEL PRESS ADVSY
RG1	FUEL P/MOTIVE FLOW ISOL V
3C3	FUEL QTY IND AC
7D1	FUEL QTY IND DC
8E4	FUEL TRANS ORIDE
8F9	FUEL VENT VALVE
8F5	GEN L CAUTION
8F4	GEN R CAUTION
9F4	GND PWR/COOLING INTLK
8G1	GND ROLL BRAKING/SPOILER POS IND
9D6	GND TEST
6A1	GUN CONTRL PWR AC
5D2	GUN PWR NO. 1
5C2	GUN PWR NO. 2
1H1	HUD CAMERA PH A
1H5	HUD CAMERA PH B
1H7	HUD CAMERA PH C
3C1	HUD PH A/MFD 1
4C5	HUD PH B/MFD 1
4C6	HUD PH C/MFD 1
1A1	HV PWR SUP PH A
1A3	HV PWR SUP PH B
1A5	HV PWR SUP PH C
7B3	HYD PRESS IND
8G11	HYD PUMP SPOILER CONTR
8E5	HYD VALVE CONTR
LE3	ICE DET
7F3	ICS NFO
7F2	ICS PILOT
1J7	IFF A/A AC
9F6	IFF A/A DC
8C7	ILS ARA−63 DC
3E5	ILS ARA−63 PH A
4E3	ILS ARA−63 PH B
4E4	ILS ARA−63 PH C
8G9	INBD SPOILER CONTR
1I7	INS BAT PWR
3C7	INS PH A

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Figure 2-38. Circuit Breaker Alphanumeric Index (Sheet 2 of 5)

4C1	INS PH B
4C2	INS PH C
3E4	INS SYNC
3A1	INST LTS
3F5	INSTR BUS FDR
1I2	INTEG TRIM AC
9F3	INTEG TRIM DC
9I5	INTRF BLANKER
9I1	INTRPT FREE DC BUS FDR NO. 1
9C6	INTRPT FREE DC BUS FDR NO. 2
9D4	IRST DC
2G2	IRST PH A
2G5	IRST PH B
2G8	IRST PH C
1J4	JTIDS BATT HEATER
1J3	JTIDS DPG PH A
1J5	JTIDS DPG PH B
1J6	JTIDS DPG PH C
8E7	JTIDS DPG/BDHI
3D5	JTIDS RT PH A
4D3	JTIDS RT PH B
4D4	JTIDS RT PH C
3D4	JTIDS/DPG/BDHI INST PWR
7C3	KY-58/Z-AHP
LF1	L AICS
2I5	L AICS HTR
8E2	L AICS LKUP PWR/EMER GEN TST
7A6	L AICS RAMP STOW
7A7	L DC TEST/RUDDER TRIM
8A5	L ENG AFT CONT/ARMT GAS/RATS IND
3A3	L ENG BACKUP IGN
3B1	L ENG OIL PRESS
7C7	L FIRE DET LT
7C5	L FIRE EXT
8F5	L GEN CAUTION
1A8	L MAIN XFMR RECT
8F2	L OIL HOT/BLEED AIR
3B7	L PH A TEST/P–ROLL TRIM
4B1	L PH B TEST/P–ROLL TRIM
4B2	L PH C TEST/P–ROLL TRIM
4E5	L PITOT STATIC HTR
8C5	LAD CAUTION/EJECT CMD IND/CAN
2H10	LIQUID COOLING CONTR AC
9B4	LIQUID COOLING CONTR DC
LE2	MACH TRIM AC
RE2	MACH TRIM DC
1A8	MAIN L XFMR RECT
2F4	MAIN R XFMR RECT
LE1	MANUV FLAP/WG SWP DR NO. 2
5A2	MASTER ARM
9H4	MASTER TEST
9G4	MFA
3C1	MFD 1/HUD PH A
4C5	MFD 1/HUD PH B
4C6	MFD 1/HUD PH C
1G1	MFD 2/MFD 3 PH A
1G3	MFD 2/MFD 3 PH B
1G5	MFD 2/MFD 3 PH C
1G1	MFD 3 PH A/MFD 2
1G3	MFD 3 PH B/MFD 2
1G5	MFD 3 PHC/MFD 2
8G5	MLG HANDLE RLY NO. 1
8G4	MLG HANDLE RLY NO. 2
7F5	MLG SAFETY RLY NO. 1
7F4	MLG SAFETY RLY NO. 2
9D3	MONITOR BUS CONTR
RG1	MOTIVE FLOW ISOL V/FUEL P
5B2	MPRU DC PWR
6D3	MPRU PH A/SMP
6D2	MPRU PH B/SMP
6D1	MPRU PH C/SMP
8B7	MSI PWR HUD TEST
6B3	MSL PWR SUP PH A
6B2	MSL PWR SUP PH B
6B1	MSL PWR SUP PH C
3C5	MSN CMPTR NO. 2 PH A
4C3	MSN CMPTR NO. 2 PH B
4C4	MSN CMPTR NO. 2 PH C
1D1	MSN CMPTR NO. 1 PH A
1D3	MSN CMPTR NO. 1 PH B
1D7	MSN CMPTR NO. 1 PH C
8A3	NLG STRUT LCH BAR ADVSY
RC2	NOSE WHEEL STEER/AFCS
2I2	NFO CONSOLE LT
3C4	OBOGS CONC
7A1	OBOGS CONTR
8F2	OIL L HOT/BLEED AIR
8D2	OIL R HOT
9C5	OUTBD SPOILER CONTR
2B3	OUTBD SPOILER PUMP
2H5	OXY CONC HTR
3C4	OXY QTY IND
8F6	OXY/BINGO CAUTION

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Figure 2-38. Circuit Breaker Alphanumeric Index (Sheet 3 of 5)

3B7	P–ROLL TRIM/L PH A TEST
4B1	P–ROLL TRIM/L PH B TEST
4B2	P–ROLL TRIM/L PH C TEST
4A6	PANEL FLOOD LTS
RB1	PEDAL SHAKER/ALPHA COMP
3B7	PH A L TEST/P–ROLL TRIM
4B1	PH B L TEST/P–ROLL TRIM
4B2	PH C L TEST/P–ROLL TRIM
2H2	PH A R TEST
2H4	PH B R TEST
2H8	PH C R TEST
4A5	PILOT CONSOLE LTS
4A3	PILOT LCD INST LTS
8B3	PITCH CMPTR DC
LB1	PITCH CMPTR AC
4E5	PITOT STATIC HTR L
4E6	PITOT STATIC HTR R
8F3	PLT ANN PNL AUX PWR/TR ADVSY
2I1	POSLT/ANTICOLL/SUPP POS
4A4	PROBE LT
RG2	PROBE/ANTI–ICE/ENG
LG1	R AICS
2I8	R AICS HTR
8E1	R AICS LKUP PWR/ANTI SKID
7A5	R AICS RAMP STOW
8A5	RAT IND/L ENG AFT CONT/ARMT GAS
9D1	R DC TEST/AMC BIT
8A4	R ENG AFT CONT/EXHAUST NOZZLE
3A4	R ENG BACKUP IGN
3B2	R ENG OIL PRESS
7C6	R FIRE DET LT
7C4	R FIRE EXT
8F4	R GEN CAUTION
2E4	R MAIN XFMR RECT
8D2	R OIL HOT
2H2	R PH A TEST
2H4	R PH B TEST
2H8	R PH C TEST
4E6	R PITOT STATIC HTR
4B3	RADAR ALTM
1C3	RADAR DD PH A
1C5	RADAR DD PH B
1C7	RADAR DD PH C
9B1	RDP
1E4	RDP PH A
1E5	RDP PH B
1E6	RDP PH C
9B2	RDP/DD ENABLE

2G4	RECON ECS CONT AC
9E1	RECON ECS CONT DC
2B1	RECON HTR PWR PH A
2D1	RECON HTR PWR PH B
2F1	RECON HTR PWR PH C
1E2	RECON POD
9E2	RECON POD CONTR
9E4	RECON POD DC PWR NO. 1
9E3	RECON POD DC PWR NO. 2
1A8	RECT/L MAIN XFMR
4A6	RED FLOOD LTS
5K1	REL PWR/STA 1 TYPE I DCDR
5J1	REL PWR/STA 1 TYPE II DCDR
5I1	REL PWR/STA 3 DCDR
5H1	REL PWR/STA 4 DCDR
5G1	REL PWR/STA 5 DCDR
5F1	REL PWR/STA 6 DCDR
5E1	REL PWR/STA 8 TYPE I DCDR
5D1	REL PWR/STA 8 TYPE II DCDR
LA1	ROLL CMPTR AC
8B2	ROLL CMPTR DC
9A7	RSP
1B2	RSP PH A
1B5	RSP PH B
1B8	RSP PH C
3D7	RUDDER TRIM PH A
4D1	RUDDER TRIM PH B
4D2	RUDDER TRIM PH C
7A7	RUDDER TRIM/L DC TEST
3D6	RUDDER/FLAP IND/TAIL
9I3	SAHRS DC
1I3	SAHRS A
1I5	SAHRS B
1I6	SAHRS C
2I4	SEATADJ/STDY POS LT
RA2	SLAT CONTR SHUT–OFF/FLAP
7E5	SMP ESS
6D3	SMP/MPRU PH A
6D2	SMP/MPRU PH B
6D1	SMP/MPRU PH C
8D8	SNSR/CURSOR CONT
1B1	SOL PWR SUP PH A
1B4	SOL PWR SUP PH B
1B7	SOL PWR SUP PH C
RB2	SPD BK P–ROLL TRIM ENABLE
8G1	SPOILER POS IND/GND ROLL BRAKING
5D3	STA 1 AIM–9 COOL
2I10	STA 1 BOL PWR
5I3	STA 1 IFOL

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Figure 2-38. Circuit Breaker Alphanumeric Index (Sheet 4 of 5)

5H1	STA 1 TYPE I DCDR/REL PWR
5G1	STA 1 TYPE II DCDR/REL PWR
6A3	STA 1A AIM−9 PWR AC
5B3	STA 1A AIM−9 PWR DC
5J2	STA 1B NO. 1/2 DC
6A6	STA 1B PWR PH A
6A5	STA 1B PWR PH B
6A4	STA 1B PWR PH C
5F1	STA 3 DCDR/REL PWR
5I2	STA 3 NO. 1/2 DC
6B6	STA 3 PWR PH A
6B5	STA 3 PWR PH B
6B4	STA 3 PWR PH C
5H3	STA 3/6 IFOL
5E1	STA 4 DCDR/REL PWR
5H2	STA 4 NO. 1/2 DC
6C6	STA 4 PWR PH A
6C5	STA 4 PWR PH B
6C4	STA 4 PWR PH C
5G3	STA 4/5 IFOL
5D1	STA 5 DCDR/REL PWR
5G2	STA 5 NO. 1/2 DC
6D6	STA 5 PWR PH A
6D5	STA 5 PWR PH B
6D4	STA 5 PWR PH C
5C1	STA 6 DCDR/REL PWR
5F2	STA 6 NO. 1/2 DC
6E6	STA 6 PWR PH A
6E5	STA 6 PWR PH B
6E4	STA 6 PWR PH C
5C3	STA 8 AIM−9 COOL
2I9	STA 8 BOL PWR
5F3	STA 8 IFOL
5E1	STA 8 TYPE 1 DCDR/REL PWR
5A1	STA 8 TYPE II DCDR/REL PWR
6F3	STA 8A AIM−9 PWR AC
5A3	STA 8A AIM−9 PWR DC
5E2	STA 8B NO. 1/2 DC
6F6	STA 8B PWR PH A
6F5	STA 8B PWR PH B
6F4	STA 8B PWR PH C
8F8	STARTER VALVE LT

3A7	STBY ATTD IND PH A
4A1	STBY ATTD IND PH B
4A2	STBY ATTD IND PH C
2I1	SUPP POS/POS LT/ANTICOLL
2I6	STORM FLOOD LTS
3D6	TAIL/RUDDER/FLAP IND
3A2	TAXI/FORM LT
1H2	TCS PH A
1H3	TCS PH B
1H6	TCS PH C
9C3	TCS SEL
4B5	TEMP CONT AC
4F5	TOTAL TEMP HTR/ANL ATTK
8F3	TR ADVSY/PLT ANN PNL AUX PWR
7D3	TURN SLIP/BARO ALT
7F6	UHF CONTR/VHF
3A6	UTILITY LTS
7F6	VHF/UHF CONTR
LE1	WG SWP DR NO. 2/MANUV FLAP
7D6	WHEELS POS IND
2I6	WHITE FLOOD LT
3F2	WING POS IND AC
7D2	WING POS IND DC
LD1	WING SWEEP DRIVE NO. 1
8C3	WSHLD DEFOG CONTR
8C2	WSHLDAIR/ANTI ICE CONTR/HOOK CONT
8B6	YAW SAS A
LD3	YAW SAS A PWR SUP
8B5	YAW SAS B
LC3	YAW SAS B PWR SUP
8B4	YAW SAS M
LB3	YAW SAS M PWR SUP
3F6	26 VAC BUS FDR

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Figure 2-38. Circuit Breaker Alphanumeric Index (Sheet 5 of 5)

The exact pressure at which the emergency generator is unable to power all three buses is dependent on the load placed on the generator and can vary from 2,000 to 1,100 psi indicated. If the emergency generator is required and there is a hydraulic emergency that could lower combined system operating pressure, the essential ac and dc No. 2 and AFCS buses can be powered with lower hydraulic pressure by reducing the electrical load, such as turning off the HUD and not jettisoning ordnance.

Note

When the emergency generator is operating with one main hydraulic system inoperative, large hydraulic flow requirements for flight controls may cause loss of the essential ac and dc No. 2 and AFCS buses. To regain these buses the emergency generator switch must be cycled through OFF/RESET to NORM after the hydraulic pressure recovers. Engine instruments are powered by essential ac bus No. 1. Engine instruments will be available or restored at lower engine rpm. The airspeed at which engine instrumentation is restored (either automatically or by pilot cycling the emergency generator switch) could be higher than minimum airspeed.

2.15.3.1.2 Emergency Generator Test. An operational check of the emergency generator can be accomplished anytime the combined system is pressurized and at least one main generator is on the line by selecting EMERG GEN on the master test switch and depressing the switch. This provides 28 Vdc to activate the emergency motor-generator and checks the tie contactors by connecting electrical power to the essential ac and dc buses. The GO light on the MASTER TEST panel indicates a satisfactory check. A malfunction in the emergency generator operation is indicated by the NO GO light.

2.16 HYDRAULIC POWER SUPPLY SYSTEMS

The aircraft employs two main, independent, engine-powered hydraulic systems, supplemented by two electrohydraulic power modules, a bidirectional transfer unit, and a cockpit handpump. The systems are pressurized to 3,000 psi and use MIL-H-83282 hydraulic fluid circulated through stainless steel and titanium lines. Hydraulic fluid is cooled by heat exchangers that use ejector air on deck. Hydraulic power system controls and indicators are shown in Figure 2-39. The components serviced by each hydraulic power system are shown on FO-10.

2.16.1 Flight and Combined Systems

2.16.1.1 Engine-Driven Pumps. The flight and the combined systems are each pressurized by engine-driven pumps. The flight hydraulic system pump is driven by the right engine and the combined hydraulic system pump by the left engine. Each of the main systems is normally pressurized to 3,000 ±100 psi at any time the respective engine is operating.

2.16.1.2 Hydraulic Pressure Light. A HYD PRESS caution light illuminates when the discharge pressure from either engine-driven hydraulic pump falls below 2,100 psi; thereafter, the light goes out when pressure in both systems via the engine-driven pumps exceeds 2,400 psi. If the HYD PRESS caution light has been illuminated by low pressure in one main system, pressure failure in the other system will not cause the MASTER CAUTION light to illuminate again. The COMB and FLT gauges on the hydraulic pressure indicator reflect system pressure provided by either the engine-driven pumps or the hydraulic transfer pump. With both systems normally pressurized to 3,000 psi, the gauge needles form a horizontal line.

Note

High-rate lateral movements may illuminate the HYD PRESS light when engines are at idle power.

2.16.1.3 Hydraulic Transfer Pump (Bidirectional Pump). To assure the continuance of main system hydraulic pressure with an engine or engine-driven pump inoperative, a second source of pressure is provided by the hydraulic transfer pump. This unit consists of two hydraulic pumps, one in each of the main hydraulic systems, interconnected by a common mechanical shaft. Thus, a pressure deficiency in one system is automatically augmented using pressure in the other system as the motive power. The result is bidirectional transfer of energy without an interchange of system fluid. The efficiency of the pump is such that a 3,000 psi system on one side will pressurize the other system to approximately 2,400 to 2,600 psi.

To prevent damage to the hydraulic transfer pump with the loss of system fluid on one side and to conserve hydraulic power in the remaining good system, the pump is automatically secured when pressure less than 500 psi is detected on either side of the pump for 10 seconds. In addition, the pilot can manually shut off the hydraulic transfer pump by lifting the guarded HYD TRANSFER PUMP switch, located aft on the right outboard console.

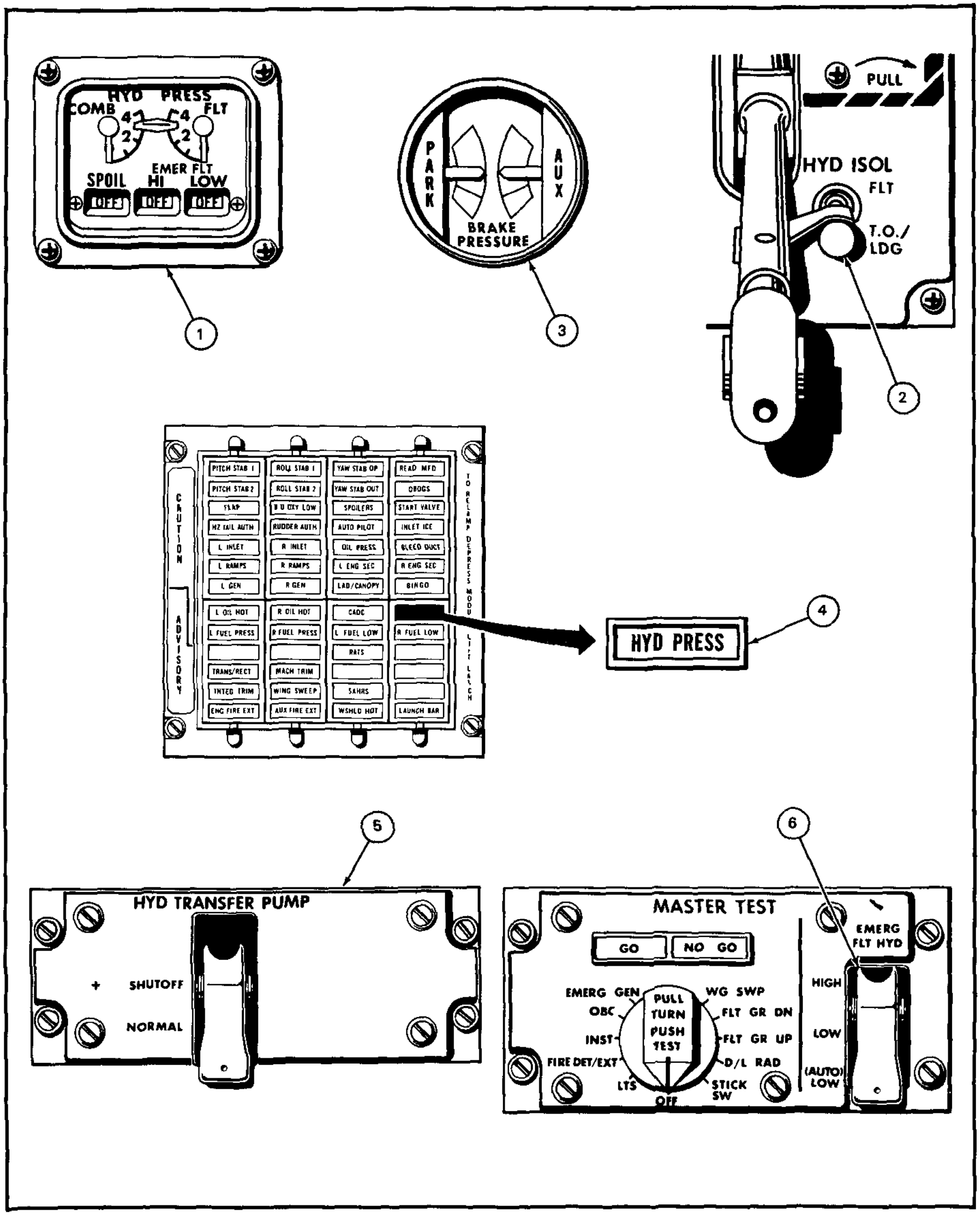

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Figure 2-39. Hydraulic System Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE		FUNCTION
(1) HYD PRESS indicator	COMB and FLT –	Indicates pump discharge pressure on each engine, normally 3,000 psi, or hydraulic transfer pressure approximately 2,400 psi.
	SPOIL –	When the outboard spoiler hydraulic module is pressurized (1,950 to 2,050 psi) the ON flag appears. Pressure below 1,900 to 1,800 psi: the OFF flag appears.
	EMER FLT –	When pressure from the backup flight control hydraulic module reaches 500 ± 50 psi the ON flag appears. Pressure below 350 ± 50 psi: the OFF flag appears.
(2) HYD ISOL switch	FLT –	Combined system hydraulic pressure is shutoff to landing gear, nosewheel steering, antiskid, and wheel brakes.
	T.O./LDG –	Hydraulic pressure is available to all combined system components.
(3) BRAKE PRESSURE gage	AUX –	Green segment indicates hydraulic pressure (2,150 ± 50 to 3,000 psi) in the auxiliary brake accumulator; auxiliary braking may be applied by rudder toe pedals (approximately 13 to 14 applications available). Red segment indicates 1,900 to 2,150 psi (approximately 5 applications available).
	PARK –	Green segment indicates hydraulic pressure (2,150 ± 50 to 3,000 psi) in the parking brake accumulator. The parking/emergency brake handle must be pulled to apply emergency braking (approximately 3 applications available). Red segment indicates 1,900 to 2,150 psi.
(4) HYD PRESS caution light	Illuminates when hydraulic pressure from either engine-driven pump is below 2,100 psi. It will go out with pressure in both systems at 2,400 psi or above, if pressure is provided by engine-driven pumps.	
(5) HYD TRANSFER PUMP switch	SHUTOFF –	Guard must be lifted. Shuts off hydraulic transfer pump. The pump should be secured when hydraulic pressure drops below 500 psi and does not rise again within 5 seconds.
	NORMAL – (Guarded)	Safety guard down. Pressure loss below 2,100 psi in one hydraulic system activates hydraulic transfer pump to supply pressure from the other system.
(6) EMERG FLT HYD switch	HIGH –	Guard must be lifted. Activates the power module (high speed mode) bypassing flight and combined 2,100-psi switches.
	LOW –	Guard must be lifted. Activates the backup power module (low-speed mode) bypassing flight and combined 2,100-psi switches.
	AUTO (LOW) –	Safety guard down. The backup flight control system is automatically activated (low-speed mode) when pressure in both the flight and combined systems is less than 2,100 psi.

Figure 2-39. Hydraulic System Controls and Indicators (Sheet 2 of 2)

CAUTION

If pressure in either system remains below 500 psi for 5 seconds, immediately lift the guard and select SHUTOFF with the HYD TRANSFER PUMP switch. Failure of the hydraulic transfer pump to automatically shut off after 10 seconds below 500 psi may cause the driving system to cavitate and overheat.

With ground electrical power connected to the aircraft, the hydraulic transfer pump is deactivated and can only be energized by a switch on the ground check panel. Normally, with both engines running, the hydraulic transfer pump is off. However with less than 2,100 psi hydraulic pump discharge pressure from either system, the pump will automatically come on and supply hydraulic power to the faulty system. The pilot has no direct control over the direction of pump flow, the system automatically shifts in the direction that supplemental power is required. Because of the location of the flight and combined system pressure switches, the pressurization contribution of the hydraulic transfer pump is reflected on the hydraulic pressure indicator but the HYD PRESS caution light will remain illuminated. Operation on the hydraulic transfer pump may produce slight pressure fluctuations. If the failed system discharge pressure is restored to normal operating pressure (>2,400 psi) by the engine-driven pump, this HYD PRESS light will go out and the hydraulic transfer pump will shut off.

2.16.1.4 Cockpit Handpump. A manually operated pump handle is provided as a supplementary source of power for ground operations with engines shut down and as a backup for the loss of combined system pressure to operate the in-flight refueling probe or charge the brake accumulator. It is an extendible handle in the pilot cockpit between the left console and ejection seat. Forward and aft stroking of the handpump operates a double-acting wobble pump. The pump, which draws fluid from the combined system return line, recharges wheelbrake accumulator pressure when the landing gear handle is down. It also serves as a backup means of extending or retracting the in-flight refueling probe by placing the REFUEL PROBE switch in the desired position (EXT or RET).

The handpump is the only means of pressurizing the radome fold actuator, an operation that must be manually selected and the radome unlocked on deck from the nose wheelwell. The operation rate using the handpump power source is a function of the number of components selected. The recommended rate of operation is approximately 12 cycles per minute (a cycle is a complete forward and aft movement of the pump handle).

2.16.2 Hydraulic Power Distribution. The distribution of hydraulic power in the flight and combined systems is shown on FO-10. Except for the left empennage control surfaces, the flight system services only those components on the right side of the aircraft and does not penetrate into the wings. The combined system distribution is more extensive throughout the aircraft, yet its services are predominantly concentrated to the left side and extend to the inboard sections of the movable wing panels and to the landing gear. Although the flight and combined systems are completely independent of each other, in certain components both pressure sources are used without an interchange of fluid. Both systems operate in parallel to supply power for operation of the primary flight control surfaces (except spoilers) and stability augmentation actuators; if one system fails, the other can continue to supply pressure for operation (with reduced power capability of such components). If either or both main hydraulic systems should fail, backup sources provide the capability for safe return flight and landing.

Major components in the combined and flight hydraulic power supply systems are shown on FO-10. Each system has a piston-type reservoir and filter module in the sponson aft of the main landing gear strut on the respective side (combined-left; flight-right). Protrusion of mechanical pins on each filter module indicates a clogged filter.

2.16.2.1 Hydraulic Priority Valves. The combined and flight hydraulic systems each incorporate two priority valves (1,800 psi and 2,400 psi) shown on FO-10. Hydraulic fluid will not pass through the one-way priority valves unless the input pressure exceeds the cracking threshold of the valve. Basically, the 2,400 psi priority valves give priority of the individual engine-driven pump discharge pressure to the primary flight controls (horizontal tails, rudders, inboard spoilers) and stability augmentation actuators. Conversely, the 1,800 psi priority valves give priority to the remaining systems on the other side (inlet ramps, wing sweep, etc.) with pressure supplied by the hydraulic transfer pump. Under such circumstances, the pilot should be aware of the hydraulic energy available and demands of the various system components. Large and abrupt control commands can rapidly consume total energy with the engine(s) at IDLE speed. For example, during a single-engine landing rollout, if excessive horizontal tail movements are commanded, the nosewheel steering and wheelbrake operation could be temporarily lost.

2.16.2.2 Normal Hydraulic Isolation. The combined system incorporates isolation circuits to limit distribution of flight essential components. With the LDG GEAR handle UP, normal isolation may be selected by the pilot to prevent loss of hydraulic fluid in the event of material failure or combat damage to the isolated systems. Normal isolation electrically shuts off hydraulic pressure to wheelbrakes, antiskid, landing gear, and nosewheel steering. It is activated by placement of the HYD ISOL switch to FLT on the landing gear panel. Placement of the gear handle to DN mechanically cams the HYD ISOL switch to T.O./LDG or the pilot can manually select it before lowering the landing gear. Such action returns all combined-system components to normal operation.

2.16.3 Outboard Spoiler System. The outboard spoilers are powered by a separate closed-loop system, independent of the main hydraulic systems (see Figure 2-40). An electrohydraulic power module supplies hydraulic pressure for outboard spoiler deflection and provides a backup power source for the main flaps and slats. Outboard spoiler operation is electrically inhibited at wing-sweep angles greater than 62° and the power module is deactivated at wing-sweep angles greater than 65°.

A thermal cutout circuit secures the system in the event of overheating. Normal operation is automatically restored when fluid temperature falls below the prescribed limit. The thermal cutout circuit is disabled with the gear handle down and weight off wheels to prevent overtemperature shutdowns during takeoff or landing. To avoid overheating because of prolonged ground operations, the outboard power module is deactivated with the flap handle up when on internal electrical power with weight on wheels.

Electrical power for the outboard spoiler system motor is supplied from the right main ac bus. The module can be activated using external ac electrical power. With the module pressurized, the ON flag appears in the SPOIL window at the bottom of the hydraulic pressure indicator; otherwise, an OFF indication is displayed in the window.

Reservoir servicing level is shown by an indicator rod protruding from the integral power package. A fluid temperature gauge that registers current and retained peak system temperatures is on the power module. Protrusion of a red-tipped pin on the integrated filter package is an indication of a clogged filter.

2.16.3.1 Flap and Slat Backup Operation. Although normal operation of the main flap and slat segments is powered by a combined system motor on the flap and slat gearbox, an auxiliary motor powered by the outboard spoiler system is geared to the same shaft to provide for emergency operation (retraction and extension) of the main flaps and slats at a reduced rate. Failure of combined system pressure activates the auxiliary motor to drive the flap and slat gearbox when selected by the normal flap handle or maneuvering flap thumbwheel.

2.16.4 Backup Flight Control System. The backup flight control system consists of a two-speed electrohydraulic power module known as the backup flight control module. The BFCM provides fluid energy to operate the horizontal tails and rudders at a reduced rate (see Figure 2-41). Emergency power provides sufficient pitch, roll, and yaw control for return flight and landing with both main hydraulic power systems inoperative.

Return flow from the combined side of the rudder and stabilizer actuators is first used to ensure the BFCM reservoir is filled. When filled, a reservoir bypass valve opens, which allows return flow to the combined system. A priority valve connects the BFCM return to the aircraft's combined system return. When the combined system pressure falls below 300 psi, the priority valve closes, isolating the BFCM return from the combined system return. When the combined pressure exceeds 500 psi, the priority valve opens allowing the backup system return to flow into the combined system return. A check valve isolates backup system pressure from the combined system when the BFCM is energized.

2.16.4.1 Backup Flight Control Operation. The BFCM may be operated in two modes: emergency and ground test. In the emergency mode, the BFCM is controlled by the EMERG FLT HYD switch, on the MASTER TEST panel. The switch has three positions: (AUTO) LOW, LOW, and HIGH mode. Electric power to the motor is supplied by the right main ac electrical bus through the FLT HYD BACKUP PH A (2A1), PH B (2C1), and PH C (2E1) circuit breakers located on right main ac circuit breaker panel (No. 2) in the rear cockpit. Loss of both engine-driven electrical generators eliminates in-flight use of the BFCM.

CAUTION

Never use the three-phase circuit breakers (PH A, PH B, and PH C) to start or shut off the BFCM as damage to the motor may result. These circuits must be engaged prior to any system test.

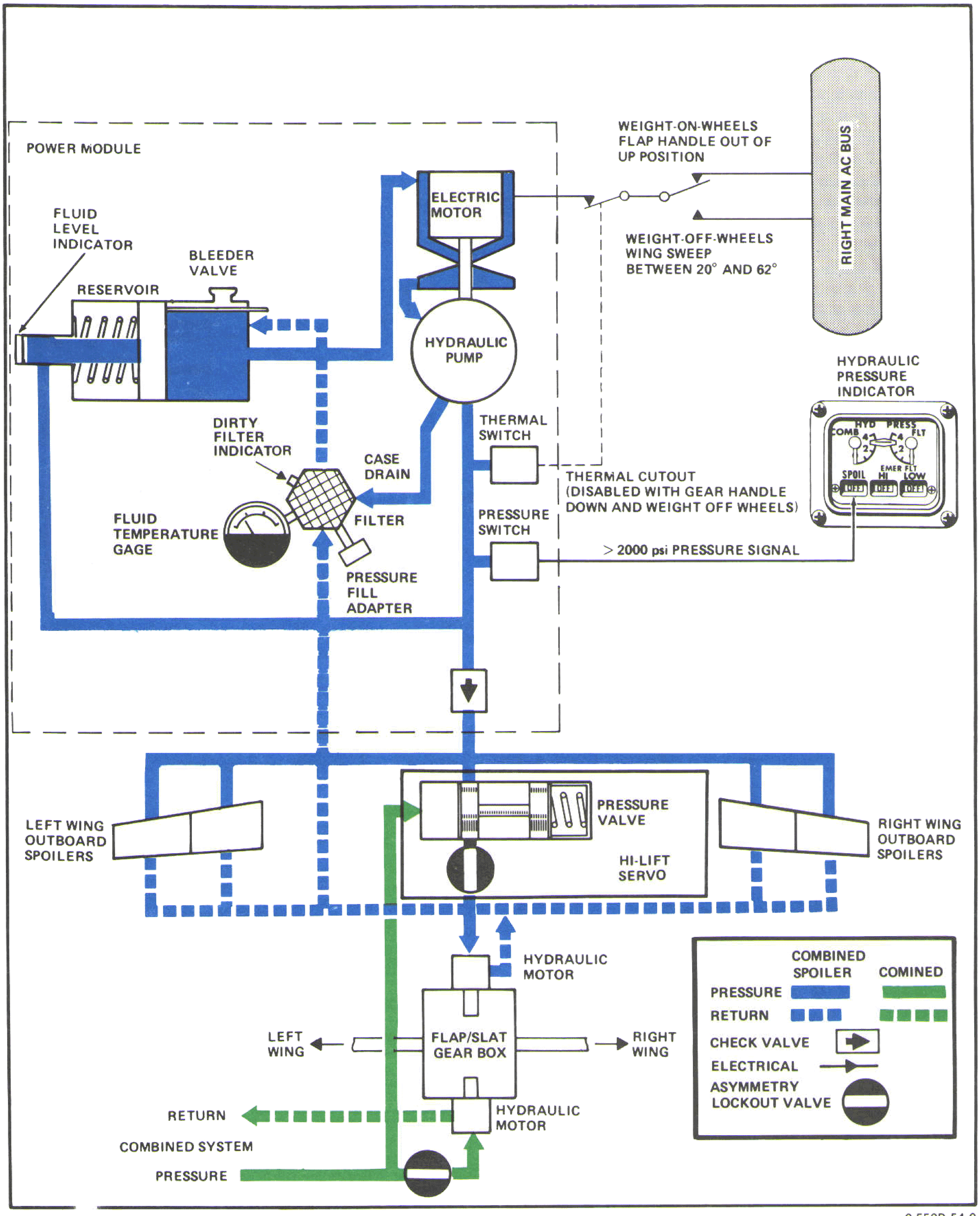


Figure 2-40. Outboard Spoiler System

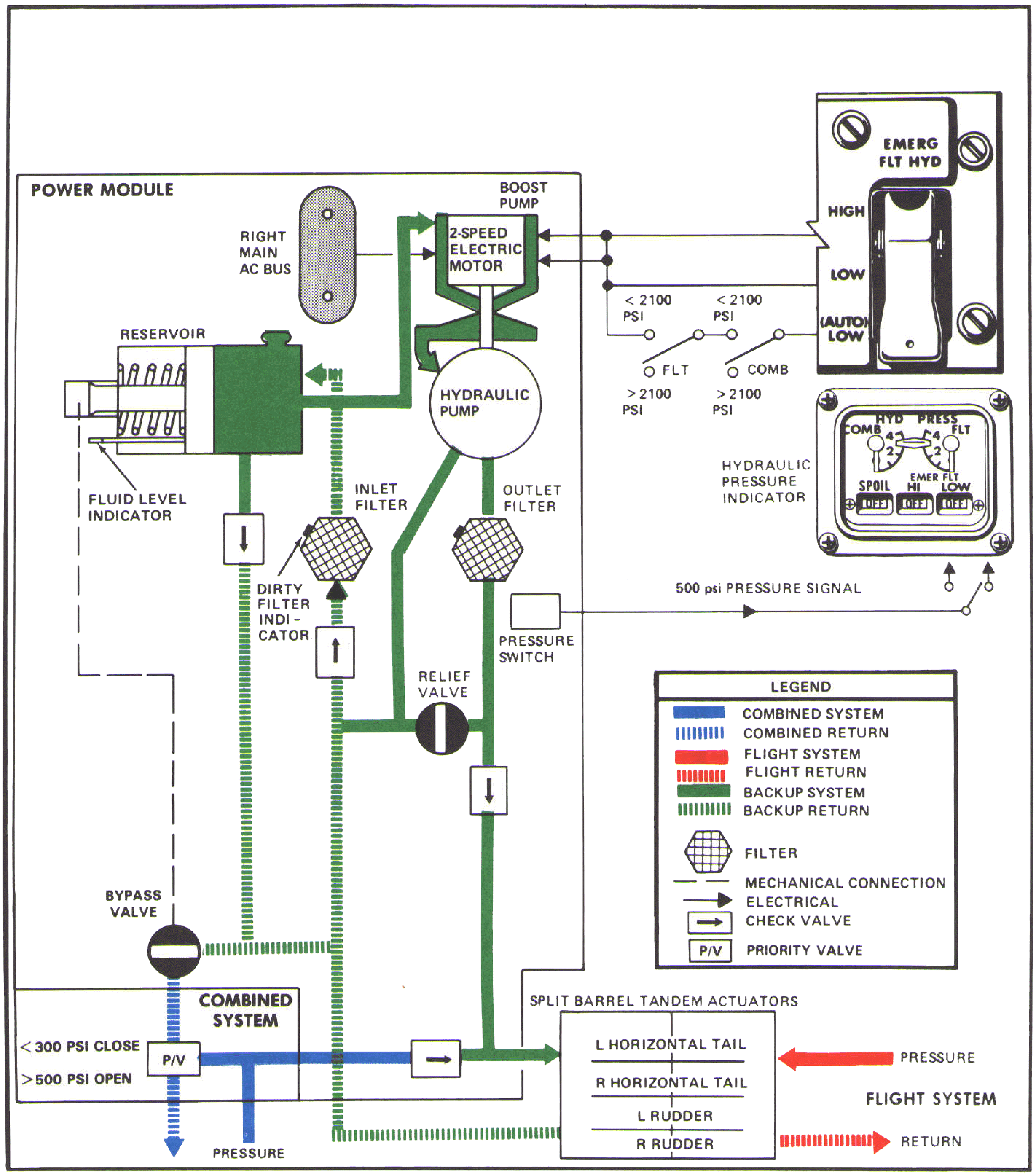


Figure 2-41. Backup Flight Control System

Automatic control of the BFCM is provided by the closing of both flight and combined hydraulic system pressure switches. Since the switches are set at 2,100 psi, both flight and combined hydraulic system pressures must drop below 2,100 psi before the BFCM is turned on in the automatic low mode. Once in this automatic mode of operation, the BFCM cannot be turned off unless either or both flight and combined systems are pressurized above 2,400 psi. The EMERG FLT HYD switch is used to select the low or high mode. Either of these positions overrides the circuitry of the automatic low mode and the BFCM will remain on even if either or both system pressures become pressurized above 2,400 psi. When the BFCM pump reaches 500 psi, the ON flag appears in the selected window at the bottom of the hydraulic pressure indicator.

WARNING

When operated in conjunction with zero combined system pressure, some BFCM hydraulic fluid will be forced out by thermal expansion. The BFCM will remain fully serviced and will operate normally as long as the elevated temperatures are maintained. Once operating, the BFCM should not be turned off in flight without combined system pressure available to reservice it. Doing so would result in fluid contraction and an underserviced condition that could prevent subsequent pump operation.

CAUTION

If either the flight or the combined hydraulic system pressure drops below 2,100 psi without illuminating the HYD PRESS caution light, the automatic low mode of the backup flight control system may be inoperative.

2.16.4.2 Ground Operations. Ground checks of the BFCM are performed by the pilot using the EMER FLT HYD switch. Before performing ground checks, the combined and brake system accumulators must be charged. The BFCM has a small volume capacity, 1,000 cc (61 cubic inches) when full, but will decrease in volume to 500 cc (30.5 cubic inches) when the aircraft is not in use. Below 500 cc (30.5 cubic inches), cavitation of the pump and overheating of the motor may occur. If the accumulators are not charged prior to starting the BFCM, depletion of the reservoir hydraulic fluid will occur. If this occurs too frequently, system damage and failure may result. Both hydraulic system pressures should indicate zero in order to fully test independent operation of the BFCM.

CAUTION

- A 180 °F thermal cutoff switch is bypassed when the BFCM is selected on with the EMERG FLT HYD switch. Prolonged ground operation in the emergency mode will result in BFCM burnout.

- Since flight control demands can exceed BFCM capability, all surface demands must be performed slowly and cautiously in order not to exceed the output rate of the system. Excessive system demands will cause the pump to cavitate and the motor to overheat. Checks should be made slowly enough to ensure continuous on indication in the hydraulic pressure indicator.

2.16.4.2.1 Ground Test Mode. The ground test mode of operation is controlled by the AUX HYD CONT switch on the ground test panel in the rear cockpit. In this mode, the BFCM operates in the high mode only. Ground test from the rear cockpit is electrically inhibited when the aircraft is on internal electrical power. For ground inspection purposes, protrusion of a red-tipped button on either the inlet or outlet filter cases is a positive indication of a dirty filter. Both such indications may be observed through an access door on the underside of the aft fuselage.

CAUTION

The ground test mode incorporates a solenoid valve that allows the BFCM to pressurize the entire combined hydraulic system. If the combined and brake accumulators are not fully charged (brake pressure indicator at top of green), or if the combined system is not fully serviced, the reservoir will be depleted and the motor will cavitate and overheat. This could result in motor failure prior to activation of the thermal cutoff switch.

In the low-speed mode, the system can operate indefinitely and should be used for maximum range and endurance. Emergency power (high mode) provides a maximum unloaded horizontal tail deflection rate approximately one fourth of that available from a full powered hydraulic system (10° per second vice 36° per second). The maximum deflection rate available will decrease as airloads increase.

CAUTION

Prolonged use (approximately 8 minutes cumulative time) of the BFCM in the high mode may result in a failure of the BFCM.

2.17 PNEUMATIC POWER SUPPLY SYSTEMS

The pneumatic power supply systems consist of three independent, stored pneumatic pressure sources for normal and auxiliary operation of the canopy and for emergency extension of the landing gear. The high-pressure bottles for normal canopy operation and emergency landing gear extension are ground-charged through a common filter connection in the nose wheelwell to 3,000 psi at 70 °F ambient temperature. Individual bottle pressure is registered on separate gauges on the right side of the nose wheelwell. An auxiliary canopy-open N_2 bottle, filter valve, and gauge is on the turtleback behind the cockpit to allow opening the canopy from the cockpit or ground. Charges may be compressed air; however, pressurized dry nitrogen is preferred because of its low moisture content and inert properties.

2.17.1 Normal Canopy Control. The bottle that supplies a pressurized charge for normal operation of the canopy is on the right side of the forward fuselage, inboard of the air refuel probe cavity. Expenditure of bottle pressure for normal operation of the canopy is controlled by three (pilot, RIO, and ground) canopy control handles. A fully charged bottle provides approximately 10 complete cycles (open and close) of the canopy before reaching the minimum operating pressure of 225 psi.

2.17.2 Auxiliary Canopy Open Control. The auxiliary canopy air bottle supplies a pneumatic charge to translate the canopy aft so that the counter-poise action of the canopy actuator facilitates opening. It is on the turtleback behind the canopy hinge line.

Activation of the auxiliary mode can be effected from either of the three (pilot, RIO, or ground) canopy control handles. After activation of the auxiliary open mode, the control system will not return to the normal mode of operation (canopy will lower but will not translate forward) until the auxiliary selector valve on the aft canopy deck is manually reset (lever in vertical position). Servicing of the auxiliary canopy air bottle is through the small access panel immediately behind the canopy on the turtleback. The reservoir is normally serviced to 3,000 psi at 70 °F ambient temperature. A fully charged bottle provides more than 20 operations in the auxiliary open mode. Minimum preflight pressure is 800 psi.

2.17.3 Emergency Gear Extension. The bottle that supplies the pneumatic force for a single emergency extension of the landing gear is on the right side of the nose wheelwell. Expenditure of bottle pressure is controlled by a twist-pull operation of the landing gear handle. Minimum bottle pressure for accomplishing emergency extension of the gear to the down-and-locked condition is 1,800 psi. Normal preflight bottle pressure is 3,000 psi at 70 °F.

Note

- Emergency extension of the landing gear shall be logged in the Maintenance Action Form (OPNAV Form 3760-2).
- Once the landing gear is extended by emergency means, it cannot be retracted while airborne and must be reset by maintenance personnel.
- Use of emergency gear extension results in loss of nosewheel steering.

2.18. MISSION COMPUTER SYSTEM

The MCS consists of two AN/AYK-14 digital computer (MC1 and MC2) and the dual redundant MIL-STD-1553B buses. The MCS is operated at 16 MHz clock speed to perform 1 million instructions per second using up to 1 megabyte of memory. The 1553B bus system in the F-14D uses time division multiplexing (TDM) with information coded into 20-bit words.

Communication protocol is established by a command response system in which all bus transmissions occur under command of a bus controller or, in case of failure of primary bus controller, a backup bus controller. Each bus is capable of addressing up to 31 remote terminals; however, address 31 is not used in the aircraft. Figure 2-42 depicts the physical connection of the WRAs in the MCS data bus system. Remote terminals incapable of communicating directly with the MCS on the 1553 data buses are routed through the converter interface unit for required analog-to-digital and digital-to-analog conversion.

2.18.1 Aircrew Interface. The principle aircrew interface with the MCS is accomplished through the pushbuttons on each MFD. The RIO has an additional interface through the DEU communicating directly with the MCS as a remote terminal. The RIO can also interface indirectly with the MCS through the radar system digital display.

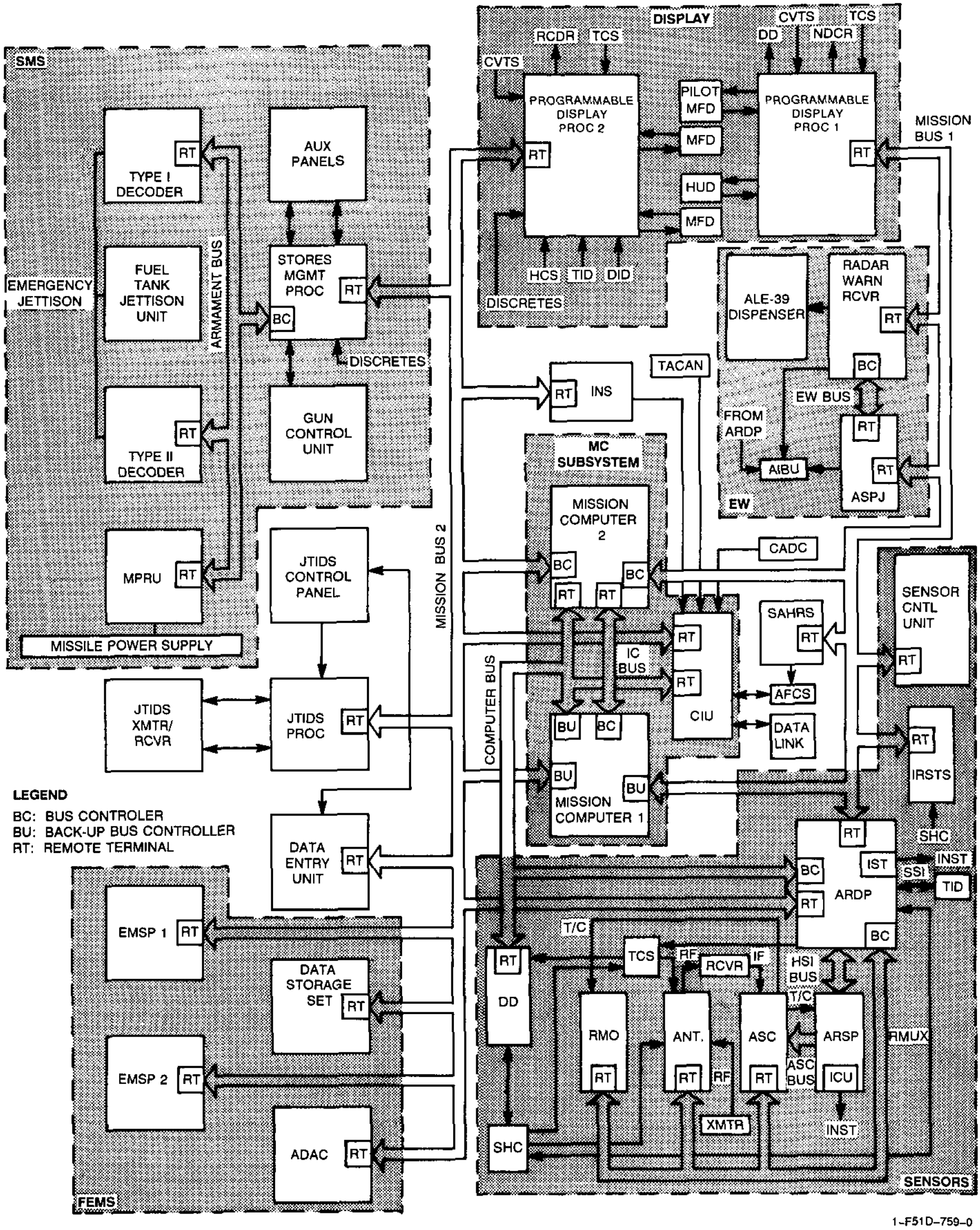


Figure 2-42. Mission Computer System Architecture

2.18.2 Operational States. The MCS has three operational states: startup, full up, and backup. These states are mutually exclusive and are determined automatically based on aircraft operation and MC1/MC2 condition.

The SYS RESET button on the NAV MODE panel forces both mission computers to transition to the startup state and execute cold start logic. It can be used to assure the aircrew that the MCS is functioning properly and/or to reinitialize the MCS by restarting the OFP. When SYS RESET is pressed, the following events occur:

1. The MCS immediately stops executing the OFP.
2. The mission computers go off line and run software BIT.
3. The OFP is automatically restarted.
4. The aircraft goes into the TLN master mode.
5. Displays revert to defaults.

Recycling power (by cycling circuit breakers) to the MCS has the same effect as pressing the SYS RESET except that both hardware and software BIT is performed.

Note

Cycling subsystem circuit breakers initiates a cold start for that subsystem. A system reset may be required to resynchronize the MCS and the restarted subsystem.

Refer to NAVAIR 01-F14AAD-1A for a complete description of the MCS architecture, operational states, and backup operation.

2.18.3 Aircraft Master Modes. There are three aircraft master modes of operation: takeoff-landing-navigation (TLN), air-to-air (A/A), and air-to-ground (A/G). The controls, displays, and avionics equipment are tailored as a function of the master mode selected by the pilot. The TLN master mode is entered automatically when power is applied to the aircraft, when the landing gear is down, or when the TLN master mode pushbutton is selected on the PDCP. The A/A master mode is entered by pressing the A/A master mode pushbutton on the PDCP, selecting an air-to-air weapon with the weapon select switch on the pilot control stick, or by commanding a radar dogfight mode. The A/G master mode is entered by pressing the A/G master mode pushbutton on the PDCP.

2.19 STANDARD CENTRAL AIR DATA COMPUTER

Note

The acronyms SCADC and CADC are used interchangeably throughout this manual.

The SCADC CPU-175/A is installed in F-14D aircraft incorporating AFC 793. The SCADC is functionally interchangeable with the CADC 1166B/A with one difference, the SCADC software incorporates the static-error source-correction curve required for the true values of Mach number, airspeed, and altitude. Aircraft prior to AFC 793 (CADC 1166B/A) aircrew should refer to NAVAIR 01-F14AAP-1.1 for HUD displayed altitude and Mach number correction curves.

Note

The standby airspeed indicator is not corrected for position error.

The CADC is a single-processor digital computer with a separate, independent, analog, backup wing-sweep channel. It is capable of making yes and no decisions, solving mathematical problems, and converting outputs to either digital or analog form as required by each aircraft system. The CADC gathers, stores, and processes pitot pressure, static pressure, total temperature and AOA data from the aircraft airstream sensors. (see Figure 2-43). It performs wing-sweep and flap and slat schedule computations, limit control and electrical interlocks, failure detection, and systems test logic. Major systems that depend on all or part of these CADC functions are shown in Figure 2-44.

The following legends appear on the MFD when activated by the CADC:

1. RDC SPD (warning legend) — (REDUCE SPEED) — Indicates flaps down above 225 knots; maximum safe Mach exceeded (2.4 Mach/ total temperature above 388 °F).
2. W/S (caution legend) — (WING SWEEP) — Indicates dual wing-sweep channel failure or wing-sweep detent disengaged.

2.19.1 Central Air Data Computer Tests

2.19.1.1 Built-In Test. BIT capabilities provide continuous monitoring of the CADC and its inputs and outputs. The failure indicator matrix (Figure 2-45) tabulates the functions that are monitored and associated fail indications.

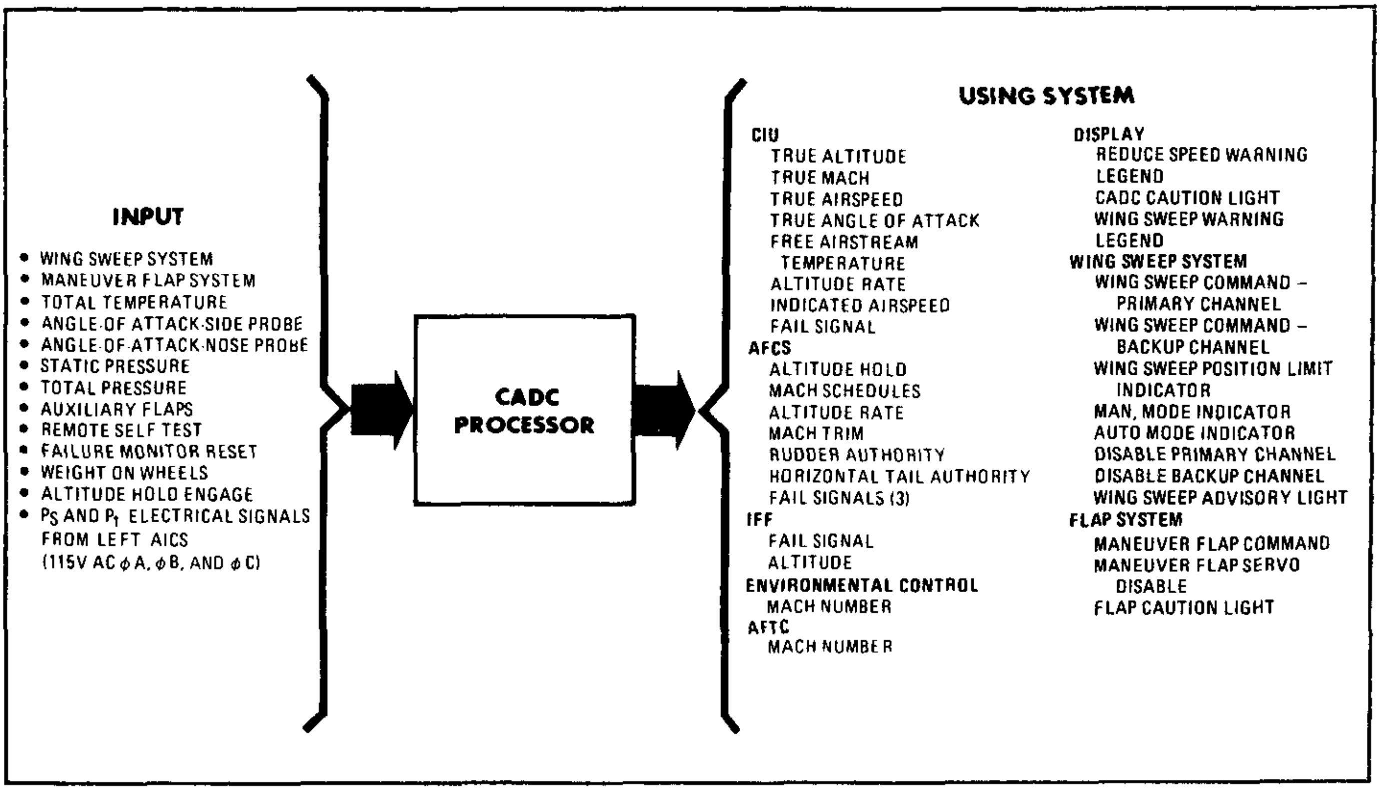


Figure 2-43. CADC Functional Relationships

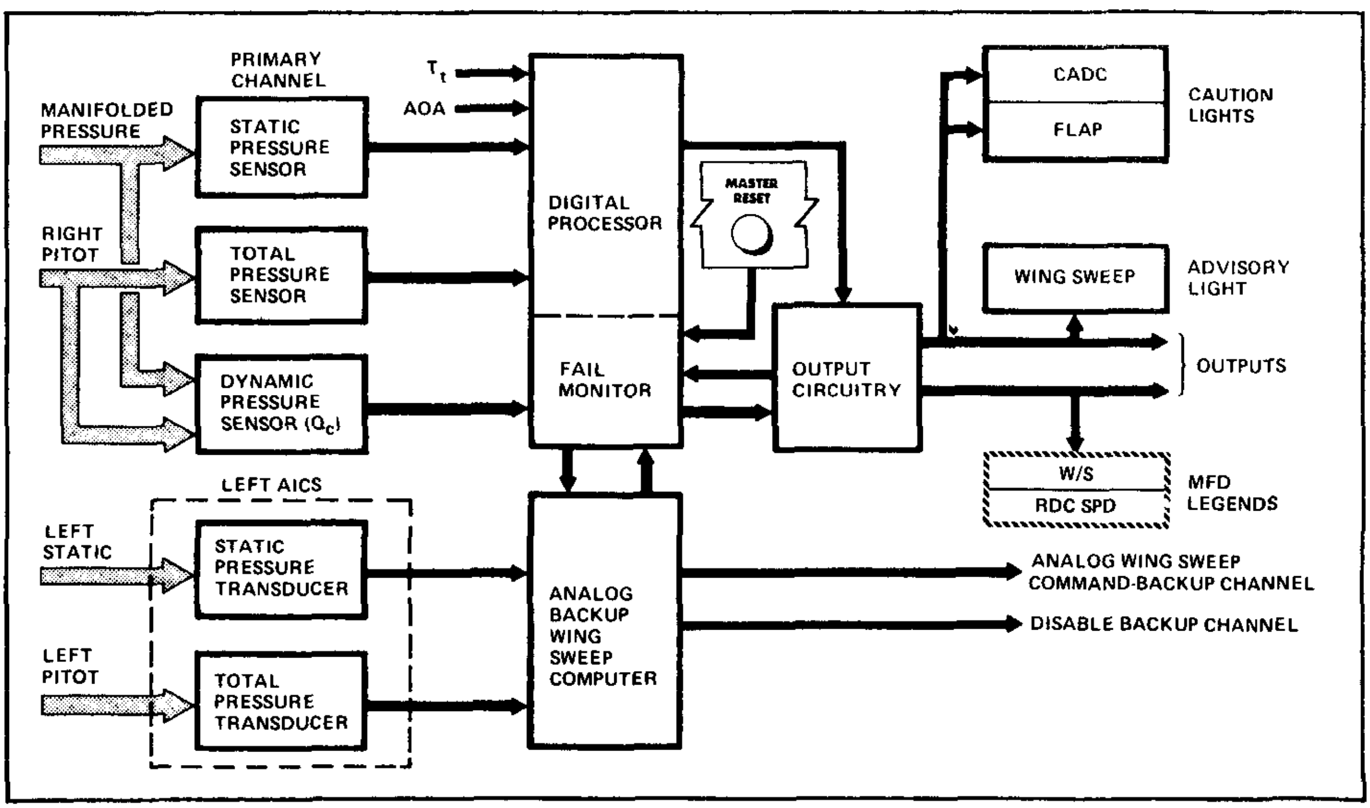


Figure 2-44. CADC Processor

FAILURE \ INDICATION	CADC CAUTION LIGHT	WING SWEEP ADVISORY LIGHT	WING SWEEP CAUTION LEGEND	FLAP CAUTION LIGHT	REDUCE SPEED WARNING LEGEND	RUDDER AUTH CAUTION LIGHT	HZ TAIL AUTH CAUTION LIGHT	MACH TRIM CAUTION LIGHT	REMARKS
CADC - P_s/P_t SENSOR COMPARE DIGITAL PROCESSOR	●	●		●	●	●	●	●	WING SWEEP LIMIT BUG MAY BE INACCURATE, MAXIMUM SAFE MACH INDICATOR MAY BE INACCURATE, MANEUVER FLAPS.
CADC WING-SWEEP COMMAND (SINGLE FAILURE)	●	●							
CADC WING-SWEEP COMMAND (DUAL FAILURE)	●	●	●						AUTO WING SWEEP INOPERATIVE
WING SWEEP (SINGLE FAILURE)		●							
WING SWEEP (DUAL FAILURE)		●	●						AUTO WING SWEEP INOPERATIVE
CADC MANEUVER FLAP COMMAND	●			●					MANEUVER FLAPS VIA THUMBWHEEL INOPERATIVE
MANEUVER FLAP - COMMAND AND SERVO MISCOMPARE				●	*				MANEUVER FLAPS VIA THUMBWHEEL INOPERATIVE
MANEUVER FLAP HYDRAULIC VALVE AND/OR ACTUATOR MISCOMPARE				●	*				
MANEUVER FLAP HANDLE AND/OR HYDRAULIC VALVE MISCOMPARE				●					
AUXILIARY FLAP AND MANUEVER FLAP MISCOMPARE				●					
AUXILIARY FLAP ASSYMETRY				●					
CADC RUDDER OR STABILIZER COMMAND AUTHORITY	●					●	●		
ANGLE-OF-ATTACK SIGNAL	●								ANGLE-OF-ATTACK DISPLAY NOT PRESENT ON HUD DURING LANDING MODE
TOTAL TEMPERATURE SIGNAL	●								AUTO PILOT CAUTION LIGHT ILLUMINATES IF IN ALTITUDE HOLD. ALTITUDE HOLD WILL BE DISENGAGED. VERTICAL SPEED NOT PRESENT ON HUD DURING TAKEOFF AND LANDING MODE
CADC WING-SWEEP INDICATOR OUTPUT	●								WING SWEEP INDICATOR INACCURATE
ECS FAILURE AND MACH > 0.25.	●								CABIN TEMPERATURE MAY RISE AFTER LANDING. COOLING AIR ADVISORY LIGHT MAY ILLUMINATE
ECS FAILURE AND MACH > 0.4.	●								
CADC-DIGITAL DATA TO CSDC	●								ALTITUDE AND MACH NOT DISPLAYED ON HUD. ANGLE-OF-ATTACK DURING LANDING DISPLAY NOT ON HUD. DURING TAKE OFF AND LANDING VERTICAL SPEED NOT ON HUD.
ALTITUDE HOLD OUTPUT ALTITUDE RATE OUTPUT	●								AUTO PILOT CAUTION LIGHT ILLUMINATES IF IN ALTITUDE HOLD. ALTITUDE HOLD WILL BE DISENGAGED.
MACH TRIM OUTPUT	●							●	

* REDUCE SPEED LEGEND WILL APPEAR IF AIRSPEED >225 KNOTS AND FLAPS ARE DOWN OR MAXIMUM SAFE MACH EXCEEDED 2.4 IMN/TOTAL TEMPERATURE ABOVE 388° F.

2-F50D-367-0

Figure 2-45. CADC Processor Indicators

2.19.1.2 On-Board Checkout. The CADC performs a self-test during OBC only with weight on wheels. When OBC is initiated, normal air data inputs are locked out and in their place constants from the computer memory are received. Self-test detected failures may be manually reset by pressing the MASTER RESET pushbutton.

Pressing the MASTER RESET pushbutton for 1 second resets transient failures in the CADC. Activating the master reset circuit recycles the failure detection process in the CADC. This recycling process puts off the caution and advisory light(s) and may take as long as 10 seconds to check out the status of the system. If a failure exists, the light(s) will illuminate again. If a transient failure existed, the light(s) will remain off.

The following caution and advisory lights are activated by the CADC:

1. CADC

2. FLAP

3. WING SWEEP (advisory) — If the WING SWEEP advisory light does not recycle when MASTER RESET pushbutton is depressed, the light is activated by the wing flap controller.

Three independent CADC fail signals drive the AFCS failure detection circuits. If these signals exist, the AFCS will illuminate the following lights:

1. CADC fail signal pitch computer — No Light

2. CADC fail signal to yaw computer — RUDDER AUTH and HZ TAIL AUTH

3. CADC fail signal to roll computer — MACH TRIM.

Pressing MASTER RESET pushbutton will also update the wing-sweep and flap commands to their respective feedback signals. As a result, there may be movement in the wings and maneuver flaps when MASTER RESET pushbutton is depressed.

2.20 WING-SWEEP SYSTEM

The variable geometry of the wing-sweep system provides the pilot with considerable latitude for controlling wing lift and drag characteristics to optimize aircraft performance over a broad flight spectrum.

Under normal operating conditions, the wings are automatically positioned to the optimum sweep angle for maximum maneuvering performance. The pilot can selectively position the wings at sweep angles aft of optimum.

A mechanical backup control system is provided for emergency and oversweep operations. Details of the wing-sweep system are shown in FO-11.

The outboard location of the wing pivot reduces the change in longitudinal stability as a function of wing-sweep angle. Two independently powered, hydromechanical screwjack actuators, mechanically interconnected for synchronization, position the wings in response to pilot or CADC commands. In flight, the wings can be positioned between 20° and 68° wing leading-edge sweep angle. On the deck, the range is extended aft 75° (oversweep position) to reduce the span for spotting. Such authority results in a variation of wing span from approximately 64 to 33 feet.

Cavities above the engine nacelles and the midfuselage accommodate the inboard portions of the wing panels as they sweep aft. Sealing of the underside is by a wiper seal and airbag. The bag is pressurized by engine bleed air. Airbag pressure is released during oversweep to avoid overloading of the flap mechanism. An overwing fairing encloses the wing cavity and provides a con-toured seal along the upper surface of the wing for the normal range of in-flight sweep angles. The left and right overwing fairing actuators are pressurized by the combined and flight hydraulic systems, respectively.

2.20.1 Wing-Sweep Performance. Maximum wing-sweep rate (approximately 15° per second) is adequate for most transient flight conditions; however, wing-sweep rate can be significantly reduced or stalled by negative-g or large positive-g excursions. Sufficient capability has been provided in the system, consistent with the sustained performance capabilities of the aircraft. With a failure of either the combined or flight hydraulic systems, the wings will move at a reduced rate.

Note

- The overwing fairings and flaps are susceptible to a high frequency (60 cycles per second), low-amplitude oscillation that can be felt in cockpit. This overwing fairing and flap buzz is normal and is influenced by rigging of the fairings and air in the hydraulic systems.

- Overwing fairing and flap buzz is usually encountered between 0.9 and 1.4 Mach.

2.20.2 Wing-Sweep Modes. Normal control of the wing-sweep position in AUTO, AFT, FWD, and BOMB modes is by the four-way wing-sweep switch on the inboard side of the right throttle grip (Figure 2-46). As an emergency mode of control, changes in wing-sweep position can be selected manually with the emergency WING SWEEP handle on the inboard side of the throttle quadrant. The handle is connected directly to the wing-sweep hydraulic valves. The command source for positioning the wings depends upon the mode selected by the pilot or, in certain cases, is automatically selected. Electrical and mechanical wing-sweep command paths are shown on FO-11. Wing-sweep modes are shown in Figure 2-47.

WARNING

Anytime hydraulic pressure is on, the wings can be moved inadvertently. When positioning the wings during ground operation other than pilot poststart or postlanding checklist procedures, use the emergency WING SWEEP handle to minimize the possibility of moving the wings inadvertently.

Note

- When positioning the wings, do not command opposite direction until wings have stopped in original commanded position (all sweep modes) to increase motor life.

- The optimum wing position (triangular index) and the AUTO/MAN flags may be unreliable when the CADC caution light is illuminated.

2.20.2.1 AUTO Mode. Selection of the AUTO mode is made by placing the four-way wing-sweep switch in the upper detented position, AUTO, permitting the CADC wing-sweep program to position the wings automatically. The program positions the wings primarily as a function of Mach number but includes pressure altitude biasing. Wing position is scheduled to the optimum sweep angle for developing maximum maneuvering performance. In addition to providing an automatic wing positioning function, the programmer also defines the forward sweep limit that cannot be penetrated using any of the other electrical (manual or bomb) modes. The forward sweep limiter prevents electrical mispositioning of the wings from a wing structure standpoint.

Pilot selection of the AUTO mode or automatic transfer from the manual mode causes the AUTO flag to appear in the wing-sweep indicator. Once in the AUTO mode, the four-way wing-sweep switch can be in the center position without changing the command mode.

2.20.2.2 Manual Mode. The manual wing-sweep mode is commanded by selecting AFT or FWD from the neutral position of the wing-sweep switch, driving the wings in the commanded direction to any wing-sweep position aft of the automatic program. The switch is spring loaded to return to the center position. Manual command mode exists unless the wing-sweep program is intercepted, at which point transfer to the AUTO mode is automatic. Indication of the existing mode is provided by the AUTO and MAN flags in the wing-sweep indicator.

2.20.2.3 Bomb Mode. Bomb mode is selected by moving the wing-sweep switch to the down (BOMB) position. With the switch in BOMB, the following occurs:

1. Wing SWEEP indicator shows MAN flag.

2. If wing sweep is less than 55°, wings will drive to 55°.

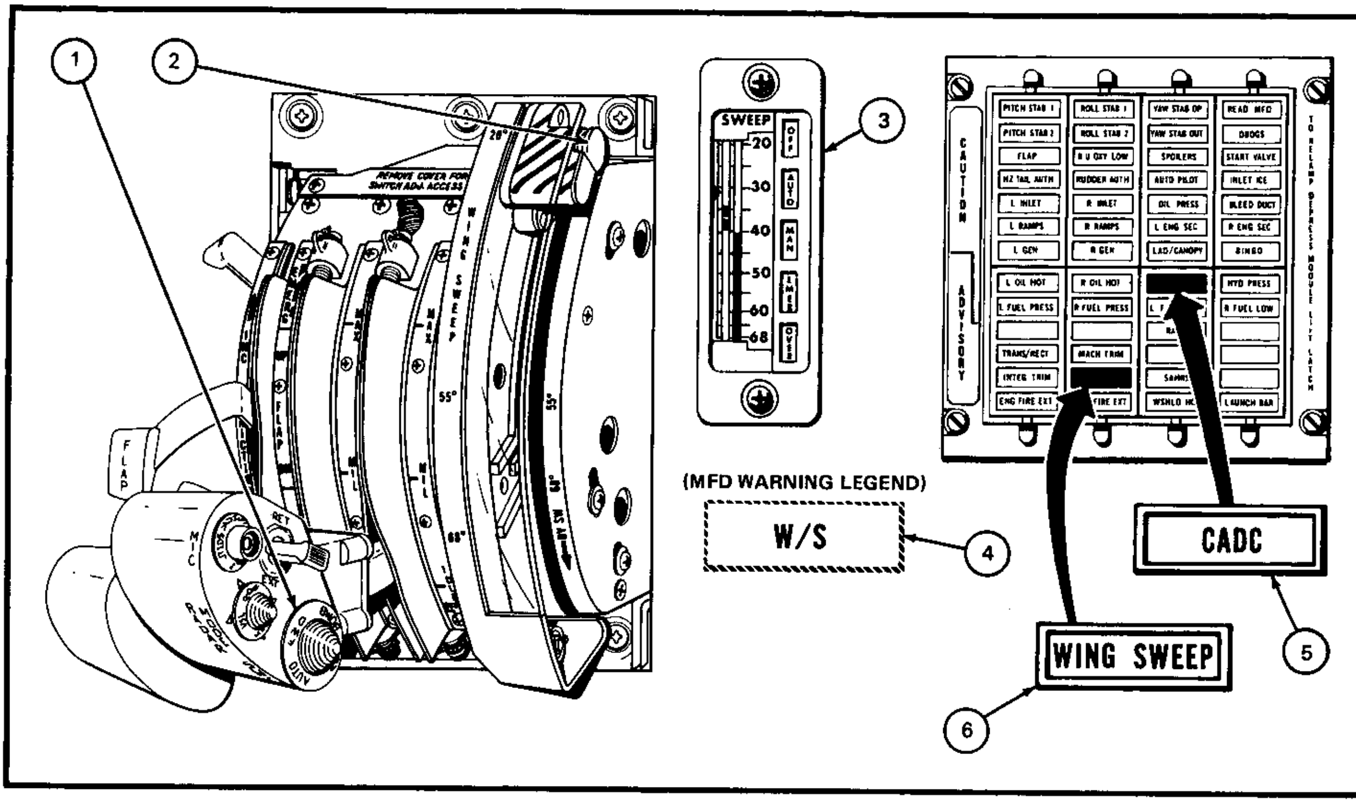
3. If wing sweep is greater than 55°, wings will not move.

4. If maneuver flaps are extended, they will retract and wings will sweep to 55°.

As the aircraft accelerates and the AUTO wing-sweep schedule is intercepted, the wings will follow the AUTO schedule even though the switch remains in BOMB mode. Upon decelerating, the wings will sweep forward to 55° and stop.

2.20.2.4 Emergency Mode. During normal mode operation of the wing-sweep system, the wing-sweep control drive servo drives the hydraulic valve command input through a spider detent mechanism. The emergency handle under a transparent guard is moved in parallel with the servo output. The emergency mode provides an emergency method of controlling wing sweep. It bypasses the normal command path of the fly-by-wire system (CADC and control drive servo loop).

To select emergency mode, the handle must be extended vertically. The guard should be moved out of the way before the handle is operated. Vertical extension of the emergency handle provides for better accessibility and leverage. The detent is not disengaged by raising the handle vertically. An initial fore or aft force of up to 30 pounds breakout and 13 pounds maximum is necessary for operation.



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NOMENCLATURE	FUNCTION
(1) Wing sweep switch	AUTO – Wing sweep angles are determined by CADC according to wing sweep program. Detented switch position. BOMB – Wings are positioned at 55° or further aft if commanded by the CADC program. Detented switch position. AFT/FWD – The pilot can select AFT or FWD wing positions within limits imposed by the wing sweep program. Switch is spring-loaded to the center position. When the forward limit is intercepted, the mode is transferred to AUTO.
(2) Emergency WING SWEEP handle	Provides a mechanical means of wing sweep control that overrides the CADC program commands. Wing sweep angles between 20° and 68° are unrestricted except for flap interlocks. Oversweep 75° is provided with weight-on-wheels, horizontal stabilizer authority restricter in reduced range, and air bag pressure dumped.
(3) Wing SWEEP indicator	Displays (from right to left) actual wing sweep position, commanded position and wing sweep program position, which is the maximum forward angle at present airspeed and attitudes. Indicator windows show the operating mode.
(4) W/S caution legend on MFD	Indicates failure of both wing sweep channels and/or disengagement of spider detent. Wing sweep positioning requires using the emergency wing sweep handle.

Figure 2-46. Wing-Sweep Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(5) CADC caution light	Indicates hardware failure and/or that certain computations of the air data computer are unreliable. Illumination of WING SWEEP advisory light and/or W/S caution legend on MFD determines pilot action.
(6) WING SWEEP advisory light	Indicates failure of a single channel in the system. Illumination of both WING SWEEP advisory and CADC caution light indicates failure of one channel in CADC.

Figure 2-46. Wing-Sweep Controls and Indicators (Sheet 2 of 2)

The spider detent is reengaged if the handle is repositioned to the detent (servo) position.

The emergency WING SWEEP handle incorporates locks at approximately 4° increments between 20° and 68°. These locks are provided to eliminate random wing movement in the emergency mode should electrical system transients be experienced. When the locks are engaged, wing movement is inhibited provided that wings match handle position. The wing-sweep locks eliminate the need for the installation of wing-sweep servo cutout switches. Locks are engaged by raising the handle 1 inch from the stowed position. In order to bypass the locks and select a wing position, the handle is raised an additional 1 inch (2 inches from stowed) and moved to the desired position. The handle is spring loaded to return to the lock position when released. The handle can be raised from 20° to 68° and oversweep, but can only be returned to the stowed position at 20° and oversweep. This feature is intended to prevent inadvertent engagement of the AUTO MODE, commanding the wings to spread causing possible damage to the aircraft or injury to personnel in a confined area. The handle is spring loaded toward the stowed position, but requires depressing the release button on the inboard side of the lever in order to return the handle to the stowed position.

CAUTION

- Except for wing flap (main and auxiliary) and oversweep interlocks in the control box, the emergency mode does not prevent pilot mispositioning the wings from a structural standpoint.

- If operating in the emergency wing-sweep mode, positively confirm all flaps are retracted prior to attempting AFT wing sweep.

Note

In certain failure modes, the flap indicator may not accurately reflect the position of all flaps.

Since the wing-sweep program acts as a forward limiter only for the normal modes of operation, the pilot must follow the following schedule in the emergency mode:

1. 0.4 Mach — 20°

2. 0.7 Mach — 25°

3. 0.8 Mach — 50°

4. 0.9 Mach — 60°

4. 1.0 Mach — 68°.

When operating in the emergency mode, pulling the WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) circuit breakers on the pilot left knee panel assures that the electrical command path cannot interfere with the emergency mode.

2.20.2.5 Oversweep Mode (75°). The wing oversweep mode allows sweeping the wings aft of 68° to 75° during on-deck operation only, thereby reducing the overall width of the aircraft for deck spotting. At 75°, the wing trailing edge is over the horizontal tail surface.

With the wings at 68°, oversweep can be initiated by raising the emergency WING SWEEP handle to its full extension and holding. Raising the handle releases air pressure from the wing-seal airbags and activates the horizontal tail authority system, restricting the surface deflections to 18° trailing edge up and 12° trailing edge down. During motion of the horizontal stabilizer restrictors, the HZ TAIL AUTH caution light is illuminated. When the horizontal tail authority restriction is accomplished (approximately 15 seconds), the HZ TAIL AUTH caution light will go off and the OVER flag on

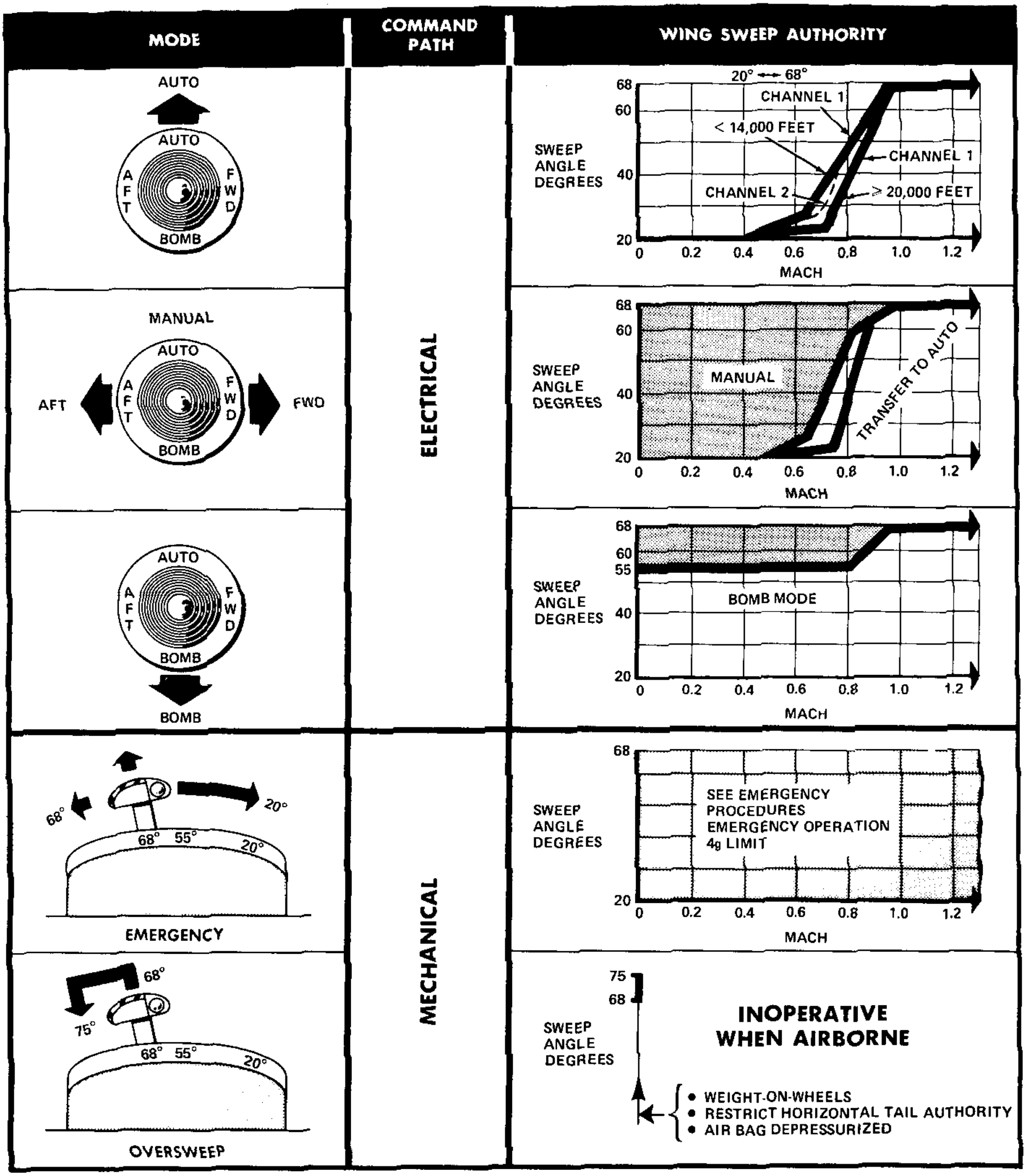

Figure 2-47. Wing-Sweep Modes

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the wing-sweep indicator will be visible. This advises the pilot that the oversweep interlocks are free, allowing movement of the emergency WING SWEEP handle to 75° and stow. The EMER and OVER on the wing-sweep indicator will be visible.

CAUTION

- Failure of the oversweep interlocks while trying to achieve oversweep may result in damage to the wingtip and horizontal tail trailing edges, and the maneuver flap actuator.

- If unusual resistance is encountered while attempting to put the wings into oversweep, continued aft pressure on the WING SWEEP handle may cause failure of the wing-sweep actuator.

- Avoid stick movements with the wings in oversweep and the HZ TAIL AUTH light illuminated and/or the OVER flag not displayed in the wing-sweep indicator.

The reverse process takes place when sweeping forward from oversweep. However, there is no need to hold the emergency handle in the raised position at 68°. Motion out of oversweep is completed (wing-seal airbag pressure established and horizontal tail authority restriction removed) when both the OVER flag and the HZ TAIL AUTH caution lights are off. Six seconds later the WING SWEEP advisory light will illuminate. Upon engagement of the spider detent by further unsweeping the emergency handle, MASTER RESET pushbutton is pressed to clear the WING SWEEP advisory light, thus activating the electrical command circuits of the wing-sweep system.

CAUTION

When coming out of oversweep and a 68° wing position is desired, the wings should be moved forward to approximately 60° and then back to 68°.

2.20.3 Wing-Sweep Interlocks. Automatic limiting of wing-sweep authority is provided under normal in-flight control modes to prevent mispositioning of the wings at conditions that could result in the penetration of structural boundaries. Wing-sweep interlocks within the CADC are shown in Figure 2-48. Wing sweep is also electrically inhibited at normal accelerations less than -0.5g.

2.20.3.1 Flap and Slat Wing-Sweep Control Box. Electromechanical (auxiliary flaps, oversweep enable) and mechanical (main flap) interlocks in the control box limit aft wing-sweep commands at 21°15', 50°, and 68°. Interlocks in the control box are shown in Figure 2-48. These interlocks, which serve as a backup to the electronic interlocks in the CADC, are imposed on both the normal and the emergency inputs to the control box and assure noninterference between movable surfaces and the fuselage.

2.20.4 Wing-Sweep System Test

2.20.4.1 Continuous Monitor. The command and execution of the wing-sweep system is continually monitored by a failure detection system. The failure detection system in the CADC governs the change from wing-sweep channel 1 to channel 2 or the disabling of wing-sweep channel 1 or 2 by switching the respective control drive servo off. A single channel failure in the wing-sweep electrical command path is indicated by illumination of the WING SWEEP advisory light followed by normal operation on the remaining channel. Failure of the remaining channel is indicated by a W/S caution legend on the MFD and requires that wing-sweep control be exercised through the emergency WING SWEEP handle. Transient failures in the CADC can be reset by pressing the MASTER RESET pushbutton, which recycles the failure detection system.

2.20.4.2 Preflight Check. A preflight check of the wing-sweep system to assure proper operation of the electrical command circuits without moving the wings should be accomplished after starting engines while the wings are in oversweep (75°).

1. Set wing-sweep mode switch to AUTO.

Note

The CADC caution light will illuminate and test will not run if AUTO is not selected on the wing-sweep switch.

2. Press MASTER RESET pushbutton.

3. Set MASTER TEST switch to WG SWP.

4. Monitor test by observing:

   a. Wing-sweep limit pointer drives to 44°.

   b. Illumination of the WING SWEEP advisory light and FLAP caution light.

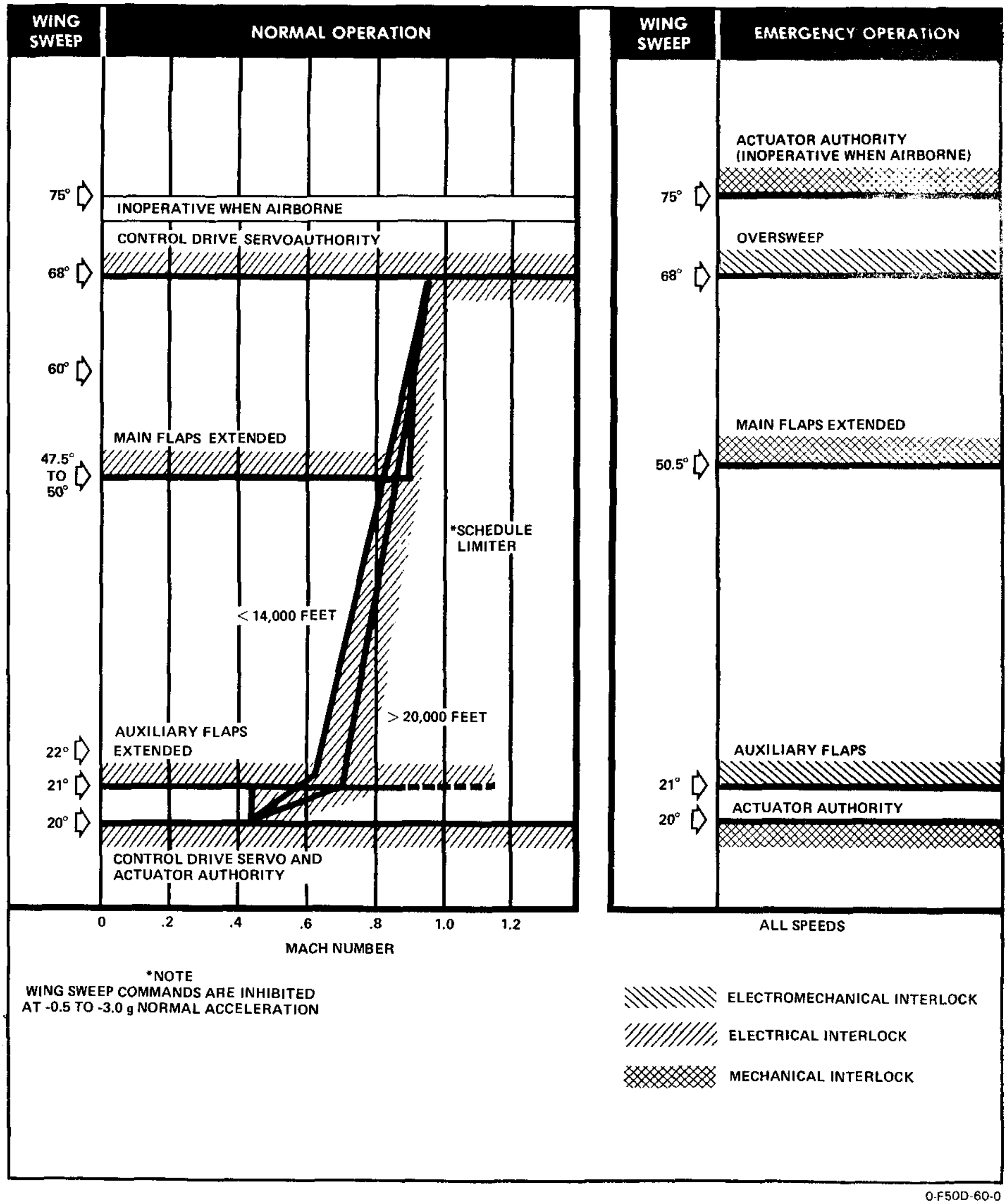


Figure 2-48. Wing-Sweep Interlocks

Note

The WING SWEEP advisory light will illuminate 3 seconds after test starts, then go off and illuminate again at 8 seconds into test.

c. RDC SPD warning legend on MFD.

d. At end of test (approximately 25 seconds) the limit pointer will drive to 20° and the above lights will go off.

5. Set MASTER TEST switch to OFF.

Note

Ignore illumination of RUDDER AUTH caution or MACH TRIM advisory lights and motion of the control stick if they occur during the test.

2.21 FLAPS AND SLATS

The flaps and slats form the high-lift system, which provides the aircraft with augmented lift during the two modes of operation: takeoff or landing, and maneuvering flight. The flaps are of the single-slotted type, sectioned into three panels on each wing. The two outboard sections are the main flaps utilized during both modes of operation. The inboard section (auxiliary flap) is commanded only during takeoff or landing. The slats consist of two sections per wing mechanically linked to the main flaps. Flaps down greater than 10° enables the wheels warning light interlock, and greater than 25° enables direct lift control and power approach spoiler gearing.

2.21.1 Flap and Slat Controls

Pilot controls for flap and slat takeoff, landing, and maneuvering modes are illustrated in Figure 2-49.

2.21.1.1 FLAP Handle. The FLAP handle, located outboard of the throttles, is used to manually command flaps and slats to the takeoff and landing position. Flap handle commands are transmitted by control cable to the flap and slat and wing-sweep control box where they are integrated with CADC electromechanical inputs to command proper flap and slat position.

2.21.1.1.1 Emergency Flaps. EMER UP enables the pilot to override any electromechanical commands that may exist because of malfunction of the CADC. To position the flaps, move the FLAP handle to the end of the normal travel range; then, move the handle outboard and continue moving to extreme EMER UP. While moving the handle, forces may be higher than normal. EMER DN has no function.

CAUTION

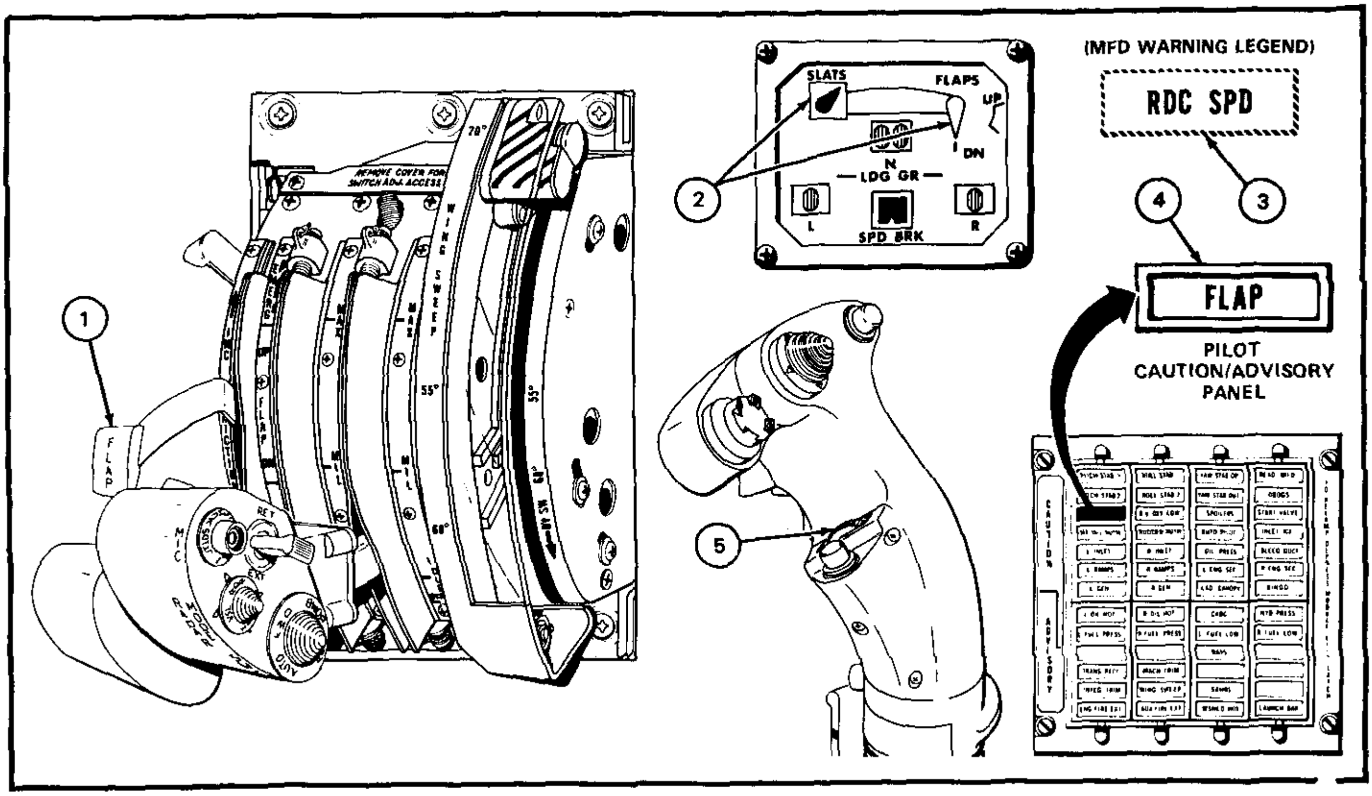
A slip clutch assembly is installed between the combined system forward flap hydraulic motor and the center gearbox assembly. While this will relieve some stall torque on the hydraulic motor, extremely fast reversals of flap direction while flaps are in motion may result in eventual failure of the flap and slat flexible driveshaft.

2.21.1.2 Maneuver Flap and Slat Thumbwheel. The maneuver flap and slat thumbwheel is located on the left side of the stick grip and is spring loaded to the center position. With LDG GEAR and FLAP handles up, automatic CADC flap and slat positioning can be overridden with pilot thumbwheel inputs to partially or fully extend or retract the maneuvering flaps and slats; however, the next time angle of attack crosses an extension or retraction threshold, the automatic command will again take precedence, unless manually overridden again. Manual thumbwheel command is a proportional command.

2.21.1.3 Main Flaps. The main flaps on each wing consist of two sections simultaneously driven by four mechanical actuators geared to a common flap driveshaft. Each wing incorporates a flap asymmetry sensor and flap overtravel switches for both the extension and retraction cycles.

Cove doors, spoilers, eyebrow doors, and gusses operate with the flaps to form a slot to optimize airflow over the deflected flap. The cove doors are secondary surfaces along the underside of the wing forward of the flap (Figure 2-50.) As the flaps pass 25° deflection, a negative command received from the AFCS depresses the spoilers to -4-1/2° to meet with the cove doors. Because the spoilers do not span the entire wing as do the flaps, gusses inboard and outboard of the spoilers perform the flaps-down function of the spoilers. With the flaps retracted, the eyebrow doors, which are the forward upper surface of the flaps, are spring loaded in the up position to close the gap between the trailing edge of the spoiler or guss and the leading edge of the flaps. Mechanical linkage retracts the eyebrow door when the flaps are lowered to provide a smooth contour over the upper surface of the deflected flap.

2.21.1.4 Auxiliary Flaps. The auxiliary flaps are inboard of the main flaps and are powered by the combined hydraulic system. The actuator is designed to mechanically lock the auxiliary flaps when in the up position. In the event of high dynamic pressure conditions, a bypass valve within each control valve opens



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NOMENCLATURE	FUNCTION
(1) FLAP handle	UP - Normal retraction of main and auxiliary flaps. DN - Normal extension of main and auxiliary flaps. EMER UP - Emergency retraction of main flaps to full up overriding any electromechanical command faults. EMER DN - No function.

Figure 2-49. Flap and Slat Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(2) Flaps and Slats Indicator	 – Power off; maneuver slats extended.
	 – Slats extended (17). { Slats position is an electrical pickoff of right slat position only.
	 – Slats retracted (0°).
	 – Flaps full up (0°). { Flap position is pickoff from hydraulic motor for main flaps only.
	 – Maneuver flaps down (10°).
	 – Flaps full down (35°).
(3) RDC SPD legend on MFD and HUD	Main flap comparator failures with flaps not retracted and airspeed >225 KIAS (see figure 2–43). Maximum safe Mach exceeded (2.4 M). Total temperature exceeds 388°F.
(4) FLAP caution light	Disagreement between main and/or AUX flap position (10 second light) or asymmetry lockout (3 second light). CADC failure. WG SWP DR NO. 2/MANUV FLAP (LE1) circuit breaker pulled.
(5) Maneuver flap and slat thumbwheel	Forward – Commands maneuver flaps and slats to retract. Neutral – Automatic CADC program. Aft – Commands maneuver flaps and slats to extend.

Figure 2-49. Flap and Slat Controls and Indicators (Sheet 2 of 2)

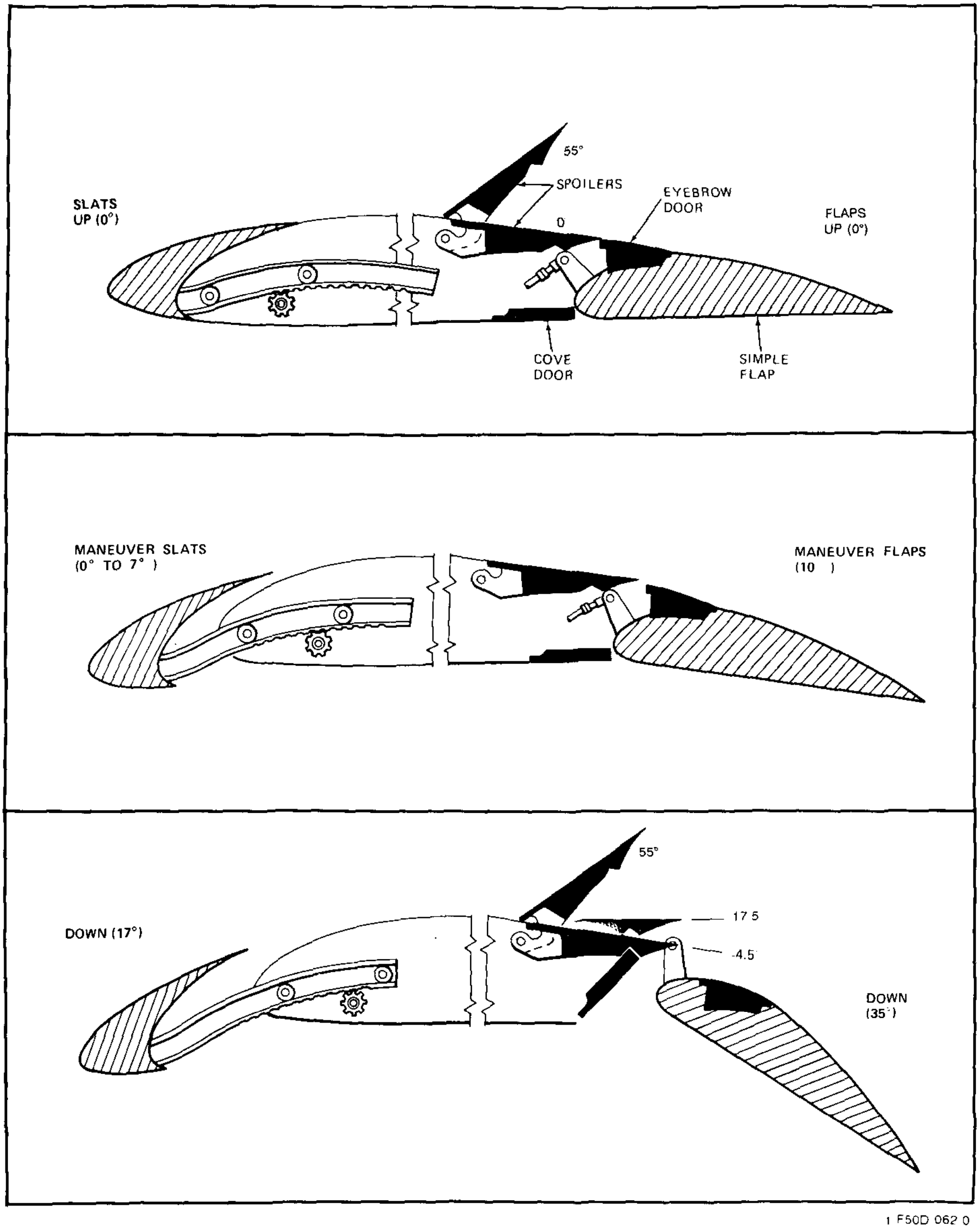


Figure 2-50. Wing Control Surfaces

causing the auxiliary flap to be blown back, thus avoiding possible structural damage. During loss of electrical power, the control valve is spring loaded to retract, retracting the auxiliary flaps within 1 minute. The auxiliary flaps use cove doors, eyebrow doors, and gusses identical in purpose and operation with those associated with the main flaps.

2.21.1.5 Slats. The slats on each wing are divided into two sections, both of which are driven simultaneously by a single-slat driveshaft. The slats are supported and guided by seven curved tracks.

2.21.2 Flap and Slat Operation

Note

- There is no automatic flap/slat retraction.
- With flaps extended by the FLAP handle and an airspeed of 225 knots or greater, the RDC SPD legend appears on the MFD and HUD.

2.21.2.1 Normal Operation. The main flap and slat portion of the high-lift system is positioned with a dual redundant hydromechanical servoloop in response to the FLAP handle command. The auxiliary flap is a two-position control surface powered by the combined hydraulic system. With the FLAP handle exceeding 5° deflection, the auxiliary flaps fully extend. Conversely, they retract for a FLAP handle position equal to or less than 5°. The torque of the flap and slat drive hydraulic motor is transmitted by flexible driveshafts to each wing.

2.21.2.2 Degraded Operation. In the event of a combined hydraulic system failure, outboard spoiler module fluid is automatically directed to a backup hydraulic motor to lower main flaps and slats only. In the event of main flap asymmetry greater than 3°, slat asymmetry greater than 4°, or flap surface overtravel, the flap and slat system is disabled. Flaps and slats will remain in the position they were in when failure or malfunction occurred. The auxiliary flaps are automatically commanded to retract. There is no asymmetry protection for the auxiliary flaps.

2.21.2.3 Flap Wing Interlocks. The main flap and auxiliary flap commands are interlocked electrically and mechanically with the wing sweep to prevent flap fuselage interference. An electrical interlock in the CADC and a mechanical command in the wing-sweep control box prevent wing sweep aft of 22° with auxiliary flaps extended. In a similar manner, upon extension of the main flaps, the wings are electrically and mechanically limited to wing-sweep angles less than 50°. The FLAP handle is mechanically prevented from moving to the down position if wing position is aft of 50°. If flaps are lowered with wings between 21° and 50°, main flaps will extend but auxiliary flaps will remain retracted.

CAUTION

- If flaps are extended with wings between 21° and 50°, auxiliary flap extension is inhibited and a large nosedown pitch trim change will occur.
- Pulling the FLAP/SLAT CONTR SHUT-OFF circuit breaker (RA2) will eliminate flap overtravel protection and could eliminate mechanical or electrical main and auxiliary flap interlocks and may allow the wings to be swept with the flaps partially or fully down in the wing-sweep emergency mode.

2.21.2.4 Maneuver Flap and Slat Mode. The main flaps can be extended to 10° with the slats extended to 7° within the altitude and Mach envelope shown in Figure 2-51.

Maneuver flaps and slats are automatically extended and retracted by the CADC as a function of angle of attack and Mach number (Figure 2-52). The schedule commands full maneuver flaps and slats as soon as the slatted wing maneuvering efficiency exceeds that of the clean wing.

Note

CADC maneuver flap commands are automatically reset when the flap handle is placed down greater than 2°, wing-sweep BOMB mode is selected, or maneuver flaps are commanded to less than 1° by the CADC because of dynamic pressure.

The angle-of-attack input to the CADC from the alpha computer is inhibited and will retract the maneuver devices if they are extended when the LDG GEAR handle is lowered. This is to ensure that the maneuver devices are retracted before lowering the FLAP handle. Maneuver devices extended condition is indicated by a SLATS barberpole and an intermediate (10°) flap position.

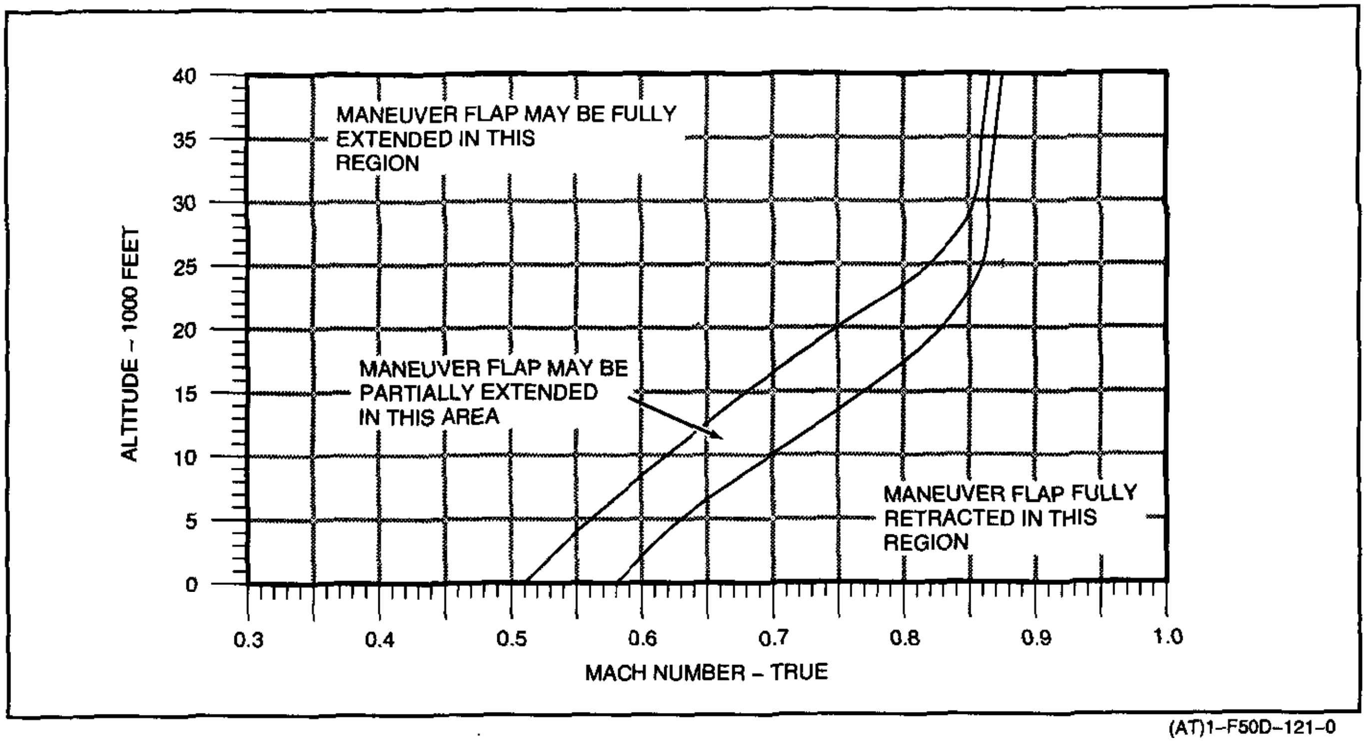


Figure 2-51. Maneuver Flap Envelope

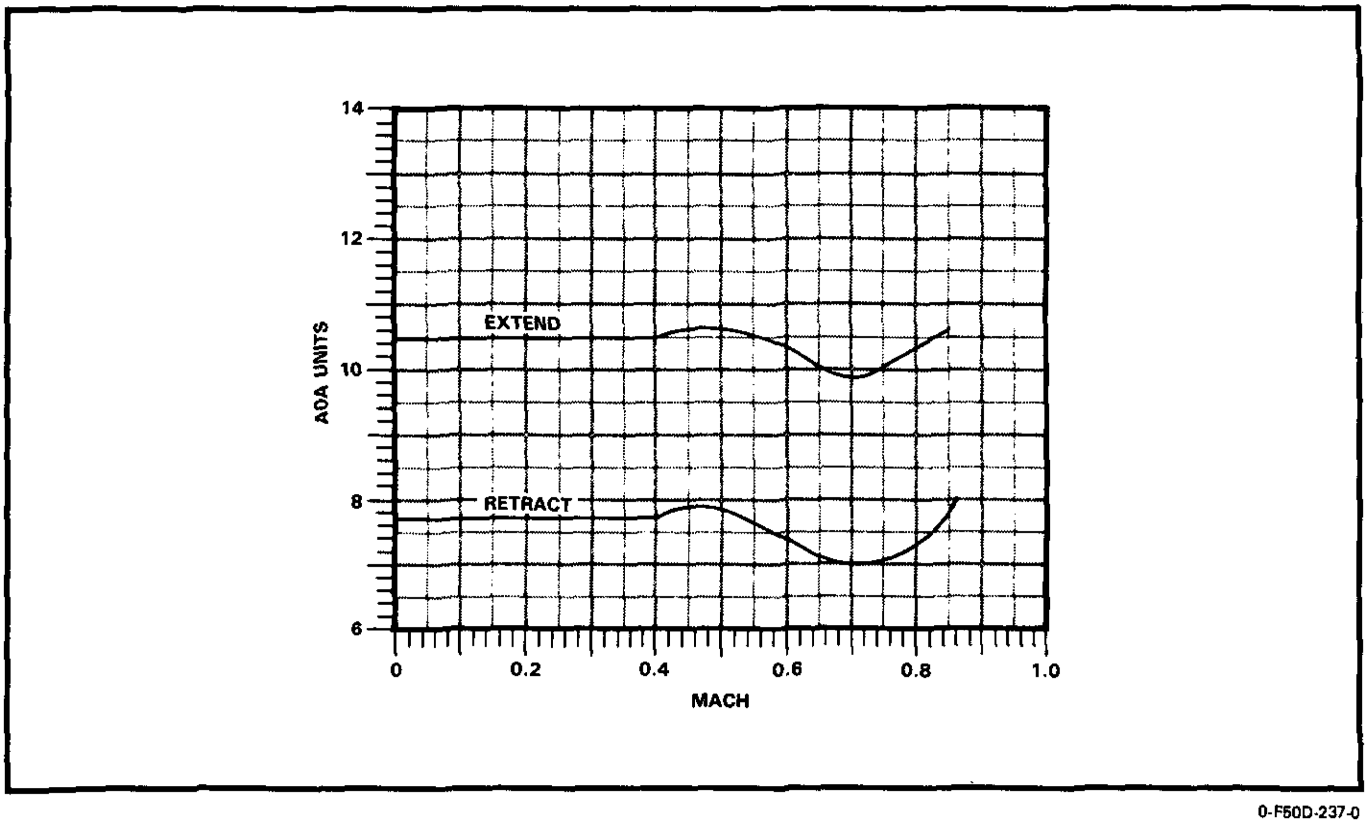


Figure 2-52. Maneuver Slat/Flap Automatic Schedule for CADC

CAUTION

If maneuver devices are not retracted prior to lowering the FLAP handle, a rapid reversal of the flaps will occur with possible damage to the flap system.

2.22 SPEEDBRAKES

The speedbrakes consist of three individual surfaces, one upper and two lower panels on the aft fuselage between the engine nacelles (Figure 2-53). The speedbrakes may be infinitely modulated on the extension and retraction cycle. Operating time for full deflection is approximately 2 seconds. Hydraulic power is supplied by the combined hydraulic system (nonisolation circuit), and electrical power is through the essential No. 2 dc bus with circuit overload protection on the pilot right circuit breaker panel (SPD BK P-ROLL TRIM ENABLE) (RB2).

2.22.1 Speedbrake Operation. Pilot control of the speedbrakes is effected by use of the three-position speedbrake switch on the inboard side of the right throttle grip (Figure 2-54). Automatic retraction of the speedbrakes occurs with placement of either or both throttles at MIL or loss of electrical power.

To avoid fuel impingement on the fuselage boattail and nozzles, fuel dump operations are prevented with the speedbrakes extended.

Note

- Loss of combined hydraulic pressure with the speedbrakes retracted or extended will cause the speedbrakes to move to a floating position.
- The speedbrake/fuel dump interlock is electrically bypassed during a combined hydraulic system failure, enabling the pilot to dump fuel when the speedbrakes are floating or modulating. The electrical bypass is enabled whenever the combined pressure falls below 500 psi.
- Do not extend the speedbrakes in flight within 1 minute (nominal) after terminating fuel dump operations to allow residual fuel in the dump mast to drain.
- A throttle must be held in MIL (or greater) for approximately 3 seconds in order for the automatic function to completely retract the speedbrake. Anything less will cause partial retraction.

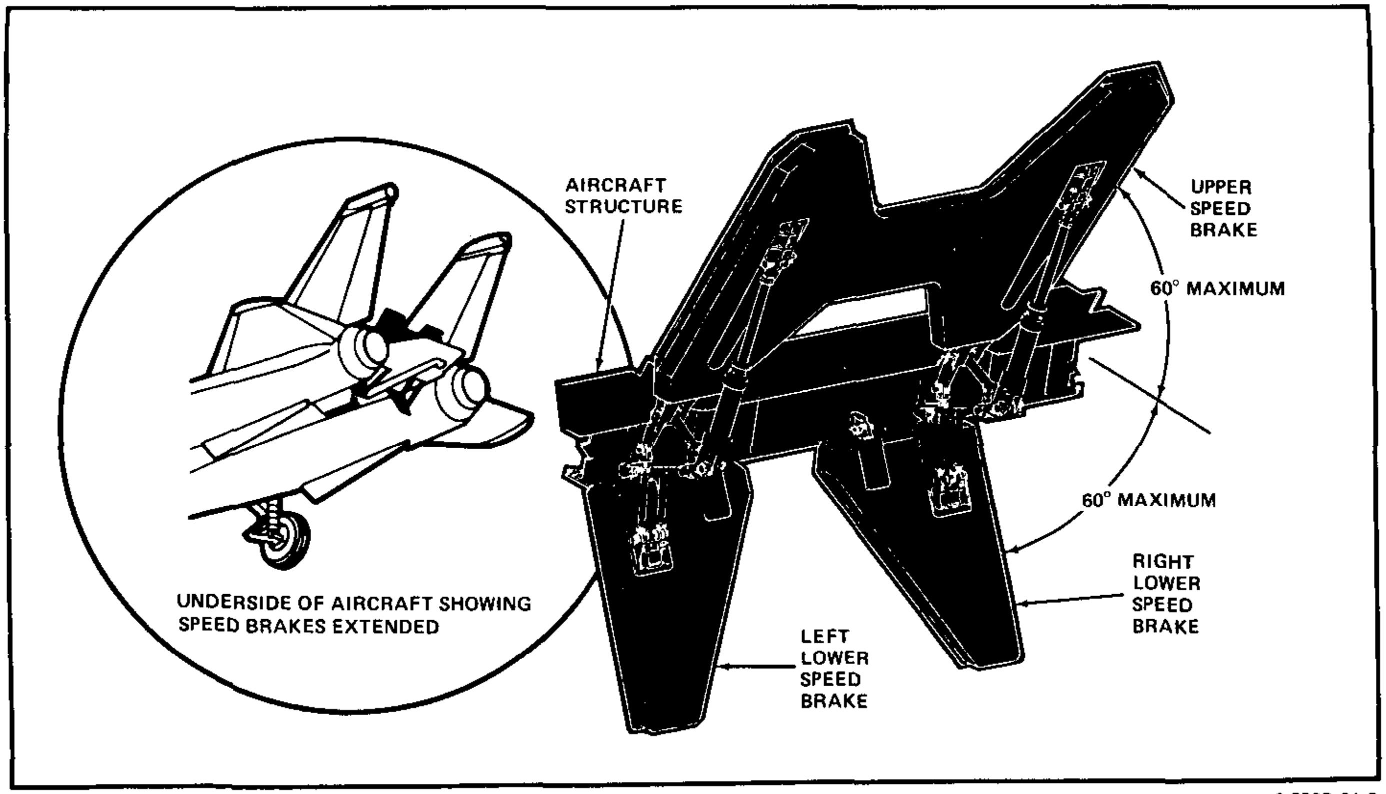
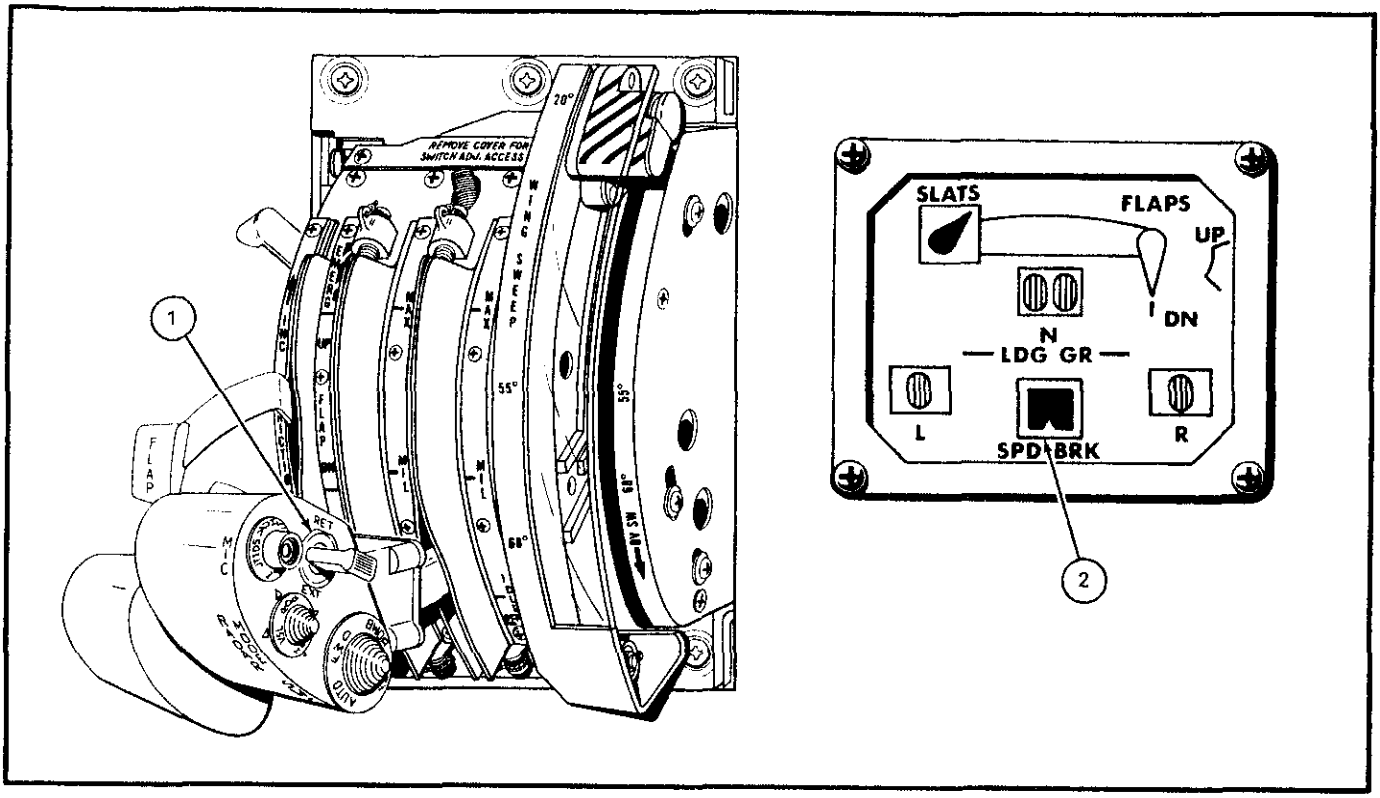


Figure 2-53. Speedbrakes



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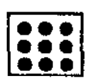
NOMENCLATURE	FUNCTION	
(1) Speed brake switch	EXT –	Momentary position used for partial or full extension. When released, switch returns to center (hold) position.
	RET –	Normal position of switch. Retracts and maintains speed brakes closed.
(2) SPEED BRAKE indicator		– Partial extension (hold).
		– Full extension (60°).
	IN	– Full retracted position.
		– Speed brakes power is off.
		Note Automatic retraction of speed brakes occurs when either or both throttles are at MIL.

Figure 2-54. Speedbrake Control and Indicator

The speedbrakes will start to blowback (close) at approximately 400 knots and will continue toward the closed position as airspeed increases to prevent structural damage. A reduction in airspeed will not automatically cause the speedbrakes to extend to the originally commanded position.

2.23 FLIGHT CONTROL SYSTEMS

Flight control is achieved through an irreversible, hydraulic power system operated by a control stick and rudder pedals. Aircraft pitch is controlled by symmetrical deflection of the horizontal stabilizers. Roll control is effected by differential stabilizer deflections and augmented by spoilers at wing-sweep positions less than 62°. Directional control is provided by dual rudders. During power approach maneuvers, the aircraft flightpath can be controlled through symmetric spoiler displacement by the pilot selecting direct lift control. Control surface indicators are shown in Figure 2-55.

The horizontal stabilizer and rudders are powered by the flight and combined hydraulic systems and controlled by pushrods and bellcranks. A third independent flight control hydraulic power source is provided by the backup module. Spoiler control is effected by an electrohydraulic, fly-by-wire system and powered by the combined hydraulic system (inboard spoilers) and outboard spoiler module (outboard spoilers).

The AFCS includes a stability augmentation system, an autopilot and auxiliary control functions for spoiler control, rudder authority control, lateral stick authority control, and Mach trim compensation.

2.23.1 Longitudinal Control. Longitudinal control (Figure 2-56) is provided by symmetric deflection of independently actuated horizontal stabilizers. Control stick motion is transmitted to the stabilizer power actuators by pushrods and bellcranks to dual tandem actuators independently powered by the flight and combined hydraulic systems. The power actuators control the stabilizers symmetrically for longitudinal control and differentially for lateral control. This is accomplished by mechanically summing pitch and roll commands at the pitch-roll mixer assembly. Nonlinear stick-to-stabilizer gearing provides appropriate stick sensitivity for responsive and smooth control. Longitudinal system authority is shown in Figure 2-57.

2.23.1.1 Longitudinal Feel. Artificial feel devices in the control system provide the pilot with force cues and feedback. A spring-loaded cam and roller assembly produces breakout force when the stick is displaced from neutral trim and provides increasing stick forces proportional to control stick displacement. Control stick forces, proportional to normal acceleration (g forces) and pitch acceleration, are produced by fore and aft bobweights. Aircraft overstresses from abrupt stick inputs are minimized by an eddy current damper that resists large, rapid control deflections.

2.23.1.2 Longitudinal Trim. Longitudinal trim is provided by varying the neutral position of the cam and roller feel assembly with an electromechanical screwjack actuator. The manual pitch trim button on the stick is a five-position switch, spring loaded to the center (off) position (Figure 2-58). The fore and aft switch positions produce corresponding nosedown and noseup trim, respectively. The manual trim switch is deactivated when the autopilot is engaged.

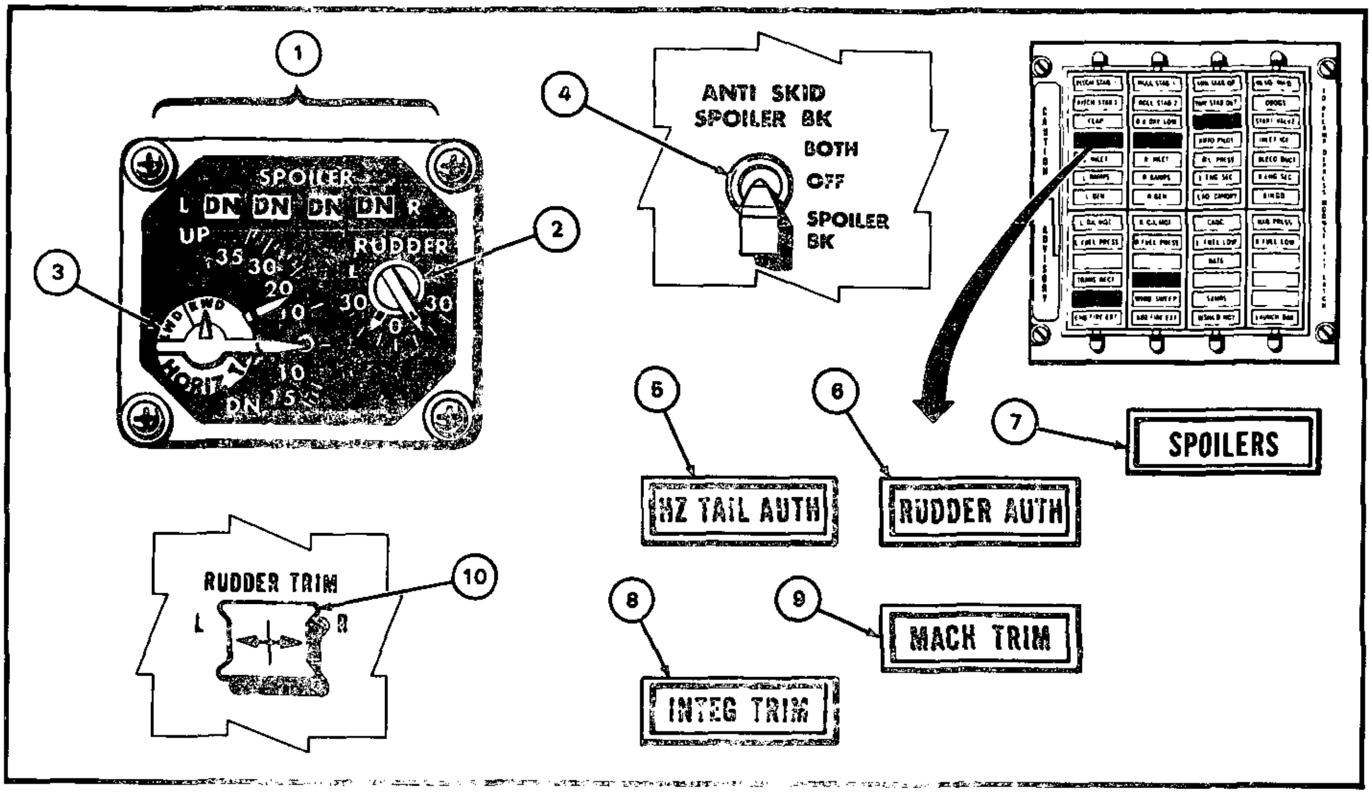
2.23.1.3 Mach Trim. Mach trim control is provided by the AFCS and is continuously engaged to provide automatic Mach trim compensation during transonic and supersonic flight. A failure of Mach trim compensation is indicated by the MACH TRIM advisory light. Transient failures can be reset by depressing the MASTER RESET pushbutton.

The manual and AFCS automatic trim and Mach trim actuator is installed in parallel with the flight control system. Trim actuation produces a corresponding stick and control surface movement.

2.23.2 Integrated Trim System. The ITS is incorporated to reduce longitudinal trim changes because of the extension and retraction of flaps and speedbrakes. Disagreement of command position removes power from the motor and illuminates the INTEG TRIM advisory light. Transient failures can be reset by pressing the MASTER RESET pushbutton. ITS schedules are shown in Figure 2-59.

CAUTION

When the AIM-54 weapon rail pallet(s) is installed, the speedbrake compensation schedule in the integrated trim computer changes. If less than four AIM-54 missiles are carried on the weapon rails, the ITS may overcompensate for the speedbrake trim change. In the worst case (low altitude, between 0.7 and 0.8 Mach, pitch SAS off, and weapon rails without AIM-54 missiles), the ITS can cause an incremental 2g nosedown trim change when the speedbrake is extended. Under these conditions with the pitch SAS engaged, maximum trim change is reduced to approximately 1g.



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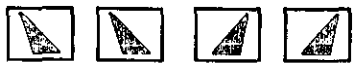
NOMENCLATURE		FUNCTION
1 SPOILER position indicators **Note** A right inboard or outboard spoiler position indicator showing one position higher than the corresponding spoilers actual position indicates a possibility of ground roll braking in flight and loss of spoiler asymmetry protection due to a failed zero degree switch.	  	-Spoilers down (flush with wing surface). -Either spoiler of the appropriate pair is extended more than 0°. -Both spoilers of the appropriate pair at a dropped position (0–4 1/2° below wing surface)
2 RUDDER position indicator		Individual rudder pointers marked R (right) and L (left) display the trailing–edge position of the rudders in degrees (0 to 30).

Figure 2-55. Control Surface Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
3 HORIZONTAL tail stabilizers position	Indicated by two pointers marked R (right) and L (left) on a scale 35° up and 15° down. Scale is graduated in 2° increments. The inner pointer indicates left wing down or right wing down (differential stabilizer position).
4 ANTI SKID SPOILER BK switch	BOTH — Antiskid activated. Spoiler brakes operate with weight on wheels and throttle at IDLE. OFF — Antiskid and spoiler brakes inoperative with weight on wheels. SPOILER BK — Spoiler brakes operate with weight on wheels and both throttles at IDLE. Antiskid is deactivated.
5 HZ TAIL AUTH caution light	Failure of lateral tail authority actuator to follow schedule or CADC failure.
6 RUDDER AUTH caution light	Disagreement between command and position, failure of rudder authority actuators to follow schedule, or CADC failure. **Note** The RUDDER AUTH caution light may illuminate when the in-flight refueling probe is extended. Press the MASTER RESET button to rese the light.
7 SPOILERS caution light	Spoiler system failure, causing a set of spoilers to be locked down. **Note** SPOILERS *caution light will not illuminate* with SPOILER FLR ORIDE switches in ORIDE position.
8 INTEG TRIM advisory light	Discrepancy between input command signal and actuator position or an electrical power loss within the computer.
9 MACH TRIM advisory light	Failure of Mach trim actuator to follow schedule. **Note** Transient failures involving HZ TAIL AUTH, RUDDER AUTH, or SPOILERS caution lights and INTEG TRIM and MACH TRIM advisory lights can be reset by pressing the MASTER RESET pushbutton.
10 RUDDER TRIM switch	Controls the electromechanical actuator that varies the neutral position of the mechanical linkage for rudder trim.

Figure 2-55. Control Surface Indicators (Sheet 2 of 2)

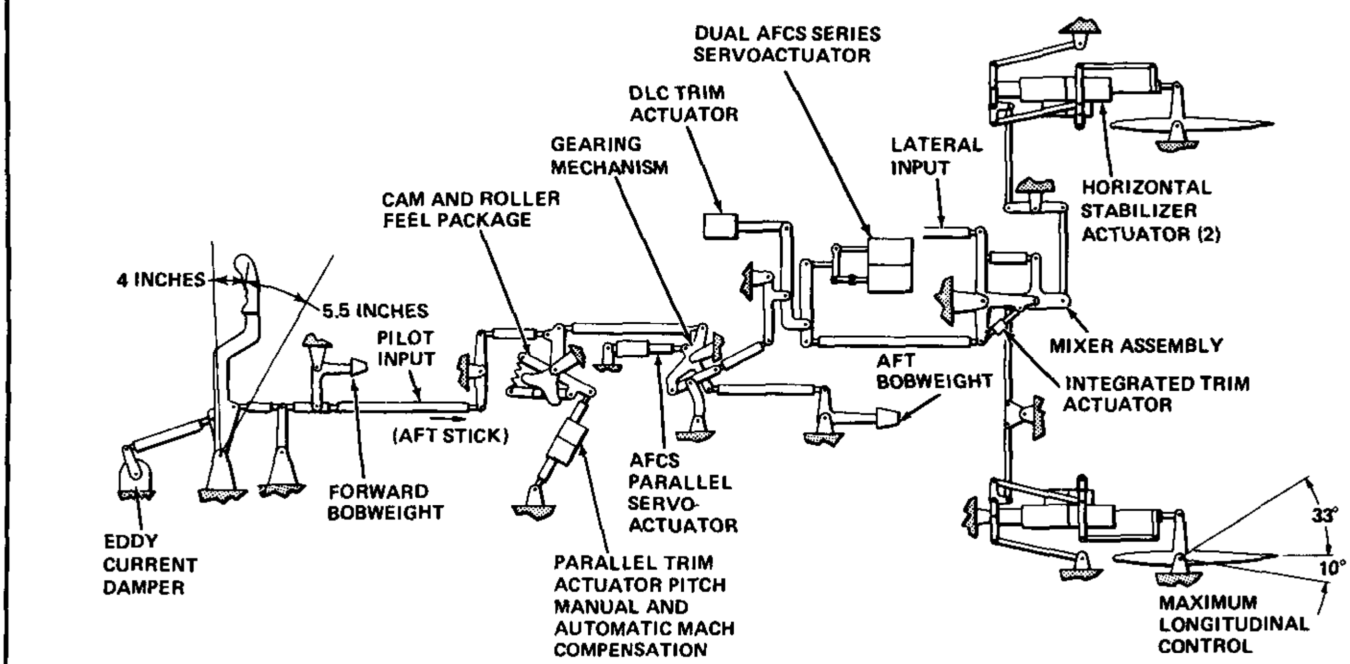


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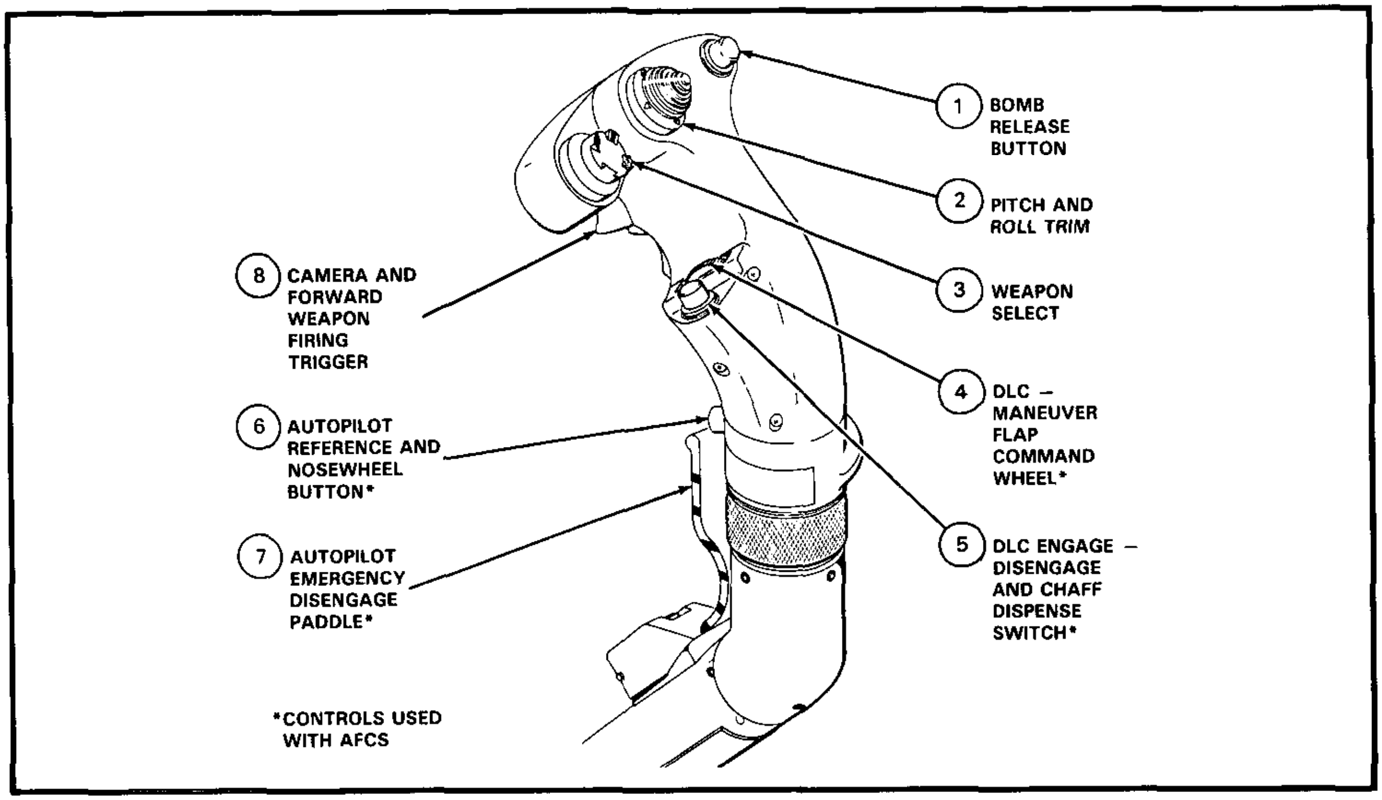
Figure 2-56. Longitudinal Control System

COCKPIT CONTROL			STABILIZER SURFACE		PARALLEL TRIM	
ACTUATION	**MODE**	**MOTION**	**AUTHORITY**	**RATE**	**AUTHORITY**	**AVERAGE RATE**
Control Stick	Manual	4 inches forward 5.5 inches aft	10° TED 33° TEU	36° per second	9° TED 18° TEU	1° per second
AFCS	Series (SAS)	None	±3°	20° per second	–	–
	Parallel Automatic Carrier Landing (ACL only)	4 inches forward 5.5 inches aft	10° TED 33° TEU	36° per second	9° TED 18° TEU	0.1° per second
Maneuver Flap Integrated Trim System (ITS) and DLC Thumbwheel	Series	±45° DLC Thumbwheel Mode	8.4° TED Maximum	36° per second	–	–
		±45° Maneuver Flap Mode	±3°	3° per second	–	–

Figure 2-57. Longitudinal System Authority



NOMENCLATURE	FUNCTION
(1) Bomb release button	Pilot control for release of stores. In aircraft with the weapons rail defense electronic countermeasures (DECM) chaff adapter, the bomb release button is used to dispense chaff.
(2) Pitch and roll trim button	Spring-loaded to (center) off position. Up and down positions control pitch trim and left and right positions control roll trim. Manual trim is inoperative during autopilot operation.
(3) Weapon Selector switch	LR - Selects Phoenix missiles. MR - Selects Sparrow missiles. SR - Selects Sidewinder missiles. GN - Selects gun.
(4) Maneuver flap, slat, and DLC command	Spring-loaded to a neutral position. With DLC engaged: Forward rotation extends spoilers (aircraft down); aft rotation retracts spoilers (aircraft up). With gear and flaps up: Forward rotation retracts maneuvering flaps/slats; aft rotation extends maneuvering flaps/slats.

Figure 2-58. Control Stick and Trim (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(5) DLC engage, disengage, and chaff switch	Momentary depression of the switch with flaps greater than 25 degrees down, throttle less than MIL, and no failures in spoiler system engages DLC. With flaps up, switch will dispense chaff or flares. DLC is disengaged by momentarily pressing the switch, raising the flaps, or advancing either throttle to MIL.
(6) Autopilot reference and nosewheel steering pushbutton	With weight on wheels, nosewheel steering can be engaged by depressing switch momentarily. Weight off wheels and autopilot engaged; switch engages compatible autopilot modes.
(7) Autopilot emergency disengage paddle	Disengages all autopilot modes and DLC. Releases all autopilot switches. Disengages the pitch and roll servos and causes the pitch and roll SAS switches to move to OFF. The yaw SAS channels in either case are not affected. Depressing the paddle switch reverts throttle system from AUTO or BOOST mode to MAN mode only while depressed and with weight on wheels.
(8) Camera and forward weapon firing trigger	Pilot control of CTVS, gun camera, and/or forward firing weapons. First detent of trigger starts gun camera and cockpit television sensor (CTVS).

Figure 2-58. Control Stick and Trim (Sheet 2 of 2)

2.23.2.1 Preflight. The ITS is automatically energized with hydraulic and electrical power applied. It can be checked by operating flaps or speedbrakes and observing a change in indicated stabilizer position.

2.23.3 Lateral Control. Lateral control (Figure 2-60) is effected by differential displacement of the horizontal stabilizers and augmented by wing spoilers at wing-sweep positions of less than 62°. A ±1/2-inch stick deadband is provided to preclude spoiler actuation with small lateral stick commands. The spoilers are commanded to the flush-down (0°) position at wing-sweep angles of greater than 62°, and roll control is provided entirely by differential stabilizer. At wing-sweep angles of 65° and greater, the hydraulic power to the spoiler actuators is cut off, locking the spoilers in the 0° position. Lateral stick commands are transmitted by pushrods and bellcranks to the independent stabilizer power actuators and electrically to the spoiler actuators. Lateral system authority is tabulated in Figure 2-61.

2.23.3.1 Lateral Feel. An artificial feel system provides the pilot with force cues and feedback. The lateral feel mechanism is a spring roller-cam assembly with a neutral stick position detent and a constant stick deflection force gradient.

2.23.3.2 Lateral Trim. Lateral trim is by differential deflection of the horizontal stabilizers. The wing spoilers are not actuated for lateral trim control. Trim is provided by adjusting the neutral position of the spring roller-cam-feel assembly with an electromechanical screwjack. Left or right deflection of the roll trim button on the stick grip produces corresponding stick movement and left or right wing-down trim, respectively. The normal stick grip trim switch is inoperative when the autopilot is engaged.

Note

With lateral trim set at other than 0°, maximum spoiler deflection is reduced in the direction of applied trim.

2.23.3.3 Lateral Control Stops. To limit the torsional fuselage loads, variable lateral control authority stops are installed. The lateral stick stops vary according to dynamic pressure airloads from full stick authority at low Q, to one-half-stick throw limits at high-Q conditions. Failure of the lateral stick stops is indicated by the HZ TAIL AUTH caution light. Transient failures can be reset with the MASTER RESET pushbutton. Failure of the stops in the one-half-stick position limits low-Q rolling performance. However, ample roll control is available for all landing conditions and configurations. Failure in the open condition with SAS on requires the pilot to manually limit stick deflection at higher speeds to avoid exceeding fuselage torsional load limits, as lateral stops do not limit SAS authority.

2.23.4 Spoiler Control. Four spoiler control surfaces (Figure 2-62) on the upper surface of each wing augment roll control power and implement aerodynamic ground-roll braking. The inboard spoilers provide DLC.

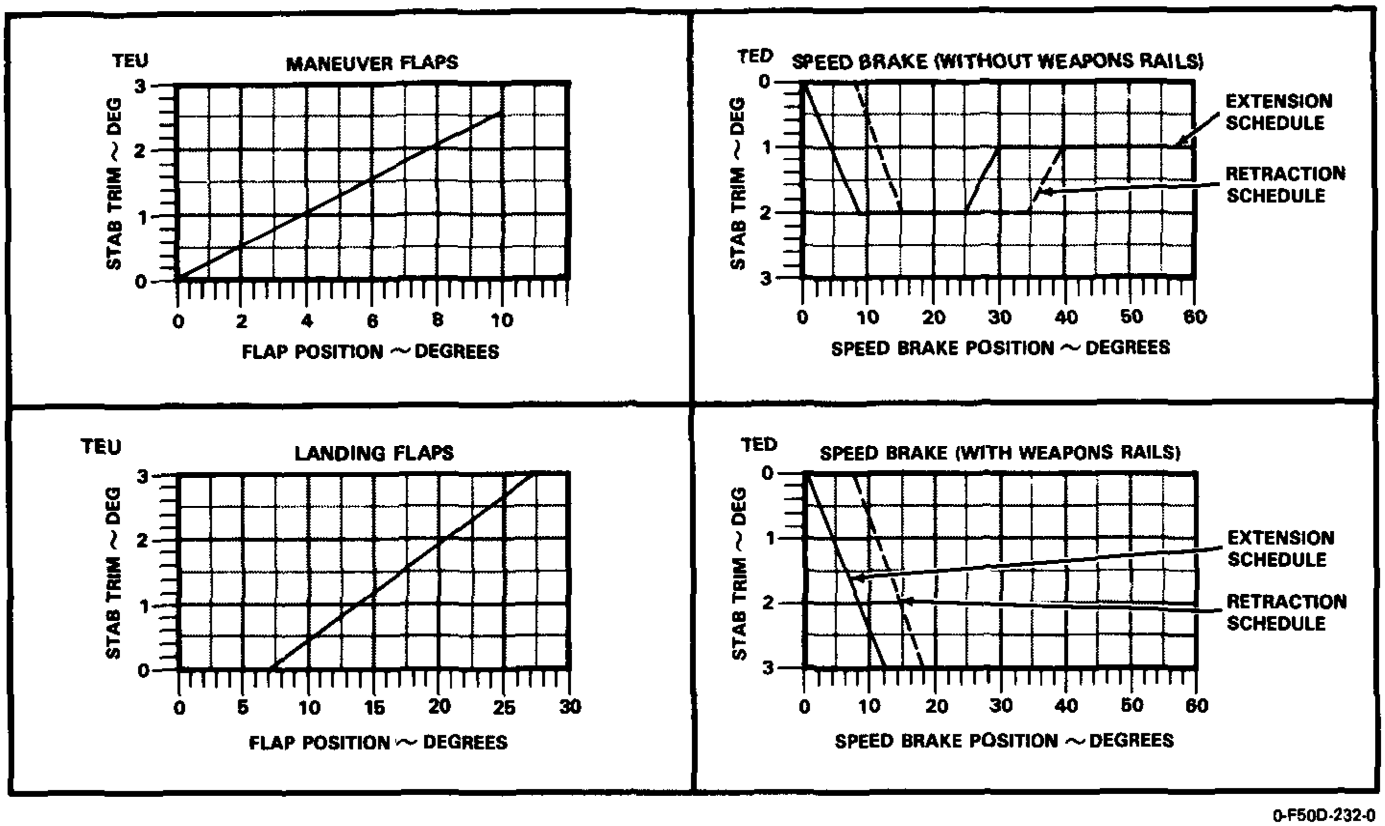


Figure 2-59. Integrated Trim Schedules

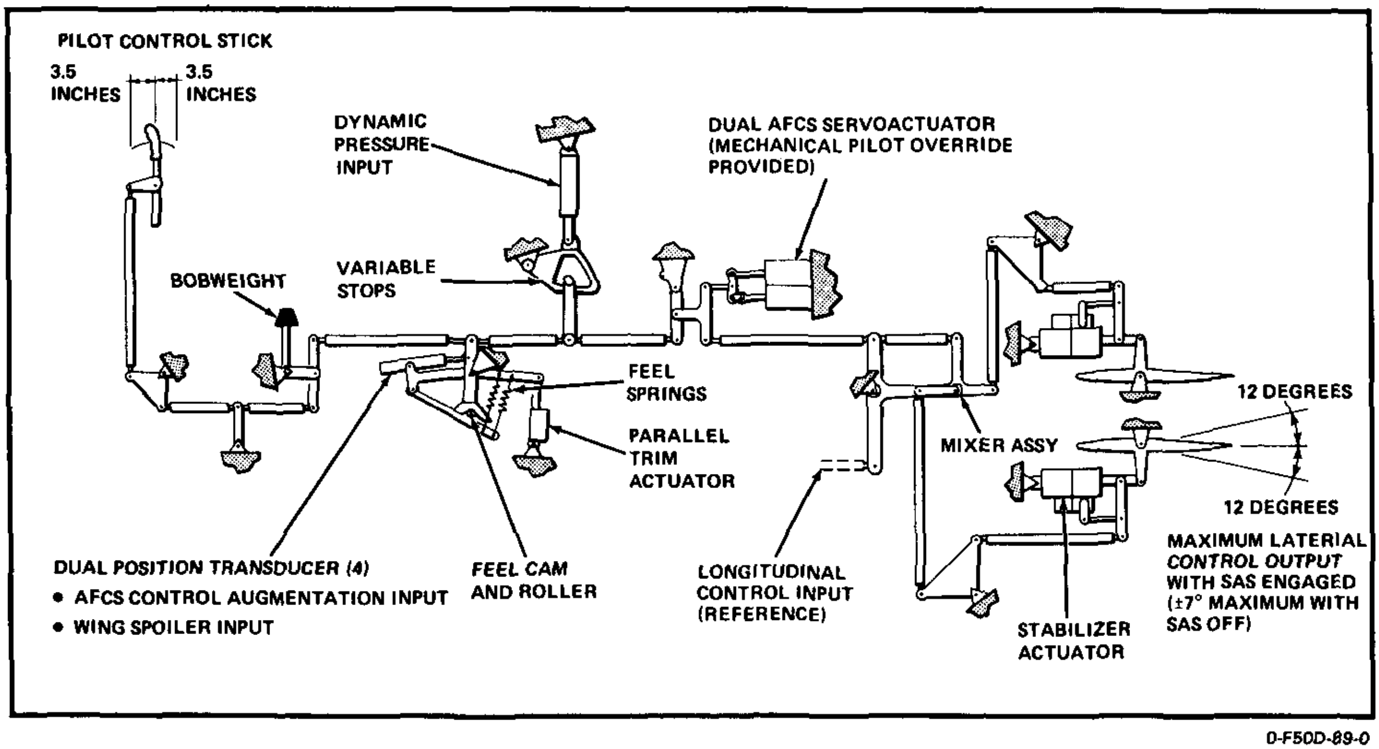


Figure 2-60. Lateral Control System

CONTROL SURFACE	COCKPIT CONTROL			SURFACE		PARALLEL TRIM	
	ACTUATION	MODE	MOTION	AUTHORITY	RATE	AUTHORITY	RATE
Differential Stabilizer	Control Stick	Manual	3.5 inches left 3.5 inches right	±7°	36° per second	±3	3/8° per second
	AFCS	Series	None	±5°	33° per second	–	–
Inboard and Outboard Spoilers	Control Stick	Manual for $\Omega \leq 62°$	3.5 inches left 3.5 inches right	±55°	250° per second	None	None
	AFCS (ACL)	Series	None	15° maximum	250° per second	None	None
	DLC/Maneuver Flap	*Manual*	*DLC/ Maneuver Flap Command Thumb-wheel ±45°*	*Inbd only 17.5° neutral -4.5° down +55° up*	*125° per second (minimum)*	*None*	*None*
	Ground Roll Braking Armed, Weight- on- Wheels	Series	None	55° up	250° per second	None	None
*Lateral Stops	Control Stick Restricted	Manual	1.75 inches left 1.75 inches right	±3-1/2° Diff. Stabilizer **28° Spoiler	36° per second 250° per second	–	–

* Programmed by CADC (Horizontal Tail Authority) as a function of dynamic pressure.

** Maximum SAS off deflection limits with full lateral stops engaged.

Figure 2-61. Lateral System Authority

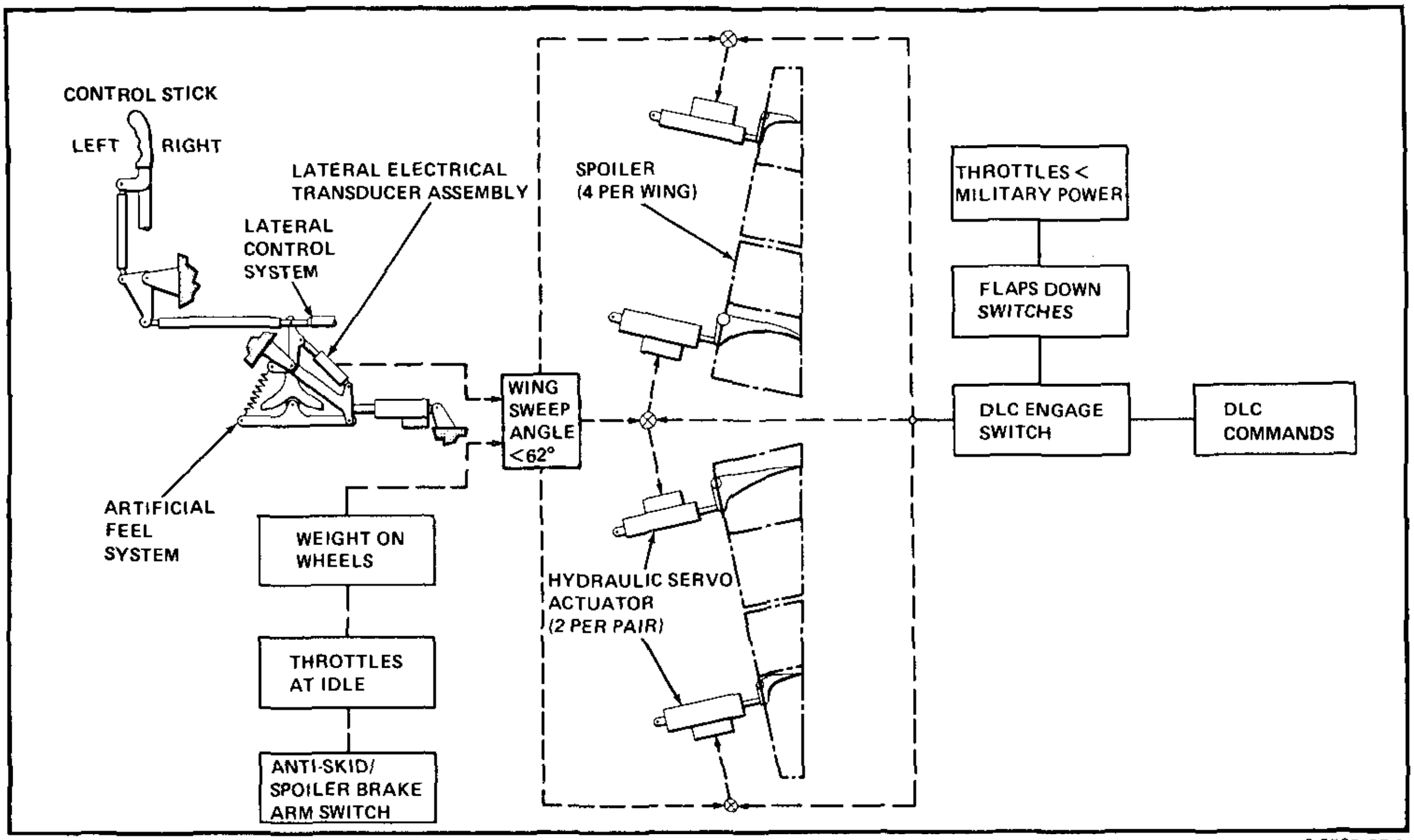


Figure 2-62. Spoiler Control System

The inboard and outboard spoilers are powered and controlled by separate hydraulic and electrical command systems and are protected by separate failure-detection circuits. The pitch computer and outboard spoiler module control the outboard spoilers, and the roll computer and the combined hydraulic system control the inboard spoilers (refer to FO-12). Hydraulic actuation of the servoactuators is controlled by electric servovalves at the actuator and commanded by control stick displacement. The aircraft has two spoiler gearing curves called cruise and power approach. Cruise spoiler gearing is the schedule that spoilers follow in the clean configuration and is shown in Figure 2-63. Power approach is the schedule that spoilers follow with the flaps down greater than 25° and is shown in Figure 2-63 (DLC engaged). With DLC engaged in the power approach mode, inboard spoilers are positioned from normal -4.5° to +17.5° position. Lateral stick inputs result in the spoilers extending on one side in the direction of stick displacement and depressing toward the landing flaps down drooped (-4.5°) position on the other side. This is the primary reason for better roll response in the landing configuration with DLC engaged.

2.23.4.1 Lateral Trim. As mentioned earlier, lateral trim is provided by adjusting the neutral position of the stick. This movement of the neutral position has an effect on the amount of spoiler deflection available. That is, as lateral trim is applied away from the zero trim position, maximum spoiler deflection is reduced in the same direction (right trim, less right wing spoiler deflection).

Full lateral trim in the same direction as lateral stick displacement will still provide approximately 25° of spoiler deflection to counteract an asymmetric flap and slat condition (see Figure 2-63). This is sufficient to control full-flap asymmetry with symmetrically down slats.

WARNING

Full slat asymmetry (17°) can result in an out-of-control situation at 15 units AOA or greater, even with 55° of spoilers available.

2.23.4.2 Ground-Roll Braking. Aerodynamic ground-roll braking is provided by symmetric deflection of all spoilers to +55°. Ground-roll braking is controlled by the ANTI SKID SPOILER BK switch on the pilot

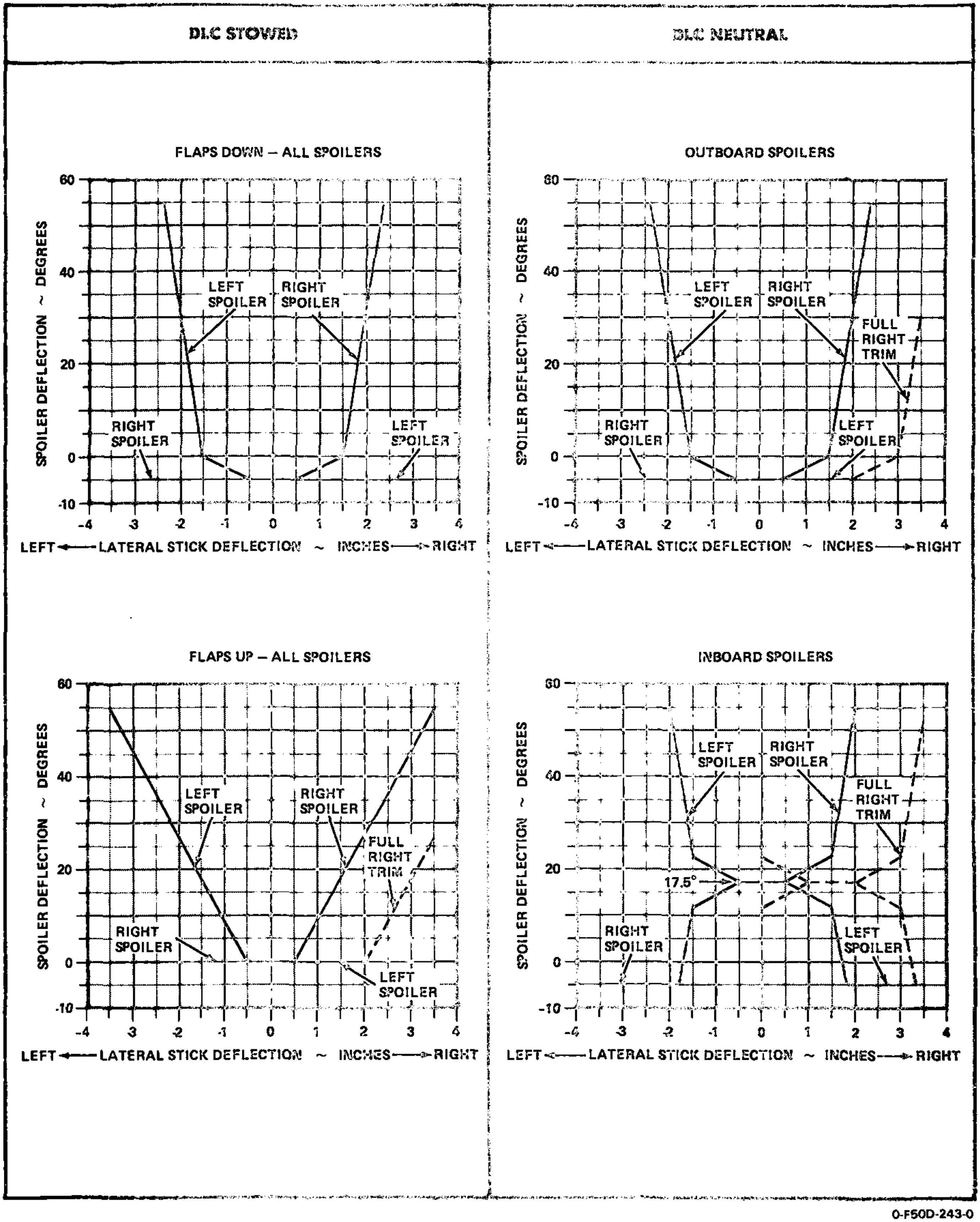


Figure 2-63. Spoiler Gearing Schedule

left vertical console. The three-position switch allows optional selection of BOTH (spoiler brake and antiskid wheelbraking), SPOILER BK (spoiler brake only), or OFF where neither spoilers nor antiskid are armed. With SPOILER BK or BOTH selected, two conditions are required to actuate the spoilers:

1. Weight on wheels
2. Both throttles a idle.

Failure to satisfy any one of the above conditions will cause the spoilers to return to the down position.

Note

During initial spoiler brake operation, it is normal for the indicators in the SPOILER window to momentarily flip-flop.

2.23.4.3 Spoiler Failure. Simultaneous deflection of corresponding spoiler pairs greater than 18°, or a stick displacement of 1 inch to oppose a symmetric spoiler greater than 18°, will signal a spoiler failure, remove all electrical commands to the affected spoiler set, hydraulically power the failed spoiler pairs to the -4-1/2° position, and illuminate the SPOILER caution light. Transient spoiler failures can be reset by pressing the MASTER RESET pushbutton. With either SPOILER BK or BOTH selected and weight on wheels, the symmetric spoiler failure logic is disarmed to permit symmetrical 55° spoiler deflection for ground-roll braking. With DLC engaged, inboard symmetric spoiler failure logic is disarmed.

Failure of the AFCS roll computer fails the inboard spoiler pairs. An AFCS pitch computer failure renders the outboard spoiler pairs inoperative.

A spoiler failure override (SPOILER FLR ORIDE) panel on the pilot right inboard console allows the pilot to manually override the automatic shutdown function. If a stuckup spoiler failure occurs, selecting the appropriate INBD or OUTBD spoiler switch to ORIDE (Figure 2-64) and then depressing MASTER RESET allows the remaining spoilers in that set to operate.

Varying ac voltage during an electrical short condition may yield one or more of the following characteristics:

1. Loss of one or both channels of computer operation.
2. Differential tail and rudder hardovers for up to 3 seconds.
3. Inoperative spoilers and SAS outputs even when voltage is reset to nominal 115 volts.
4. Inability to reset computers through master reset and reengage pitch and roll SAS switches.

Note

On deck, when the flap handle is cycled to UP, the outboard spoiler module is shut down. This may cause the outboard spoilers to indicate a droop or down position. If this occurs, position the flap handle to DN and move the control stick laterally. This will result in a proper spoiler indication.

2.23.4.4 Spoiler Test. The spoiler test provides a continuity and logic test for the spoiler 18° and stick switches. The test is conducted with the flaps down and spoilers up. Select STICK SW on the MASTER TEST switch (SPOILERS caution light illuminates, spoilers droop). Move the stick left and right of center 1 inch. Observe GO light illuminate on the MASTER TEST panel after moving the stick in each direction. Return the MASTER TEST switch to off and depress the MASTER RESET pushbutton to reset the spoilers.

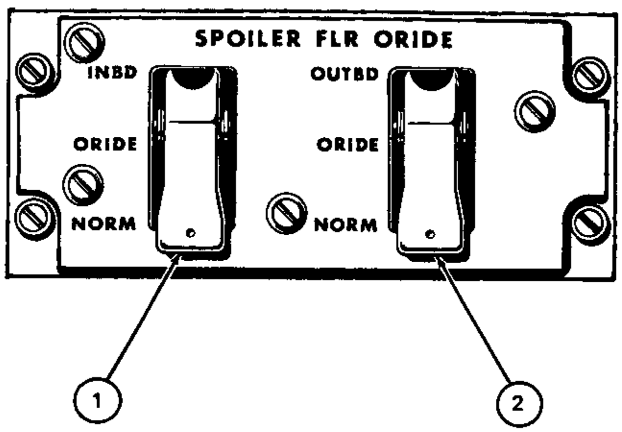
2.23.5 Yaw Control. Yaw control (Figure 2-65) is effected by twin rudders, one on each vertical tail. The rudder pedals adjust through a 10-inch range in 1-inch increments with the adjust control on the lower center pedestal, forward of the control stick.

Yaw commands are transmitted mechanically from the rudder pedals to the rudder power actuators by pushrods and bellcranks. Tandem power actuators are powered independently by the flight and combined hydraulic systems. Yaw system authority is tabulated in Figure 2-66.

2.23.5.1 Rudder Feel. Artificial feel is provided with a spring roller-cam mechanism similar to the longitudinal and lateral feel systems.

Rudder force with pedal deflection is nonlinear with a relatively steep gradient about the neutral detent and gradually decreasing with increased pedal travel.

2.23.5.2 Rudder Trim. Rudder trim is effected by varying the neutral position of the feel assembly with an electromechanical screwjack actuator. Rudder trim control is actuated by a three-position switch on the left console outboard of the throttle quadrant. Left (L) and right (R) lateral switch movement commands left and right rudder trim, respectively. The switch is spring loaded to the center off position. Trim actuation produces an associated movement of the rudder pedals, rudders, and rudder indicator.



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NOMENCLATURE	FUNCTION	
1 INBD spoiler override switch	ORIDE –	Overrides inboard spoiler symmetry protection logic. If an inboard spoiler fails more than 18° up, allows remaining inboard spoilers to operate after MASTER RESET is depressed.
	NORM – (guarded – position)	Safety guard down. Allows inboard spoiler symmetry protection. If an inboard spoiler fails up, all inboard spoilers are commanded to the droop position and the SPOILERS light illuminates.
2 OUTBD spoiler override switch	ORIDE –	Overrides outboard spoiler symmetry protection logic. If an outboard spoiler fails more than 18° up, allows remaining outboard spoilers to operate after MASTER RESET is depressed.
	NORM – (guarded position)	Safety guard down. Allows outboard spoiler symmetry protection. If an outboard spoiler fails up, all outboard spoilers are commanded to the droop position and the SPOILERS light illuminates.

Figure 2-64. Spoiler Failure Override Panel

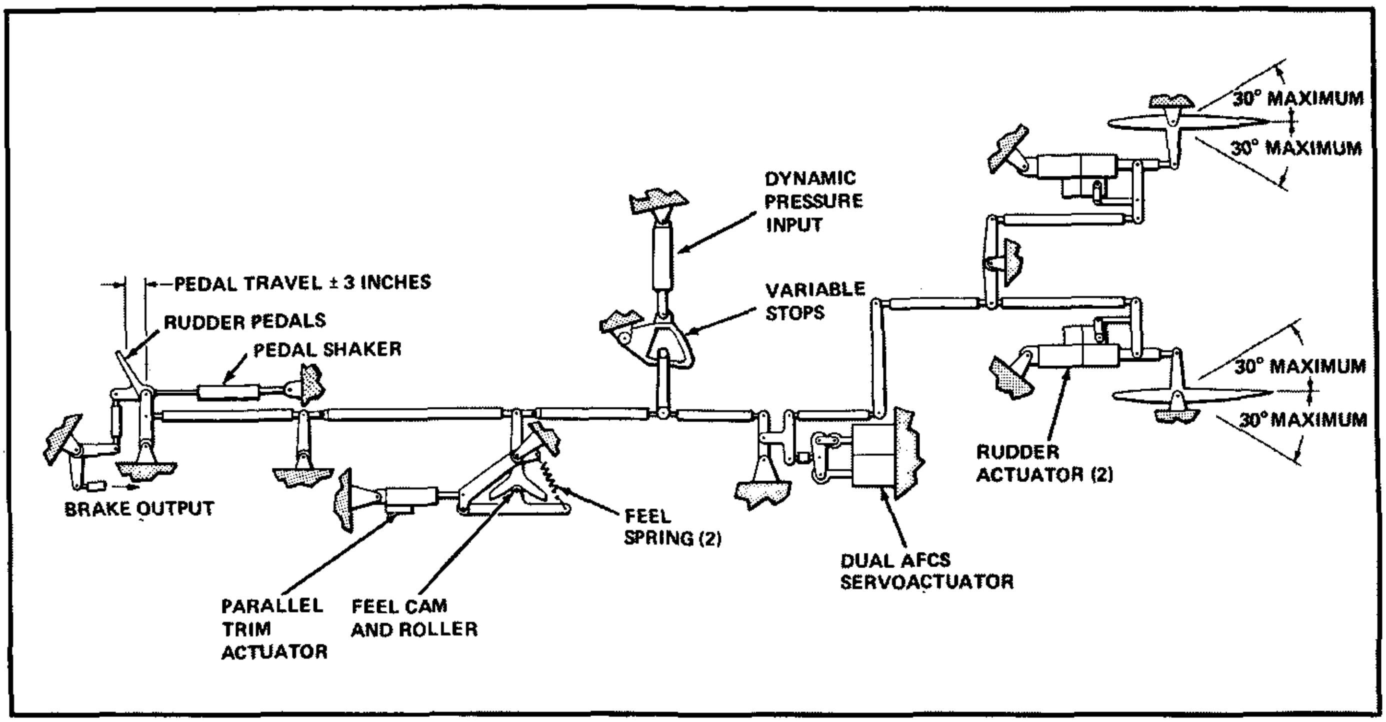

Figure 2-65. Yaw Control System

COCKPIT CONTROL			RUDDER SURFACE		PARALLEL TRIM	
ACTUATION	MODE	MOTION	AUTHORITY	RATE	AUTHORITY	AVERAGE RATE
Rudder Pedals	Manual (unrestricted)	3 inches left, 3 inches right	±30° maximum	106° per second	7°	1.13° per second
	*Manual (restricted)	1 inches left 1 inches, right	±9.5° minimum	106° per second	7°	1.13° per second
AFCS	Series	None	*±19°	80° per second	–	–

*Stops programmed by CADC (rudder authority) as a function of dynamic pressure.

Figure 2-66. Yaw System Authority

2.23.5.3 Rudder Authority Stops. Rudder authority control stops limit rudder throws in the high-Q flight environment. Rudder deflection limits are scheduled by the CADC, commencing at about 250 knots. Above approximately 400 knots, the stops are fully engaged, restricting manual rudder deflection to 9.5°. Disagreement between command and position removes power from the motor and illuminates the RUDDER AUTH caution light.

CAUTION

> A CADC failure may drive the rudder authority stops to 9.5°. This condition should be determined prior to making a single-engine or crosswind landing. With the 9.5° stops in, rudder control may be insufficient to maintain directional control with single-engine afterburner operation or during crosswind conditions. Nosewheel steering authority is greatly reduced with the 9.5° stops engaged.

2.23.5.4 Rudder Pedal Shaker. The rudder pedal shaker operates only during OBC/YAW BIT and is disabled during flight.

2.23.6 Direct Lift Control. During landing approaches, the inboard spoilers and horizontal stabilizers can be controlled simultaneously to provide vertical glidepath correction without changing engine power setting or angle of attack.

Before DLC can be engaged, the following conditions are required:

1. Flaps down greater than 25°.
2. Throttles less than MIL power.
3. Inboard spoilers operational.
4. Pitch and roll AFCS computers operational.
5. Operable combined hydraulic pump.

2.23.6.1 DLC Operation. DLC is engaged with the control stick DLC switch and commanded by the thumbwheel. The thumbwheel is spring loaded to a neutral position. Forward rotation of the wheel extends spoilers and aft rotation retracts them proportionally to the degree of thumbwheel rotation. DLC is provided by the pitch and roll computers.

Upon engagement of DLC, the roll computer extends the inboard spoilers from the landing flaps down drooped (-4-1/2°) position to +17.5° above the flush (0°) position. The pitch computer displaces the trailing edges of the horizontal stabilizers 2.75° down from their trim position. If the thumbwheel control is rotated fully forward, the spoilers extend to their 55° position and the stabilizer trailing edges remain at 2.75°. This increases the rate of descent. If the thumbwheel control is rotated fully aft, the spoilers retract to their -4.5° position and the stabilizer trailing edges return to the trim position. This decreases the rate of descent.

2.24 AUTOMATIC FLIGHT CONTROL SYSTEM

The AFCS (FO-12) augments the aircraft's natural damping characteristics and provides automatic commands for control of attitude, altitude, heading, and approach modes selected by the pilot. All AFCS functions are integrated into the primary flight control system. A BIT capability is provided to exercise in-flight monitoring and to conduct an automatic operational readiness test for preflight checks. AFCS rates and authorities are tabulated in Figure 2-67.

2.24.1 Stability Augmentation System. Stability augmentation is provided for all three aircraft axes (pitch, roll, and yaw). Control surface commands are generated by the roll, pitch, and yaw computers in response to inputs from AFCS sensors.

Computer outputs are fed through the flight control system dual-series actuators that drive the control system mechanical linkages in series (no stick motion) to produce surface motion. Stability augmentation is controlled by the three STAB AUG switches on the upper half of the AFCS control panel (Figure 2-68). SAS is engaged by placing these switches to ON during normal poststart procedures. The PITCH and ROLL STAB AUG switches are solenoid held and the YAW STAB AUG switch is a manually operated toggle switch. PITCH and YAW SAS switches should normally remain in ON throughout the flight. Roll SAS reduces departure resistance and shall be placed OFF prior to conducting maneuvering flight above 15 units AOA. Pitch and roll SAS axes consist of two redundant channels that provide fail-safe operation.

Yaw SAS consists of three electronic channels to provide fail-safe operational capability.

2.24.2 Voltage Monitor Control Unit. The VMCU detects abnormal voltage transients in the aircraft electrical supply system and reduces the voltage to a low enough level to allow the AFCS to detect it and disengage the SAS. If the VMCU detects a low-voltage

AXIS	ACTUATOR	SURFACE	AUTHORITY	SURFACE RATE
Pitch	Dual Series SAS	Stabilizer	±3°	20° per second
	ITS	Stabilizer	±3°	3° per second
	Parallel (ACL only)	Stabilizer	10° TED 33° TEU	36° per second
	Parallel Trim	Stabilizer	10° TED 18° TEU	0.1° per second
Roll	Dual Series	Differential Stabilizer	±5°	33° per second
		Spoilers (ACL)	15° maximum	250° per second
Yaw	Dual Series	Rudder	±19°	80° per second

Figure 2-67. AFCS Rates and Authorities

condition of 97 volts or less in the ac, phase A supply, the unit will activate a relay to drop the voltage to zero and maintain that level for a minimum of 1.25 seconds plus the duration of the detected low-voltage condition. Activation of the VMCU because of a low-voltage condition results in the simultaneous illumination of the following lights for the duration of the transient:

1. PITCH STAB 1 and 2
2. ROLL STAB 1 and 2
3. YAW STAB OP and OUT
4. SPOILERS
5. HZ TAIL AUTH
6. RUDDER AUTH
7. AUTO PILOT
8. MACH TRIM.

2.24.2.1 VMCU Operation. While the VMCU is activated, all spoilers will be commanded to -4.5°, all SAS and AFCS functions will be turned off, and the PITCH and ROLL STAB AUG switches drop to OFF. When normal supply voltage is sensed, the VMCU is deactivated and normal power is restored to the phase A bus, all lights will go out, except the RUDDER AUTH light at low speeds and the HZ TAIL AUTH light at high speeds, and SAS will be available for the yaw axis since the YAW STAB AUG switch remains ON. SAS operation of the remaining axis will be available when the PITCH and ROLL STAB AUG switches are set to ON and the illuminated light(s) will reset with the MASTER RESET pushbutton.

2.24.2.2 VMCU Check. The VMCU is checked prior to flight during the poststart procedure. The voltage drop obtained when the emergency generator is turned off is sufficient to activate the VMCU and illuminate the affected caution and advisory lights.

2.24.3 Autopilot. The autopilot is controlled by four switches on the lower half of the AFCS control panel (Figure 2-68) and the autopilot reference and nosewheel steering pushbutton on the stick grip. With all three SAS axes engaged, autopilot operation is commanded by placing the ENGAGE/OFF switch to ENGAGE. No warmup period is required. The autopilot may be engaged with the aircraft in any attitude. If, however, aircraft attitude exceeds ±30° in pitch and ±60° in roll, the autopilot will automatically return the aircraft to these limits. Normally, IMU is the prime reference and attitude heading reference system (SAHRS) a backup.

2.24.3.1 AFCS Series Actuator. The AFCS series actuator is a dual-channel servoactuator that is controlled and commanded by the AFCS computers to provide a low-authority input that can be mechanically overridden by the pilot. Each servo of the dual actuator is monitored to provide failure detection and automatic shutdown of a malfunctioning actuator channel. PITCH STAB and ROLL STAB caution lights notify the pilot of a malfunction. The remaining functional channel will continue to provide half authority for the pitch and roll axes. Autopilot modes may be engageable but will have reduced authority.

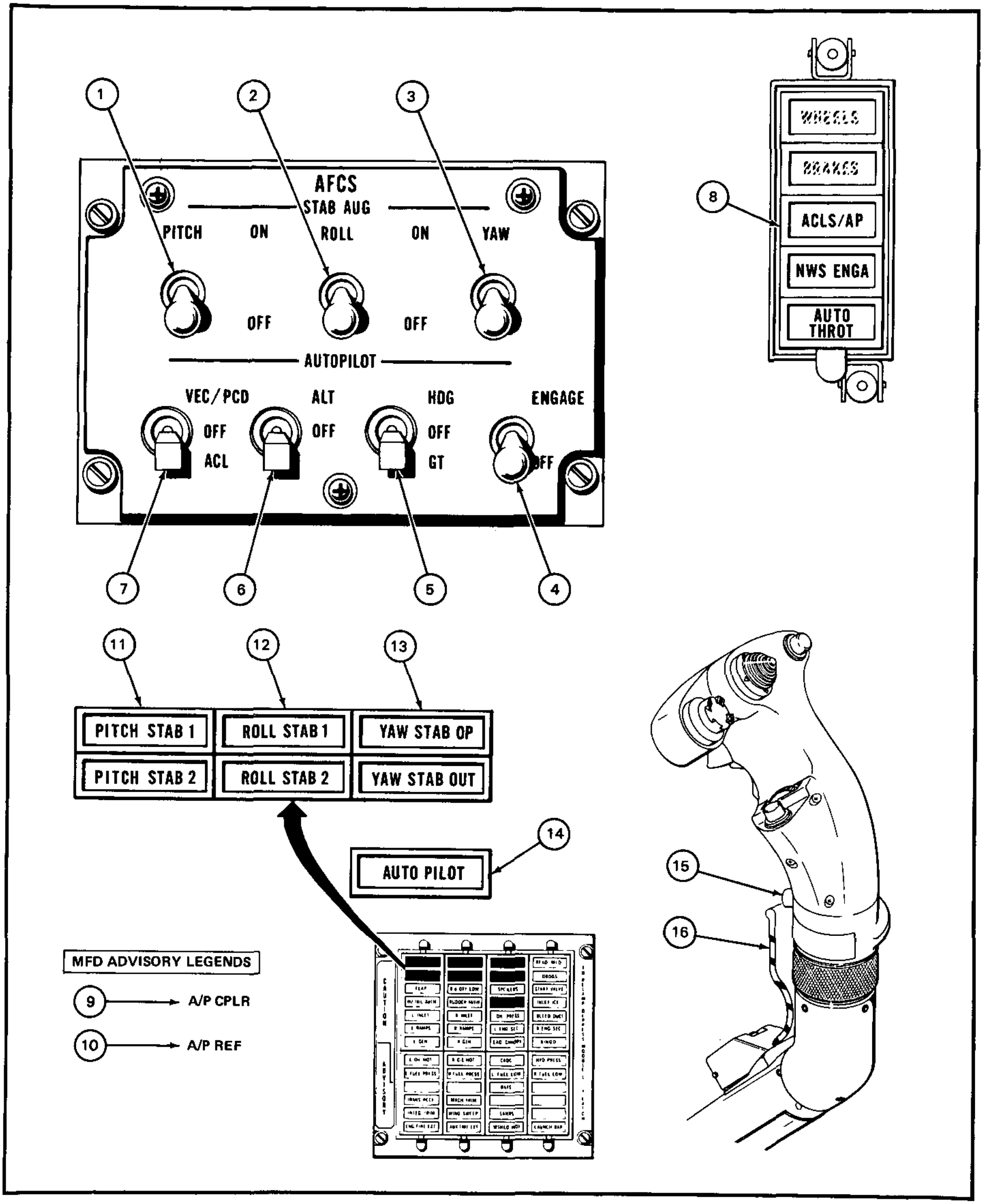

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Figure 2-68. AFCS Controls and Indicators (Sheet 1 of 3)

NOMENCLATURE	FUNCTION	
(1) PITCH STAB AUG engage switch	Engages dual-channel pitch stability augmentation. Solenoid held in ON. Spring-loaded to OFF.	
(2) ROLL STAB AUG engage switch	Engages dual-channel roll stability augmentation. Solenoid held in ON. Spring-loaded to OFF.	
(3) YAW STAB AUG engage switch	Engages three-channel yaw stability augmentation.	
(4) AUTOPILOT ENGAGE-OFF switch	ENGAGE –	Engages autopilot. PITCH, ROLL, and YAW SAS must be engaged. No warmup required. Engages attitude hold. Requires weight off wheels.
	OFF –	Disengages autopilot.
(5) HDG-OFF-GT switch	HDG –	Autopilot will lock on constant aircraft heading when aircraft is less than ±5 degrees roll.
	OFF –	Disengages heading hold and ground track.
	GT –	Selects autopilot ground tracking computed at time of engagement using inertial navigation system (INS) data. Engaged by nosewheel steering pushbutton
(6) ALT-OFF switch	ALT –	Autopilot will maintain barometric altitude. Engaged by nosewheel steering pushbutton.
	OFF –	Disengages altitude mode.
(7) VEC/PCD-OFF-ACL	VEC/PCD –	Autopilot roll axis commands steer aircraft using data link signals for vectoring. If the precision course direction (PCD) discrete is present both roll and pitch axis commands are used. Engaged by nosewheel steering pushbutton.
	OFF –	Disengages VEC/PCD and ACL modes.
	ACL –	Autopilot will accept data link signals for carrier landing, using spoilers for roll and parallel servo for pitch. Only pitch commands are transmitted to stick movement. Engaged by nosewheel steering pushbutton.
(8) ACLS/AP caution light	Autopilot and automatic carrier landing system (ACLS) mode disengaged.	

Figure 2-68. AFCS Controls and Indicators (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
(9) A/P CPLR advisory legend on MFD	Indicates the aircraft can be coupled to the ACL system for a mode I or mode IA approach. A/P CPLR legend remains in conjunction with the CMD CTRL legend after coupling is accomplished.
(10) A/P REF advisory legend on MFD	Autopilot mode is selected but is not engaged. (Except attitude and heading hold.)
(11) PITCH STAB 1 and PITCH STAB 2 caution	One light, illuminated channel inoperative. Single channel 50% loss of authority. Both lights illuminated, indicates PITCH STAB failure.
(12) ROLL STAB 1 and ROLL STAB 2 caution lights	One light illuminated channel inoperative. Single channel, 50% loss of authority. Both lights illuminated, indicates ROLL SAS failure.
(13) YAW STAB OP and YAW STAB OUT caution lights	OP - One channel inoperative. OUT - Two channels inoperative. Yaw stabilization inoperative.
(14) AUTO PILOT caution light	Indicates failure of one or more of pilot relief modes.
(15) Autopilot reference and nosewheel steering	Engages the ALT, GT, ACL or VEC/PCD autopilot mode selected. Autopilot must be engaged and compatible autopilot modes selected. Requires weight off wheels.
(16) Autopilot emergency disengage paddle	Disengages all autopilot modes and releases all autopilot switches. Disengages the pitch and roll servos and causes the pitch and roll SAS switches to move to OFF. The yaw channels in either case are not affected.

Figure 2-68. AFCS Controls and Indicators (Sheet 3 of 3)

The YAW STAB OP caution light indicates one of the three yaw channels is inoperative. Full authority is retained.

Note

Taxiing with one engine shut down and the HYD TRANSFER PUMP off may illuminate the pitch, roll, and/or yaw caution lights.

2.24.3.2 AFCS Pitch Parallel Actuator. The AFCS pitch parallel actuator is a single-channel electrohydraulic servoactuator that provides automatic longitudinal control during mode I and mode IA ACLS approaches. Pitch commands received by the data link are supplied to the parallel actuator via the AFCS pitch computer. As a safety feature, the parallel actuator system contains a mechanical force link that is designed to disconnect the actuator from the control system when excessive force (greater than 90 pounds) is encountered at the actuator control rod, thus uncoupling the autopilot from the ACL system. Upon ACL engagement, the parallel actuator centers itself automatically as a function of stick position, pitch rate, and pitch attitude. Coupling with the aircraft out of trim or in a climb or descent will result in improper centering of the parallel actuator and decreased actuator authority in one direction. This will greatly increase the probability of uncoupling during the approach since the actuator may command the control system against the physical stop in the direction of reduced authority and disconnect the force link. Similarly, it is possible for the force link to disconnect during pilot OBC if longitudinal trim is not properly set prior to OBC commencement. Once the force link is disconnected, further mode I or mode IA approaches will be impossible until the force link is reset by maintenance.

CAUTION

- It is absolutely imperative that the aircraft be trimmed hands-off in level, on-speed, wings-level flight with landing checks complete prior to coupling in order to achieve proper centering of the pitch parallel actuator. Engagement of ACL in any other flight condition will seriously degrade mode I/IA flight characteristics and may result in a force link disconnect. The recommended method for coupling is to engage ACL after 15 to 30 seconds of flight in the landing configuration with AFCS attitude and altitude hold engaged to utilize the AFCS automatic pitch trim system.
- OBC commencement with less than 3° noseup trim with flaps down or less than zero degrees with flaps up may result in a force link disconnect when the stick hits the forward stick stop during the pitch parallel actuator checks.

2.24.3.3 Automatic Pitch Trim. Automatic pitch trim is used in all autopilot pitch modes to trim the aircraft in order to minimize pitch transients when disengaging autopilot functions. The pitch servo position is monitored to drive the aircraft pitch trim motor at one-tenth manual trim rate. The pilot manual trim button on the control stick is inoperative during all autopilot operations.

2.24.3.4 AFCS Emergency Disengage. Operation of the autopilot emergency disengage paddle on the control stick (Figure 2-68), disengages the autopilot and DLC. All autopilot switches will return to OFF. The pitch and roll SAS servos are disengaged while the paddle is held depressed. Depressing the paddle with weight on wheels reverts throttle system from the AUTO or BOOST mode to the MAN mode only while depressed. Depressing the paddle disengages the pitch and roll SAS servos and causes the pitch and roll SAS switches to move to OFF. The yaw SAS switch is not affected by operation of the autopilot emergency disengage paddle and will remain ON.

Note

The AUTO PILOT light may or may not illuminate when the autopilot is disengaged with the autopilot emergency disengage paddle.

2.24.4 Pilot Relief and Guidance Modes

2.24.4.1 Control Stick Steering. With the autopilot engaged, the aircraft may be maneuvered using control stick steering. In control stick steering mode, the AFCS automatically synchronizes to the new attitude.

2.24.4.2 Attitude Hold. Attitude hold is selected by setting the AUTOPILOT ENGAGE switch to ENGAGE. To change attitude, use control stick steering. Reengagement is achieved by releasing pressure on the stick. The autopilot will hold pitch attitudes up to ±30° and bank angles up to ±60°. Inertial measurement unit failure will cause mode disagreement and the engage switch will return off. The mode may be reengaged using the SAHRS as a reference.

2.24.4.3 Heading Hold. Heading (HDG) hold is engaged by setting the HDG-OFF-GT switch to HDG. After maneuvering the aircraft to the desired reference heading, release the control stick at a bank angle of less than ±5°. The autopilot will then hold the aircraft on the desired heading. Heading reference is obtained from the SAHRS via the converter interface unit.

2.24.4.4 Ground Track. To engage ground track, set the HDG-OFF-GT switch to GT. When the A/P REF advisory legend (on upper left side of the MFD) appears, press the nosewheel steering pushbutton on the control stick grip. When the A/P REF legend goes off, the mode is engaged.

Disengagement will occur if more than 1-1/2 pounds lateral stick force is applied and will be indicated by the A/P REF legend. The ground-track mode may be reengaged by releasing the stick force and pressing the nosewheel steering pushbutton.

Ground-track steering computations are performed by the mission computer, based on inputs from the CIU, IMU, and SAHRS. The computer output, in the form of ground-track error signals, is processed in the CIU, which generates steering commands to the autopilot roll axis. Bank angles are limited to ±30°. Failure of INS or SAHRS will cause loss of ground-track steering.

2.24.4.5 Altitude Hold. Altitude hold mode is engaged by setting the ALT-OFF switch to ALT. When the A/P REF advisory legend appears, press the nosewheel steering pushbutton when at the desired altitude. This will engage the altitude hold mode and the A/P REF legend will go off. Applying 10 pounds longitudinal stick force will cause the A/P REF legend to appear. The mode may be reengaged by depressing the nosewheel steering pushbutton on the stick grip, when at the desired altitude, and observing that the A/P REF legend goes off. Altitude hold should not be engaged during any maneuvers requiring large, rapid, pitch trim changes because of limited servo authority and slow automatic trim rate. Disengagement of altitude hold is accomplished by applying 10 pounds or more longitudinal stick force or by placing the ALT-OFF switch to OFF.

Note

Do not actuate in-flight refueling probe with altitude hold engaged because of large transients in pitot-static systems sensed by the CADC.

2.24.4.6 Data-Link Vector — Precision Course Direction. This mode is engaged by placing the VEC/PCD-OFF-ACL switch to VEC/PCD, and pressing the nosewheel steering pushbutton. Mode engagement is evidenced by the A/P REF advisory legend going off. Disengagement of the mode is accomplished by application of stick forces of 7-1/2 pounds lateral or 10 pounds longitudinal, or disengagement by placing the VEC/PCD-OFF-ACL switch to OFF. If the switch is left in VEC/PCD, the A/P REF legend will appear and the mode may be reengaged by depressing the autopilot reference and nosewheel steering pushbutton.

Determination of whether data-link or precision course direction signals are present is made in the AFCS pitch and roll computers in response to inputs from the data link converter and CIU. If the data-link vector discrete is present, the autopilot roll axis will respond to data-link heading commands and bank angle authority will be limited to ±30°.

When the PCD discrete is present, the autopilot roll and pitch axes will respond to data-link commands.

2.24.4.7 Automatic Carrier Landing. To engage the ACL mode, place the VEC/PCD-OFF-ACL switch to ACL and press the nosewheel steering pushbutton. Mode engagement is evidenced by the A/P REF legend going out. Disengagement of the ACL mode causes complete autopilot disengagement. All autopilot switches return to OFF and the AFCS reverts to SAS modes only. The AUTO PILOT caution light and the ACLS/AP caution light on the windshield frame are illuminated. They may be extinguished by pressing the MASTER RESET pushbutton.

WARNING

If the autopilot/ACLS uncouples after approach commencement, do not attempt to recouple with the CMD CTRL advisory legend. To do so could cause abrupt attitude changes and a possible force-link disconnect. The pilot should verbally instruct the approach controller, "Downgrade to mode II." Upon downgrading, the CMD CTRL legend should go out. The ACL RDY and A/P CPLR legends must appear prior to any attempt at recoupling.

Note

Application of more than 2 to 3 pounds of stick force while attempting to couple will cause the AUTO PILOT caution light to illuminate and coupling cannot be accomplished. It is imperative that any stick force be avoided while depressing the autopilot reference and nosewheel steering pushbutton to preclude illumination of the AUTO PILOT caution light.

The pilot can disengage from the ACL mode (and autopilot) by application of 7-1/2 pounds of lateral or 10 pounds of longitudinal force, by disengaging the AUTOPILOT ENGAGE switch, or by pressing the autopilot emergency disengage paddle.

Pilot takeovers may be required during mode I or IA ACLS approaches. The recommended method for a PTO is to manually disengage the autopilot ENGAGE switch on the AFCS control panel and then disengage the APC by use of the cage button. This may be difficult to accomplish, especially during the final portions of the approach. If this method is not feasible, then 10 pounds of aft stick pressure and simultaneous disengagement of APC will accomplish the PTO. If the aft stick method is used at or inside the in-close position, the pilot must avoid overrotation. The waveoff technique described in Chapter 8 applies.

WARNING

A PTO initiated by APC disengagement with large power additions prior to uncoupling from ACLS will result in large nosedown commands. A force-link disconnect may occur if the control stick hits the forward stop.

Note

Routine downgrading from an ACL mode I or IA approach by depressing the autopilot emergency disengage paddle is not recommended since DLC, roll SAS, and pitch SAS will also be disengaged.

The ACLS mode (and autopilot) will be disengaged automatically by loss of data-link A/P CPLR legend, no message for more than 2 seconds, or a waveoff discrete from the boat.

ACL commands control the aircraft through the autopilot by spoiler commands in roll and by parallel servo in pitch. Pitch commands move the control stick. See AFCS Pitch Parallel Actuator, paragraph 2.24.3.2, for pitch actuator operation.

Note

> If the pitch parallel actuator force link is mechanically disconnected, the A/P REF advisory legend indicating ACL engagement may go out when coupling is attempted, but the aircraft will not respond to SPN-42 commands and the autopilot will uncouple from the ACL system when the first pitch commands are received.

2.24.5 AFCS Test. An independent test program and associated hardware is in each AFCS axis computer.

2.24.5.1 AFCS OBC. Preflight indication of AFCS performance can be obtained during poststart OBC. All SAS switches should be engaged. After selecting OBC on the MASTER TEST switch, the autopilot switch should be placed to ENGAGE. A complete test sequence encompassing all functions specially associated with the selected axis (axes) will commence upon test initiation and will cycle to OFF after completion. The PITCH STAB 1 and 2, ROLL STAB 1 and 2, YAW STAB OP, and YAW STAB OUT caution lights illuminate and serve as an AFCS BIT running indication. All other AFCS caution lights will illuminate momentarily during BIT testing.

If the pitch parallel actuator is functioning properly, large longitudinal control stick deflections should be observed during OBC. An OBC with the flaps down requires a longitudinal trim of 3° or more nose up; an OBC with the flaps up requires not less than 0° nose up. A disconnected pitch parallel actuator force link during OBC is indicated by illumination of the AUTO PILOT caution light, a PC acronym, and the absence of large control stick deflections. It is possible for the force link to be partially disconnected, that is, disconnected mechanically while electrical continuity is maintained. If this has occurred, the AUTO PILOT caution light or PC acronym may be absent after OBC but no large stick deflection will be observed. The implications of this condition are the same as for a total disconnect.

2.24.5.2 AFCS In-Flight BIT. AFCS in-flight BIT provides automatic failure-initiated testing for the AFCS pitch and roll axes only. In-flight BIT is not provided for the yaw axis. If yaw axis failures occur, the appropriate caution light will illuminate and flight envelope restrictions must be observed as applicable. In-flight testing in the pitch and roll axes is automatically initiated when an AFCS computer failure is detected. When this failure is detected, the affected axes will disengage, both SAS caution lights for the affected areas will illuminate, and BIT will automatically run for 9 to 14 seconds, depending upon the axis affected. Upon completion of BIT, the failed channel light remains illuminated and the other channel light goes out. WRA failure indications can be observed in flight by the RIO on the TID.

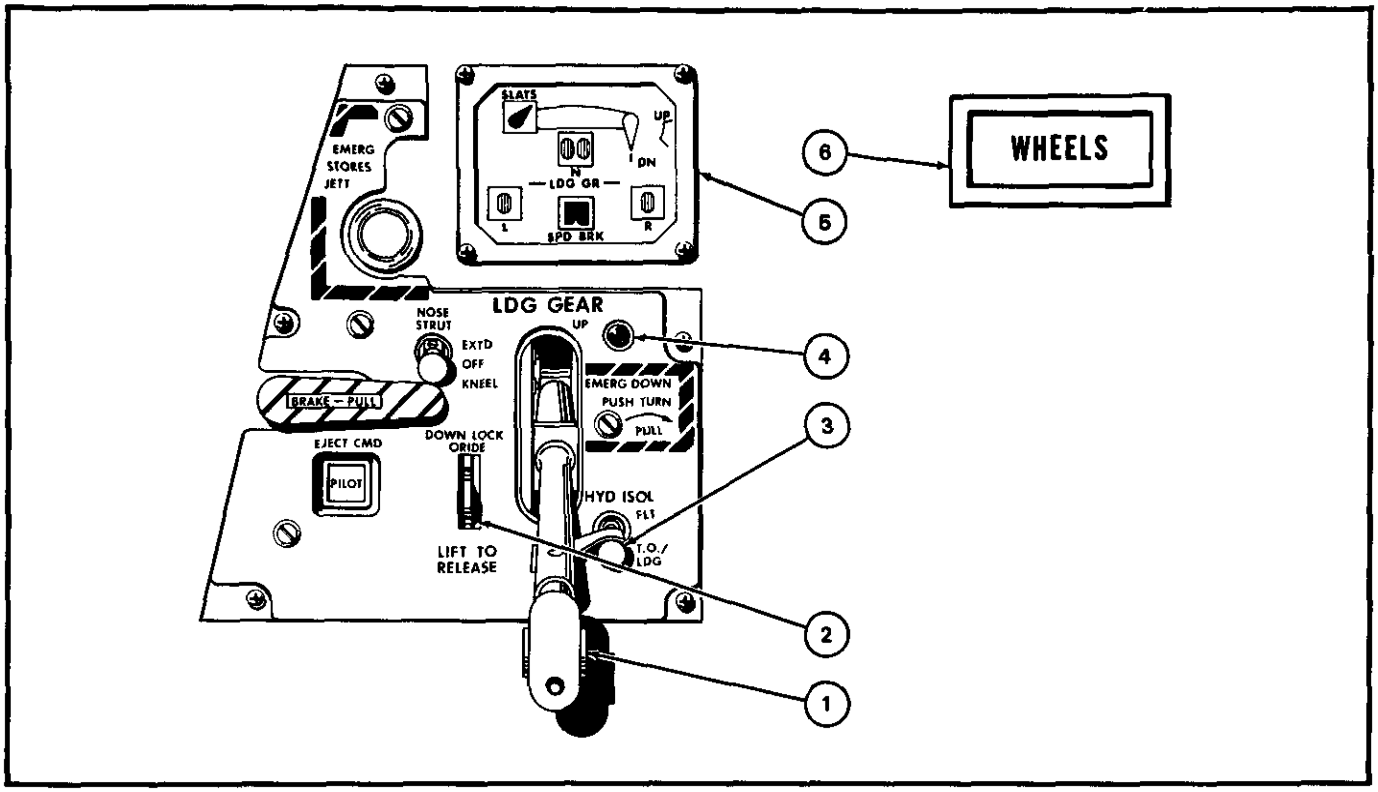
2.25 LANDING GEAR SYSTEMS

The aircraft has fully retractable, tricycle landing gear operated by combined hydraulic pressure in the normal mode of operation and a stored source of pressurized nitrogen for emergency extension. The landing gear retract forward so that airloads and gravity assist on emergency extension. Air-oil shock struts with oil metering pins reduce landing loads transmitted to the airframe, and the struts are fully extended with the gear in the wells. All landing gear doors remain open with the gear extended.

2.25.1 Landing Gear Handle. The landing gear handle mechanically positions the landing gear valve for normal operation. Pulling the handle mechanically selects emergency extension of the gear using the pneumatic backup source. Both modes of gear operation can be accomplished without electrical power except for the gear position indication, which requires dc essential No. 2 bus power. Gear downlock actuators incorporate internal mechanical finger locks that maintain the downlock inserted position in the absence of hydraulic pressure. The landing gear handle contains other interlocks that are discussed under their respective systems such as weapons firing, jettison systems, APC, maneuvering flaps, and ground power system test panel.

Design limit landing sink speed for the aircraft is 25.3 feet per second (nominal landing sink speed is about 11 feet per second). Normal and emergency controls and displays associated with operation of the landing gear are shown in Figure 2-69.

2.25.2 Main Landing Gear. Each main landing gear shock strut consists of an upper outer cylinder and a lower internal piston, which has a maximum stroke of



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NOMENCLATURE	FUNCTION	
(1) LDG GEAR handle	Normal –	Up and down overcenter action provides normal retraction and extension by the combined hydraulic system.
	Emergency –	Down-push-turn clockwise pull action provides emergency extension of all gear by a compressed nitrogen charge.
(2) DOWN LOCK ORIDE lever	Down –	Weight-on-wheels indication, prevents gear handle being retracted without pilot override (raising lever).
	Up –	Weight-off-wheels indication, does not inhibit pilot raising gear handle. Automatic operation by electrical solenoid.
(3) HYD ISOL switch	FLT –	Combined system hydraulic pressure is shut off to the landing gear, nosewheel steering and wheel brakes.
	T.O./LDG –	Switch is automatically placed in this position with gear handle down. Combined hydraulic pressure is available to all components.
(4) Landing gear transition light	On whenever gear and door positions (including main landing gear sidebrace actuators) do not correspond to handle position. Out when gear and doors are locked in position selected by handle.	

Figure 2-69. Landing Gear Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(5) LDG GR indicator	 - Landing gear down and locked (except main landing gear sidebrace actuator).  - Landing gear retracted and doors closed.  - Unsafe gear or power off indication.
(6) WHEELS warning light	Light flashes with flaps greater than 10° deflection and either or both throttles less than approximately 85% rpm, and all landing gear not down and locked. Approach lights and indexer will illuminate when the LDG GEAR handle is placed in the down position, but this is not an indication of gear down and locked.

Figure 2-69. Landing Gear Controls and Indicators (Sheet 2 of 2)

25 inches. A hard step (31,000 pounds required for further compression) in the strut air curve provides a consistent 4-inch stroke remaining in the ground static condition. A side-brace link is mechanically extended from the inboard side of the strut outer cylinder to engage in a nacelle fitting and thus provides additional side load support for ground operations.

The path of the wheel assembly is controlled by the drag brace as it folds (jackknifes upwards) during gear retraction and unfolds during extension. The fully extended shock strut and jackknifed drag brace retracts forward and rotates the wheel assembly 90° to lie flat in the wheelwell. Inboard and outboard and aft main gear doors are individually actuated closed in sequence to provide fairing for the retracted gear. An uplock hook on the shock strut engages a roller in the wheelwell to hold the gear in the retracted position. The main landing gear actuator on the inboard side of the shock strut retracts and extends the gear assembly.

The gear downlock actuator, mounted at the drag brace knee pin, extends to prevent unlocking (jackknifing) of the drag brace. Hydraulic pressure must be supplied to the downlock actuator in order to retract it against the spring action of the integral locking mechanism. A paint stripe across the drag brace knee pin provides an external visual indication of the drag brace locked condition. A ground lock device clamps onto the downlock actuator rod for safetying the main gear.

Maximum strut extension and wheel alignment are controlled by torque arms that incorporate cam-operated microswitches to detect a weight-on-wheels condition (greater than 5 inches of strut compression). The single split-type wheel assembly incorporates thermal fuse blow plugs and a pressure relief device to prevent overinflation of the tire.

CAUTION

- Illumination of indexer lights does not indicate that the main landing gear are clear of the runway. Raising the gear before a positive rate of climb is established will result in blown main tires.

- Illumination of indexer and approach lights is not an indication of gear down and locked.

2.25.3 Nose Landing Gear. The dual-wheel nose landing gear has a shock strut consisting of an outer cylinder and a lower internal piston that has a maximum stroke of 18 inches. During normal ground operations, the strut is fully extended. Pilot control is provided to kneel the strut (4 inches stroke remaining) for catapult operations. During retraction, the fully extended nose strut is rotated forward by the retract actuator into the well and enclosed by two forward and two aft doors. The forward doors are operated by a separate actuator that also engages the gear uplock, whereas the two aft doors are mechanically linked to the shock strut. An uplock hook actuator engages a roller on the lower piston to hold the gear and doors in the retracted position. During extension, the telescoping drag brace compresses so that a downlock actuator mechanically locks the inner and outer barrel to form a rigid member for transmission of loads to the airframe.

Note

- There is no foolproof visual check of the nose landing gear locked-down status. Neither the downlock mechanism, which is concealed in the fuselage nor insertion of the ground lock pin will provide a positive indication of gear-locked status. In flight, the pilot must normally rely on his indicator. Visual determination of nose landing gear unlocked status is assisted by a red band painted on the nose landing gear drag brace. If red is visible, the nosegear is not locked.

- An additional sequencing switch in series with the existing down-and-locked switch provides the pilot with a positive indication of nosegear position. If the nose landing gear is unsafe in the down position because of premature deployment of the nose landing gear locking pin, the nosegear indicator will indicate unsafe and the transition light will illuminate.

Maximum strut extension and wheel steering angle are controlled by torque arms interconnecting the steering collar and the lower piston. The split-type wheel assembly incorporates a tire pressure relief device to prevent overinflation of the tire. Additional hardware on the nose landing gear include the launch bar, holdback fitting, approach lights, nosewheel steering actuator, and taxi light. The wheel axles incorporate recessed holes for attachment of a universal tow bar with maximum steering angle of ±120°.

CAUTION

Restrict nosewheel deflection to ±90° to prevent structural damage to the nosegear steering unit.

2.25.4 Landing Gear Normal Operation.

The landing gear handle is mechanically connected to the landing gear valve that directs combined hydraulic fluid into the gear-up and gear-down lines and provides a path for return flow. In the down position, the handle mechanically sets the hydraulic isolation switch to provide hydraulic pressure for gear operation. The handle is electromechanically locked in the down position with weight on wheels to prevent inadvertent gear retraction. Pilot override of the solenoid-operated handle lock can be effected by lifting the downlock lever next to the gear handle. Vertical movement of the gear handle causes a corresponding up and down selection of the landing gear with the combined hydraulic system pressurized. Three flip-flop indicators provide a position display for each of the landing gear, and a gear transition light on the control panel illuminates anytime the gear position and handle do not correspond. In addition, a WHEELS warning light alerts the pilot if the landing gear is not down with flaps deflected greater than 10° and either or both throttles set for less than approximately 85-percent rpm.

CAUTION

- Unless attempting fast-cycle troubleshooting for gear that indicates unsafe nosegear down, transition light illuminated, wait for gear to completely transition (15 seconds with normal hydraulic pressure) before recycling the landing gear handle. When fast cycling the gear handle, the pilot must immediately return the gear handle to the down position to avoid damaging the main landing gear doors and inducing a possible combined hydraulic or brake system failure.

- Maximum landing gear tire speed is 190 knots.

2.25.4.1 Landing Gear Handle Up.

Placement of the landing gear handle to UP actuates the landing gear valve that ports hydraulic pressure to the downlock actuators, gear retract actuators, and, in sequence, to the door and uplock actuators. The gear shock strut and door uplocks are hydraulically operated into a mechanical overcenter position. An UP indication is displayed on the gear position indicators when the gear are in the uplock and all doors closed.

2.25.4.2 Landing Gear Handle Down.

Placement of the LDG GEAR handle to DN actuates the gear control module to port hydraulic pressure to the door uplocks, door actuators, and the strut uplocks. The landing gear are hydraulically extended and assisted by gravity and airloads. A gear-down symbol (wheel) is displayed on the gear position indicators when the gear downlocks are in the locked position. The gear transition light will go out when the main gear side-brace links are engaged.

Note

With the main gear downlock inserted but the side-brace link not engaged, landing sink speed is restricted to 8 feet per second. Minimize yaw and sideslips on touchdown and rollout.

2.25.5 Emergency Gear Extension. Although emergency gear extension can be initiated with the landing gear control handle in any position, it is preferable that the LDG GEAR handle be placed in DN before actuating the emergency extension system.

CAUTION

The landing gear handle must be held in the fully extended emergency position for a minimum of 1 second to ensure complete actuation of the air release valve. Approximately 55 pounds pull force is required to fully actuate the emergency nitrogen bottle. The pulling motion should be rapid and continuous to ensure the air release valve goes completely overcenter to the locked position. The landing gear handle will be loose (fore and aft) in its housing as an indication of complete extension of the handle. An incomplete handle motion could cause partial porting of gaseous fluid, initiating the emergency dump sequence. Interruption of handle motion without completing the overcentering action of the valve could cause the extending gears to contact and damage the strut doors.

The emergency landing gear nitrogen bottle is located in the nose wheelwell. Normal preflight bottle pressure is 3,000 psi at 70 °F. Minimum bottle pressure for accomplishing emergency extension to the down-and-locked position is 1,800 psi.

Pneumatic pressure is directed by separate lines to power open the gear door actuators in sequence, release the gear uplock actuators, pressurize the nosegear actuator to extend the gear (main gear free fall), and pressurize the downlock actuators. A normal gear-down indication is achieved upon emergency gear extension. Following emergency gear extension, nosewheel steering is disabled. Once the landing gear is extended by emergency means, it cannot be retracted while airborne and must be reset by maintenance personnel.

CAUTION

- Emergency extension of the landing gear shall be logged in the Maintenance Action Form (OPNAV Form 3760-2).

- To facilitate in-flight refueling probe extension when the landing gear has been blown down, raise the landing gear handle to give priority to the refueling probe system.

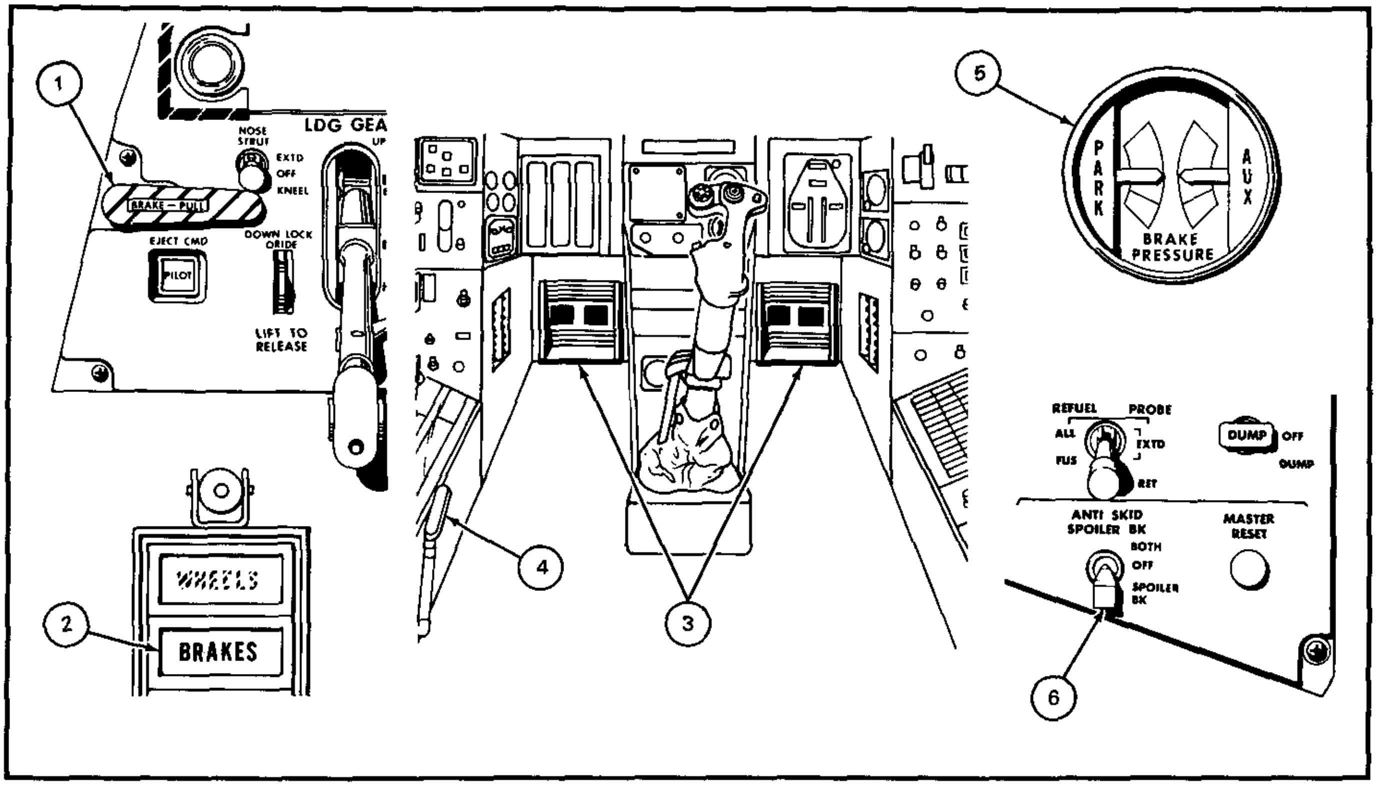
2.26 WHEELBRAKE SYSTEM

The wheelbrake system provides power boost hydraulic control of the multiple disk-type main wheelbrakes using pressurized fluid in the landing gear down line from the combined hydraulic system. Individual or collective wheelbrake control can be modulated by depression of the rudder toe pedals or collective; unmodulated brake control is available with the parking brake. An antiskid system is provided to operate electrohydraulically in conjunction with the normal wheelbraking mode. Wheelbrake controls are shown in Figure 2-70.

Brake pedal and parking brake control motions are mechanically transmitted to the power brake module together with the antiskid valve. Separate hydraulic lines transmit normal and emergency fluid pressure from the power brake module to the left and right wheelbrake assemblies. At each brake assembly, the normal and emergency lines input to the brake shuttle valve, which applies brakes as a function of normal or emergency line fluid pressure. Two wear-indicator pins on the brake piston housing measure lining wear for preflight inspection. For new brakes, these pins extend approximately one-half inch above the piston housing. When the pin is flush with the piston housing with the parking brake applied, the brake assembly is worn to the point of replacement.

Four thermal relief plugs are mounted in each main wheel assembly to relieve tire pressure and thus avert a blowout because of hot brakes if the local wheel temperature exceeds 428 °F.

The capacities of the wheelbrake assemblies are sufficient to restrain the aircraft in a static condition on a dry surface with MIL power set on both engines. The minimum hydroplaning speed for the main tires on a wet runway is approximately 90 knots.



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NOMENCLATURE	FUNCTION
(1) Parking brake handle	Forward – Parking brake released. Modulated braking action available with brake pedal depression. Aft – Parking brake set. No modulation of control, locks both main wheel brakes.
(2) BRAKES warning light	Indicates parking brake handle is pulled, antiskid has failed, or operation is in auxiliary brake mode when brake pedals are depressed.
(3) Brake Pedals	Press top of rudder pedals to command normal or auxiliary braking.
(4) Hand pump	Recharges auxiliary and parking brake accumulators with gear handle down. With REFUEL PROBE switch in FUS or ALL EXTD, provides emergency extension or retraction of refueling probe regardless of gear handle position. With the gear handle down priority is given to brake accumulator pressure.
(5) BRAKE PRESSURE gage	Provides pilot indication of brake accumulator pressure remaining which is indicative of auxiliary and emergency brake cycles remaining.
(6) ANTI SKID SPOILER BK switch	BOTH – Antiskid activated. Spoiler brakes operative with weight on wheels and both throttles in IDLE. OFF – Antiskid deactivated, spoiler brakes inoperative. SPOILER BK – Spoiler brakes operate with weight on wheels and both throttles IDLE. Antiskid is deactivated.

Figure 2-70. Wheelbrake Controls and Indicators

2.26.1 Brake Characteristics. Because carbon brakes contain solid disk-shaped carbon rotors and stators, they cannot shingle. The thermal characteristics prevent them from fusing together during or following heavy braking.

Carbon brakes may produce a sudden increase in brake torque as brake pedal force is smoothly increased. This can produce grabbing at low brake pedal force inputs. This grabbing is caused by excessive air in the combined hydraulic system. Open-loop bleeding of the combined hydraulic system by maintenance personnel will reduce the amount of air in the system and should eliminate any associated grabbing. If grabby brakes are experienced, smooth modulation to higher braking forces is easily accomplished after the initial grabbing. The sudden increase in torque is most noticeable at moderate to slow taxi speeds. As groundspeed increases, the kinetic energy of the aircraft increases and the effect of the sudden torque increase is significantly reduced. Normal braking technique should be used during normal rollout.

The pilot must apply maximum pressure on the brake pedals to hold the aircraft static at MIL. If carbon brakes have been heated up by a full-stop landing, and for about 45 minutes thereafter, they will probably not hold the aircraft static with military power set on both engines even with the parking brake set. In this case, 75 to 100 pounds of pedal force will hold the aircraft static with afterburner set on one engine and idle power set on the other. In all cases, holding the aircraft static at high power settings depends on adequate runway and tire conditions. Degraded conditions such as wet runways or worn tires may result in tire skid at high power settings.

CAUTION

When the antiskid system becomes inoperative at 15 knots during a maximum-effort stop, carbon brakes can lock the wheels and pedal pressure should be relaxed as the aircraft decelerates through 15 knots during a maximum-effort antiskid stop.

2.26.2 Normal Braking. In the normal mode of operation, wheelbrake application is modulated by brake pedal depression using pressurized fluid from the combined hydraulic system through the brake module and through the normal brake line to the brake assembly. In the normal mode of operation, the brake pressure gauge indication should continue to indicate a full charge on the brake accumulators since this fluid energy is maintained by the combined hydraulic system. Normal combined-system operations can result in pressure excursions that will be trapped in the brake system. This can cause the brake pressure indicators to read beyond the full range of the gauges. This will not affect system performance.

CAUTION

- After heavy or repeated braking or if hot brakes are suspected, allow a 5- to 10-minute cooling period with the gear extended before retracting the gear.
- If heavy braking is used during landing or taxiing followed by application of the parking brake, normal brake operation may not be available following release of the parking brake if the brakes are still hot. Check for normal brake operation after releasing the parking brake and prior to commencing taxiing.

2.26.3 Antiskid. The antiskid system operates electrohydraulically in conjunction with the normal mode of wheelbrake operation to deliver maximum wheelbraking upon pilot command without causing a skid. Essential No. 2 bus dc power for antiskid operation is supplied through the ANTI SKID/R AICS LKUP PWR circuit breaker (8E1) and controlled by the ANTI SKID SPOILER BK switch (Figure 2-70). When energized, approximately 200 milliseconds are required for antiskid system warmup. Individual wheel rotational velocity is sensed by skid detectors mounted in the wheel hubs and transmitted to the skid control box. The control box detects changes in wheel deceleration and reduces fluid pressure in the normal brake lines to both wheels, simultaneously, to prevent a skid.

With the antiskid system armed in flight, the touchdown circuit in the control box prevents braking until weight is on both main gear and the wheels have spun up, regardless of brake pedal application. The antiskid system is inoperative at groundspeeds of less than 15 knots. During maximum-effort antiskid braking, expect a rough, surging deceleration. When the ANTI SKID SPOILER BK switch is in BOTH during low-speed taxi (less than 10 knots for more than a few seconds), subsequent acceleration of the aircraft through approximately 15 knots will cause a temporary loss of brakes lasting from 2 to 10 seconds. Should this happen, use of the brakes can be regained instantly by turning antiskid OFF. To preclude this possibility, antiskid must be OFF during taxi.

WARNING

- Failure of the weight-on-wheels switch results in continuous release signal with antiskid selected. Normal braking is available with antiskid off.
- If the antiskid system fails, allowing antiskid to operate below 15 knots, place the ANTI SKID SPOILER BK switch in OFF; otherwise the aircraft cannot be stopped using normal braking.

CAUTION

Failure to release brakes prior to deselecting ANTI SKID may result in blown tires.

The antiskid system is inoperative when the wheelbrakes are in the auxiliary or parking modes of operation since the emergency brake lines bypass the brake valve. If an electrical failure occurs in the antiskid system or if hydraulic pressure is withheld from either brake for greater than 1.2 seconds by the control box, the system automatically becomes inoperative and illuminates the BRAKES warning light with the ANTI SKID SPOILER BK switch in BOTH.

2.26.3.1 Antiskid Ground Test. During ground operation, a self-test of the antiskid system can be initiated on the face of the control box with the system energized, parking brake handle released, and the aircraft in a ground static condition. Before taxiing (chocks in place), but after releasing the parking brake and while the pilot presses the toe pedal brakes, the plane captain should press the antiskid test pushbutton on the control box in the nose wheelwell. Approximately 10 seconds is required for self-test, which checks the operational status of the control box, brake valve, and wheel sensors. Any discrepancies detected will be displayed by the BIT flags on the face of the control box (Figure 2-71).

A valid BIT test requires that three criteria be met: the BIT flags on the face of the control box must check good, the pilot must feel both brakes release during BIT test, and the BRAKES warning light must not remain illuminated. A flash of the BRAKES light coinciding with brake pedal thumps during the antiskid BIT check is acceptable.

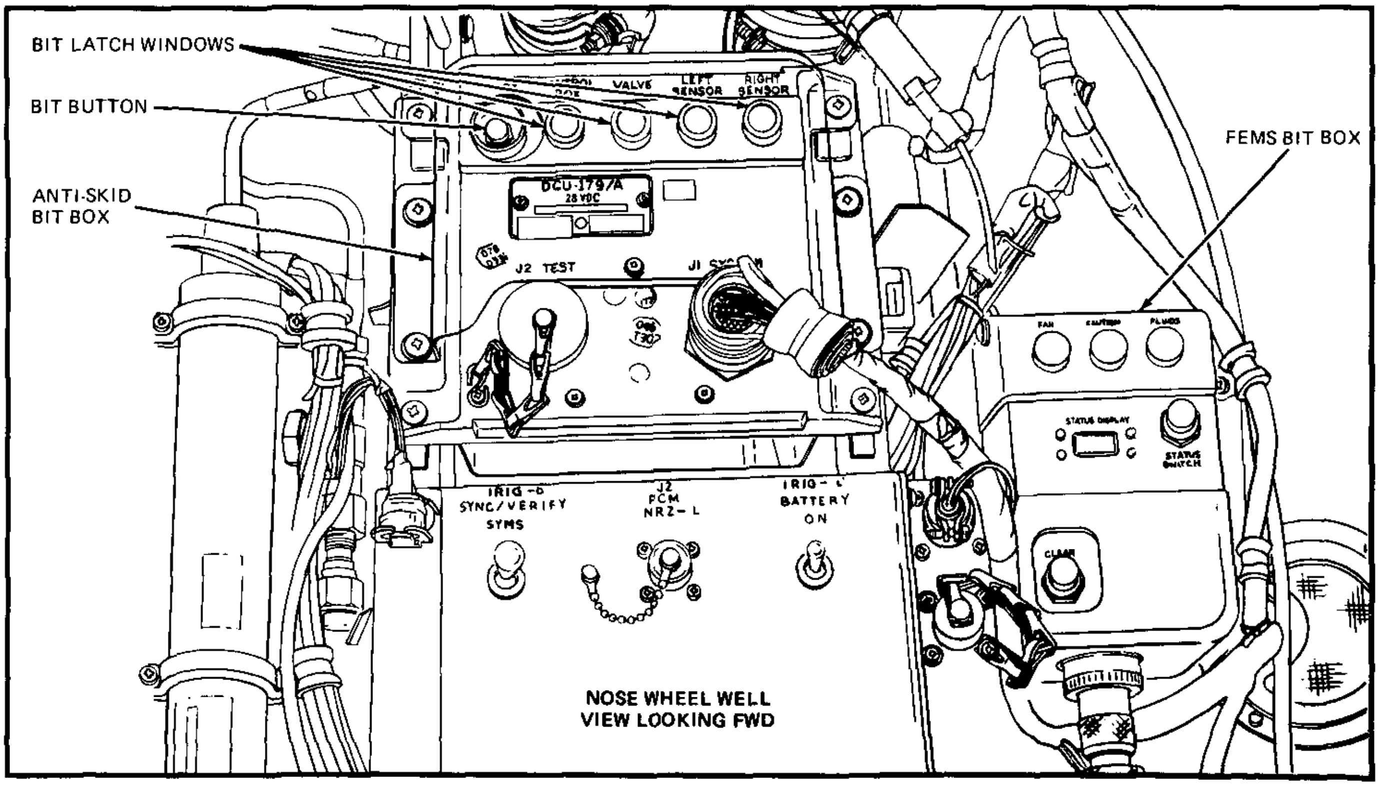

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Figure 2-71. Antiskid BIT Box

WARNING

Before initiating antiskid self-test by pressing the antiskid pushbutton on the control box, ensure that the aircraft chocks are in place. Initiation of antiskid self-test will release aircraft brakes.

2.26.4 Auxiliary Brake. Two different auxiliary brake systems are presently incorporated in the aircraft. Entry into the auxiliary brake mode is the same for both systems. Transfer of normal brake operation to the auxiliary mode is automatic without the requirement for pilot action upon the loss of combined hydraulic system pressure. Both auxiliary braking systems have two brake accumulators that provide pressure for auxiliary and parking brake modes of operation when combined hydraulic system is not available. Accumulators deliver 3,000 psi when fully charged by the combined hydraulic system or hydraulic handpump (with the gear handle down only). When the combined hydraulic system pressure decreases below 1,425 psi, the shuttle valve in the power brake module shifts the brake system to the auxiliary brake mode.

Approximately 13 to 14 full dual-brake applications are available in the auxiliary mode. Dual pneumatic BRAKE PRESSURE gauges on the front cockpit center pedestal show auxiliary and parking brake accumulator pressures. Full capability operations of the brake accumulators in the auxiliary modes of operation is predicated on the system serviced with a nitrogen precharge of 1,900 ±50 psi. The green band of the dial indicates pneumatic pressure between 3,000 psi at the top of the band to 2,150 psi; the red band indicates pneumatic pressures between 2,150 and 1,900 psi at the bottom of the band. Approximately five auxiliary brake applications are available in the red band. Once the auxiliary braking system is depleted, braking must be accomplished by the emergency/parking brake. Three applications of the parking brake are available.

With either auxiliary brake system, additional braking can be achieved only by pulling the parking brake handle aft. If the shuttle valve in the power brake modules does not return to the normal position with combined hydraulic pressure greater than 2,000 psi, the BRAKES warning light will illuminate when a brake pedal is depressed. In this instance the wheelbrake accumulators can be recharged only by the hydraulic handpump with the landing gear handle down. Pilot manual isolation or system automatic isolation of the combined hydraulic system cuts off the supply of combined hydraulic pressure to the power brake module so that depression of the brake pedals will cause depletion of the brakes' accumulator charge.

WARNING

- Even though braking action is available at accumulator pressures less than 3,000 psi, braking force is proportional to pressure remaining. Red band pressure (1,900 psi) is sufficient to hold the brakes locked with the aircraft stationary in all deck conditions; however, rolling motion greatly increases pressure requirements. Accumulator pressure of up to 2,100 psi may be required to stop a moving aircraft in a 4° deck roll. In deck rolls greater than 6°, 3,000 psi may not be sufficient to stop a moving aircraft.
- Complete loss of hydraulic fluid through the wheelbrake hydraulic lines will render parking brake ineffective.

2.26.5 BRAKES Warning Light. The BRAKES warning light will illuminate whenever auxiliary brake pressure is applied to the brakes via the brake pedals, indicating the combined hydraulic system pressure is not available to the brakes and cautioning the pilot to monitor brake application with the auxiliary brake pressure indicator. A postlight is installed above the BRAKE PRESSURE gauge to illuminate the dial.

Note

The postlight requires electrical power. Brakeriders on carrier night respot must use a flashlight to check the cockpit brake pressure gauge.

2.26.6 Parking Brake. The parking brake mode provides a means for collective locking of the wheelbrakes to maintain a ground static position during normal operations or during emergency conditions. Aft movement of the parking brake handle provides for unmodulated porting of accumulator fluid pressure through emergency lines to the shuttle valve at the wheelbrake assembly. In the parking brake mode, the rudder pedals have no effect on wheelbrake operation. Pushing the parking brake handle forward releases wheelbrake pressure and the power brake module reverts to the normal and auxiliary braking mode. When auxiliary mode braking action is no longer available by depression of the rudder pedals, sufficient accumulator fluid pressure remains for a minimum of three parking brake applications.

Note

The AUX brake and parking brake pressure indicator should be pumped into the green band prior to breaking down and moving the aircraft without combined hydraulic power. The indicator should be maintained in the green band until the aircraft is secured. Full 3,000 psi pressure is required if conditions are severe (greater than 4° roll, wet brakes, etc.).

In the absence of a pressurized combined hydraulic system, the wheelbrake accumulators can only be recharged by the pilot hydraulic handpump with the landing gear handle in the down position.

WARNING

Complete loss of hydraulic fluid through the wheelbrake hydraulic lines will render parking brake ineffective.

2.26.7 Wheel Antirotation. During the initial phase of the landing gear retraction cycle, pressurized fluid from the gear-up lines is directed to the power brake module to displace the normal metering valves to stop main wheel rotation before the wheels enter the wells. This feature is not provided for the nosewheels.

CAUTION

Illumination of indexer lights is not a positive indication that the main landing gear is clear of the runway. Raising the gear before a positive rate of climb is established will result in blown main tires.

2.27 NOSEWHEEL STEERING SYSTEM

The electrohydraulic nosewheel steering system provides for on-deck aircraft directional control, nosewheel shimmy damping, and nosewheel centering. The power unit is located on the lower portion of the nose landing gear strut outer cylinder, which, through a ring gear, controls the directional alignment and damping of the lower piston assembly.

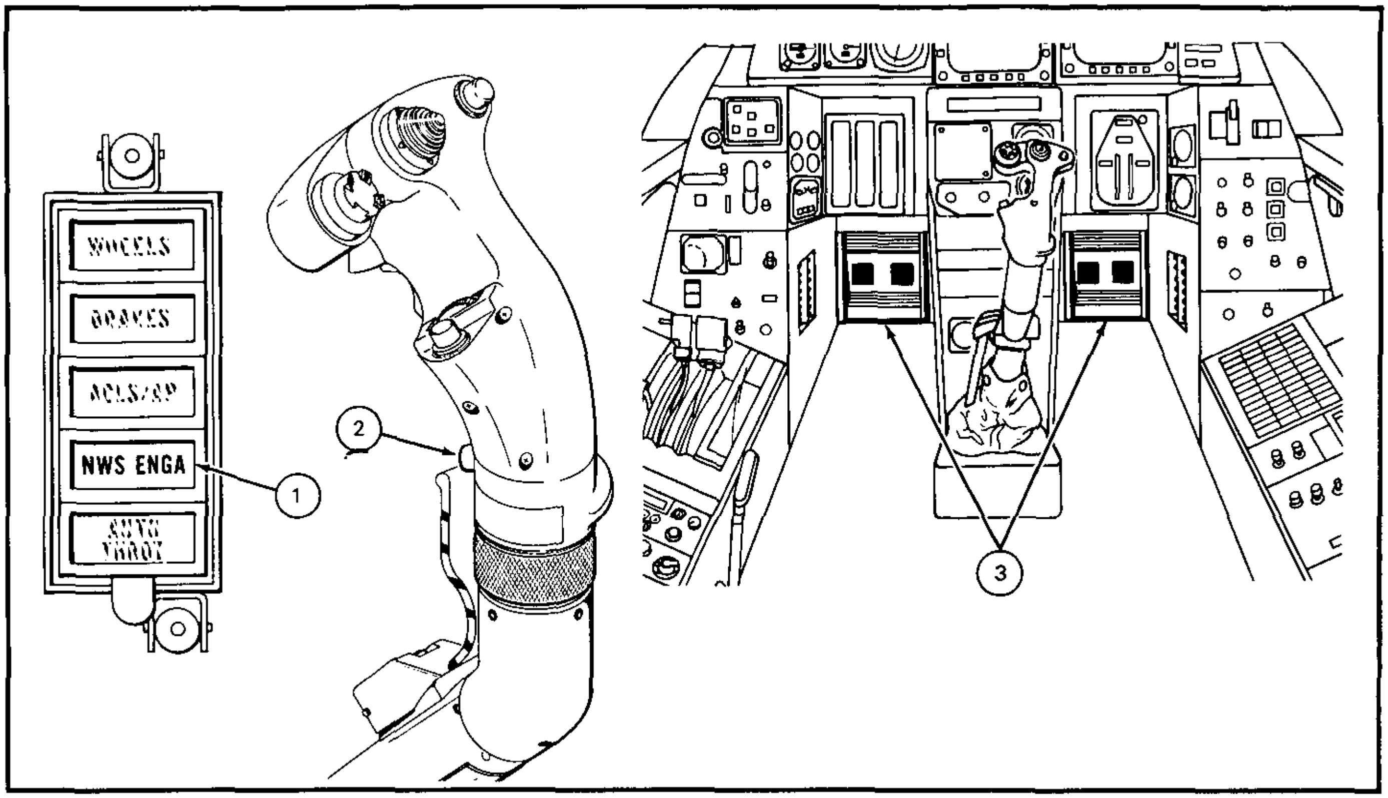
Combined hydraulic system pressure is the motive power used for steering and centering. Electrical power is supplied from the essential dc bus with circuit protection by the NOSE WHEEL STEER/AFCS circuit breaker (RC2) on the pilot right knee panel. Hydraulic pressure is derived from the gear-down line such that steering control is disabled subsequent to emergency extension of the landing gear (Figure 2-72).

Note

If nosewheel steering is inoperative, the emergency gear extension air release valve may be tripped, which will prevent gear retraction.

2.27.1 Nosewheel Steering Control. Nosewheel steering control during ground operations is energized by momentarily pressing the autopilot reference and nosewheel steering pushbutton on the lower forward side of pilot stick grip (see Figure 2-72). The system cannot be engaged without weight on wheels. The system will remain engaged until weight is off wheels, electrical power is interrupted, or the pushbutton switch is pressed again. Engagement of nosewheel steering is indicated by illumination of the NWS ENGA caution light. An automatic nosewheel steering system disengage feature is provided. If this feature has been activated by cycling the hook on deck with the throttles at idle, then the nosewheel steering will be disengaged and the NWS ENGA light extinguished when the launch bar is lowered. The nosewheel steering automatic disengage feature is deactivated if the nosewheel steering button is depressed.

With the system engaged, nosewheel steering is controlled by rudder pedal position. Centering is unaffected by directional trim displacement. Maximum steering authority is 70° either side of neutral, and the nosewheel can swivel a maximum of 120° about the centered position. With greater weight on the nosewheel (wings forward, high gross weight, etc.) the steering torque can only turn the nosewheel +5° with the aircraft static. However, only a slight forward movement will provide the pilot with full-power steering authority. In a full pedal-deflection turn using nosewheel steering, the aircraft pivots about a point between the main gear such that the inboard main wheel rolls backward. Under this condition, application of either main wheelbrake will only serve to increase the radius of turn. Because of the outboard location of the engines, the application of thrust in tight turns should be made on the outboard engine to efficiently complement the turning movement of the nosegear. Nosewheel centering is enabled by the same latching relay that enables nosewheel steering automatic disengagement with launch bar lowering. Therefore, if the nosewheel steering is automatically disengaged when the launch bar is lowered, the nosewheels will be hydraulically centered.



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NOMENCLATURE	FUNCTION
(1) NWS ENGA caution light	Illumination when nosewheel steering engaged and will respond as a function of rudder pedal displacement. Nosewheel steering automatically centers with hook down. Nosewheel centering requires throttles at IDLE and weight-on-wheels with hook down.
(2) Autopilot reference and nosewheel steering pushbutton	Press to engage and disengage nosewheel steering. Requires weight-on-wheels.
(3) Rudder pedals	Controls nosewheel steering position with system engaged.

Figure 2-72. Nosewheel Steering Controls

2.27.2 Nosewheel Centering. The nosewheel is automatically centered during gear retraction before the nosewheel enters the wheelwell. During gear retraction with weight off wheels, hydraulic pressure from the combined system bypasses the steering unit shutoff valve to center the nosewheel independent of rudder pedal movement. If the nosewheel is cocked beyond 15° either side of center after takeoff, the nosewheel is automatically prevented from retracting and the LAUNCH BAR advisory light illuminates.

During carrier arrestment, the nosewheel is centered with weight on wheels and hook down when both throttles are retarded to IDLE to prevent castoring during rollback. After arrestment and rollback, the nosewheel will remain centered until nosewheel steering is engaged.

WARNING

> Nosewheel centering can contribute to launch bar misalignment in the catapult shuttle, which could result in premature launch bar separation during launch. The nosewheel centering latching relay must be deactivated by depressing the nosewheel steering button after the hook check and prior to entering the catapult. As this will also deactivate the nosewheel steering automatic disengagement function, the nosewheel steering must be manually disengaged when entering the catapult.

2.27.3 Shimmy Damping. Shimmy damping is provided in the steering actuator. Increased shimmy damping action is obtained with NWS disengaged.

CAUTION

> If excessive nosewheel shimmy is encountered, disengage nosewheel steering.

2.28 NOSEGEAR CATAPULT SYSTEM

Catapult connection components on the nose landing gear shock strut piston provide nosegear catapult capability. A launch bar attached to the forward face of the nosegear steering collar guides the aircraft onto the catapult track and serves as the tow link that engages the catapult shuttle. A holdback fitting secures the holdback restraint prior to launch. The two-piston nose strut uses the stored energy catapult principle to impart a positive pitch rotation movement to the aircraft at shuttle release, thus providing for a hands-off launch flyaway technique.

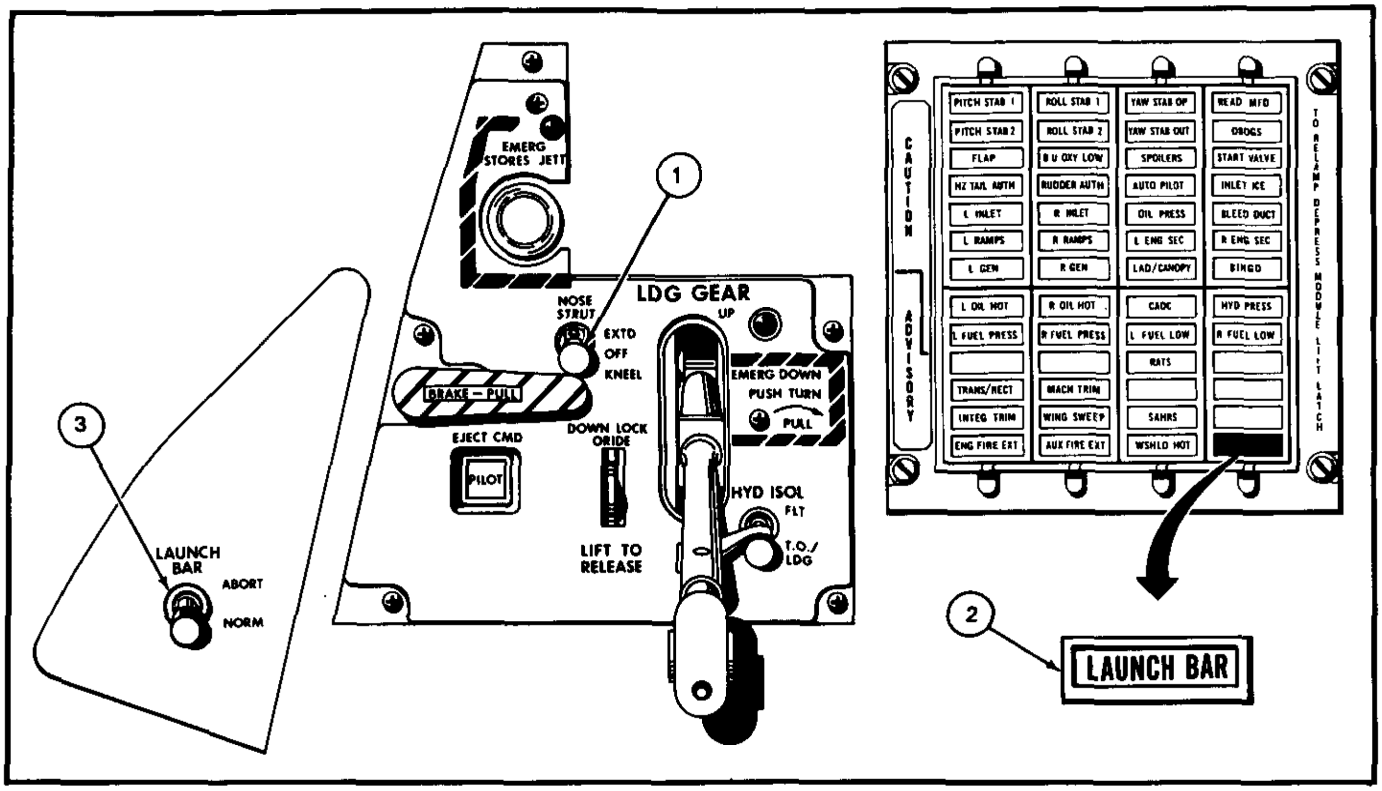
2.28.1 Nose Strut Kneel. Prior to catapult hookup, the nose strut is compressed 14 inches. Control of the nose strut kneel function is provided by the NOSE STRUT switch on the landing gear control panel (see Figure 2-73.) The three-position (EXTD, OFF, and KNEEL) toggle switch is spring loaded to return to the detented center to OFF. The position of the strut remains in the last commanded position independent of electrical or hydraulic power interruptions. In both cases, the transfer control valve source of electrical power is the essential No. 2 bus and combined hydraulic system fluid is used as the transfer medium. With external electrical power on the aircraft, the combined hydraulic system must be pressurized (>500 psi) before the control switch can command a position change of the transfer control valve. The control switch need only be held momentarily to effect a change in transfer control valve position.

Selection of KNEEL releases hydraulic fluid from the shock strut transfer cylinder to the combined hydraulic system return line, causing the weight of the aircraft to compress the shock strut 14 inches. Stroking of the nose strut causes the aircraft to rotate about the main wheels. The aircraft may be taxied or towed in the strut-kneeled position except for the nuisance trip of the launch bar at greater than 10° steering angle; this is the position used for taxiing onto the catapult and enhances accessibility to the forward fuselage compartments during ground maintenance. Since the nose strut is bottomed during the catapult launch stroke, the energy stored in the last 4 inches of strut-piston stroke is released upon shuttle release at the end of the catapult stroke to impart a noseup pitching moment to rotate the aircraft to the fly-away attitude without any control required by the pilot. All the stored energy is expended before the nosewheels leave the deck edge.

Note

> Under certain launch conditions (high wind over deck and light aircraft gross weights) the nose strut will not be fully compressed during the catapult stroke. Subsequent nose rotation following shuttle release will be at a less than normal rate. Aircraft launch bulletins for the aircraft are written to ensure that catapult launch pressures are sufficient to provide safe launch pitch rates and flyaway capability.

Full extension of the nose strut after launch and weight off wheels provides a redundant and automatic transfer of the control valve to the extend position. With weight off wheels, the NOSE STRUT switch is inoperative.



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NOMENCLATURE	FUNCTION
(1) NOSE STRUT switch	EXTD – Hydraulic pressure causes strut to extend. Combined hydraulic system must be pressurized before switch is activated on external power. Launch bar is lifted into the up-lock position by torque arms as strut extends 14 inches. OFF – Spring-loaded return position. KNEEL Nose strut transfer control valve releases pressure in the shock strut, which strokes 14 inches. Combined hydraulic system must be pressurized before switch is active on external power. Launch bar uplock can be released manually to allow bar to lower to deck, or by turning nosewheel ±10°.
(2) LAUNCH BAR advisory light	Illuminates under the following conditions: *Weight On Wheels* • Aircraft kneeled, throttles less than MIL (goes out when throttles are advanced to MIL to provide lights out criterion for catapult launch). • Launch bar not up and locked (normal operation) *Weight Off Wheels (Inhibits nosegear retraction)* • Launch bar not up and locked • Nosewheel not within ±15° of center • Nose strut not fully extended
(3) LAUNCH BAR switch	ABORT – Enables pilot to disengage the launch bar from the catapult while remaining at MIL power and in the kneel position. NORM Allows launch bar to be lowered.

Figure 2-73. Launch Bar Controls

2.28.2 Launch Bar. The launch bar is attached to the nosegear and serves as the tow link for catapulting the aircraft (see Figure 2-74). With the nose strut extended, the launch bar is held in the retracted position. The launch bar can be lowered by kneeling the aircraft and turning the nosewheel greater than ±10° from the centered position. The launch bar can also be lowered by the deck crew with no pilot action after the aircraft has been kneeled. A proximity sensing switch on the uplock detects the latch out of the locked position and illuminates the LAUNCH BAR advisory light (see Figure 2-73). Ears on the head of the launch bar engage under the lip of the catapult lead-in track and the head serves as a guide to steer the nosewheel on the catapult track and engage the shuttle. For an abort, the launch bar cannot be raised until the shuttle is disengaged.

2.28.2.1 LAUNCH BAR Light. The LAUNCH BAR advisory light is interlocked to go off when both throttles are at MIL even though the launch bar position and mechanism remain unchanged; this action is effected to establish a "lights out" criterion for launch. The light circuit is disabled with nosegear up and locked. A pilot-controlled LAUNCH BAR switch is installed that enables the pilot to disengage the launch bar from the catapult while remaining at MIL power and in the kneel position. This switch is on the pilot left vertical console.

CAUTION

To avoid damage to the launch bar retract mechanism, do not set the LAUNCH BAR switch to ABORT with the nosewheel deflected off center.

After the catapult launch stroke, extension of the strut mechanically cams the launch bar up to the retracted-and-locked position. If the launch bar is not engaged in the uplock with weight off wheels, the LAUNCH BAR advisory light will illuminate and nosegear retraction will be electrically inhibited.

2.28.3 Holdback Fitting. The holdback fitting is provided on the nose strut for insertion of the holdback bar. A groundcrewman must manually attach the bar before the aircraft is taxied into the catapult lead track. The holdback bar is reusable and provides for repeated releases at a tow force of 76,000 pounds. Force greater than this on launch causes the holdback bar to release the aircraft holdback fitting.

Single-engine, high-power turnup operations can use the holdback fitting to attach aircraft restraining hardware to deck-secured fittings. Prior to the application of single-engine high power, the nose strut should be kneeled and slack taken out of the holdback mechanism, otherwise dynamic loads may exceed mechanism design strength conditions.

2.29 ARRESTING HOOK SYSTEM

The arresting hook installation consists of a stinger tailhook and associated control mechanism mounted to the underside of the center fuselage. The hook shank is free to pivot up and down at its attachment point. A pneumatic dashpot preloads the hook down to minimize hook bounce on contact with the deck. The hook shank is free to pivot left or right within a ±26° sway angle with positive centering action provided by a pneumatic damper housed inside the tailhook shank. The trail angle of the arresting hook provides for hookpoint-deck contact even with the nose landing gear strut fully compressed.

2.29.1 Arresting Hook Operation. Normal operation of the arresting hook requires combined and flight hydraulic system pressure, dashpot charged, and dc essential No. 2 electrical power. Because of a redundant means of pilot control (electrical and mechanical), emergency extension of the arresting hook can be accomplished without these sources of power.

Note

Hook retraction requires electrical and combined hydraulic power.

2.29.1.1 Normal Operation. Normal operation (Figure 2-75) on the pilot hook control consists of a straight down-up movement of the HOOK handle. This action actuates switches that provide electrical command signals to the hook control valve. For lowering the hook, the uplock is released and the lift cylinder is vented. Flight hydraulic pressure is the medium that disengages the hook uplock actuator. When flight hydraulic pressure drops below 2,100 psi with weight off wheels, the hook/auxiliary flap isolation relay circuit is energized. This disables the arresting hook control valve and, therefore, disallows normal hook extension. This condition remains until either the starboard engine-driven hydraulic pump (flight) produces greater than 2,400 psi or weight on wheels is restored.

Note

If emergency hook extension is inoperative in conjunction with a flight hydraulic failure, cycling the HYD VALVE CONT circuit breaker (8E5) with the hook handle down will permit hook extension.

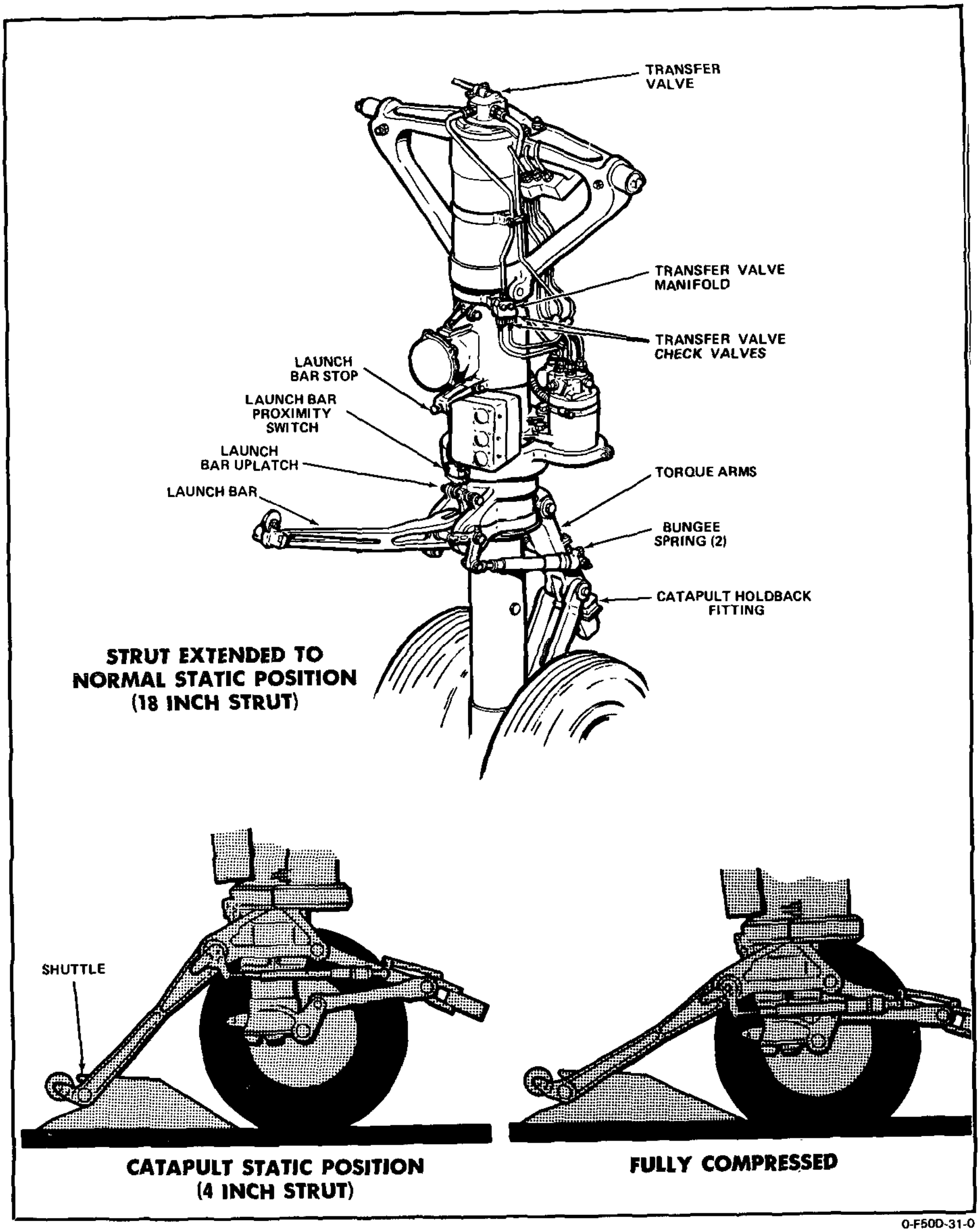
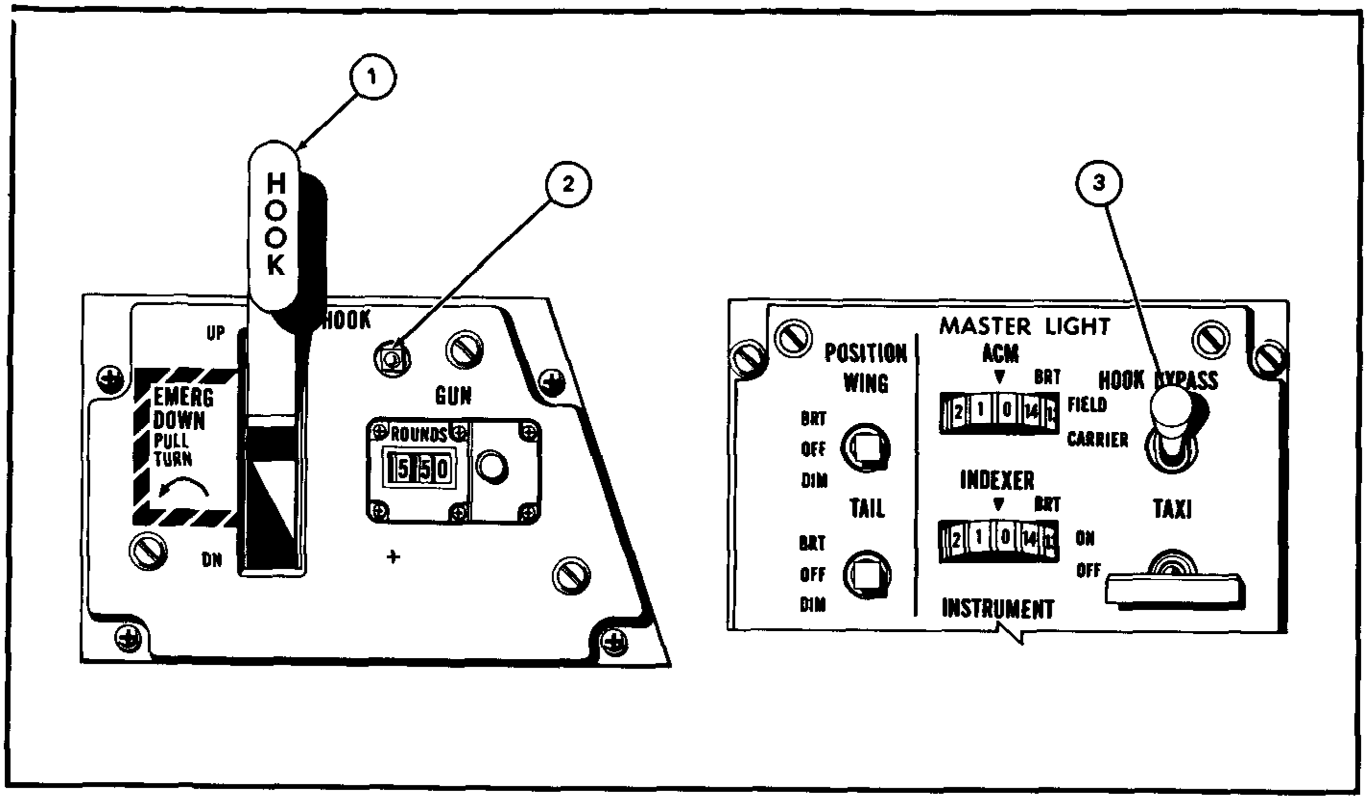


Figure 2-74. Launch Bar (Catapult)



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NOMENCLATURE	FUNCTION
(1) Arresting HOOK handle	UP – Electrically energizes hydraulic retract actuator to raise hook into uplock. DN – Electrically releases hydraulic uplock actuator and allows hook to extend by dashpot pressure and gravity. EMERG DOWN – (Pull-twist) mechanically releases uplock actuator and allows hook to extend by gravity and dashpot pressure.
(2) Hook transition light	Illuminates whenever arresting hook position does not correspond with handle position. Light will not go out in down position until hook is in full trail angle.
(3) HOOK BYPASS switch	FIELD – Used for nonarrested landings. Bypasses the flashing feature of the approach lights and indexer when landing gear is down and hook retracted. CARRIER Used for arrested landings. Approach lights and indexer flash when landing gear is down and the hook retracted.

Figure 2-75. Arresting Hook Controls

2.29.1.2 Hook Retraction. For hook retraction, the control valve pressurizes the retract side of the lift cylinder and the lock side of the actuator.

CAUTION

Do not attempt to raise the hook when the hook is engaged in the arresting gear.

When the arresting hook roller engages the uplock mechanism, the lift cylinder is depressurized. On deck, hook retraction time is approximately 3 seconds. The hook transition light is illuminated as long as a discrepancy exists between the hook and cockpit handle positions. On-deck extension requires approximately 1 second. The transition light will remain illuminated, unless the aircraft is kneeled, as contact with the deck precludes full hook extension.

Note

The hook transition light may remain illuminated when the hook handle is lowered at airspeeds greater than 300 knots because of hook blowback.

2.29.1.3 Emergency Hook Extension. The emergency control system lowers the hook by mechanically (cable) tripping the uplock and venting the hook lift actuator pressure. Emergency extension of the hook may be initiated when the handle is in either UP or DN. In either case, the hook handle is pulled aft (approximately 4 inches) and turned 90° counterclockwise. Rotation 90° counterclockwise will lock the handle in the extended position. With the handle locked, the hook will not retract regardless of the handle position (UP or DN).

Note

After emergency hook extension, the hook can be retracted airborne or on deck provided that the handle is rotated 90° clockwise, pushed full forward, and placed in UP. Combined and flight hydraulic system pressures are required to retract the hook while airborne. On deck, only combined hydraulic system pressure is required to retract the hook.

2.30 ENVIRONMENTAL CONTROL SYSTEM

The ECS regulates the environment of flightcrew and electronic equipment. The system provides temperature-controlled, pressure-regulated air for the following systems.

1. External drop tank pressurization
2. OBOGS
3. Cockpit pressurization
4. Canopy seals
5. Windshield and canopy defogging
6. Windshield anti-ice
7. Anti-g suit inflation
8. Wing airbag seals
9. Gun-gas purging
10. Electronic equipment cooling and pressurization
11. Temperature control of liquid coolant supplied to APG-71 radar control system, television camera set, and infrared search and track.

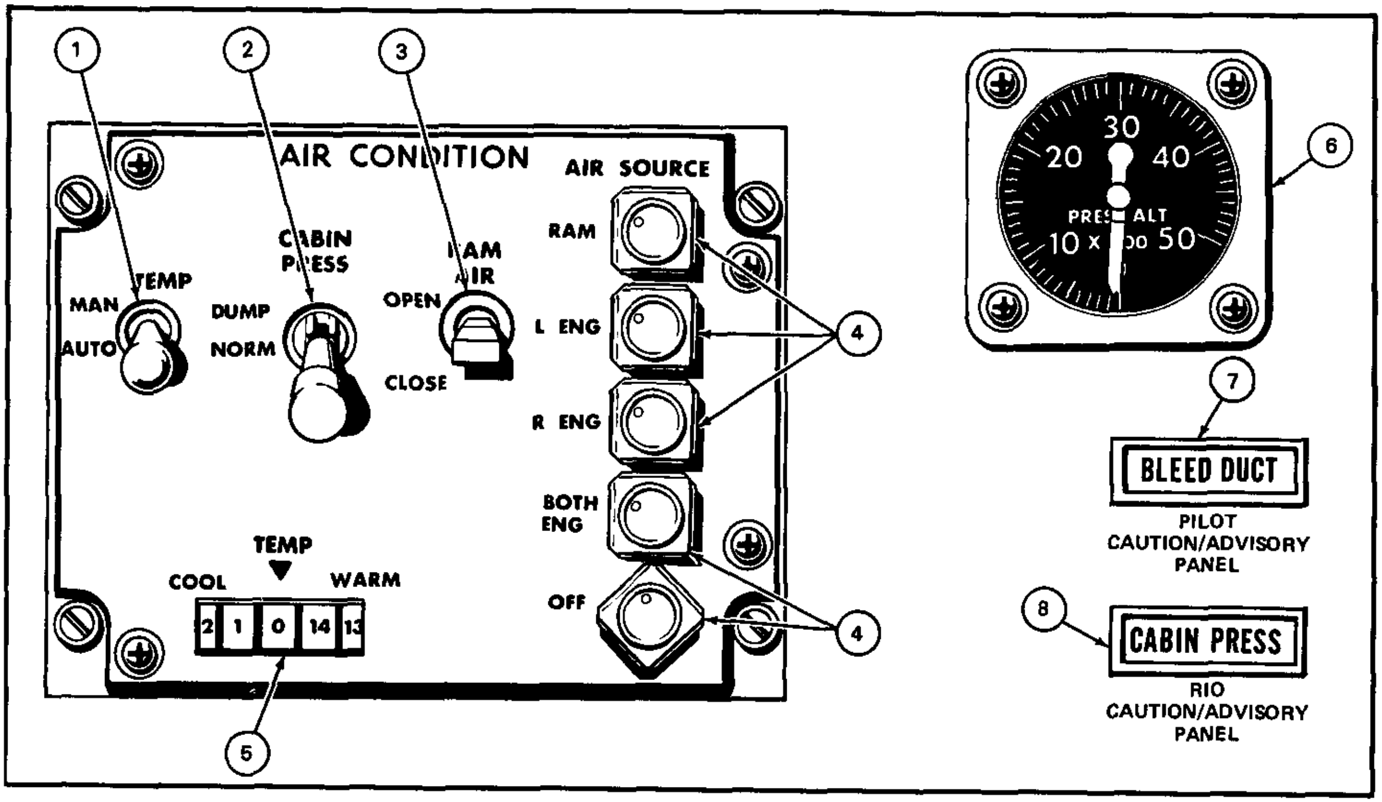
2.30.1 ECS Air Sources

2.30.1.1 Bleed Air. The normal source of ECS air is ninth-stage bleed air from both engines. Through a series of manifolds and valves, this air is cooled and mixed to reduce temperature and pressure to usable levels. The primary valves are the two engine bleed air shutoff valves, the dual pressure regulating and shutoff valve, and the turbine compressor modulating and shutoff valve, which are all controlled by the AIR SOURCE selector pushbuttons: L ENG, R ENG and BOTH ENG (Figure 2-76.)

2.30.1.2 Ram-Air Source. If either the RAM or OFF pushbutton is selected by the pilot, the cooling turbine compressor is shut down and emergency ram air can be used to ventilate the cockpits and provide cooling air to the service and suit heat exchanger and those electronic subsystems requiring forced air cooling. However, if OFF is selected, pressurization to the service systems (canopy seal, anti-g suit, external fuel tank, wing airbag seal, OBOGS), and 400 °F air supply to the windshield air defog and heating systems is lost. Selecting AIR SOURCE RAM will provide air to the service systems and 400 °F manifold air to the defog and heating systems.

CAUTION

Selection of the AIR SOURCE pushbutton to RAM with a failure of the 400 °F temperature manifold will continue to circulate 400 °F air throughout the system surrounding aircraft components and may cause a fire.



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NOMENCLATURE	FUNCTION	
(1) TEMP mode selector switch	AUTO –	Cockpit and pressure suit temperature is automatically maintained at that comfort level selected on the temperature control selector.
	MAN –	Cockpit temperature and air flow must be manually selected as airspeed and altitude change to maintain a desired temperature.
(2) CABIN PRESS switch Lever-lock switch which must be lifted to be moved to DUMP.	NORM –	Cockpit pressure will be maintained at an altitude of 8,000 feet up to 23,000 feet, above which the regulator maintains a 5-psi pressure differential.
	DUMP –	The cockpit safety valve is opened, depressurizing the cockpit.
(3) RAM AIR switch	OPEN/ CLOSE –	Manually modulates the ram air door and regulates the amount of ram air supplied to the cabin and electronics bay after the AIR SOURCE pushbutton is selected to RAM or OFF. (Approximately 50 seconds to full open.)

Figure 2-76. Air-Conditioning and Pressurization Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(4) AIR SOURCE selector pushbuttons	RAM – Closes the bleed air flow modulator pressure regulator and shutoff valve, thereby securing the cooling bootstrap turbine compressor. Inhibits gun firing. The RAM AIR switch is enabled. *Combined ram air and regulated 400°F bleed air are available* to the cockpits and air cooled electronic equipment for temperature control.When either BOTH ENG, L ENG or R ENG are selected, the ram air door automatically closes. L ENG – The left engine is the source of bleed air for the environmental system and the right engine bleed air shutoff valve is closed. R ENG – The right engine is the source of bleed air for the environmental system and the left engine bleed air shutoff valve is closed. BOTH ENG – The right and left engine bleed air shutoff valves are open and both supply bleed air to the environmental control system. This is the normal position. Automatically closes ram air door. OFF – Both the left and right engine bleed air shutoff valves and the dual pressure regulator valve are closed. Inhibits gun firing. Pressurization and air conditioning are not available. Enables the RAM AIR switch.
(5) TEMP thumbwheel control	Selects cockpit and suit air temperature. It can be rotated through a 300° arc (0 to 14) with mechanical stops at each end placarded COOL and WARM. A midposition temperature (7) is approximately 70°F in the automatic mode. With the TEMP mode selector switch in AUTO the temperature selected is automatically maintained by the modulating temperature control valves. In MAN, the TEMP control thumbwheel must be repositioned to maintain cockpit and suit air temperature. Air flow and temperature will not change as a function of airspeed and altitude.
(6) CABIN PRESS ALT indicator	Displays cabin pressure altitude in 1,000-foot increments from 0 to 50,000 feet.
(7) BLEED DUCT caution light	Indicates overheating (575°F or greater) along the high-temperature bleed air duct routing forward of the engine fire wall past the primary heat exchanger and then up to the right diverter area. *An additional sensor*, detecting temperatures of 255°F or greater, senses from the right diverter area, along the 400°F manifold and into the bootstrap turbine compartment.
(8) CABIN PRESS caution light (RIO's cockpit)	*Indicates cabin pressure is less than 5-psi absolute pressure or cockpit* altitude is above 27,000 feet.

Figure 2-76. Air-Conditioning and Pressurization Controls and Indicators (Sheet 2 of 2)

Interconnects inhibit gun firing with RAM or OFF selected. The emergency ram-air door is on the lower right side of the fuselage, inboard of the right glove. To activate the ram-air door, either the OFF or RAM AIR SOURCE pushbutton must be depressed and the RAM AIR switch on the air-conditioning control panel must be moved to OPEN. To activate the emergency ram-air door from fully closed to fully open requires approximately 50 seconds.

CAUTION

- Before opening the ram-air door, reduce airspeed to 350 knots or 1.5 Mach, whichever is lower, to prevent ram-air temperatures above 110 °F from entering the system. After ram-air flow is stabilized, airspeed may be varied as required for crew comfort or to increase flow to electronic equipment.

- With AIR SOURCE OFF selected, limit airspeed to less than 300 knots/0.8 Mach to prevent damage to the deflated wing airbag seals.

For maximum cockpit ram-air flow, the cockpit pressurization must be dumped. Pressing either L ENG, R ENG or both ENG pushbuttons automatically closes the ram-air door if it is open.

2.30.1.3 External Air. The adapter for connecting a ground air-conditioning unit is under the fuselage, aft of the nose wheelwell. An additional provision for connecting an external source of servo air is in this same area.

External electrical power is automatically inhibited from AYK-14 1, IRST, TR1, TR2, and the CIU if external air-conditioning is not connected to the aircraft. A pressure switch interrupts electrical power to the above forced-air-cooled equipment.

2.30.2 Cockpit Air-Conditioning. ECS manifolding consists of:

1. The high-temperature (bleed air) manifold

2. The 400° manifold

3. The cold-air manifold.

High-temperature engine bleed air is routed through the primary heat exchanger. The cooled output of this heat exchanger is split and a portion is mixed with hot engine bleed air to a temperature of approximately 340 °F; the remainder is further cooled by the turbine compressor. Here the air is compressed, run through the secondary heat exchanger, and then expanded in the turbine section, resulting in cold air that is mixed with 340 °F air to obtain any temperature desired. The primary and secondary heat exchangers are between the left and right engine inlets and the fuselage. At speeds above 0.25 Mach, ram air across the heat exchangers is used for cooling. During ground operations and at airspeeds less than 0.25 Mach, airflow across the heat exchanger is augmented by air-powered turbine fans.

Note

With the system in MAN to increase airflow to forced-air-cooled equipment, place CANOPY DEFOG-CABIN AIR control lever in CANOPY DEFOG.

The third heat exchanger is the service air-to-air heat exchanger. This normally uses cold air from the cold-air manifold as a heat sink but can use emergency ram air if the cold-air manifold is not operating. Air from the service heat exchanger is used by the pressure suit, anti-g suit, canopy seal, OBOGS, servo air, and for pressurization of waveguides, the radar liquid cooling loop tank, and the television camera set.

2.30.2.1 Temperature Management. The pilot can control cockpit temperature by selecting either a manual (MAN) mode or automatic (AUTO) mode with the TEMP mode selector switch (Figure 2-76). In the AUTO mode, temperature (60 °F to 80 °F) is selected by the pilot with the TEMP thumbwheel control. This desired temperature is maintained by a cabin temperature sensor in the forward left side of the cockpit. In the MAN mode, the TEMP thumbwheel control maintains airflow and temperature. If cockpit inlet airflow temperature (in either AUTO or MAN) exceeds 250 °F, a cockpit overtemperature switch closes the hot-air-modulating valve.

The conditioned air entering the cockpit is divided forward and aft, with 50 percent of the air going to each cockpit. A CANOPY air diffuser lever on the right console in each cockpit individually controls the percentage of airflow through the cockpit diffusers and the canopy defog nozzles. When the lever is in CABIN AIR (full aft), 70 percent of the air is directed through the cockpit diffusers and 30 percent through the canopy defog nozzles. In DEFOG, 100 percent of the air is directed through the canopy defog nozzles.

2.30.2.2 Vent Airflow Thumbwheel. This control has no function.

2.30.2.3 Anti-G Suit. Each anti-g suit is connected to the aircraft pressurization system by an anti-g suit hose that delivers pressurized air to the suit control valve and then to the suit through a composite disconnect. Below 1.5g, the suit remains deflated. A spring-balanced anti-g valve automatically opens when g forces exceed 1.5g. Operation of the anti-g suit valve may be checked by depressing the test button marked G VALVE on each crewman's left console.

2.30.3 Electronic Equipment Cooling. Ambient cooled equipment in the electronic bays is cooled by the air exhausted from the cockpits. Equipment incapable of being cooled by free convection is cooled from the cold-air manifold.

A schematic of the radar and electronic equipment cooling is shown in FO-14. Controls and lights are shown in Figure 2-77.

2.30.3.1 Radar Liquid Cooling. Radar equipment is cooled by liquid coolant (FO-14). The heat is rejected in the ram-air heat exchanger. This is accomplished by circulating coolant fluid through the electronics and ram-air heat exchanger and/or the radar heat exchanger. The cooling loop is also used for automatic warmup of the radar using 400 °F manifold.

The radar liquid cooling loop incorporates a separate ram-air liquid-heat exchanger. A ram-air door is located under the right glove, forward of the primary heat exchanger inlet. There are no cockpit controls for this ram-air door. It is controlled by the radar controller and is independent of the air-conditioning and pressurization system. The radar system ram-air heat exchanger automatically maintains the liquid temperature within operating limits when ram air is used for cooling.

2.30.3.1.1 Controls and Lights. Figure 2-77 shows the controls and lights associated with the radar cooling loop. The radar cooling loop is activated by the RADAR COOLING switch on the RIO left outboard console. In ON, the radar cooling loop is activated for airborne operation. A temperature sensor in the heat exchanger outlet illuminates the SENSOR COND advisory light when the liquid temperature goes above 104 °F. In addition, a pressure switch in the radar pump illuminates the SENSOR COND advisory light when pump output pressure is too low.

If the coolant pump temperature rises to 230 ±5 °F, the thermal switch opens, shutting down the pump to prevent pump failure and illuminating the SENSOR COND advisory light.

2.30.3.1.2 Ground Operation. During ground operation with electrical power, external air-conditioning, and servo air available to the aircraft and the GND CLG switch in RADAR, the cockpit low-flow sensor is overridden. The OFF position of the GND CLG switch enables cockpit air priority. With engines running on the ground, select OFF on the ground cooling switch.

2.30.3.2 Cockpit Air Priority Function. The cockpit air priority function is operational during all engine-on operations (FO-14). It provides the cockpit with priority over the radar liquid-cooling loop in the event there is a shortage of conditioned air. On engine power, the GND CLG switch (Figure 2-77) should always be in OFF and the canopy locked to enable the cockpit air priority function.

There is no indication to the flightcrew that the cockpit priority action is taking place unless it progresses to the point that the SENSOR COND advisory light illuminates. Even then, it is only one of several problems that could have triggered the light.

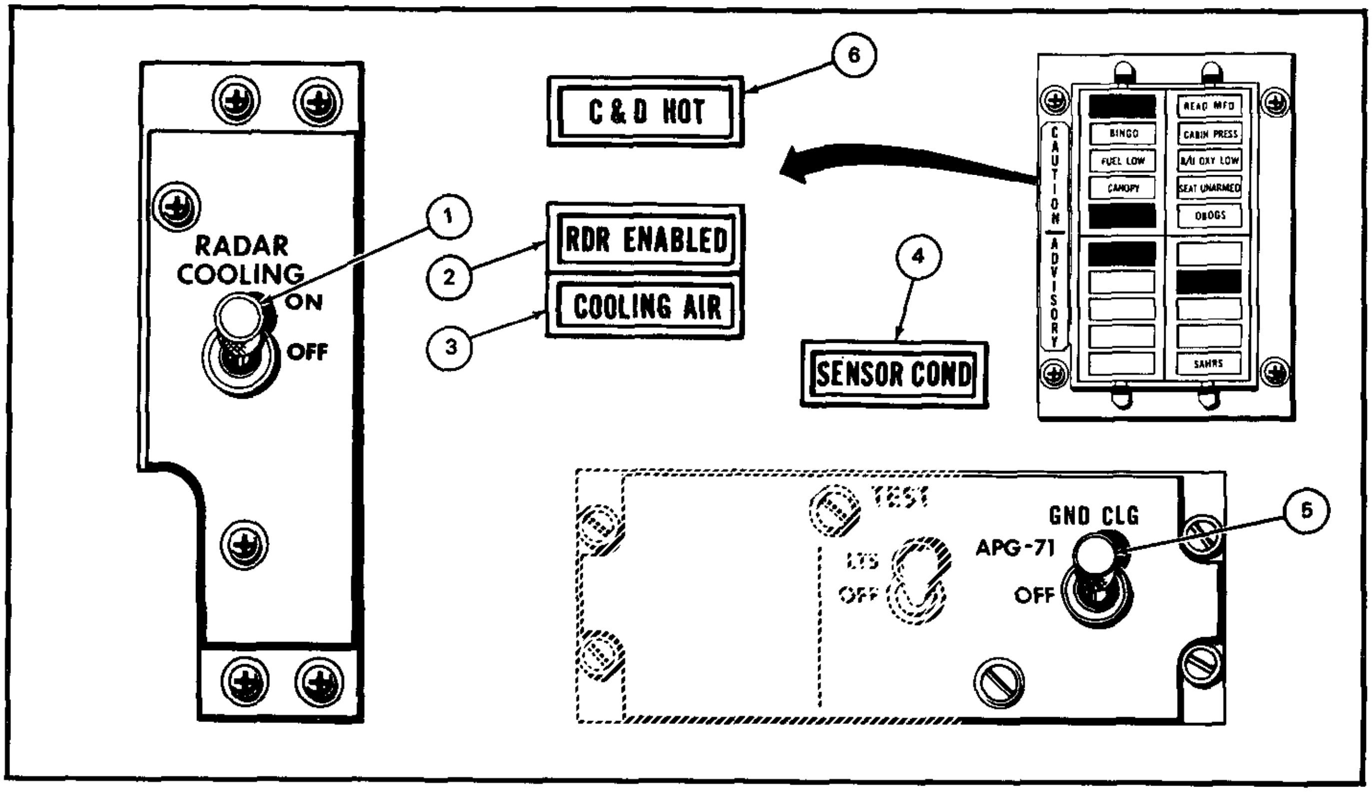
2.30.4 Pressurization

2.30.4.1 Cockpit Pressurization. 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 constant 5-psi pressure differential greater than ambient pressures. An illustration of the cabin pressure schedule is shown in Figure 2-78.

2.30.4.1.1 Cockpit Pressure Indicators. A cockpit pressure altimeter (Figure 2-76) is provided for the pilot. In the rear cockpit, the RIO has a low-pressure caution light on the CAUTION and ADVISORY light panel. This low-pressure caution light, placarded CABIN PRESS, illuminates when cockpit pressure drops below 5 psi absolute pressure or cockpit altitude is above 27,000 feet.

2.30.4.1.2 Cockpit Pressure Malfunctions. If the cockpit pressure regulator malfunctions, the cockpit safety valve will open to prevent a cockpit pressure differential from exceeding a positive 5.5-psi or a negative differential of 0.25 psi. The cockpit pressure regulator and the safety valve are pneumatically operated and function independently through separate pressure sensing lines.

2.30.4.1.3 Cockpit Pressure Dump. Cockpit pressurization can be dumped by the pilot by selecting DUMP with the CABIN PRESS switch. When DUMP is selected the safety valve is immediately opened and the cockpit is depressurized.



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NOMENCLATURE	FUNCTION
(1) RADAR COOLING switch	OFF - Deactivates the radar cooling pumps. ON - Activates the radar cooling pump for ground and airborne thermal conditioning.
(2) RADAR ENABLE caution light	Indicates that radar operation on the ground is possible.
(3) COOLING AIR advisory light	Illuminates after a delay of 25 to 40 seconds when insufficient cooling is provided to the electronic forced air cooling system. Degraded cooling may result from cooling system failure, turbine failure, or ECS duct failure.
(4) SENSOR COND advisory light	Illuminates when coolant exiting the heat exchanger is greater than 104°F, or pump output pressure is too low, or when the overtemperature switch shuts down the radar, television camera set (TCS), and the infrared search and track (IRST).

Figure 2-77. Avionic Equipment Liquid Cooling Controls and Lights (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(5) GND CLG switch	APG-71 – Cockpit low flow sensor is overridden. **CAUTION** • Servo air required to actuate servo operated valves. • Use RADAR only when engines are shut down. OFF – Cockpit low flow interlock is operational.OFF shall be selected when engines are operating.
(6) C & D HOT caution light	Indicates DD or TID overheat condition.

Figure 2-77. Avionic Equipment Liquid Cooling Controls and Lights (Sheet 2 of 2)

2.30.4.2 Canopy Seal Pressurization. Pressurized air from the air-conditioning system is ducted through the cockpit to the canopy seal. The seal is automatically inflated when the canopy actuator is moved to the closed position. A check valve in the canopy pressure regulating valve prevents the loss of canopy seal pressurization if the conditioned air manifold is depressurized. Initial movement of the canopy actuator automatically deflates the seal.

2.30.5 Windshield Air and Anti-Ice. Compressor bleed air at approximately 340 °F and at high pressure is directed over the outside of the windshield through a fixed-area nozzle. This blast of hot air over the windshield will evaporate rain and ice and prevent its further accumulation. It is activated by selecting ON with the WSHLD AIR switch. A temperature overheat sensor at the base of the windshield protects the windshield from overheating. When the sensor detects overheating (300 °F), a signal closes the pressure regulating valve and illuminates the WSHLD HOT advisory light on the pilot CAUTION ADVISORY light panel (Figure 2-79).

CAUTION

- Selecting WSHLD AIR ON prior to entering rain or icing conditions may cause windshield cracking because of the rapid cooling effects of precipitation.
- Extended operations in clear air with the windshield air on may cause windshield cracking and discoloration.

2.30.6 Gun-Gas Purging. External airflow is used to ventilate the gun compartment for gun-gas purging. A flush air inlet on the fuselage gun bump and an aft louvered door containing a FOD screen provide a continual flow of air to purge gun gases. Gun firing is limited to 200-round bursts.

2.30.7 Degraded ECS Operation. There are various temperature and pressure safeguard systems that cause the ECS system to shut down if an unsafe situation is detected. A complete failure of the dual valve will cause it to shut down the pressurization and air-conditioning system. Should that fail to close, a pressure switch will close both engine bleed air shutoff valves if an overpressure (155 psi) situation exists in the outlet of the primary heat exchanger. A shutdown of the bleed air supply duct, either automatically or pilot-selected AIR SOURCE OFF pushbutton, will cause total ECS air shutdown.

CAUTION

Failure of the left or right weight-on-wheels switches to the in-flight mode can cause loss of engine ejector air to the IDGs and hydraulic heat exchangers causing thermal disconnect and/or heat damage to the generators and aircraft hydraulic systems.

Note

After an automatic shutdown of the system, the pilot should select either OFF or RAM AIR SOURCE to enable the emergency ram-air door and then hold ram-air switch to OPEN for approximately 50 seconds to provide ram-air cooling to electronic equipment and to the cabin.

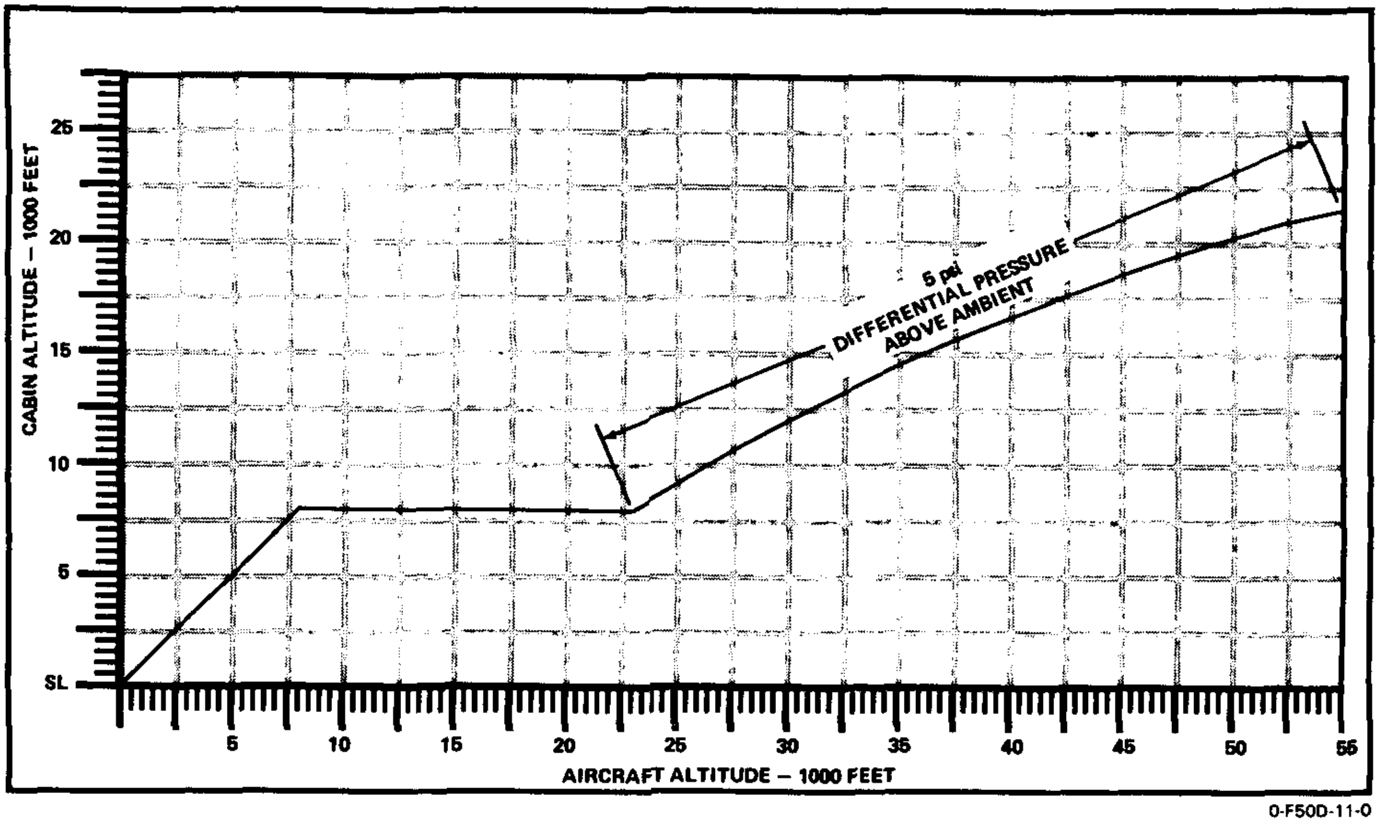


Figure 2-78. Cabin Pressure Schedule

Note

- Loss of electrical power with bleed air still operating will result in smoke entering the cockpit through the ECS when the aircraft is on the deck. In flight, only cold air will be supplied to the cabin and suit. Icing of the water separator may occur, causing reduced flow to the cabin. Since the ECS panel is dependent on electrical power, selector pushbuttons will be inoperative.
- Retarding throttles to IDLE above 30,000 feet may result in a considerable reduction in ECS airflow, leading to a loss of cockpit pressurization, SENSOR COND light, and/or COOLING AIR light.

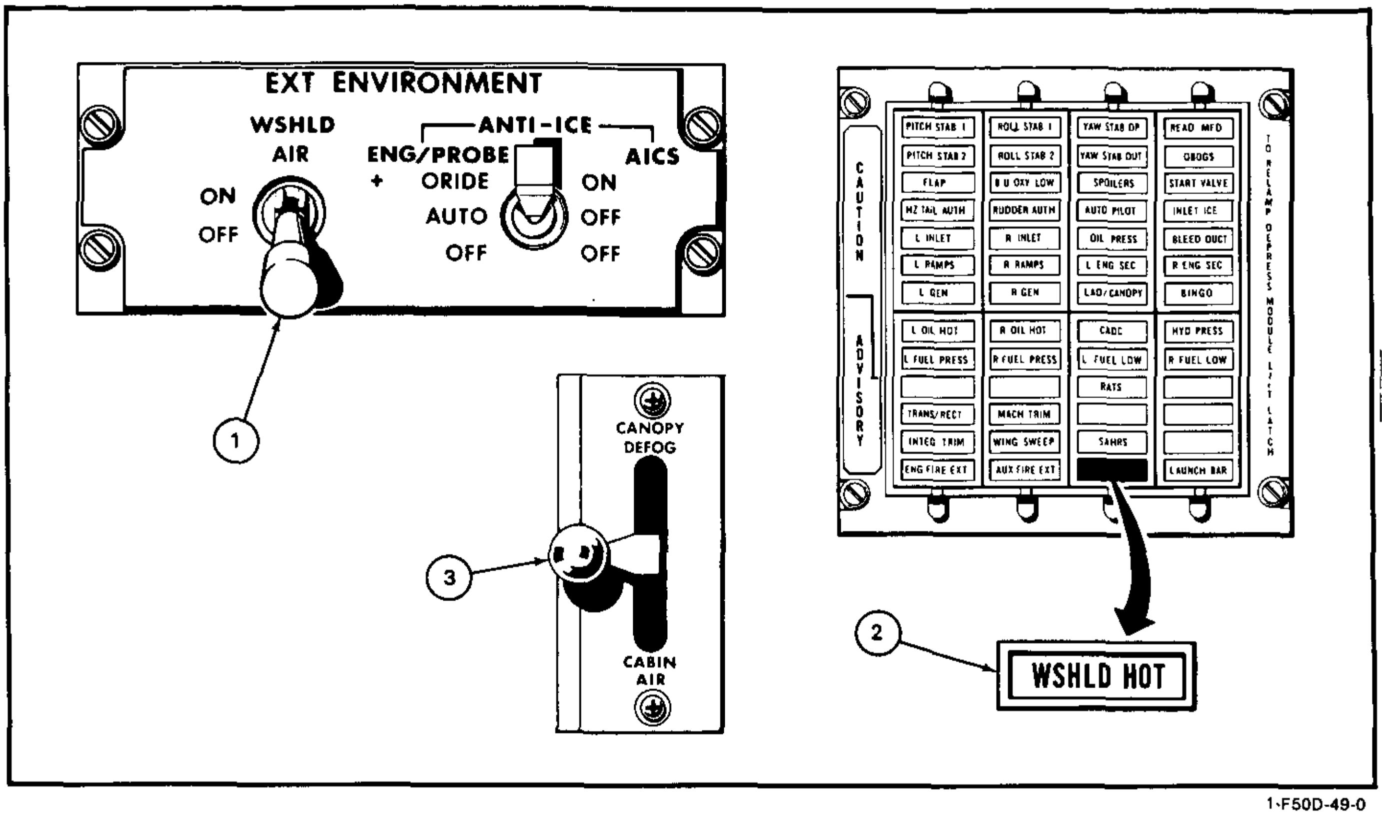
If the 400° manifold reaches 475 °F, a 400 °F shutoff valve closes, stopping the flow of unconditioned engine bleed air to the 400 °F manifold.

If either compressor inlet or turbine inlet temperature becomes excessive, the refrigeration unit will shut down. Cockpit indications will be as follows:

1. No cockpit airflow.
2. RIO COOLING AIR advisory light illuminated.
3. RIO SENSOR COND advisory light illuminated.
4. If ram-air cooling is not selected, extended flight with AIR SOURCE OFF could cause an overheating condition of the converter interface unit and a subsequent loss of primary attitude and navigational indications (i.e., multifunction displays, HUD, NAVAIDs).

The pilot should press the AIR SOURCE RAM pushbutton and set the RAM AIR switch to OPEN to open the ram-air door to provide forced-air cooling to the electronic equipment and to the cabin.

ECS duct failures may be indicated by diminishing cabin cooling airflow and/or cabin pressurization with or without COOLING AIR advisory light illumination. Duct failures may additionally be indicated by pressurization loss to the service systems and airflow loss to rain removal, defog, and heating systems. This cannot be verified if the system is not in use. Selection of AIR SOURCE OFF and ram air increase is appropriate when any indication of duct failure exists. ECS malfunctions that are not caused by duct failure are usually indicated by loss of temperature control without a cabin or system airflow/pressurization degradation. Failure of the 400 °F modulating valve or duct should not cause illumination of the cooling air light. Any duct failure in this area



NOMENCLATURE	FUNCTION	
(1) WSHLD AIR switch	ON –	Provides a continuous blast of hot air (340°F) over the exterior windshield. Used for windshield anti-ice.
	OFF –	Closes the shutoff valve after a 5-second delay. The system is deenergized.
(2) WSHLD HOT advisory light	Light illuminates when a sensor in the warm air nozzle to the center windshield indicates overheat (300°F).	
(3) CANOPY air diffuser lever (both cockpits)	CABIN AIR –	70% of the conditioned air directed through the cockpit air diffusers and 30% is through the canopy defog rails. This is normal position.
	DEFOG –	Air flow is directed through the canopy defog rails only.

Figure 2-79. Canopy Defog Controls and Windshield Air

associated with the COOLING AIR light is strictly coincidental. However, the duct failure between the primary heat exchanger and the turbine compressor assembly, or between the secondary heat exchanger and the turbine compressor assembly, could cause degraded cooling airflow and a COOLING AIR light to illuminate.

Actuation of the overtemperature switch results in cycling of the 400 °F valve. During this period the heating capacity of the 400 °F manifold would be degraded.

2.31 OXYGEN SYSTEM

Breathing oxygen is provided to each crewmember by the OBOGS. A backup oxygen system provides a supply of gaseous oxygen sufficient for a maximum-range descent in the event of a failure of the OBOGS. In addition, emergency oxygen is available to each crewmember through a high-pressure, gaseous oxygen bottle located in the ejection seat survival kit.

2.31.1 On-Board Oxygen Generating System. The OBOGS provides 95-percent pure pressure- and temperature-regulated oxygen to each crewmember. The system includes an oxygen concentrator, an oxygen monitor, and two regulators. Controls and indicators for the OBOGS are shown in Figure 2-80.

The oxygen concentrator is in the right side of the fuselage adjacent to and beneath the forward cockpit. Filtered and cooled ECS service air is directed to the oxygen concentrator when ON is selected on the OBOGS master switch on the pilot cockpit panel. A molecular sieve in the concentrator removes the nitrogen from the compressed air, leaving a breathing gas equivalent in concentration to 95-percent oxygen at 34,000 feet. The oxygen concentrator receives 115-Vac motor power from the pilot ac essential bus No. 1 and heater power from the ac right main bus. OBOGS 28-Vdc control power is provided by essential dc bus No. 1 via the OBOGS CONTR circuit breaker.

The oxygen monitor is on the pilot right console. It constantly monitors the oxygen concentrator output to ensure a sufficient concentration of oxygen is being generated. When the monitor detects an oxygen partial pressure less than 182 mm Hg, it generates an alarm signal that illuminates the OBOGS caution lights, shuts off output from the concentrator and enables the backup oxygen system. The concentrator and the monitor continue to function as long as the OBOGS switch is in the ON position. The monitor will automatically shift back to the OBOGS supply source when it detects adequate concentrator output.

Power to the monitor is provided by 28 Vdc OBOGS control power from the essential dc bus No. 1 when the OBOGS master switch is in the ON position. The sensor in the monitor is heated for proper operation. Upon initial selection of the OBOGS master switch to ON, the OBOGS is powered and functioning but the monitor will not be accurately detecting oxygen concentration until the sensor is warmed up. This can take up to 2 minutes, depending on the ambient temperature. The OBOGS light will not be illuminated during the warmup period. The pilot may test operation of the monitor via the press-to-vent TEST button. The button actuates a valve that must be held for up to 1 minute to vent oxygen sensor. Laboratory testing has demonstrated that the test can normally be completed in approximately 15 seconds. Once vented, the monitor will sense insufficient oxygen, illuminating the cockpit caution lights and shifting the oxygen supply source to BOS. The monitor will automatically shift back to OBOGS operation and extinguish the caution light after release of the TEST button. Testing has demonstrated this occurs within 5 to 7 seconds, but may take up to 20 seconds.

WARNING

> The aircrew will not have any indication of a failure of the monitor. If the aircrew suspects the onset of hypoxia at any time, immediately select BACKUP. The monitor may be tested once the aircraft has descended to a cabin altitude of 10,000 feet or less and the ON position on the OBOGS master switch has been reselected.

The regulators are chest mounted, pressure demand type through which pressure- and temperature-regulated oxygen is provided to each crewman. Pressure breathing is activated above 34,000-foot cabin altitude.

When the OBOGS master switch is on, filtered, cooled engine bleed air is directed to the oxygen concentrator where a molecular sieve removes the nitrogen from the compressed air, leaving a breathing gas consisting of 95-percent oxygen. The oxygen monitor checks system operation to ensure that a sufficient concentration of oxygen is being generated, provides a cockpit indication, and brings the backup gaseous supply on line as required. A test button on the monitor enables the pilot to verify that the monitor and the backup oxygen system are functioning. When pressed, the OBOGS advisory light illuminates indicating the system is in backup. The oxygen concentrator receives 115 Vac from pilot ac essential bus No. 1 and from the ac right main bus. Control power and power to the monitor is 28 Vdc from essential dc bus No. 1.

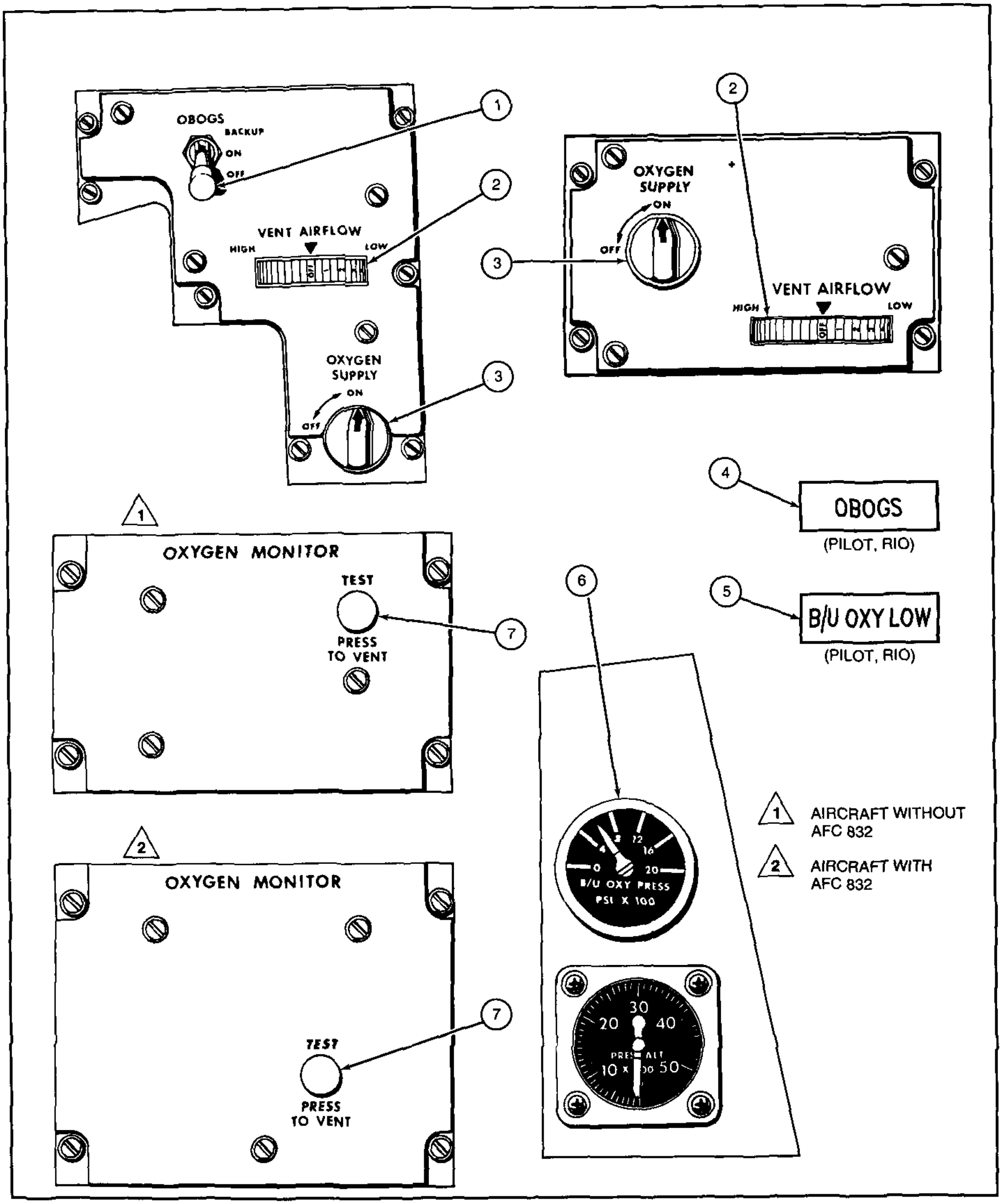


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Figure 2-80. Oxygen System Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
1 OBOGS master switch	BACKUP – Deenergizes oxygen concentrator and Process Air Shutoff Valve. Enables Backup Oxygen. ON – Applies power to oxygen generator and oxygen monitor. Opens solenoid valve providing ECS Service Air to Oxygen Concentrator. OFF – Removes power from OBOGS and BOS. Process air shutoff valve closes.
2 VENT AIRFLOW	NOT FUNCTIONAL.
3 OXYGEN SUPPLY valve	ON – Opens oxygen supply permitting OBOGS or BOS oxygen flow to crewmember. OFF – Secures OBOGS and BOS oxygen flow to crewmember.
4 OBOGS caution light	Illuminates when OBOGS has failed or OBOGS master switch is in OFF or BACKUP.
5 B/U OXY LOW caution lights	Illuminates when pressure remaining in BOS assembly oxygen cylinder is below 200 psi.
6 BACKUP OXY PRESS Indicator	Indicates pressure remaining in BOS assembly oxygen cylinder.
7 OXYGEN MONITOR TEST Button	Provides functional test of the oxygen monitor, BOS, and OBOGS control systems.

Figure 2-80. Oxygen System Controls and Indicators (Sheet 2 of 2)

2.31.2 Backup Oxygen System. The BOS consists of a BOS assembly, BOS controller, B/U OXY LOW caution light, and a BACKUP OXY PRESS indicator. This system was designed to provide only enough oxygen for maximum-range descent. In the event of an OBOGS failure, the aircrew must take immediate action to conserve backup oxygen.

Switching to the backup system can be accomplished three ways:

1. Automatically upon monitor detection of an OBOGS failure or loss of OBOGS control power

2. Manually via direct selection of BACKUP on the OBOGS master switch

3. Automatically with total loss of electrical power or selection of OFF on the OXYGEN system master switch, when the aircraft is above 10,000 feet MSL.

Backup oxygen cannot be disabled above 10,000 feet MSL by turning the OXYGEN system master switch off. Therefore, the individual OXYGEN SUPPLY valves (Figure 2-80) in both cockpits must be used to turn off oxygen flow to the personnel regulators.

The BOS assembly consists of an oxygen cylinder, pressure gauge, pressure regulator, fill port, pressure transducer, low-pressure switch, manual shutoff valve, and quick disconnect on a palletized assembly that is removable for servicing and maintenance. A 200-cubic-inch, high-pressure cylinder containing 500 to 590 liters of gaseous oxygen at 1,800 to 2,100 psi, respectively, provides a backup oxygen supply to the OBOGS. The BOS assembly is located on the right forward side of the fuselage, just below the forward end of the pilot cockpit.

The BOS controller enables flow from the BOS assembly via a diaphragm valve. This diaphragm valve is controlled by two solenoid valves and an aneroid valve. The BOS controller is in the BOS assembly compartment. Power for automatic operation of the BOS controller is provided by 28 Vdc essential bus No. 1 via the OBOGS CONTR circuit breaker. Alternate power is provided via the BOS CONTR/B/U OXY LOW circuit breaker for automatic activation of backup oxygen in the event of a failure of the OBOGS control relay and when BACKUP is manually selected.

The B/U OXY LOW caution light is actuated by the BOS assembly low-pressure switch when the BACK UP OXY PRESS gauge reads less than 200 psi, or when BOS CONTR/B/U OXY LOW power is lost. Figure 2-81 provides backup oxygen breathing time for two crewmembers for various cabin altitudes based upon BOS oxygen cylinder pressure.

2.31.3 BOS Pressure Indicator. The BACK UP OXY PRESS indicator (Figure 2-80), on the right side of the pilot right knee panel, shows the pressure in the BOS assembly oxygen cylinder. The indicator will not function unless the BOS manual shutoff valve on the BOS assembly is open.

2.31.4 Emergency Oxygen Supply. The 50-cubic-inch oxygen cylinder in the survival kit of each ejection seat provides a limited supply of gaseous oxygen. This oxygen cylinder can be manually activated in the event of a failure of the OBOGS and depletion of the backup supply. The cylinder is charged to 1,800 to 2,100 psi and a pressure gauge is visible on the inside face of the left-thigh support. Flow from the emergency cylinder is routed through a pressure reducer and a shuttle valve, then follows the path of the normal oxygen system, flowing through the oxygen regulator to the face mask. The supply of oxygen available in the emergency cylinder is adequate for up to 8 to 10 minutes, depending upon altitude. The manual actuation handle is a green ring under the left side of the survival kit cushion.

WARNING

Turn the OXYGEN supply valve to OFF before pulling the emergency oxygen manual actuating handle if contamination of the normal system is suspected. Failure to do so will inhibit seatpan shuttle valve operation, preventing flow of emergency oxygen.

Note

Flow of oxygen from the emergency cylinder can be stopped by reseating the manual actuation handle.

2.32 PITOT-STATIC SYSTEM

The pitot-static pressure system supplies impact (pitot) and atmospheric (static) pressure to the pilot and RIO flight instruments, to the CADC, and to the engine AICS programmers. Some systems require static pressure only; others require static and pitot pressure (see Figure 2-82).

The pitot-static system is composed of two separate systems with individual pitot-static probes, one on each side of the forward fuselage.

The left pitot pressure (P_T) probe supplies the pilot standby airspeed indicator and the left AICS programmer. The right pitot pressure (P_T) probe supplies the RIO standby airspeed indicator, the right AICS programmer, and the CADC with airspeed indications. An electrical P_T input from the left AICS programmer is supplied to the CADC backup channel as airspeed indications for wing sweep.

The left and right forward static ports (P_{S1}) are manifolded to provide static pressure to the pilot standby airspeed indicator, standby altimeter, vertical speed indicator, and the CADC. Static pressure from the right aft (P_{S2}) static ports supply the RIO standby airspeed indicator, standby altimeter, and the right AICS programmer. The static pressure from the left aft (PS2) static ports supply the static pressure to the left AICS PS sensor. An electrical PS input from the left AICS programmer is supplied to the CADC backup channel for wing sweep.

Note

- With the in-flight refueling probe extended, the pilot and RIO standby altimeters and airspeed indicators show erroneous readings because of changes in airflow around the pitot-static probes.
- The RUDDER AUTH caution light may illuminate when the in-flight refueling probe is extended. Press the MASTER RESET button to reset the light.

2.32.1 Pitot-Static Heat. Each pitot-static probe is equipped with electrical heating elements to prevent icing. Pitot-static heat is controlled by the pilot through the ANTI-ICE switch on the pilot right console. In AUTO/OFF, pitot probe heat is available only with weight off wheels. ORIDE/ON activates the probe heat elements independently of the weight-on-wheels switch and illuminates the INLET ICE caution light on the CAUTION ADVISORY panel. OFF/OFF removes heat from the probes.

WARNING

The ANTI-ICE switch should normally be in AUTO/OFF during takeoff and landing. Engine anti-icing has adverse effects on engine stall margin.

CABIN ALTITUDE	BACK-UP OXYGEN PRESSURE					
	2000	1600	1200	800	400	200
35 & ABOVE	100	80	60	40	20	10
30	72	58	43	29	14	7
25	52	42	31	21	10	5
20	41	33	24	16	8	4
15	32	26	19	13	6	3
10	27	22	16	10	5	2.9
8	24	19	14	9	4	2.5
5	21	17	12	8	4	2.2
SL.	17	14	10	7	3	1.8

Minutes remaining based on two-man consumption.

Duration data should be used as a guide

Consumption rate based on 13.1 liters per minute per man.

Figure 2-81. Oxygen Duration Chart

2.33 CONTROL AND DISPLAY SYSTEM

The control and display system (Figure 2-83) provides the crew with control and display of navigation, aircraft status, and flight tactical information. The control and displays system consists of two display processors (DP1 and DP2), three multifunction displays (pilot center MFD1, pilot right MFD2, and RIO MFD3), and a heads-up display system, cockpit television sensor, HUD-VIDEO panel, pilot DISPLAYS control panel, and a multistatus indicator.

The control and display system also sends display information to the digital display, the radio frequency indicator, radio frequency/control indicator, and the mission video recorder.

The data entry unit is a remote terminal that communicates with the mission computers via the multiplex buses.

2.33.1 Display Types. The following types of display information are provided by the MFD system:

1. Calligraphic or stroke writing is displayed on the HUD, MFDs, and the DD.
2. Raster video (for example radar, television) generated internally (VDI formats) or provided by an external sensor, with or without a stroke overlay, is displayed on the MFDs and the DD.
3. Alphanumeric data is displayed on the multistatus indicator and the radio frequency and radio frequency/control indicators.

Displays presented on the HUD and MFDs are identified as formats. The formats are categorized as display format groups.

HUD format groups consist of takeoff/landing/navigation (TLN), air-to-air (A/A), air-to-ground (A/G), and multimode formats that can be overlaid on the other three. The HUD also displays a manual reticle and a test pattern.

MFD display format groups are shown in Figure 2-84. The HUD and MFD VDI format groups are basically the same; however, HUD symbology is scaled to be overlaid on the real world, and certain differences, such as symbol location, addition, and deletion occur between the HUD and MFD VDI formats. MFDs also display repeats of the TID and DD as well as TCS and CTVS video.

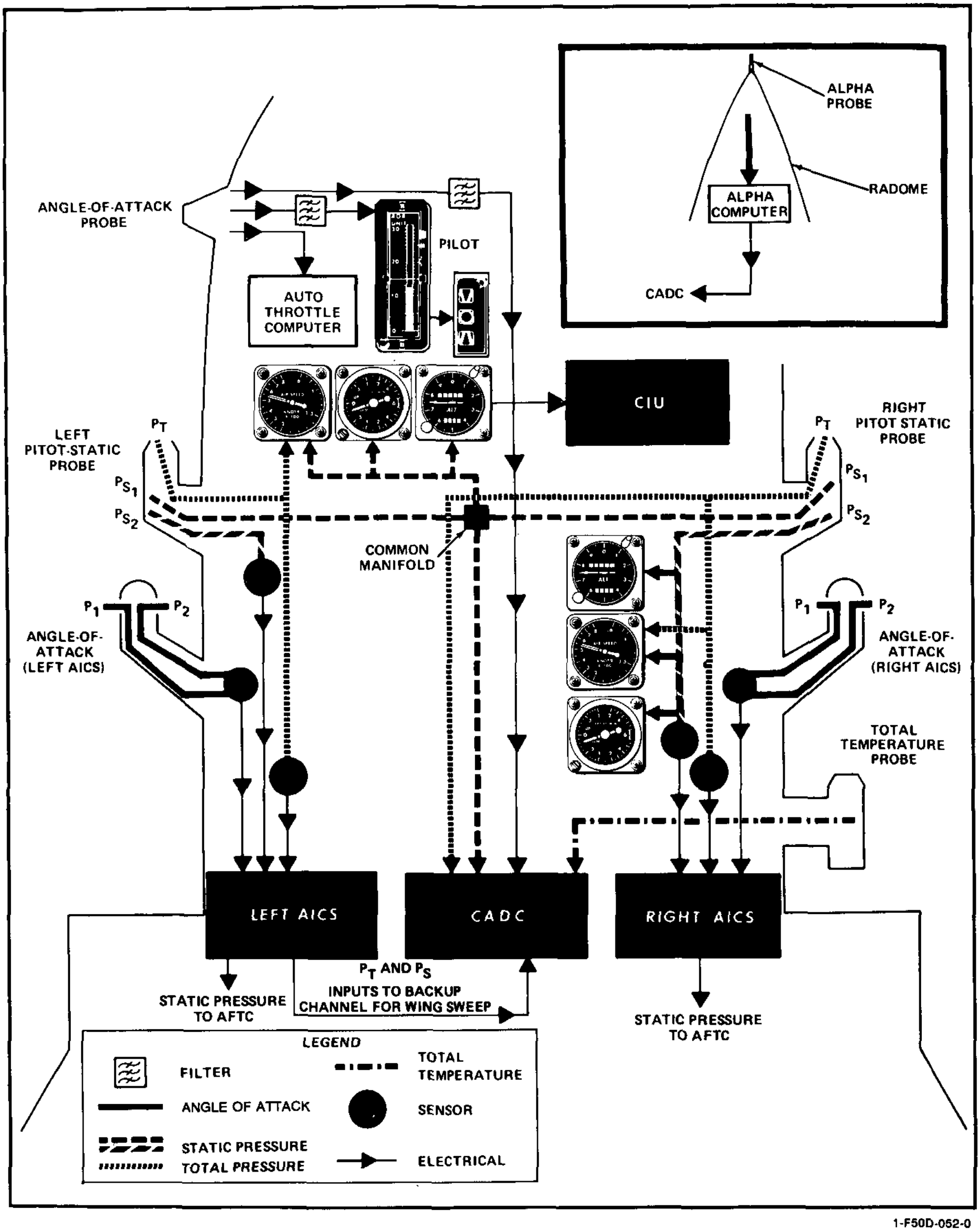

Figure 2-82. Airstream Sensors

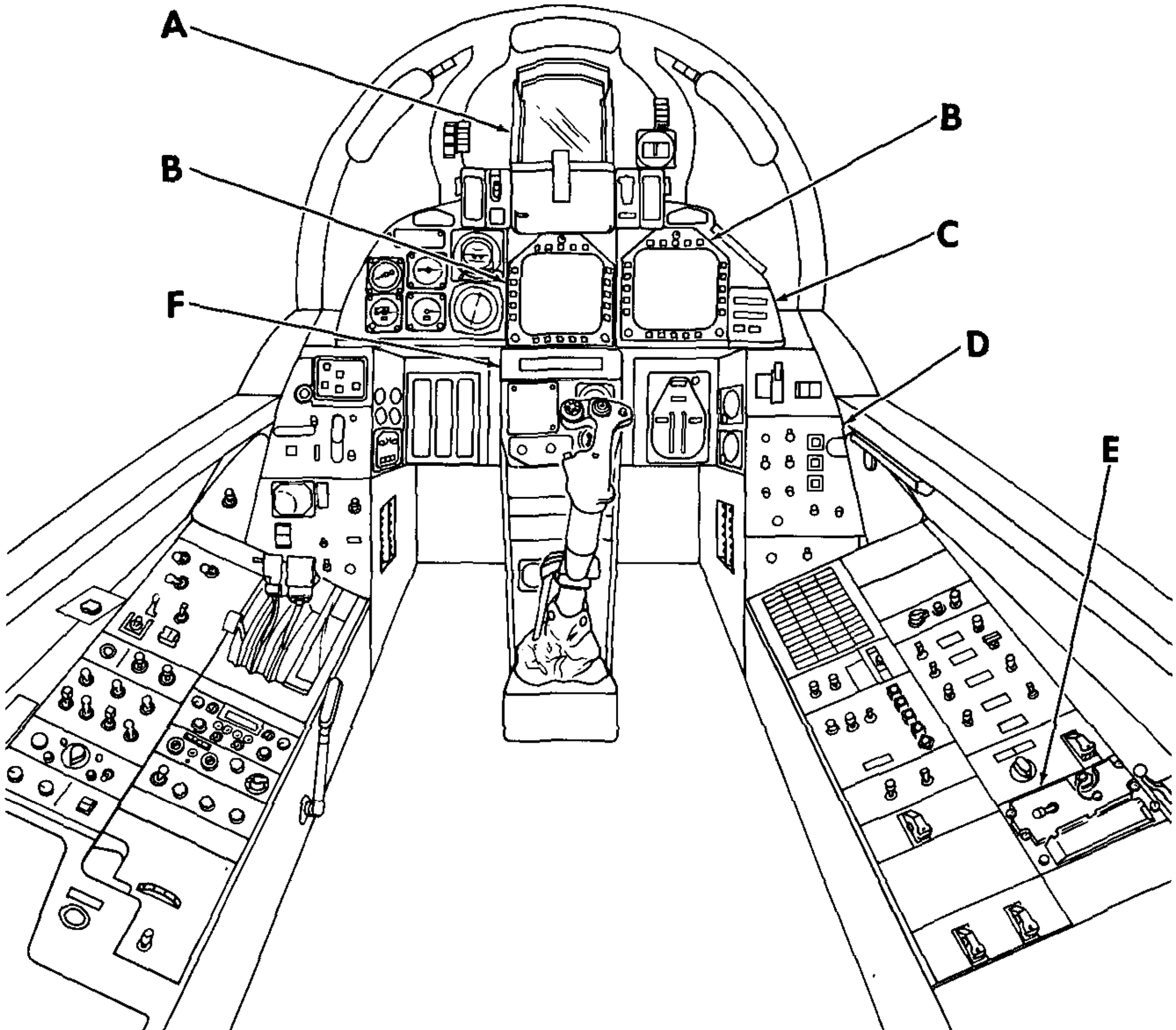

Figure 2-83. Display Systems Controls and Indicators (Sheet 1 of 4)

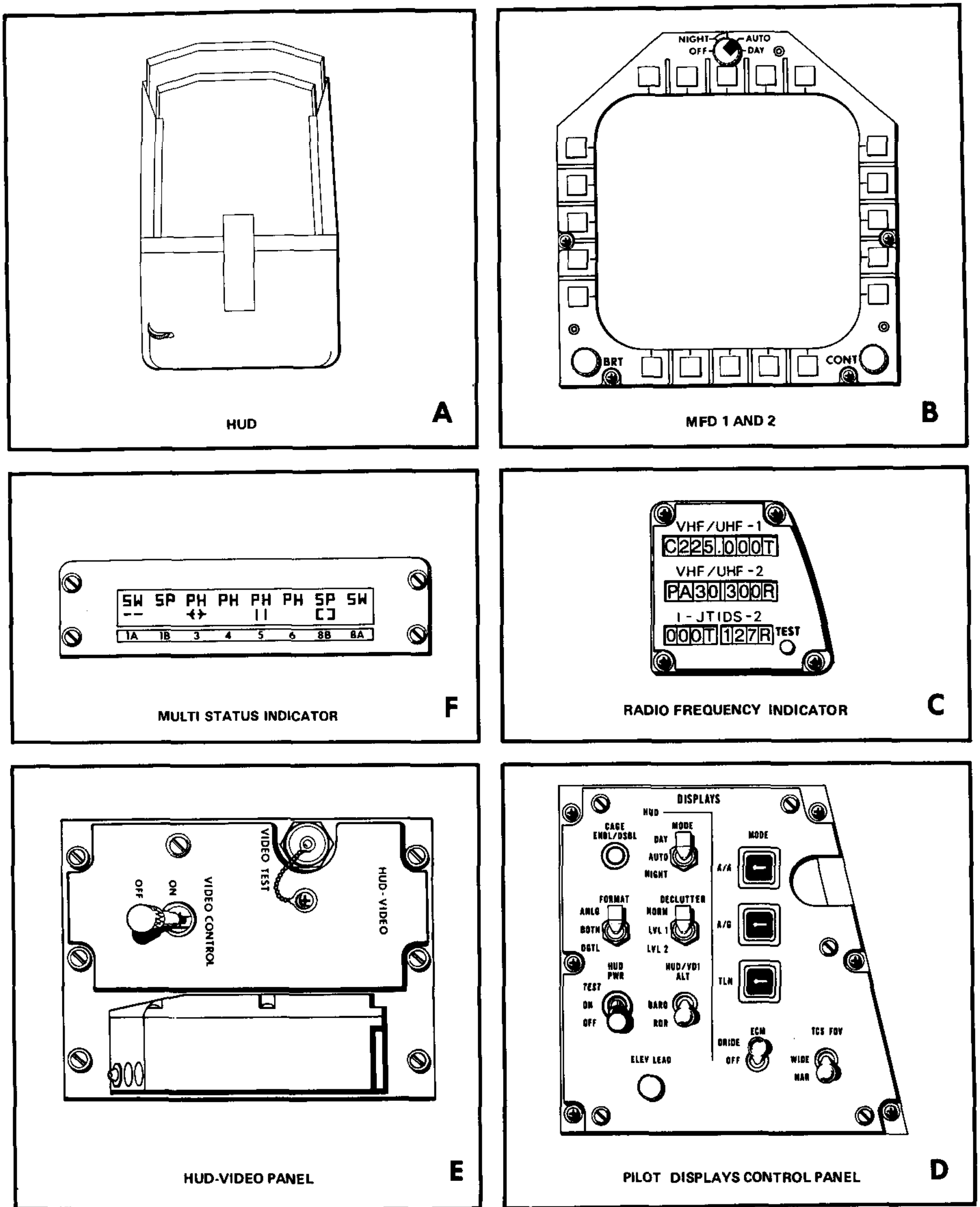

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Figure 2-83. Display Systems Controls and Indicators (Sheet 2 of 4)

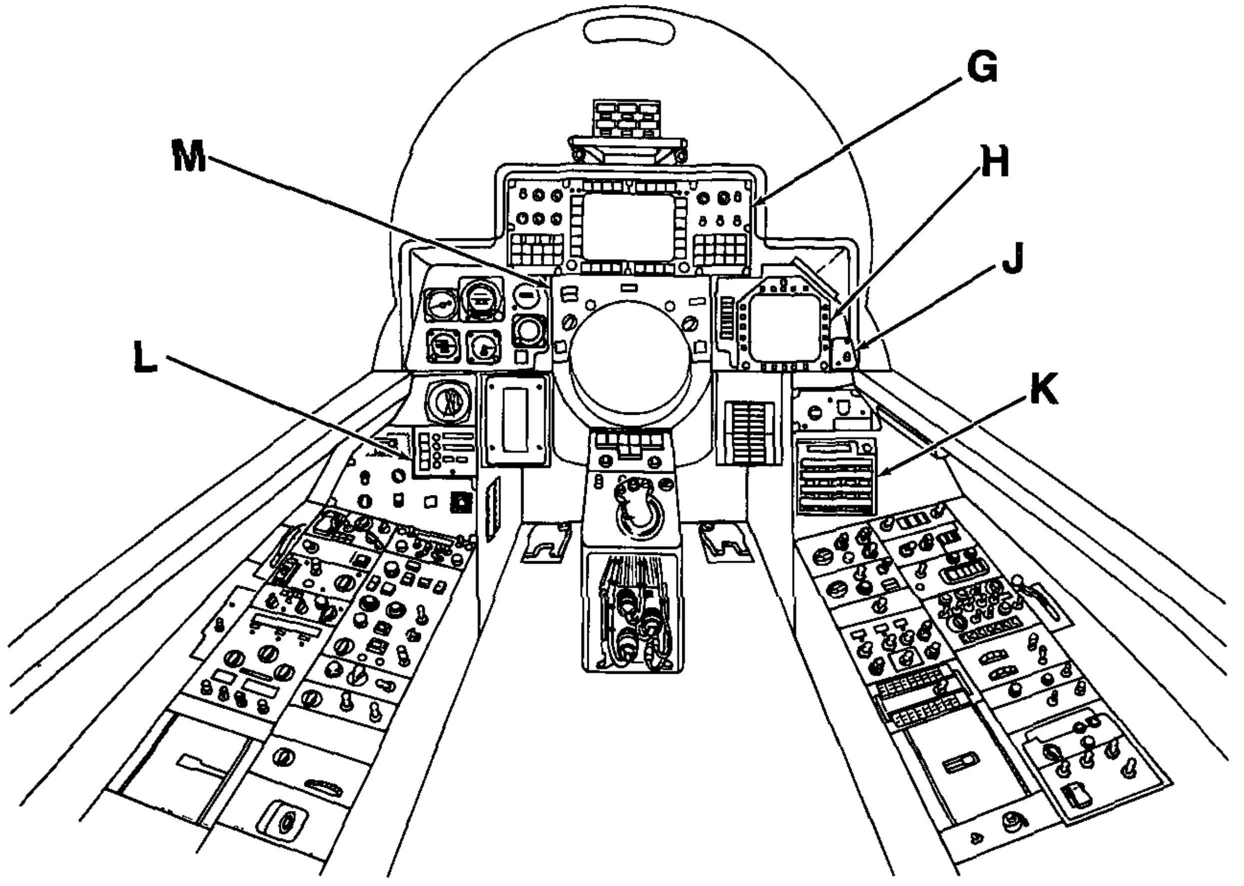

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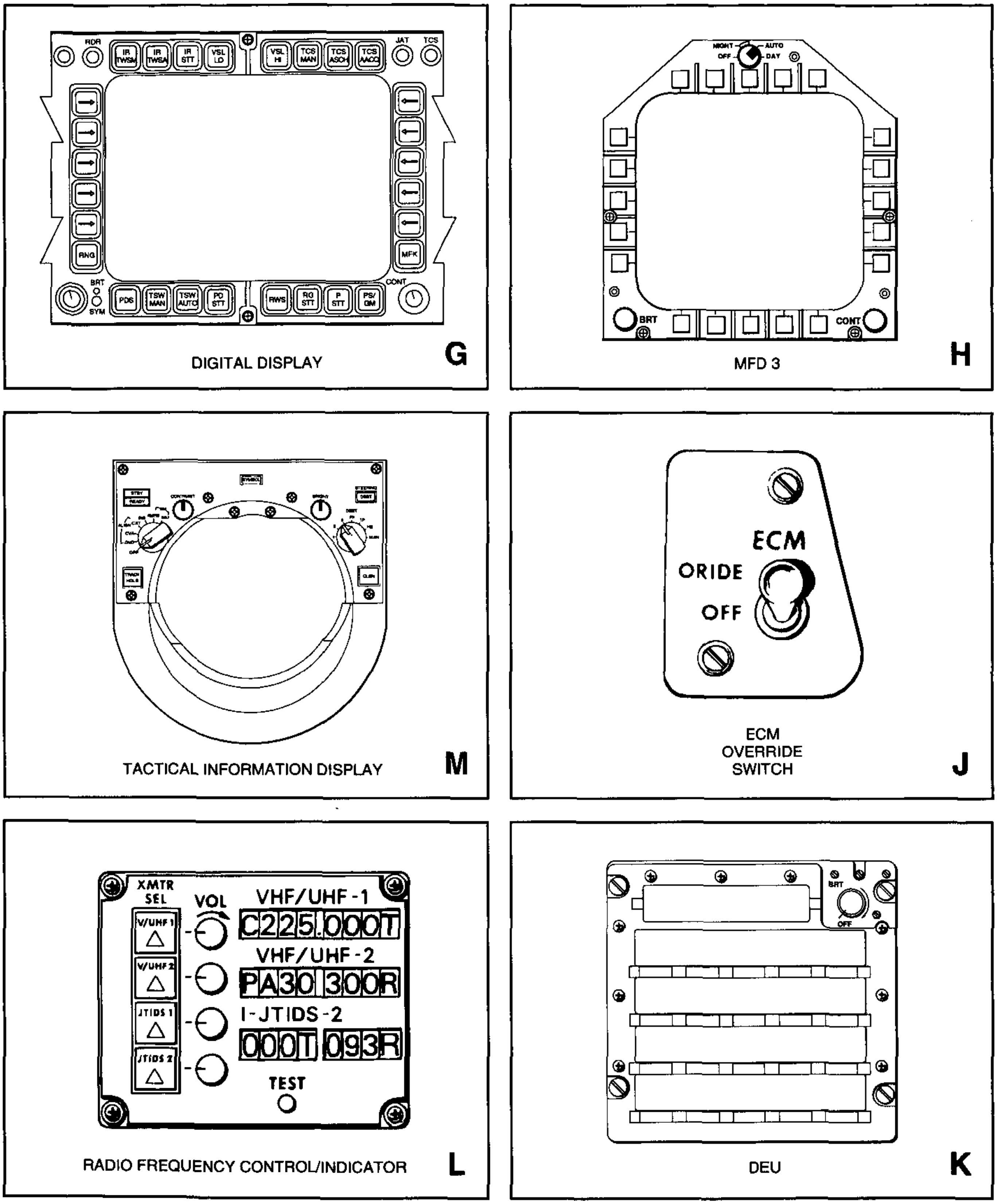
Figure 2-83. Display Systems Controls and Indicators (Sheet 3 of 4)



DIGITAL DISPLAY G

MFD 3 H

TACTICAL INFORMATION DISPLAY M

ECM OVERRIDE SWITCH J

RADIO FREQUENCY CONTROL/INDICATOR L

DEU K

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Figure 2-83. Display Systems Controls and Indicators (Sheet 4 of 4)

DISPLAY FORMAT	FORMATS WITHIN GROUP
MFD Vertical Display Indicator (VDI)/HUD Formats	TLN BASIC (TLN−GU, TLN−GD)
	TLN DESTINATION
	TLN MANUAL
	TLN TACAN
	TLN DATA LINK
	AWL (All Weather Landing)
	A/A BASIC
	A/A SPARROW SEARCH
	A/A PHOENIX SEARCH
	A/A SIDEWINDER SEARCH
	A/A PHOENIX TRACK
	A/A SPARROW TRACK
	A/A SIDEWINDER TRACK
	A/A TRACK WHILE SCAN
	A/A MULTIPLE MODE GUN SIGHT (MMGS)
	A/A GUN BACKUP
	A/G BASIC
	A/G CCIP
	A/G MANUAL
	RECON
	IRSTS TWS
MFD Horizontal Situation Display (HSD) Formats	WAYPOINT
	TACAN
	CDI TACAN
OWN A/C and WAYPOINT Formats	OWN A/C BASIC
	OWN A/C GROUND
	OWN A/C CVA
	OWN A/C IFA
	WAYPOINT DATA 1
	WAYPOINT DATA 2

Figure 2-84. Display Format Groups (Sheet 1 of 2)

DISPLAY FORMAT	FORMATS WITHIN GROUP
NAV Align Formats	CV MAN DATA CV Ships Inertial Navigation System (SINS) DATA IFA Standard Attitude Heading Reference System (SAHRS) (Norm Mag SHDG) SAHRS CV
Inertial Navigation System (INS) UPDATE Format	
Continuous Update Formats	NAV AID CORRECTIONS NAV AID ENABLED NAV AID OPTIONS
SURFACE WAYPOINT POSITION Format	
Stores Management System (SMS) Format	
SPIN INDICATOR Format	
ENGINE MONITOR Format	
On Board Checkout (OBC) Formats	OBC BASIC OBC Groups: CD, CNI, FLT, NAV, AUX, TAC, EW, SMST, and SNSR OBC Failed Data: CADC, CIU, SAHRS, DINS, DEU, DP1, DP2, MC1, MC2, DSS, APC, EMSP1, EMSP2, IFX, SMS, SWITCHES, RWR, and RDR/TCS MAINT Format
Failure History Format (FHF)	
Cooperative Support Software (CSS) Format	
Missile Status Readout Formats	MISSILE SUBSYSTEM 1 MISSILE SUBSYSTEM 2
Electronic Counter Measures (ECM) Format	
Recon Formats	RECON DATA RECON WPT DATA1 RECON WPT DATA2
Tactical Situation Display (TSD)	TSD MENU TSD PRIORITY TSD DECLUTTER 1 TSD DECLUTTER 2 TSD COMMAND TSD REPLY TSD TARGET MODIFIER
JTIDS Data Readouts (JDR)	JTIDS OWN A/C DATA JTIDS DATA – TSD/TID (Non–F–14D PPLI Hook) JTIDS DATA – TSD/TID (F–14D PPLI Hook) JTIDS DATA – TSD/TID (Target Hook)
Infrared Search and Track (IRST) Formats	IRSTS NORMAL IRSTS CSCAN IRSTS SUMMARY

Figure 2-84. Display Format Groups (Sheet 2 of 2)

2.33.2 Display Processors. Two display processors (DP1 and DP2) drive the display system. The DPs receive various signal inputs from the aircraft systems. These signals are processed and converted to display information for the HUD, MSI, MFDs, DD, RFI, RFCI, and the mission video recorder.

2.33.2.1 Normal Operation. During normal operation, DP1 drives the HUD and MFD1, while DP2 drives MFD2 and MFD3. Should either DP fail, the mission computer commands backup operation, where the remaining DP provides limited functions.

2.33.2.2 DP Backup Operation. During backup operation, the remaining DP drives the HUD, MFD1, and MFD3, with MFD2 not operating. Should one of these three displays be OFF or subsequently selected off, then MFD2 will operate. If both stroke generators in the remaining DP are in use, an MFD format that is normally produced by stroke writing may be generated in raster. With the following exception, either DP can perform any display function: Mission video record is not performed during backup operation.

2.33.2.3 Data Failure Modes. In addition to the backup mode, there are other failure modes. Some examples are as follows.

If the DPs fail to receive pitch and roll data, the message PITCH/ROLL FAIL will appear on the MFDs and all pitch/roll-related symbols are removed from the displays. The symbols are returned if pitch and roll information is restored.

If the DPs lose communication with the MCS, a manual reticle will appear on the HUD and the MFDs will display only the message DP-MC COMM FAIL and MENU1. The lighted MODE pushbuttons also turn off with a loss of MCS communication. Should communications be restored, the DP-MC COMM FAIL message is removed and the MODE buttons are lighted again. If the MC performed a cold start or a system reset, default formats are presented on the displays.

2.33.3 System Operation. The display system requires 115 V, 400 Hz electrical power. DP1, HUD, and MFD1 receive power from ac essential No. 2 bus and DP2, MFD2, and MFD3 are on the ac left main bus. All displays and DPs are electrically protected by circuit breakers. There are no power switches for the DPs. Each of the displays has a power switch that is normally turned off at the conclusion of flight. The HUD power switch is on the PDCP, and the MFD power switches are on each MFD as a part of the DAY/AUTO/NIGHT switch.

After a short warmup (under 2 minutes), the default formats appear on the displays. The default formats are as follows:

1. HUD — TLN basic
2. MFD1 — VDI TLN basic
3. MFD2 — OBC basic
4. MFD3 — OWN A/C basic.

If the mission computers are not in communication, test patterns will appear on all four displays.

Format selection for the HUD is made by use of the MODE pushbuttons on the PDCP and by the type of steering selected. MFD format families are selected by pressing the pushbutton adjacent to a menu legend or by cursor designation of the legend. Every MFD format (except repeats) has MENU select as the center pushbutton on the lower edge of the display. Also appearing on all formats for immediate selection are SMS to the left of MENU and ECM to the right of MENU. Other selections vary according to format requirements. When a repeat format (HUD, DD, or TID) is being displayed on the MFD, no legends are available for format selection. To change formats from a repeat, press any pushbutton. This returns MENU1 to the MFD, permitting other format selections to be made. Cursor designation of legends cannot be used with repeat displays.

2.33.4 Heads-Up Display. The HUD (Figure 2-85) provides a combination of real-world cues and flight direction symbology, projected directly on a combining glass assembly. The flight information on an optical combiner is projected in the pilot forward field of view. The display is focused at infinity, thereby creating the illusion that the symbols are superimposed on the real world (and so that visual cues received from outside the aircraft are not obscured). The pilot usually steers based on interpretation of the visually observed real world. The HUD can be selected to be the primary flight reference for all flight regimes displaying navigation and weapon delivery information. The HUD symbol brightness control is on the HUD; all other HUD controls are on the PDCP.

2.33.4.1 Pilot DISPLAYS Control Panel. The PDCP on the pilot right console (Figure 2-86) provides control of the mode and display presentation of the HUD, VDI, ECM, and TCS formats. Display information is dependent on the mode selected with the A/A, A/G, and TLN pushbuttons.

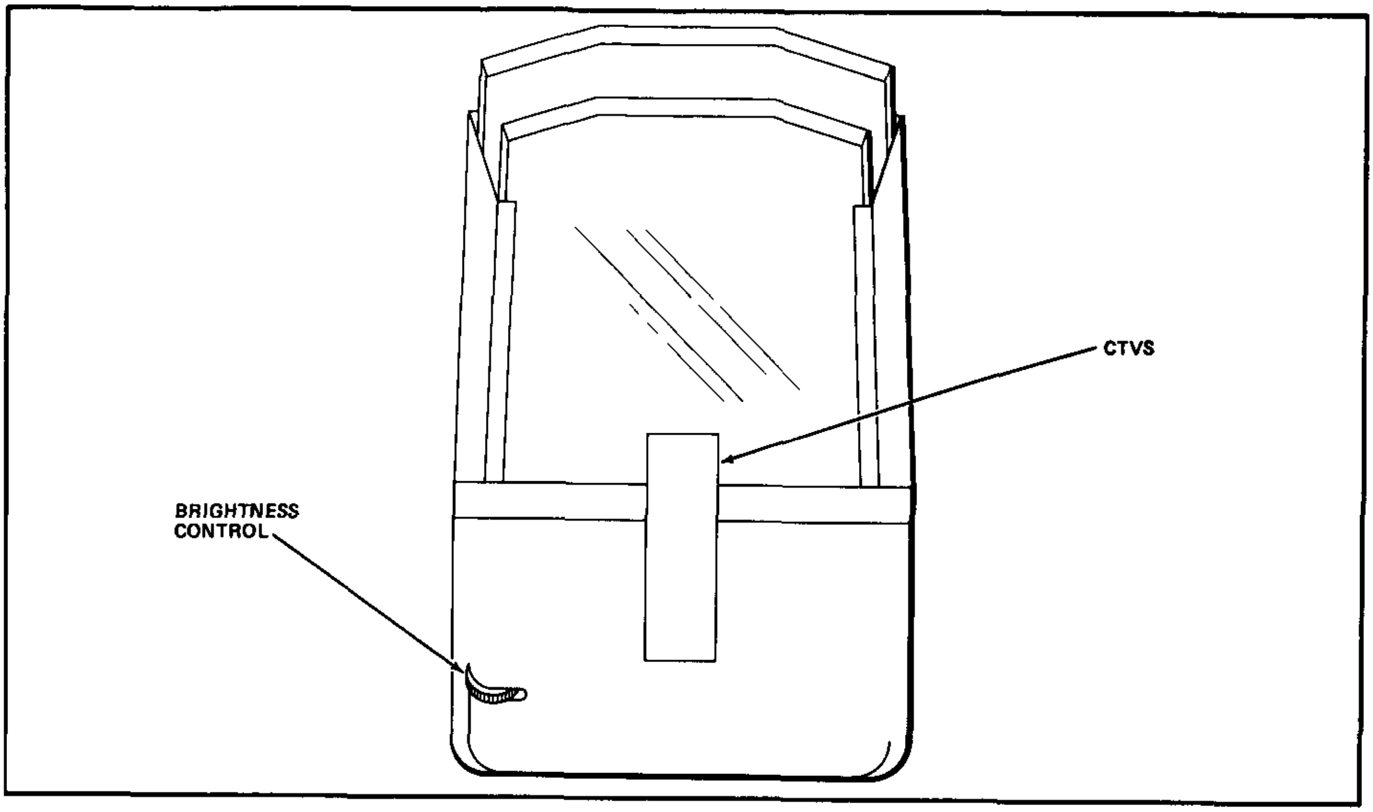


Figure 2-85. Heads-Up Display

2.33.4.2 Cockpit Television Sensor. The CTVS is an electro-optical system that images symbology present on the HUD combiner and outside world information as well. The unit consists of a video sensor head on the HUD and an electronic unit in the HUD-VIDEO panel (Figure 2-83). The sensor signal can be fed to the mission video recorder and can be displayed on the MFDs. Operation of the CTVS is controlled by the VIDEO CONTROL switch on the HUD-VIDEO control panel.

2.33.4.3 HUD-VIDEO Control Panel. Operation of the CTVS is controlled by the HUD-VIDEO control panel (Figure 2-83). The panel contains the two-position VIDEO CONTROL toggle switch, a BIT button, a green GO light, and a yellow NO GO light. Setting the VIDEO CONTROL switch to ON provides power to the CTVS; selecting OFF removes power. Depressing the BIT button initiates a CTVS self-test. A good test results in a momentary flash of the yellow NO GO light followed by a steady green GO light. A failure results in a steady yellow NO GO light. *During BIT, if CTVS video* is being displayed on an MFD, or is being recorded, bright white flashes of video will be displayed or recorded. This is normal for BIT operation.

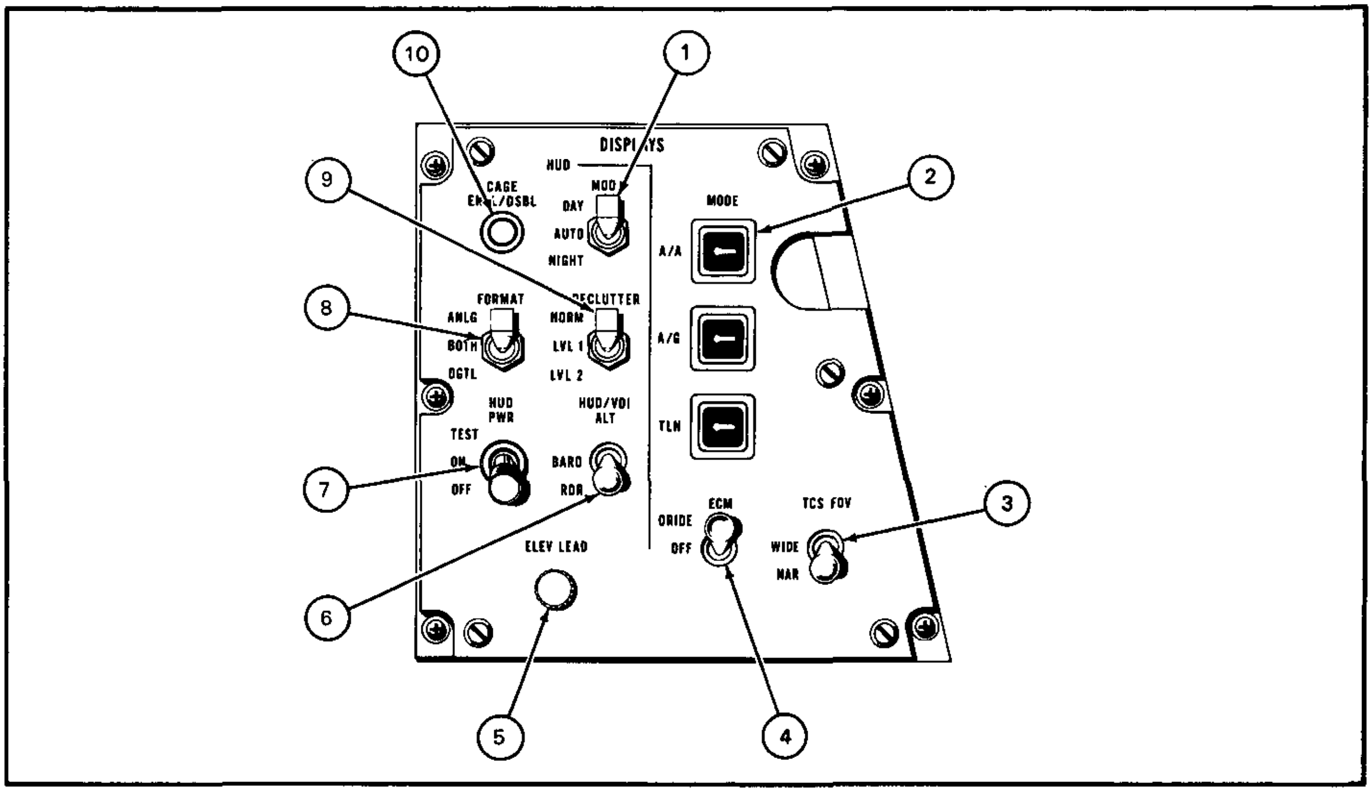
2.33.5 Multistatus Indicator. The MSI is an LCD panel on the lower center instrument panel below the center MFD (MFD1) (Figure 2-83). The MSI displays the weapon type and status on each store station.

The lower row displays weapon status: ready, degraded, ready/selected or degraded/selected. The selected symbol never appears alone; it is always superimposed over the ready or degraded symbol. Figure 2-87 provides a representative display of available MSI symbols along with their meanings.

The upper row of the display identifies the weapon. Two dashed lines at a store station indicate that the missile at that station has failed or is hung. A blank display on a station indicates no weapon is loaded or the weapon loaded is not recognized.

There are no controls on the MSI. Power to the MSI is provided by the HUD subsystem. The MCS must be transmitting data for a display to be presented. Selecting TEST on the HUD PWR switch causes all LCD segments on the MSI to be displayed.

An MFD displays tactical and flight command situations, navigation, and discrete information either separately or simultaneously with radar and TV data. There is also a power/brightness select switch above the display screen (Figure 2-88).



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NOMENCLATURE	FUNCTION	
1 MODE Switch	DAY –	Provides a full range of HUD symbol brightness control: 0 to 100%. Disables automatic brightness control.
	AUTO –	Provides automatic symbol brightness operation superimposed on the level selected with the symbol brightness control.
	NIGHT –	Provides a HUD symbol brightness control range of 0 to 1.0% of DAY level.
		Note When switching from NIGHT to DAY, the brightness level gradually increases until it reaches the level established for DAY.
2 Display MODE pushbuttons	A/A –	Provides selection of air–to–air display mode.
	A/G –	Provides selection of air–to–ground display mode.
	TLN –	Provides selection of takeoff/landing/navigation mode.

Figure 2-86. Pilot DISPLAYS Control Panel (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
3 TCS FOV (Television Camera Field of View)	NAR – Selects TCS narrow field of view for display on pilot's MFD1. WIDE– Selects TCS wide field of view for display on pilot's MFD1.
4 ECM switch	ORIDE – Enables ECM display to override whatever is being displayed on MFD2 for as long as the threat is being reported. OFF – ECM display override not enabled.
5 ELEV LEAD Control	A continuous rotary control that provides a range of elevation positions for the HUD manual reticle with the 0 mr setting coincident with the armament datum line (ADL). Clockwise rotation increases elevation lead.
6 HUD/VDI ALT source switch	BARO – Selects barometric altimeter as source for display of altitude on HUD and VDI. RDR – Selects radar altimeter as source for display of altitude on HUD and VDI. Radar altitude is displayed as follows: • Below 5000 feet AGL • Radar altitude valid • AOB ≤ 45°
7 HUD PWR switch (lever lock)	TEST – (Momentary) Presents an intersecting vertical and horizontal line at the center of the HUD field of view, and illuminates all segments of the multistatus indicator (MSI). ON – Provides power to HUD and MSI. OFF – Removes power from HUD and MSI.
8 FORMAT switch	ANLG – Selects analog dial format for HUD display of airspeed and altitude. BOTH – Selects a combination of analog dial and digital readout for HUD display of airspeed and altitude. DGTL – Selects digital readout format for HUD display of airspeed and altitude.
9 DECLUTTER switch	NORM – Normal display symbology is presented. LVL 1 – Depending on MODE selected, the following symbols are removed: TLN – GEAR UP (AOA bracket and target pointer/AON are not displayed) • Vertical velocity • AOB scale • Peak G

Figure 2-86. Pilot DISPLAYS Control Panel (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
	TLN – GEAR DOWN (Target pointer/AON and Mach are not displayed) • Peak G (displayed as required in normal mode only) • AOB scale • Radar altitude A/A • Radar altitude readout A/A and A/G (Vertical velocity, AOB scale, and AOA bracket are not displayed) • AOA readout • Potential flight path marker (PFPM) LVL 2 – Depending on MODE selected, the following additional symbols are removed: TLN – GEAR UP • AOA • Mach • Nav range • PFPM • Radar altitude readout • Digital boxes TLN – GEAR DOWN • AOA • Digital boxes • PFPM • Vertical velocity A/A • Nav range A/G (Closer and target pointer/AON are not displayed) • Radar altitude readout A/A and A/G (AOB scale, AOA bracket, and vertical velocity are not displayed) • Mach number • Peak G • Digital boxes • Heading scale • Ghost FPM
10 CAGE ENBL/DSBL Pushbutton	Momentary contact pushbutton used to enable/disable HUD CAGE option. Caging restricts pitch ladder and flight path marker symbols in azimuth to the center of the HUD display.

Figure 2-86. Pilot DISPLAYS Control Panel (Sheet 3 of 3)

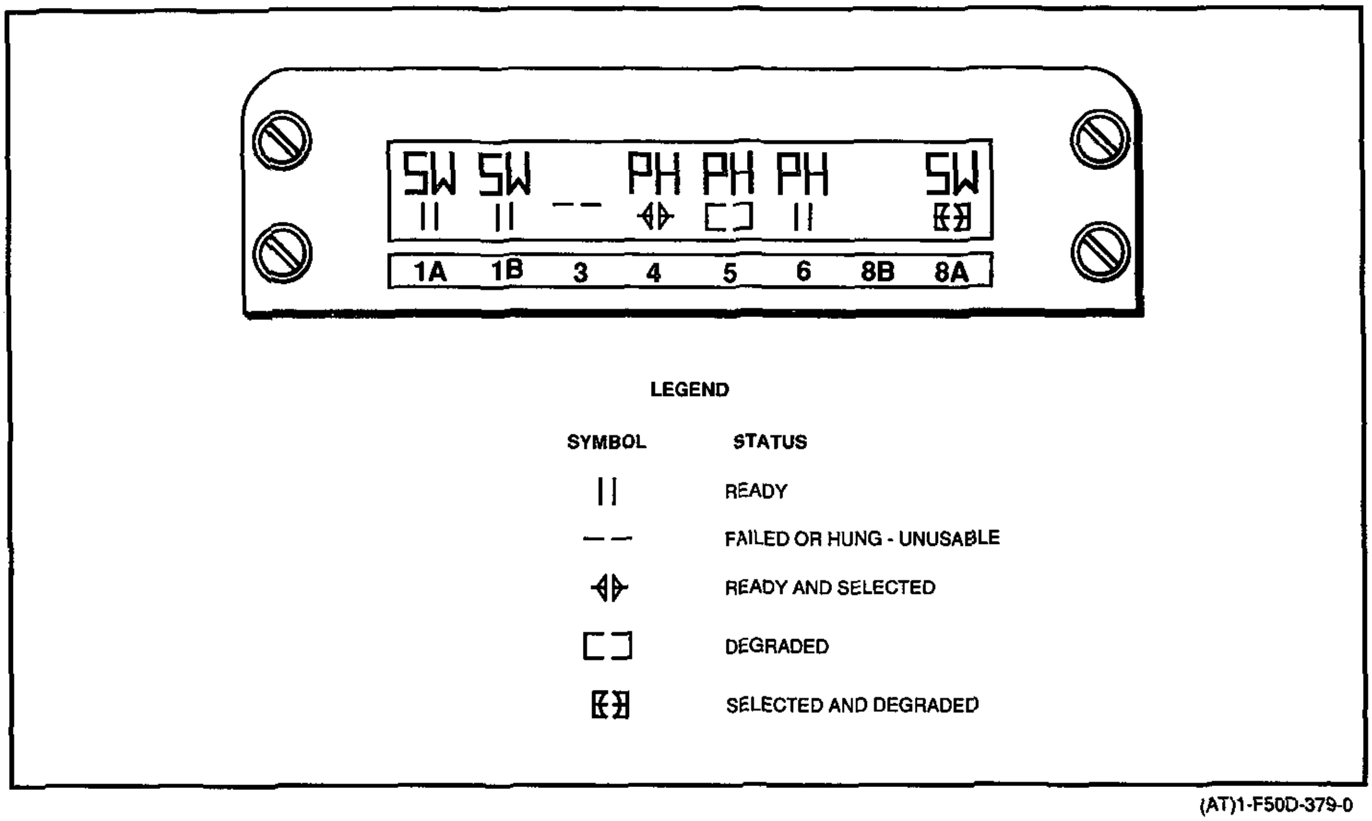


Figure 2-87. Multistatus Indicator Symbols/Meanings

2.33.6 Multifunction Displays. The three identical MFDs are CRT displays with 20 pushbuttons around the perimeter of the display screen. The MFD pushbuttons with adjacent legends are used for menu selection, data entry/readout, and system test and/or status indications. The three programmable MFDs, two in the pilot instrument panel and one in the RIO instrument panel provide display flexibility such that either crewmember is able to select any display available, allowing the pilot and RIO to monitor and back up each other. The HUD format may be repeated on any MFD by depressing pushbutton No. 11 from the MENU 1 format.

Multifunction pushbuttons with adjacent CRT legends located around the perimeter of the MFD are used for menu selection, data entry/readout, and system test and/or status indications. An MFD displays tactical and flight command situations, navigation, and discrete information either separately or simultaneously with radar and TV data.

Normally the pilot uses the MFD below the HUD on the aircraft centerline as the primary in-the-cockpit flight instrument.

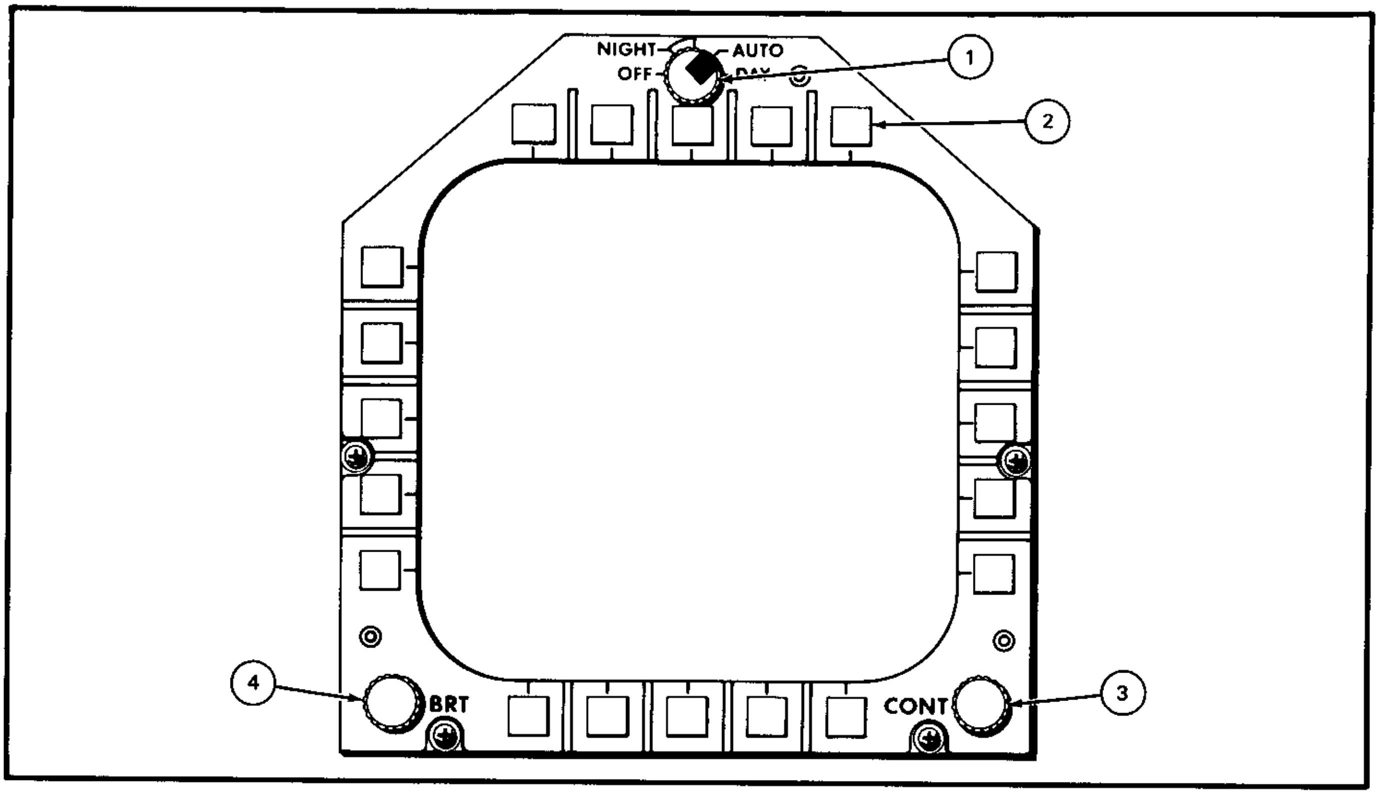
Attitude information is displayed on the MFD VDI format by an aircraft reticle, a horizon line, and a calligraphic pitch ladder. The aircraft reticle is fixed at the center of the display, and the horizon line and pitch ladder move about it in accordance with the aircraft pitch and roll attitudes.

The flight parameters displayed include magnetic heading, data link (D/L), commanded airspeed (Mach number), airspeed, altitude, and vertical velocity.

Note

If pitch or roll data is not updated within 240 milliseconds, the pitch ladder and roll marker will be blanked and the horizon, sky, and ground plane will darken.

2.33.7 Cursor Controls. Both the pilot and RIO have cursor controls (Figure 2-89) that permit the remote selection of MFD pushbutton options as well as symbol and spot hooking. A symbol is hooked when the cursor is placed over a format symbol and cursor designate is activated. Hooking is used to set waypoints on the HSD waypoint format and to select tracks and other symbols, for the purpose of obtaining information, or identifying symbols of interest on the TSD format. The cursor symbol is a small circle inside a larger circle when displayed on the MFDs and a circle with four tic marks extending from the circle inward at 0°, 90°, 180°, and 270° when displayed on the HUD.



NOMENCLATURE	FUNCTION
1 Power switch	OFF– Power removed from MFD. **Note** Selecting NIGHT, AUTO, or DAY applies power to the MFD, however a DP must be on and providing data to the MFD for a format to be displayed. NIGHT – Disables automatic contrast adjustment and limits automatic brightness adjustment to a small percentage of the DAY range. AUTO – Automatic adjustment of brightness and contrast to compensate for changing light conditions as seen by sensors above the BRT and CONT controls. DAY – Full range of manual brightness and contrast control. Disables automatic brightness and contrast adjustment.

Figure 2-88. Multifunction Display (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(2) Pushbuttons	20 momentary contact pushbuttons that provide for selection of display, operating modes, and system parameters. A selected legend is normally enclosed by a rectangular box. A dashed rectangular box indicates that a legend has been selected but is not available.
(3) CONT control	Varies the amplitude of the shades of grey. Effects are most visible when viewing video or raster graphics.
(4) BRT (brightness) control	Varies intensity of overall display. As brightness is decreased, fewer shades of grey are discernable.

Figure 2-88. Multifunction Display (Sheet 2 of 2)

2.33.7.1 Pilot Cursor Control. The pilot controls cursor position with the throttle designator controller. The TDC is a circular disk that is a combination four-way force sensor and momentary switch on the outboard throttle grip. Finger pressure on the outer edges of the control will move the cursor in the direction selected. When cursor movement exceeds the limit of a display that is adjacent to another display (e.g., the right edge of MFD1 or the bottom of the HUD), the cursor will move to the adjacent display. If the cursor symbol reaches a display limit that is not adjacent to another display (e.g., the right edge of MFD2), the cursor remains at that limit. Depressing and releasing the TDC designates the cursor position.

2.33.7.2 RIO Cursor Control. The RIO cursor control is on the sensor hand control. It consists of a four-position select switch, a two-position (half-full action) trigger switch, and a handgrip. When the top, bottom, or right edge of the select switch is pressed, the DD, TID, or MFD3, respectively, is selected for cursor display. Pressing the left edge toggles sensor control between radar and infrared. The cursor symbol becomes visible when the trigger switch is pressed to the half-action position. Full trigger depression designates the cursor position. Cursor symbol movement is controlled by handgrip movements.

2.33.7.3 Cursor Hooking Functions. Spot, symbol, and MFD pushbutton hooks can be performed by the pilot on the HUD or MFD by activation of the TDC or on the TID or MFD by the RIO through use of the sensor hand control.

Normal symbol hooking is accomplished by placing the cursor over the desired symbol using either the TDC or the SHC and activating the appropriate cursor designate switch. The hooked symbol brightens and the previously hooked symbol returns to normal intensity. Symbol hooks are used to display additional information about those symbols or to designate tracks for functions that are format dependent. Only HUD, TID, TSD, and IRST normal format support symbol hooking.

MFD pushbutton hooks permit remote activation of MFD pushbutton functions through the TDC or SHC. They are accomplished by positioning the cursor over the desired MFD menu choice and activating the cursor-designate switch.

2.33.8 Displays, Formats, and Symbology. The paragraphs that follow describe the HUD and MFD displays. Sample formats from format families are illustrated, symbols associated with these families are identified and defined, and format selection is described.

Many symbols are common to more than one format family. Once a symbol has been defined for a format family, the definition is not repeated when describing other format families. Certain features, such as changes in scaling between formats, that are obvious when viewing the display are not covered.

All symbols available to a format are illustrated; however, they will rarely be displayed at the same time. Not all formats are illustrated. Where only minor differences exist, they will be noted. Formats that contain only alphanumerics are described but are not illustrated.

2.33.8.1 Warning, Caution, Advisory Indicators. Warnings are displayed on the lower center of the HUD viewing area. These warnings are: L FIRE, R FIRE, L STALL, R STALL, and RDC SPD. The CLSN advisory is also displayed on the HUD. If there are more than two warnings, then they will scroll up at the rate of one warning per second.

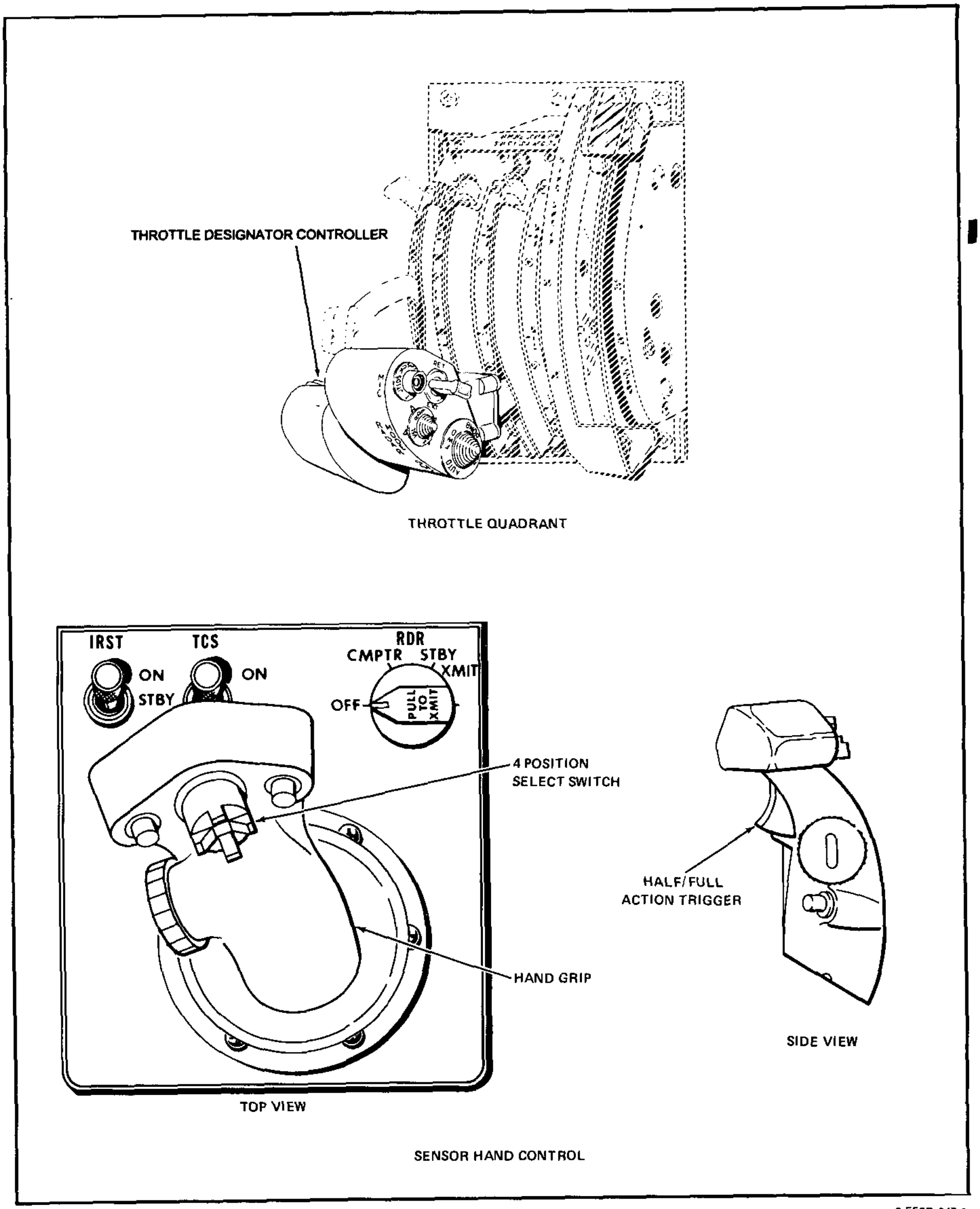


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Figure 2-89. Cursor Controls

On the MFDs, warning/caution/advisory indications are shown in a viewing window that appears on all formats except repeats. This window is displayed in the upper left of the MFD and is referred to as the CAW window or CAW box. A similar window on the upper right of the MFD displays data-link legends. The message window allows up to four CAWs to be displayed at one time. If more than four CAWs are to be displayed, they scroll up from the bottom of the window at a rate of one per second. Warning, caution, advisory legends are independent of format and may be directed to a specific crewmember. Figure 2-90 lists specific CAWs and the crewmember to whom they are directed.

When warning, caution, or advisories are displayed, pressing the pushbutton above the CAW window (PB6) will remove the window and replace it with a boxed CAW legend. Pressing the CAW pushbutton when the legend is boxed returns the window and indications to the display and removes the box from the legend.

Note

If a repeat format is on MFD1, the CAW window is shifted to MFD2 in its current state, open or closed (acknowledged). New CAWs continue to be displayed on MFD2 until the repeat format is removed from MFD1. If a repeat format is displayed on both MFD1 and MFD2 or on MFD3, receipt of CAW data removes the repeat format from MFD1 and/or MFD3 and displays a new format with the CAW in the appropriate window. Receipt of a data-link advisory removes the repeat format from MFD1 (if appropriate) and MFD3 and displays the menu format with data-link advisories. (DD and TID displays are repeats on MFD1; HUD, DD, and TID displays are repeats on MFD2 and MFD3).

2.33.8.2 Test Patterns. The test patterns (Figure 2-91) appear on the HUD and MFD when the display system is turned on with the MCs off during ground tests and are generated by the DP.

Note

The large cross that appears on the HUD when the HUD PWR switch is set to TEST is generated by the HUD, independent of the DP, and is used to check HUD operation.

The HUD and MFD test patterns also momentarily appear during IBIT and following a system reset. Both test patterns are written in stroke and are used to check stroke accuracy.

The MFD/KROMA test pattern (a future-growth color display) includes an MFD TEST legend, used to select the MFD RASTER test pattern.

The MFD RASTER test pattern allows for testing of individual pushbuttons. When a button is pressed, a solid-line box appears around the PRESS legend; pressing the button again removes the box. The diamond and blinking breakaway symbol are used to check RASTER accuracy. Numerics 0 through 7 check RASTER shades of grey. Selecting EXIT returns the display to MFD/KROMA test pattern.

2.33.8.3 HUD Formats. HUD format category (TLN, A/A, A/G) is normally selected by use of MODE buttons on the PDCP. However, air-to-air formats are selected automatically if the pilot selects a weapon using the weapon select switch on the stick grip; selects RDR PLM/PAL, IR PLM/PAL (all with gear up) with the sensor mode switch; lifts the ACM guard; or if VSL HI/VSL LO is selected with the sensor mode switch or DD. Air-to-ground formats are automatically selected when an air-to-ground weapon is selected on the SMS format since the air-to-ground master mode is automatically entered in this case. The HUD default format is the TLN basic format (Figure 2-92). This format is displayed on power-up and if DP1 experiences a cold start (power outage of over 1 second).

The amount of information displayed on HUD formats is pilot selectable by means of the FORMAT and DECLUTTER switches on the PDCP. Symbols are also added or deleted by the mission computer depending on aircraft status, steering mode, and weapon selection. When the FORMAT switch is set to BOTH, airspeed and altitude information are displayed as boxed digital readouts with analog dials. In the ANLG position, the boxes are removed from the digital readouts. In the DGTL position, only the boxed digital readout is presented and the analog dials are removed.

The position of the HUD/VDI ALT switch on the PDCP selects the type of altitude data that is to be displayed, either radar or barometric. If radar is selected and a valid radar altitude exists (altitude <5,000 feet and AOB <45°), radar altitude is displayed in the center of the altitude dial. If the aircraft's altitude exceeds 5,000 feet or the radar altitude becomes invalid, the system automatically substitutes barometric altitude and a "B" will flash to the right of the analog dial to indicate radar altitude is not being used. Switching HUD/VDI ALT to BARO removes the flashing "B."

ACRONYM	TYPE	AIRCREW	DISPLAY	FUNCTION
L STALL	W	BOTH	HUD/MFD	Warns of left engine stall.
R STALL	W	BOTH	HUD/MFD	Warns of right engine stall.
L FIRE	W	BOTH	HUD/MFD	Warns of fire in left engine.
R FIRE	W	BOTH	HUD/MFD	Warns of fire in right engine.
RDC SPEED	W	PILOT	HUD/MFD	Safe Mach number exceeded for current position of flaps.
W/S	C	PILOT	MFD	Indicates failure of wingsweep system.
L N2 OSP	C	PILOT	MFD	Indicates overspeed of left rotor N2.
R N2 OSP	C	PILOT	MFD	Indicates overspeed of right rotor N2.
L N1 OSP	C	PILOT	MFD	Indicates overspeed of left rotor N1.
R N1 OSP	C	PILOT	MFD	Indicates overspeed of right rotor N1.
L TBT OT	C	PILOT	MFD	Indicates overtemp of left turbine blade.
R TBT OT	C	PILOT	MFD	Indicates overtemp of right turbine blade.
L FLMOUT	C	PILOT	MFD	Indicates left engine flameout.
R FLMOUT	C	PILOT	MFD	Indicates right engine flameout.
L IGV SD	C	PILOT	MFD	Indicates left inlet guide vane adjust schedule is not correct.
R IGV SD	C	PILOT	MFD	Indicates right inlet guide vane adjust schedule is not correct.
A/P REF	A	PILOT	MFD	Indicates autopilot mode is selected but not engaged.
CLSN	A	PILOT	HUD	Indicates collision course steering to target has been selected.
IFF ZERO	A	RIO	MFD	Indicates the identification friend or foe transponder is not operating correctly.

Figure 2-90. Warning, Caution, Advisory Functions (Sheet 1 of 3)

ACRONYM	TYPE	AIRCREW	DISPLAY	FUNCTION
AAI ZERO	A	RIO	MFD	Indicates the air to air intercept interrogator is not operating correctly.
SDU ALM	C	RIO	MFD	Indicates the JTIDS Secure Data Unit is not operating properly or does not contain valid JTIDS crypto keys. Under certain conditions the display of this alarm is normal.
ASPJ HOT	C	RIO	MFD	Indicates an overtemp condition of the airborne self−protection jammer.
JTID HOT	C	RIO	MFD	Indicates an overtemp condition of the JTIDS R/T.
RWR	C	RIO	MFD	Indicates the radar warning receiver is not operating correctly.
FWD ASPJ	C	RIO	MFD	Indicates the forward ASPJ is not operating correctly.
AFT ASPJ	C	RIO	MFD	Indicates the aft ASPJ is not operating correctly.
AFT CG	C	BOTH	MFD	Indicates that stores station status has shifted center of gravity to preclude landing without correction.
MC 1	C	RIO	MFD	Indicates mission computer 1 is not operating correctly.
MC 2	C	RIO	MFD	Indicates mission computer 2 is not operating correctly.
CIU	C	RIO	MFD	Indicates the computer interface unit is not operating correctly.
MC1 HOT	C	RIO	MFD	Indicates an overtemp condition of the mission computer #1.
MC2 HOT	C	RIO	MFD	Indicates an overtemp condition of the mission computer #2.
INS	A	RIO	MFD	Indicates the inertial navigation system is not operating correctly.
IMU	A	RIO	MFD	Indicates the inertial measurement unit is not operating correctly.
CIU HOT	A	RIO	MFD	Indicates an overtemp condition of the CIU.

Figure 2-90. Warning, Caution, Advisory Functions (Sheet 2 of 3)

ACRONYM	TYPE	AIRCREW	DISPLAY	FUNCTION
DP1 HOT	A	RIO	MFD	Indicates an overtemp condition of display processor 1.
DP2 HOT	A	RIO	MFD	Indicates an overtemp condition of display processor 2.
SMS HOT	A	RIO	MFD	Indicates an overtemp condition of the stores management system.
RDR HOT	A	RIO	MFD	Indicates an overtemp condition of the radar system.
HUD HOT	A	PILOT	MFD	Indicates an overtemp condition of the HUD.
RWR HOT	A	RIO	MFD	Indicates an overtemp condition of the radar warning receiver.
DSS HOT	A	RIO	MFD	Indicates an overtemp condition of the data storage system.
DEU HOT	A	RIO	MFD	Indicates an overtemp condition of the data entry unit.
MPS HOT	A	RIO	MFD	Indicates an overtemp condition of the missile power supply.
IRSTS HOT	A	RIO	MFD	Indicates an overtemp condition of the infrared search and track system.
TARPS	A	RIO	MFD	Indicates the tactical air reconnaissance pod system is not operating correctly.
IPF	A	RIO	MFD	Indicates a failure in the JTIDS R/F output detected by the JTIDS Interference Protection Feature.
JTID	A	RIO	MFD	Indicates the joint tactical information distribution system is not operating correctly.
IR WIDE	A	BOTH	MFD	Indicates the TARPS IR must be switched to wide for adequate video resolution.
SAHR HOT	A	RIO	MFD	Indicates an overtemp condition of the standard attitude heading reference set.

Figure 2-90. Warning, Caution, Advisory Functions (Sheet 3 of 3)

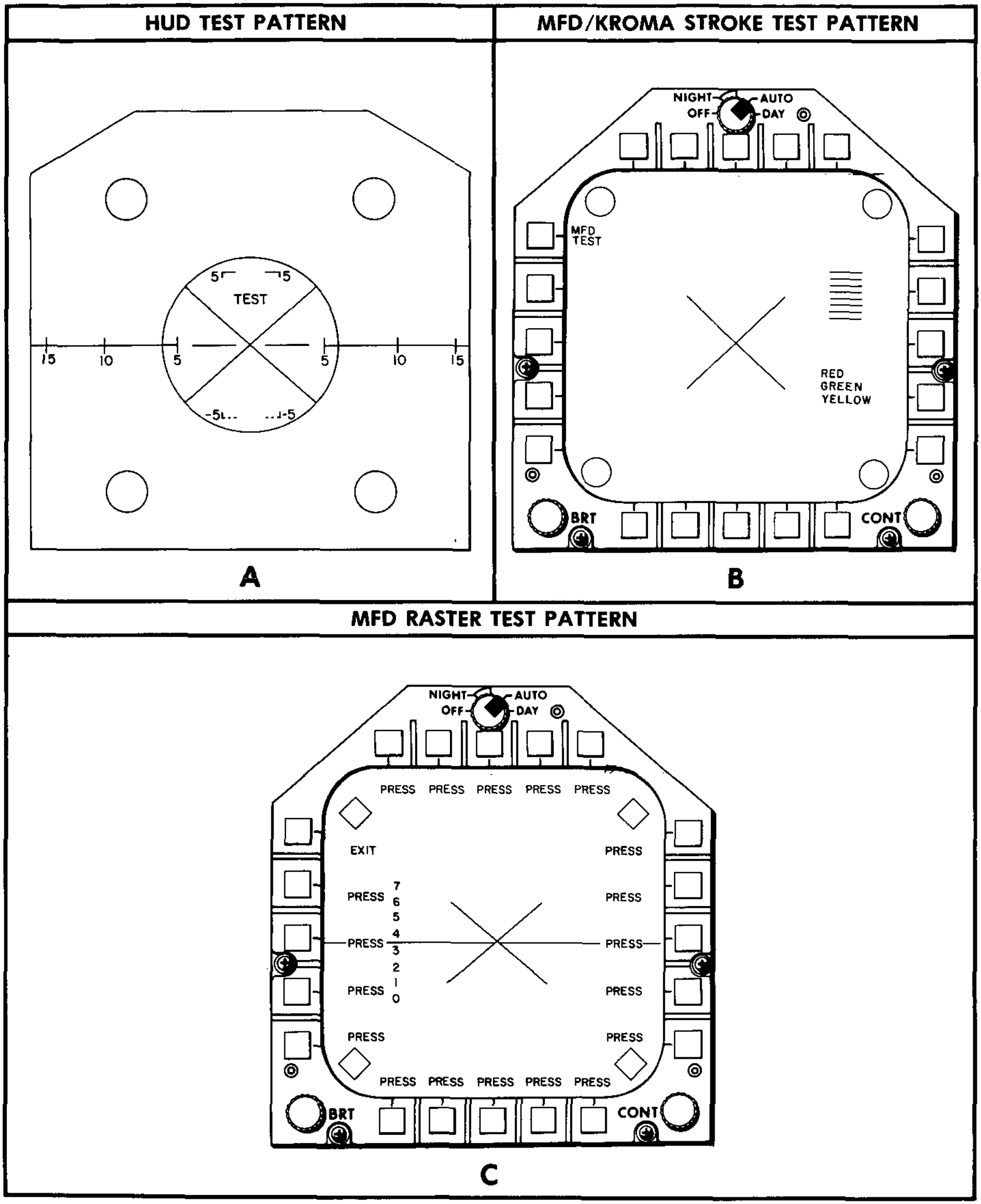

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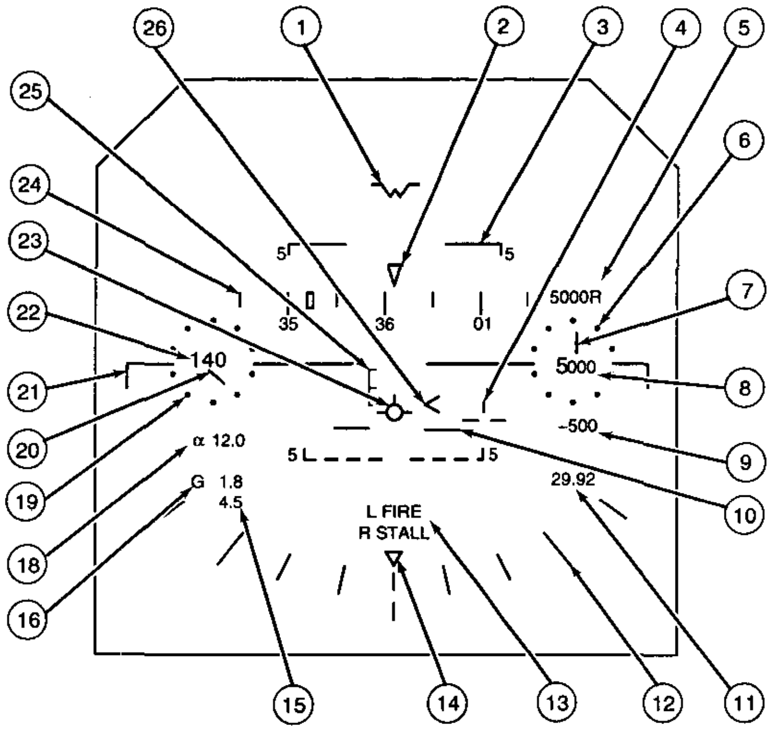
Figure 2-91. Test Patterns

GEAR DOWN – ANALOG



GEAR UP – ANALOG

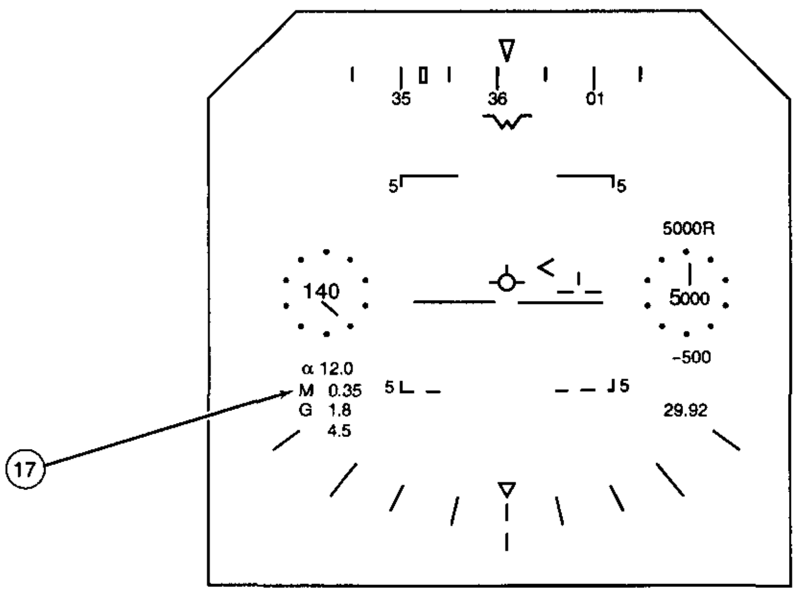


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Figure 2-92. HUD TLN Basic Format (Sheet 1 of 4)

SYMBOL	FUNCTION
(1) Water line	Indicates fuselage reference line (FRL). Displayed when attitude information is not valid. Also displayed when gear down or the flightpath marker is at, or beyond the HUD's full field of view.
(2) Heading pointer	Actual aircraft heading is displayed below the stationary heading pointer.
(3) Pitch/flightpath ladder	Ladder displays aircraft climb/dive angle and roll angle. Aircraft vertical flightpath angle is indicated by the position of the flightpath marker on the pitch/flightpath ladder. Positive pitch lines are solid and negative pitch lines are dashed. To aid in determining flightpath angle when it is changing rapidly, the pitch lines are angled toward the horizon at an angle half that of the flightpath angle. For example, in a 40° climb, the pitch lines are angled 20° toward the horizon. "Up" appears at +90° and "down" appears at −90°.
(4) Ghost flightpath marker	Displayed at the true velocity vector position when the flightpath marker is caged and the true velocity vector position differs from the caged position in azimuth. When the true flightpath marker position is actually outside the HUD total field of view, the symbol will be pegged at the edge of the total FOV and flash.
(5) Radar altitude indicator	Displays radar altitude when the aircraft is below 5000 feet AGL and bank angle is less than 45°. If RDR is selected as the altimeter source and valid radar altitude exists, the radar altitude is displayed within the dial, replacing the barometric altitude. An R is displayed to the right of dial to indicate radar altitude. If BARO is selected and a valid radar altitude exists, radar altitude is displayed above the altitude dial or box.
(6) Altitude analog dial	The HUD analog altimeter consists of ten dots encircling the altitude readout. Each dot indicates altitude in hundreds of feet with the zero mark located at the top center of the dial.
(7) Altitude pointer	An analog pointer indicating altitude moves uniformly around the inside of the altitude dial based on indicated altitude. Increasing altitude is indicated by clockwise rotation of this pointer.
(8) Digital altitude readout	Digital barometric or radar altitude is displayed depending on the source of the data. When the ALT switch is in the BARO position, barometric altitude is displayed. When the ALT switch in the RDR position and if aircraft altitude is 5000 feet or lower, radar altitude is displayed within the dial and is identified by an R to the right of the least significant digit. If the radar altitude becomes invalid by exceeding 5000 feet or 45° AOB, barometric altitude is substituted and a B will flash to indicate that barometric altitude is being displayed rather than radar altitude.
(9) Vertical velocity readout	The vertical velocity readout consists of a maximum of five digits for a positive vertical velocity indication and a maximum of four digits with a leading minus sign for a negative vertical velocity indication. If the limit 32,999 or −9,999 is exceeded, a minus sign with four X's (−XXXX) is displayed. It is displayed below the six o'clock dot of the altitude dial.

Figure 2-92. HUD TLN Basic Format (Sheet 2 of 4)

SYMBOL	FUNCTION
(10) Negative three degree marks	Indicates the negative 3 degree position on the pitch ladder.
(11) Barometric pressure setting	The barometric pressure setting used by the display system and the weapon system is the value set on the pilot's barometric altimeter. The setting will be displayed for up to 5 seconds on the HUD and VDI in the TLN mode when the setting is changed. At 18,000 feet, if it is off, the symbol comes on and blinks for 5 seconds.
(12) Bank scale	Provides indication of bank angle to ±45°. Tick marks are provided at 0°, ±10°, ±20°, ±30° (slightly larger) and ±45°.
(13) Warning/caution/ advisory readout	The warnings L STALL, R STALL, L FIRE, R FIRE, and RDC SPEED and the CLSN advisory will appear on the HUD in the steady condition. Up to two indications may be displayed at any one time. When more than two indications are present, they scroll up from the bottom at the rate of one per second.
(14) Bank angle pointer	Moving pointer provides indication of aircraft bank angle. At bank angles in excess of ±45°, the pointer will be pegged at ±50° and will flash.
(15) Peak aircraft g	Peak Aircraft g is displayed on the HUD as follows; TLN Gear Down: If aircraft g falls below +0.0 or exceeds +2.0. TLN Gear Up, A/A, A/G: If aircraft g falls below −2.0 or exceeds +4.5. Peak g indication is displayed until a declutter mode is cycled.
(16) Aircraft g	Aircraft g is displayed on the HUD as follows; TLN Gear Down: If aircraft g falls below +0.5 or exceeds +1.5. TLN Gear Up, A/A, A/G: If aircraft g falls below −2.0 or exceeds +4.5.
(17) Mach number	Indicates speed of the aircraft in mach.
(18) Angle−of−attack	Indicates angle−of−attack in units. **Note** When the TLN gear down format is displayed, the AOA readout is removed when AOA is between 14 and 16 units. If AOA is greater than 14 units and decreasing, the readout remains off until AOA decreases below 13 units. If AOA is less than 16 units and increasing, the readout remains off until AOA increases above 17 units.
(19) Airspeed dial	The HUD analog airspeed dial consists of ten dots encircling the airspeed readout. Each dot indicates airspeed in tens of knots with the zero mark located at the top center of the dial.
(20) Airspeed pointer	An analog pointer indicating airspeed moves uniformly around the inside of the airspeed dial based on indicated airspeed. Increasing airspeed is indicated by clockwise rotation of the pointer.
(21) Extended horizon line	Represents the horizon with respect to the aircraft and changes orientation with any change in aircraft pitch or roll.

Figure 2-92. HUD TLN Basic Format (Sheet 3 of 4)

SYMBOL	FUNCTION
(22) Digital airspeed readout	Provides digital readout of calibrated airspeed.
(23) Flight path marker	The flight path marker is displaced in azimuth and elevation to present computed flight path. Aircraft vertical flight path angle is indicated by the position of the flight path marker on the pitch/flight path ladder. In the caged mode, the flight path marker is caged in azimuth and the true flight path marker position is indicated by the display of the ghost flight path marker when the true position is more than 2° from the caged position. The flight path marker can be caged or uncaged by alternately pressing the CAGE/SEAM switch. On selection of TLN or A/A, the flight path marker is initially caged; selection of A/G presents the uncaged mode initially.
(24) Heading scale	Aircraft magnetic heading is indicated by the moving 360° heading scale. In TLN, the major divisions are numbered every 10 degrees. In A/A, the major divisions are numbered every 20 degrees. **Note** When the aircraft is in the TLN mode with the gear handle down, the heading scale remains 2 degrees above the position of the flight path marker. The lowest point of the heading scale, including the numbers, will never rise above the normal (gear up) position. The heading scale is occluded by the altitude and airspeed dials and readouts.
(25) Angle-of-attack bracket	The AOA bracket is a pitch related variable that indicates the deviation of the current AOA from a desired value and is vertically referenced to the left wing of the flight path marker symbol. The center of the bracket represents the optimum AOA. The bracket moves lower with respect to the flight path marker as AOA increases and it moves higher as AOA decreases.
(26) Potential flight path marker	Indicates the acceleration along the flight path marker. Provides a graphical representation of the ability to change the flight path angle by varying the thrust acceleration and/or angle of attack. Deceleration is indicated by the PFPM below the flight path marker and acceleration by the PFPM above the flight path marker.

Figure 2-92. HUD TLN Basic Format (Sheet 4 of 4)

The symbols removed by the DECLUTTER switch vary with formats and are discussed in the applicable paragraphs. Refer to Figure 2-93 for declutter information in TLN-GD, TLN-GU, A/A, and A/G modes.

2.33.8.3.1 Takeoff/Landing/Navigation Formats. TLN formats are categorized by the selected steering mode and landing gear position. TLN basic, the HUD default format, does not display steering information. Refer to Figure 2-92 for the location and description of TLN basic symbology.

Steering mode selection is made through MFD pushbutton or cursor designate action on the VDI AWL formats. TCN and DEST steering mode selections are also available on the HSD by boxing the tacan data buffer or waypoint data butter, respectively. Making a steering mode selection changes TLN basic to TLN TCN (tacan), MAN (manual), DEST (destination), D/L (data link), or AWL (all-weather landing). Steering mode is identified on the HUD by a legend in the data readout display area. Steering modes are described in Chapter 20.

SYMBOL NAME	HUD MODES											
	TLN−GD			TLN−GU			A/A			A/G		
	N	1	2	N	1	2	N	1	2	N	1	2
MACH *				Present	Present		Present	Present		Present	Present	
AIRCRAFT G	As Required	As Required	As Required	Present	As Required	As Required	Present	Present	As Required	Present	Present	As Required
PEAK G	As Required			As Required			As Required	As Required		As Required	As Required	
DIGITAL BOXES	Present	Present		Present	Present		Present	Present		Present	Present	
ANALOG DIALS	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
AOB SCALE	Present			Present								
AOA READOUT	As Required	As Required		Present	Present		Present			Present		
HEADING SCALE	Present	Present	Present	Present	Present	Present	Present	Present		Present	Present	
NAV RANGE	Present	Present	Present	Present	Present		Present	Present		Present	Present	Present
PFPM	Present	Present		Present	Present		Present			Present		
GHOST FPM	As Required	As Required	As Required	As Required	As Required	As Required	As Required	As Required		As Required	As Required	
AOA BRACKET	Present	Present	Present									
RADAR ALTITUDE READOUT	As Required			As Required	As Required		As Required			As Required	As Required	
VERTICAL VELOCITY	Present	Present		Present								
WATERLINE	Present	Present	Present	As Required	As Required	As Required	As Required	As Required	As Required	As Required	As Required	As Required
A/A RANGE	As Required	As Required	As Required	As Required	As Required	As Required	As Required	As Required	As Required			
CLOSURE	As Required	As Required	As Required	As Required	As Required	As Required	Present	Present	Present			
TARGET POINTER/AON							As Required	As Required	As Required			
PITCH LADDER	Present	Present	Present	Present	Present	Present	Present	Present	*	Present	Present	Present

☐ Not Present

▒ Present

▨ As Required

* Pitch ladder replaced on Spin

Figure 2-93. HUD Declutter Levels

1. TCN selection adds a course-steering arrow and course-deviation dots. Distance to the tacan station is displayed to the right of the TCN legend.

2. MAN steering selection adds a commanded heading marker to the heading scale. The commanded heading marker also appears on destination, data-link, and AWL formats.

3. DEST steering selection adds the waypoint destination range to TLN basic format.

4. D/L selection displays the range to the data-link destination. A large flashing "X" will appear in the center of the display when a data-link waveoff command is received.

5. AWL steering selection provides for the display of ACL and ILS, ACL only, ILS only, or no ACL and ILS glidepath situation displays. The display of the HUD flight director glideslope and centerline steering can also be independently controlled. Selections are made via MFD pushbutton activation on the VDI AWL format. A large, flashing "X" will appear in the center of the display when a waveoff command is received. Distance to the tacan station is displayed as is the TCN legend.

When the landing gear handle is placed in the down position, the HUD cage/uncage function is enabled on the CAGE/SEAM switch located on the inboard throttle, the system transitions to TLN-GD mode, and all weapon selections are cleared. In TLN-GD mode, the Mach number is removed and aircraft g is displayed if the g's fall below +0.5 or exceed +1.5; peak g is displayed in normal declutter mode if aircraft g falls below 0.0 or exceeds +2.0; the horizon line is extended across the HUD field of view and a flying "W" (waterline) symbol is added at the fuselage reference line.

Note

The waterline symbol is also added in other HUD formats when the flightpath marker is at or beyond the HUD field of view or when altitude data is lost.

Figure 2-94 shows the symbols that are added during tacan and AWL flight director steering modes, landing gear down, with digital or analog display selection. Refer to Figure 2-95 for a description of the symbols that are available for TLN formats.

2.33.8.3.2 Air-to-Air Formats. A/A formats (Figures 2-96 and 2-97) are presented when the pilot selects the A/A pushbutton on the pilot DISPLAYS control panel, when a weapon is selected, the radar hot modes are selected, or when the ACM guard is lifted. The A/A formats provide target acquisition, weapon status, and shoot prompts as well as primary flight information. Target data and the selection legends A/A, PH, SP, SW, and G are displayed. Quantity of the selected weapons is also shown. When GUN is selected, the quantity number indicates rounds remaining in hundreds. A large "X" through a weapon selection legend indicates that the master arm switch is SAFE.

Refer to NAVAIR 01-F14AAD-1A for a description of air-to-air attack.

2.33.8.3.3 Sensor Mode Indications. Radar modes are indicated on the HUD via alphanumerics. The radar mode alphanumerics are removed when the radar is off or in the computer mode. An "X" overlays the mode indication if the IRST is failed (Figure 2-96). The radar mode alphanumerics are as follows:

1. Hot range while search (HRWS)
2. Manual rapid lock-on (MRL)
3. Pilot automatic lock-on (PAL)
4. Pilot lock-on mode (PLM)
5. Pulse Doppler search (PDS)
6. Pulse Doppler single-target track (PDSTT)
7. Pulse search (PS)
8. Pulse single-target track (PSTT)
9. Range while search (RWS)
10. Range while search velocity (RWS)
11. Sniff (SNIFF)
12. Standby (STBY)
13. Track while scan automatic (TWSA)
14. Track while scan manual (TWSM)
15. Vertical scan lock-on high (VSLHI)
16. Vertical scan lock-on low (VSLLO).

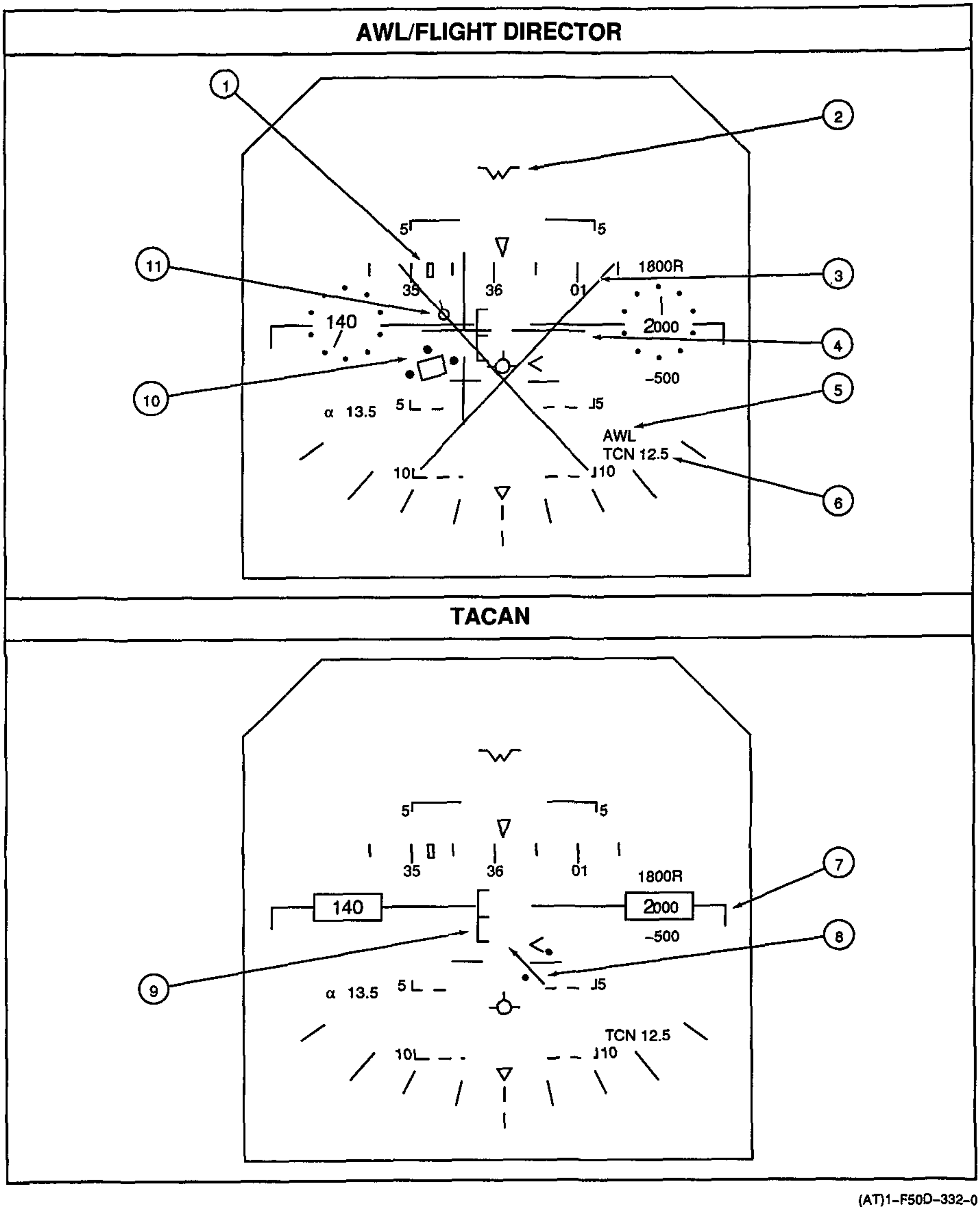

Figure 2-94. HUD Added Symbology (Sheet 1 of 2)

SYMBOL	FUNCTION
(1) Command heading marker	This symbol indicates the heading required to achieve the selected course. Course selection may be manual, data link commanded, or waypoint destination. Where commanded heading is beyond display scale limits, the symbol will be pegged at the nearest edge to the commanded heading. This symbol does not appear on the basic or tacan formats.
(2) Waterline	Indicates fuselage reference line (FRL). Displayed when attitude information is not valid. Also displayed when gear down or TLN Gear Up or, the flight path marker is at or beyond the HUD's full field of view.
(3) Breakaway, waveoff	A large flashing X will appear in both D/L and AWL steering modes if a WAVEOFF command has been received.
(4) ILS precision course vectors	Consists of two independent vectors (vertical and horizontal) which form a cross pointer. The horizontal vector responds to ILS glide slope error and the vertical vector responds to ILS localizer error. Null/center indications are provided to enable the pilot to null the error and keep the vertical and horizontal needles centered.
(5) AWL legend	This message indicates that the all weather landing steering mode has been selected.
(6) Range	Depending on the format, this message will indicate either the range to the tacan station, data link destination or distance to waypoint destination. The legends TCN, D/L, or WPT, may also appear. When in the manual steering mode no range appears but the MAN legend is displayed.
(7) Extended horizon line	Indicates the horizon with respect to the aircraft with landing gear down. Changes orientation with any change in aircraft pitch and roll.
(8) Course arrow and deviation dots	The course arrow represents the selected course to the tacan station. Two dots will appear on the side of the flight path marker toward the course arrow and perpendicular to the arrow. The dot closest to the flight path marker represents a half scale deflection of 4° off course, while the outermost dot represents full scale deflection of 8° off course. When the aircraft crosses the selected course, the arrow moves to the opposite side of the flight path marker and the dots would appear on that side. For deviations of more than 9°, the arrow pegs. If the arrow is centered on course, the dots disappear. Flight path marker centered over the course arrow indicates being on course. For tacan bearings aft of ±90°, the arrow will be dashed.
(9) Angle−of−attack bracket	The AOA bracket is a pitch related variable that indicates the deviation of the current AOA from a desired value and is vertically referenced to the left wing of the flight path marker symbol. The center of the bracket represents the optimum AOA. The bracket moves lower with respect to the flight path marker as AOA increases and it moves higher as AOA decreases.
(10) Flight director	The flight director symbol provides glide slope and centerline steering information computed by the mission computer using navigation system parameters and Data Link information from the SPN−42/46 ACLS system. The box with the three dots will provide the pilot with optimal glide path intercept and following when the flight path marker is inside the flight director box and the three dots are aligned with the wings and the tail of the flight path marker. The same procedures are used whether the flight path marker is caged or uncaged. The flight director symbol is removed from the HUD when the FLT DIR pushbutton on the VDI is unboxed.
(11) ACL steering indicator	Provides ACL steering commands driven by the ASW−27C data link.

Figure 2-94. HUD Added Symbology (Sheet 2 of 2)

SYMBOL	FORMAT					
	BASIC	AWL	DATA LINK	DESTINATION	MANUAL	TACAN
Aircraft G's Readout	(On all formats except GEAR DOWN & DECLUTTER−2)					
Airspeed Dial	(On all formats except DIGITAL)					
Airspeed Readout Box	(On all formats except ANALOG or DECLUTTER−2)					
Airspeed Readout	(On all formats)					
Altitude Dial	(On all formats except DIGITAL)					
Altitude Readout Box	(On all formats except ANALOG or DECLUTTER)					
Altitude Readout	(On all formats)					
Angle−of−Attack Readout	(On all formats except DECLUTTER−2)					
Bank Scale	(On all formats except DECLUTTER−1 and 2)					
Baro Setting Readout (5 sec)	+	+	+	+	+	+
Ghost flight path marker	+	+	+	+	+	+
Extended Horizon Line	(On all formats when GEAR DOWN)					
Heading Scale	+	+	+	+	+	+
Horizon	(On all formats when GEAR UP)					
Reference Markers	+	+	+	+	+	+
Mach Readout	(On all formats except GEAR DOWN and GEAR UP DECLUTTER−2)					
Peak A/C G's Readout	(On all formats except DECLUTTER−1 and 2)					
Pitch Ladder−TLN	+	+	+	+	+	+
Radar Altitude Readout	(On all formats except GEAR DOWN DECLUTTER−1 & 2 and GEAR UP DECLUTTER−2)					
Flight Path Marker	+	+	+	+	+	+
Vertical Velocity Readout	(On all formats except DECLUTTER−1 & 2 in GEAR UP and DECLUTTER−2 in GEAR DOWN)					

Figure 2-95. HUD Symbology Available on TLN Formats (Sheet 1 of 2)

SYMBOL	FORMAT					
	BASIC	AWL	DATA LINK	DESTINATION	MANUAL	TACAN
Waterline	(On all formats or when flight path marker pegged or altitude data invalid)					
Altitude Source–B or R	+	+	+	+	+	+
HUD Cursor	+	+	+	+	+	+
Potential Flight Path Marker	(On all formats except DECLUTTER–2)					
Angle of Attack Bracket	(On GEAR DOWN only. All formats)					
IRST Pointer	+	+	+	+	+	+
TCS Pointer	+	+	+	+	+	+
Caution/Advisory/Warning	+	+	+	+	+	+
Breakaway Symbol	o	+	+	o	o	o
Command Heading Marker	o	+	+	+	+	o
HUD Steering Legend–AWL	o	+	o	o	o	o
HUD Steering Legend–TCN	o	+	o	o	o	+
HUD Steering Legend–D/L	o	o	+	o	o	o
HUD Steering Legend–MAN	o	o	o	o	+	o
HUD Steering Legend — WPT	o	o	o	+	o	o
ILS Precision Course Vectors	o	+	o	o	o	o
Range Readout	o	+	+	+	o	+
ACL Steering Indicator Tadpole	o	+	o	o	o	o
Flight Director	o	+	o	o	o	o
Course Arrow & Deviation Dots	o	o	o	o	o	+

Notes:

+ indicates that the symbol is available for display on the selected format.

o indicates that the symbol is not available for display on the selected format.

Figure 2-95. HUD Symbology Available on TLN Formats (Sheet 2 of 2)

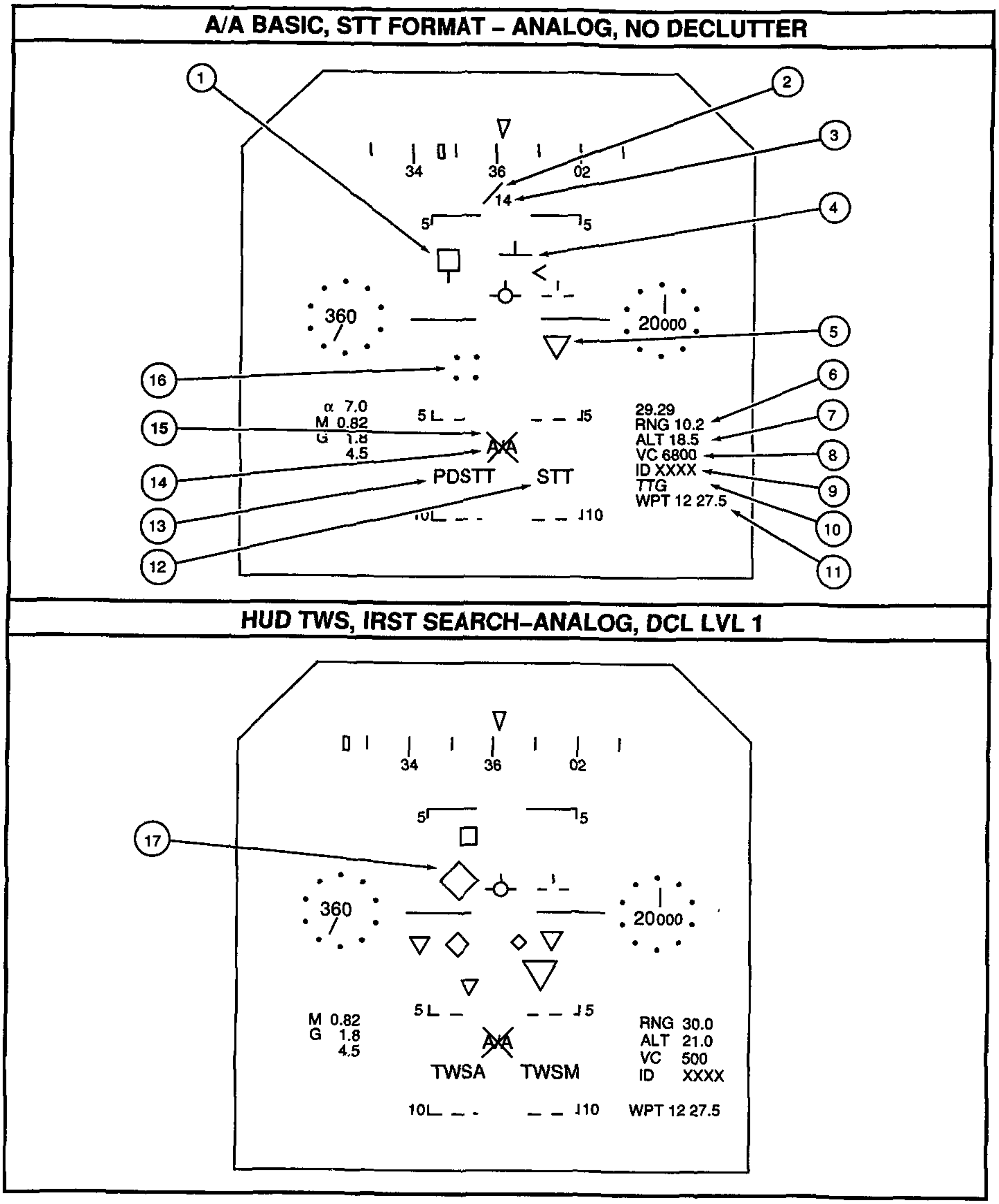

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Figure 2-96. HUD A/A Search Formats (Sheet 1 of 2)

SYMBOL	FUNCTION
(1) Radar target designator and target aspect	Indicates the radar line of sight (LOS) to the target. Symbol is displayed on all A/A weapon modes when radar is tracking a target. The position is computed from the radar LOS. The symbol is positionable over the total HUD field of view (FOV). The symbol will be pegged at the FOV limits and flash. In STT, target aspect is represented by a pointer which points in the direction of the aspect angle. Zero target aspect is straight down.
(2) Target pointer	Indicates the direction of the target designator (TD) box position on the HUD. The target pointer is present when pointing to a TD box under the following conditions: 1) FONO 1 track is outside the IFOV (Instantaneous Field of View). 2) TID hooked track is outside the IFOV with no FONO 1 present. 3) Closest TMA is outside the IFOV and there is no FONO 1 TID hooked track.
(3) Angle–off–the–nose indicator	The angle–off–the–nose (AON) indicator defines the angle between the FRL and the target line of sight that the target pointer is pointing to, in the plane described by the FRL and the target pointer. When the target designator is being pointed to by the target pointer, a three digit readout is displayed indicating the AON of that target. The AON indicator is not earth stabilized. The AON readout is centered below the origin of the target pointer and is given in degrees .
(4) Steering tee	Provides azimuth steering only, in search mode. Provides elevation and azimuth steering in track mode.
(5) IRST symbol	Indicates location of sensed target. Up to four displayed.
(6) Target range	Range of closest radar target in nautical miles and tenths. Numeric is displayed only when range is valid.
(7) Target altitude	Altitude of closest radar target in thousands of feet. Displayed only when information is valid.
(8) Target closing velocity	Displays closing rate to radar target. A minus sign indicates an opening velocity.
(9) Target ID	Target ID display.
(10) Time of flight	TTG or TTA, refer to NAVAIR 01–F14AAD–1A.
(11) Navigation Data	Display mode of steering or steering mode, waypoint selected or range (DEST or D/L).
(12) IRST mode indicator	Displays current IRST mode.
(13) Radar mode indicator	Displays current radar mode.
(14) Weapon select legend	Displays missile type and quantity, if selected, or gun and rounds remaining, in hundreds. If no weapon is selected, displays A/A.
(15) Master arm safe cue	A large X through the A/A or weapon select legend indicates the Master Arm Switch is in SAFE.
(16) TCS pointer	Indicates the direction of the TCS track.
(17) NCTR	Indicates non–cooperative target recognition is available. Refer to NAVAIR 01–F14AAD–1A.

Figure 2-96. HUD A/A Search Formats (Sheet 2 of 2)

SYMBOL	FORMAT								
		PHOENIX		SPARROW		SIDEWINDER			
	BASIC	SEARCH	TRACK	SEARCH	TRACK	SEARCH	TRACK	MMGS	GUN BACKUP
Aircraft G's Readout	+	+	+	+	+	+	+	+	+
Airspeed Dial	(On all formats except DIGITAL)								
Airspeed Readout Box	(On all formats except ANALOG & DECLUTTER−2)								
Airspeed Readout	(On all formats)								
Altitude Dial	(On all formats except DIGITAL)								
Altitude Readout Box	(On all formats except ANALOG & DECLUTTER−2)								
Altitude Readout	(On all formats)								
Angle of Attack Readout	(On all formats except DECLUTTER)								
Baro Setting Readout	+	+	+	+	+	+	+	+	+
Ghost Flight Path Marker	(On all formats except DECLUTTER−2)								
Heading Scale	(On all formats except DECLUTTER 1 & 2)								
Horizon	+	+	+	+	+	+	+	+	+
Reference Markers	+	+	+	+	+	+	+	+	+
Mach Readout	(On all formats except DECLUTTER−2)								
Peak A/C G's Readout	(On all formats except DECLUTTER−2)						+	+	+
Pitch Ladder	(On all formats except DECLUTTER−1 & 2)								
Radar Altitude Readout	(On all formats except DECLUTTER−1 & 2)								
Flight Path Marker	+	+	+	+	+	+	+	+	+
Waterline	(On all formats when flight path marker pegged, gear is down, or altitude information is invalid.)								
Altitude Source−B or R	+	+	+	+	+	+	+	+	+
HUD Cursor	+	+	+	+	+	+	+	+	+
IRST Pointer	+	+	+	+	+	+	+	+	+
TCS Pointer	+	+	+	+	+	+	+	+	+
Caution/Advisory/Warning	+	+	+	+	+	+	+	+	+
Breakaway Symbol	+	+	+	+	+	+	+	+	+
Command Heading Marker	+	+	+	+	+	+	+	+	+
Select Legends, Weapon−Qty	A/A	PH#	PH#	SP#	SP#	SW#	SW#	G#	G#

Figure 2-97. HUD Symbology Available on A/A Formats (Sheet 1 of 2)

SYMBOL	FORMAT								
	BASIC	PHOENIX SEARCH	PHOENIX TRACK	SPARROW SEARCH	SPARROW TRACK	SIDEWINDER SEARCH	SIDEWINDER TRACK	MMGS	GUN BACKUP
Master Arm Switch Safe Cue	+	+	+	+	+	+	+	+	+
Target Range–RNG, #	+	o	+	o	+	o	+	o	+
Target Range Indicator	+	o	+	o	+	o	+	o	o
Waypoint Select	o	+	o	+	o	+	o	o	o
Steering Tee	+	o	+	o	+	o	+	o	o
Target Designator	+	o	+	o	+	o	+	+	o
Target Closing Velocity	+	o	+	o	+	o	+	o	o
Target Altitude	+	o	+	o	+	o	+	o	o
Target ID	+	o	+	o	+	o	+	o	o
TACAN Digital Readout	o	+	o	+	o	+	o	o	o
Flood Illumination Pattern	o	o	o	+	o	o	o	o	o
Sidewinder Seeker Circle	o	o	o	o	o	+	+	o	o
SHOOT Cue	o	o	+	o	+	o	+	o	o
Reticle	o	o	o	o	o	o	o	+	o
Reticle A	o	o	o	o	o	o	o	+	o
Reticle B	o	o	o	o	o	o	o	+	o
Target Range Tape	o	o	o	o	o	o	o	+	o
Target Lead Cue	o	o	o	o	o	o	o	+	o
BATR Symbol	o	o	o	o	o	o	o	+	o
Gun Mode Indication–MAN	o	o	o	o	o	o	o	o	+
Reticle Depression–#	o	o	o	o	o	o	o	o	+
A/A Gun/Backup Mode Reticle	o	o	o	o	o	o	o	o	+

Notes:

+ indicates that the symbol is available for display on the selected format.

o indicates that the symbol is not available for display on the selected format.

Figure 2-97. HUD Symbology Available on A/A Formats (Sheet 2 of 2)

IRST modes are indicated on the HUD via alphanumerics. The IRST mode alphanumerics are removed when the IRST is failed. The IRST alphanumerics are as follows:

1. Cooldown (COOL)
2. Hot IR (HOTIR)
3. Pilot automatic lock-on (PAL)
4. Pilot lock-on mode (PLM)
5. Single-target track (STT)
6. Standby (STBY)
7. Track while scan automatic (TWSA)
8. Track while scan manual (TWSM).

2.33.8.3.4 Air-to-Ground Formats. Pushbutton selection on the PDCP or selection of an air-to-ground weapon places the A/G basic format on the HUD (Figures 2-98 and 2-99). The A/G basic format can display waypoint and tacan information. A/G DECLUTTER and ANLG and DGTL displays are similar to A/A formats. Refer to NAVAIR 01-F14AAD-1A.

2.33.8.4 Overlay Symbology. Symbology (Figure 2-100) may be overlaid on displayed HUD formats when additional information is required. These include RECON, TWS, and IRST TWS.

RECON, used with the TARPS pod, is selected as an overlay from the MFD RECON formats. This overlay adds the RECON command heading marker, command ground-track line, RECON steering symbol, target-designator hexagon, and camera selection legend.

Radar track while scan adds up to four radar target diamonds that indicate the four closest targets. Size of the symbols indicates relative proximity (i.e., the largest is the closest). The four symbols are of preset sizes, not scaled to reflect actual distances.

The infrared search and tracking system TWS adds up to four triangular IRST symbols to existing formats. Unlike TWS, these symbols are all the same size. Both IRST and TWS symbols are added automatically when a target is being tracked.

2.33.8.5 Manual Reticle. If the mission computer loses communication with both DPs, the DP driving the HUD provides a manual reticle format (Figure 2-101) allowing gun aiming by displaying the A/A gun/backup mode reticle. The reticle depression angle, adjusted by the ELEV LEAD knob on the PDCP, is shown in the lower right corner of the HUD along with the MAN gun-mode indication.

2.33.9 MFD Formats. Initial turn on or a cold start (defined as a system reset or a power outage to the MCS of at least 300 milliseconds) causes the following default formats to be displayed: VDI TLN basic on MFD1, OBC basic on MFD2, and OWN A/C basic on MFD3. The actual format displayed on MFD3 depends on the navigation mode selected and the conditions existing at the time. If the NAV MODE switch is at OFF, the OWN A/C basic format is displayed.

MFD3 may also act as a controller of the DEU in that, when certain formats are being displayed on MFD3, the DEU is commanded to display corresponding slaved formats. Refer to Figure 2-102 for a listing of MFD3/DEU slaved control conditions.

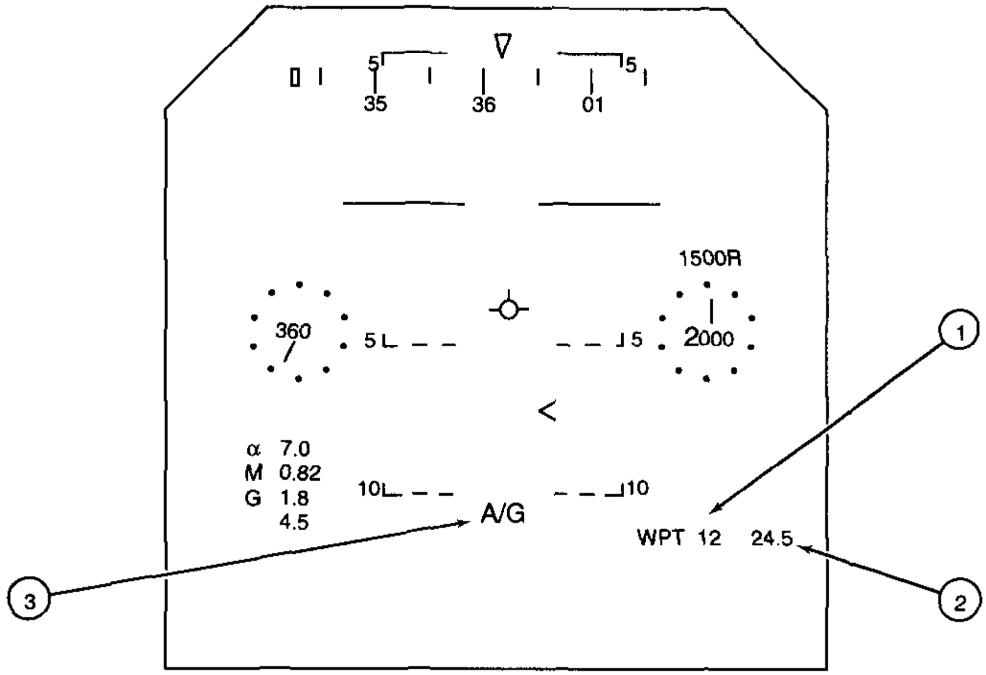
With the exception of high-priority formats (ECM and spin), which appear when required, most MFD formats are selectable by means of MFD pushbutton or cursor designation. The actual format that will appear may depend on other factors, however, such as aircraft state (TLN, A/A, or A/G), steering mode selection, and the alignment condition.

The MENU legend appears on every MFD format except for HUD, DD, and TID repeats. These repeat formats do not display selections; pressing any pushbutton when in a repeat mode will place MENU1 on the MFD. The MENU legend is located above the center pushbutton on the lower edge of the MFDs. Also appearing on every MFD format for ease of immediate selection, are the SMS and ECM pushbutton legends (Figure 2-103).

Repeated depressions of the ECM or SMS pushbuttons toggle between these formats and the previously selected display. This permits the crew to quickly check ECM or SMS conditions without having to reselect previous formats.

Selecting MENU places menu 1 on the display. The legend reads MENU1 and is enclosed by a rectangular box. Selecting MENU1 when it is boxed places menu 2 on the display with the legend MENU2 displayed in the box. The MENU pushbutton toggles between MENU1 and MENU2. Menu selection changes the pushbutton legend but does not alter the display being presented.

HUD A/G FORMAT – ANALOG, NO DECLUTTER



(AT)2–F50D–336–1

SYMBOL	FUNCTION
(1) Waypoint select	Displays destination waypoint selection.
(2) Range to waypoint readout	Displays range to selected waypoint.
(3) Select legend	Displays mode/weapon selected. Will display A/G if no weapon has been selected.

Figure 2-98. HUD A/G Basic Format

SYMBOL	FORMAT		
	BASIC	CCIP	MANUAL
Aircraft G's Readout			
Airspeed Dial	(On all formats except DIGITAL)		
Airspeed Readout Box	(On all formats except ANALOG & DECLUTTER – 2)		
Airspeed Readout	(On all formats)		
Altitude Dial	(On all formats except DIGITAL)		
Altitude Readout Box	(On all formats except ANALOG & DECLUTTER – 2)		
Altitude Readout	(On all formats)		
Angle of Attack Readout	(On all formats except DECLUTTER – 1 & 2)		
Baro Setting Readout	+	+	+
Ghost flight path marker	(On all formats except DECLUTTER – 2)		
Heading Scale	(On all formats except DECLUTTER – 2)		
Horizon	+	+	+
Reference Markers	+	+	+
Mach Readouts	(On all formats except DECLUTTER – 2)		
Peak A/C G's Readout	(On all formats except DECLUTTER – 2)		
Pitch Ladder	(On all formats)		
Radar Altitude Indicator	(On all formats except DECLUTTER – 2)		
Flight Path Marker	+	+	+
Altitude Source–B or R	+	+	+
HUD Cursor	+	+	+

Figure 2-99. HUD Symbology Available on A/G Formats (Sheet 1 of 2)

SYMBOL	FORMAT		
	BASIC	CCIP	MANUAL
IRST Pointer	+	+	+
TCS Pointer	+	+	+
Caution/Advisory/Warning	+	+	+
Breakaway Symbol	o	+	o
Command Heading Marker	+	+	+
Select Legends, Weapon–Qty	A/G	G	G
Master Arm Switch Safe Cue	+	+	+
Pull Up Cue	o	+	o
Waypoint Select	+	+	+
Steering Tee	+	+	+
TACAN Digital Readout	+	+	+
Gun Mode Indication	o	CCIP	MAN
Gun Rounds Remaining (100's)	o	+	+
Max. Gun Firing Range	o	+	o
Reticle	o	+	+
Target Range Tape	o	+	o
Reticle Depression Numerics	o	o	+

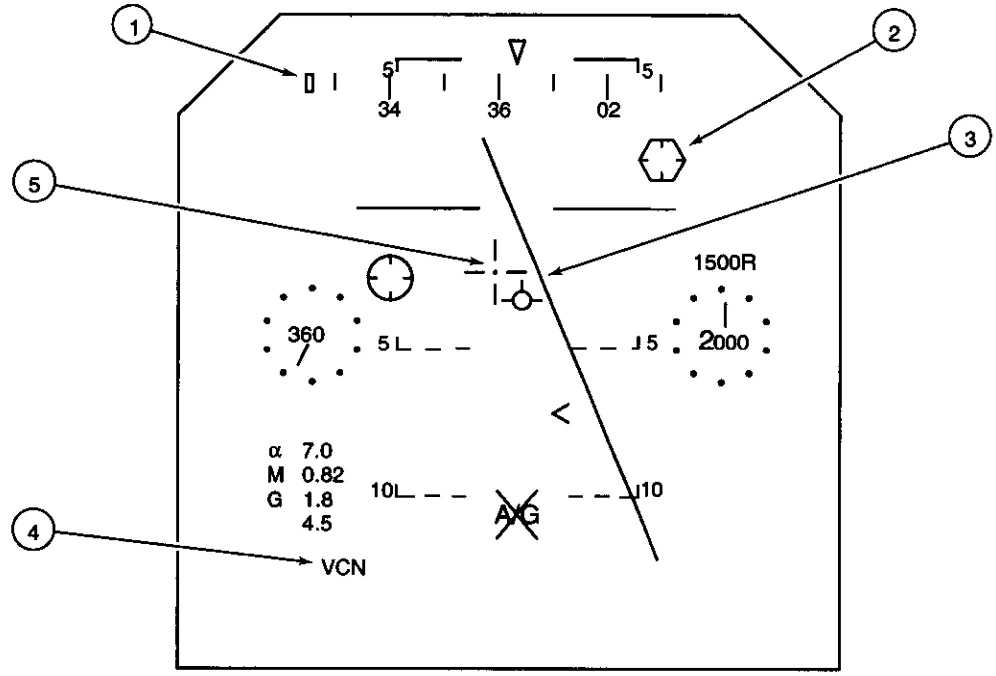
Notes:

+ indicates the symbol is available for display on the selected format.

o indicates that the symbol is not available for display on the selected format.

Figure 2-99. HUD Symbology Available on A/G Formats (Sheet 2 of 2)

HUD RECON STEERING A/G



(AT)2-F50D-337-0

SYMBOL	FUNCTION
1 Recon command heading marker	Indicates the magnetic heading to the dynamic steering point or commanded in the 90 deg−270 deg maneuver during map steering.
2 Target designator, hexagon	Displays target position. Positioned by on−board sensors or data link.
3 Command ground track line	Displays the path of the command ground track.
4 Camera selection legend	Displays the camera operational mode. First letter indicates frame position: V = vertical, F = forward, or blank. Second letter indicates pan position: C = center, R = right, L = left, or blank. Third letter indicates IRLS position: N = narrow field of view, W = wide field of view, S = standby, or blank.
5 Recon steering symbol	Provides elevation and azimuth steering information when in reconnaissance mode.

Figure 2-100. HUD Overlay Formats

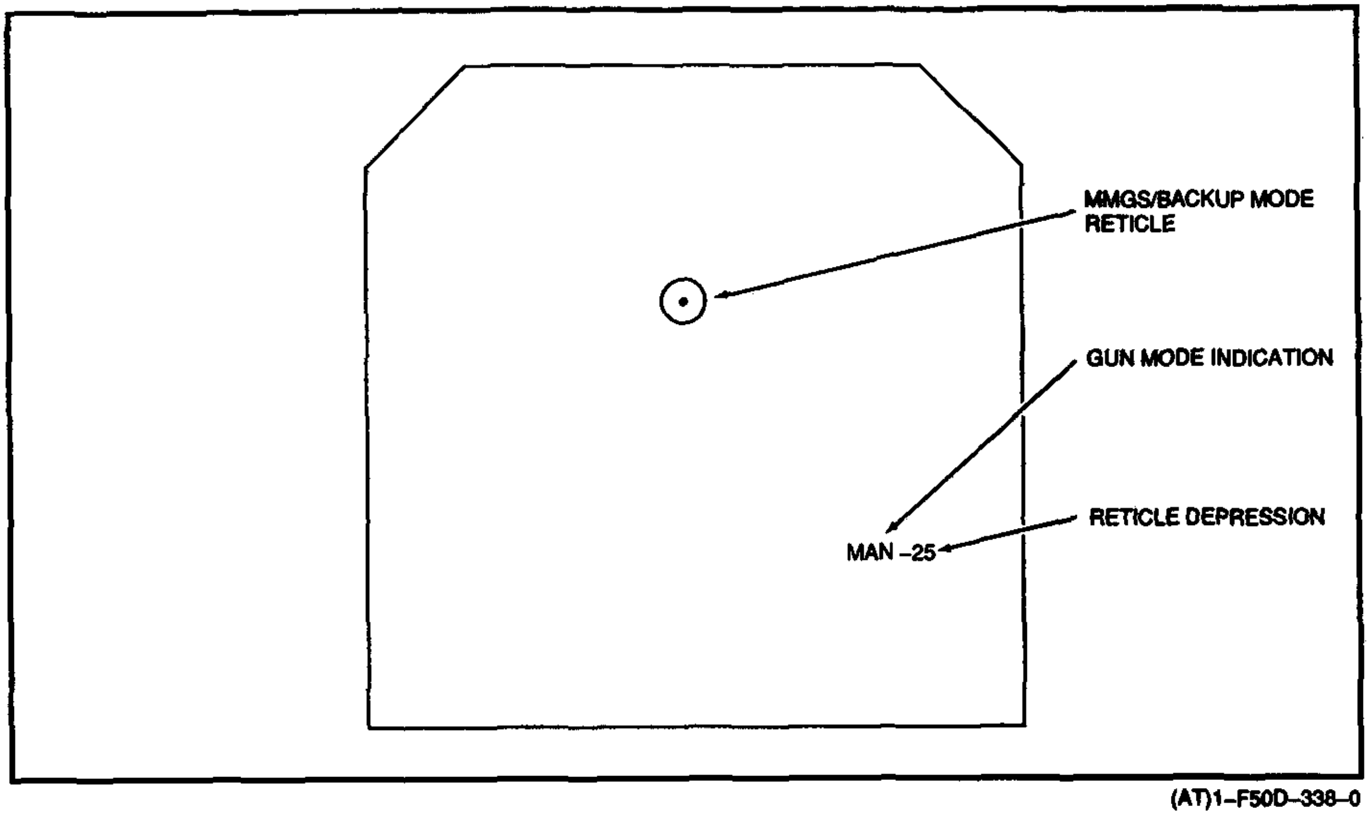


Figure 2-101. HUD Manual Reticle Format

With a MENU display selected, format legends (Figure 2-103) are displayed around the edges of the CRT. A format is selected by cursor designation or by pressing the pushbutton adjacent to the legend. When a format is selected, its legend is highlighted on the display by enclosing it in a rectangular box.

When a display processor acknowledges a pushbutton being depressed, the legend is boxed with a dashed line. When the MC acknowledges the pushbutton request, the line becomes solid. If the MC does not acknowledge the request, the dashed box disappears. This system is used to show the crew that the display system has received the request. Selecting MENU only changes the pushbutton legends. The current display remains until a selection is made from MENU.

For convenience in describing format selection, numbers are assigned to the pushbuttons starting from the lower left side and counting clockwise. On the MENU1 display, PB1 is the pushbutton corresponding to the DATA legend.

From MENU1 the following formats may be selected:

1. PB1 DATA — This selection presents one of four OWN A/C formats. The format to be displayed depends on the position of the NAV MODE switch in the RIO cockpit. Either OWN A/C basic, ground align, CVA (carrier align), or IFA (in-flight align) formats will be displayed.

2. PB2 NAV — Selecting NAV presents one of a number of NAVAID or SAHRS ALIGN formats, depending on alignment mode conditions. Formats that may be displayed include NAV AID options, NAV AID corrections, NAV AID enabled, SAHRS ALIGN (NORM, MAG, SHDG), or SAHRS ALIGN (CV).

3. PB3 — No selection.

4. PB4 TSD — This selection places the tactical situation display format on the display. Switching logic prevents TSD formats from appearing on more than one of the pilot MFDs. Therefore, if TSD has been established on MFD2 and it is selected for MFD1, it will appear on MFD1, and be replaced on MFD2 with MENU1. Refer to the Supplemental NATOPS Flight Manual, NAVAIR 01-F14AAD-1A, for a description of TSD formats.

MFD3 FORMAT	SLAVED DEU FORMAT
OWN A/C BASIC	OWN A/C
OWN A/C GROUND	OWN A/C
OWN A/C CVA	OWN A/C
OWN A/C IFA	OWN A/C
HSD TACAN	OWN A/C
HSD WAYPOINT	WAYPOINT PLOT
WAYPOINT DATA 1 (Note 1)	WAYPOINT
WAYPOINT DATA 2 (Note 2)	WAYPOINT
RECON WPT DATA 1 (Note 6)	WAYPOINT
RECON WPT DATA 2 (Note 7)	WAYPOINT
CV MAN DATA (Note 3)	CV ALIGN
CV SINS DATA (Note 4)	CV ALIGN
CSS	CSS
SMS	SMS
SAHRS ALIGN (NORM, MAG, SHDG)	OWN A/C
SAHRS ALIGN (CV)	CV ALIGN
NAV AID OPTIONS	NAV AID
NAV AID ENABLED (Note 5)	NAV AID
TSD	NAV GRID

Notes:

(1) No slaved DEU format shall be established if MFD 3's previous format was WAYPOINT DATA 2 or RECON WPT DATA 1.

(2) No slaved DEU format shall be established if MFD 3's previous format was WAYPOINT DATA 1 or RECON WPT DATA 2.

(3) No slaved DEU format shall be established if MFD 3's previous format was CV SINS DATA.

(4) No slaved DEU format shall be established if MFD 3's previous format was CV MAN DATA.

(5) No slaved DEU format shall be established if MFD 3's previous format was NAV AID CORRECTIONS.

(6) No slaved DEU format shall be established if MFD 3's previous format was RECON WPT DATA 2.

(7) No slaved DEU format shall be established if MFD 3's previous format was RECON WPT DATA 1.

Figure 2-102. Slaved DEU Page Control

5. PB5 VDI — This selection places one of several VDI formats on the display. VDI formats are head-down attitude displays presenting basic flight information as well as steering and weapon delivery cues. Format selection depends on PDCP MODE pushbutton selection, steering selection, weapon selection, and track or search modes.

6. PB6 — No selection.

7. PB7 CTVS — This selection displays video from the HUD cockpit television sensor on the MFD. The video consists of a real-world view plus the symbology appearing on the HUD.

8. PB8 OBC — Selecting OBC places the ON BOARD CHECKOUT basic format on the display. From the basic format, other OBC formats can be selected, allowing BITs to be commanded and test results to be displayed. There are 10 OBC formats. Refer to Chapter 38 for a description of these formats and their use.

9. PB9 CHKLST — This selection initially places the TAKEOFF checklist on the MFD. From the TAKEOFF format, the LANDING checklist may be selected. PB9 toggles between TAKEOFF and LANDING when CHKLST has been selected.

10. PB10 — No selection.

11. PB11 HUD — This selection displays a repeat of the current HUD symbology on the MFD.

12. PB12 TID — This selection displays a repeat of the tactical information display presentation on the MFD.

13. PB13 DD — This selection displays a repeat of the digital display presentation on the MFD.

14. PB14 TCS — This selection displays the video from the television camera set on the MFD.

15. PB15 IRST — This selection displays the infrared search and track system normal format on the MFD.

16. PB16 HSD — This selection displays one of three horizontal situation display formats on the MFD. The format displayed will be the last previously displayed. If no HSD format has been selected after a cold start or system reset, then the HSD waypoint format will be presented.

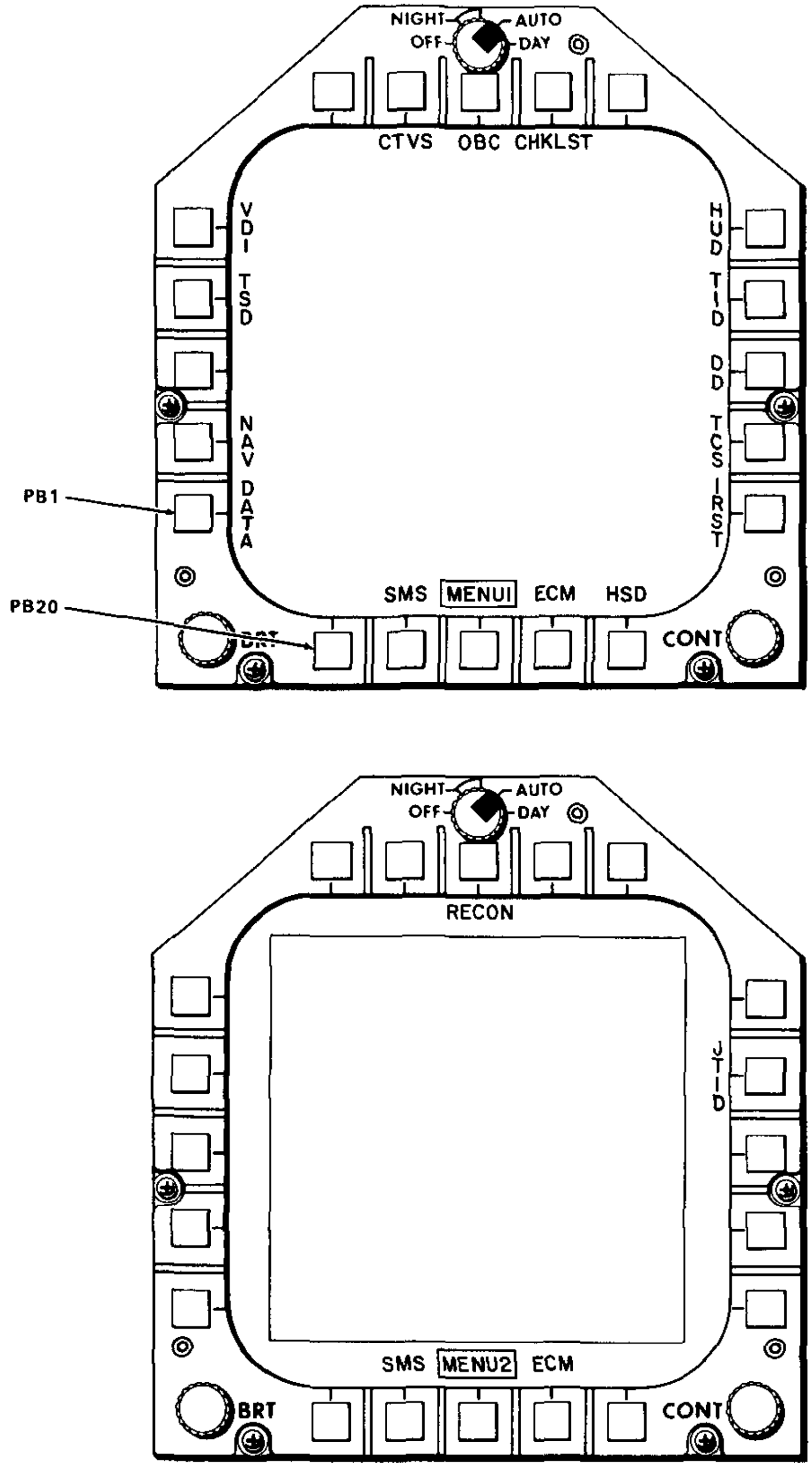


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Figure 2-103. MFD MENU Displays

17. PB17 ECM — This selection places the ECM format on the MFD. A second selection of ECM while viewing the ECM format returns the previous format to the MFD, providing that ECM ORIDE has been selected and threat is being reported.

18. PB18 MENU1 — This legend will be boxed. Selection of MENU1 when boxed presents MENU2.

19. PB19 SMS — This selection places the stores management system format on the MFD. In addition to weapon test and select via the SMS format, TACTS and SIM modes are enabled. Refer to NAVAIR 01-F14AAD-1A for a complete description of TACTS and SIM modes. A second selection of SMS while viewing the SMS format returns the previous format to the MFD.

20. PB20 — No selection.

MENU2 (Figure 2-103) allows selection of the RECON and JTIDS formats on the MFD.

21. PB21 JTID — This selection displays the JTIDS OWN A/C DATA format. From the JTIDS OWN A/C DATA format, the TSD MENU (TMENU) or JTIDS Hook — TSD or TID format can be selected.

2.33.9.1 High-Priority Formats. High-priority formats include spin indicator, ECM, warning/caution/advisory and system message displays.

2.33.9.1.1 Spin Indicator. If a spin condition is detected, that is, if body yaw rate exceeds 30° per second, a spin indicator format (Figure 2-104) is displayed on MFD 1 and the TID, MFDs 2 and 3 display the VDI. If MFD 1 is not on, the spin display will appear on MFD 2. When the spin condition is no longer valid (yaw rate of 27° per second or less), the spin indicator format is removed and the previous format is restored to the display except as follows:

1. If conditions for the display of the ECM format exist, the ECM format will appear on the display instead.

2. If the previous format was a HUD, DD, or TID repeat, MENU1 with a display of warning/caution/advisory and/or data link (D/L) advisory messages will be displayed.

3. If INS and SAHRS failures occur while the spin arrow format is displayed, the pointer on the yaw rate scale is removed from the MFD, the spin arrow is frozen, and an X is superimposed over the spin arrow. The airspeed, AOA, and altimeter scales are not obscured (refer to Chapter 11).

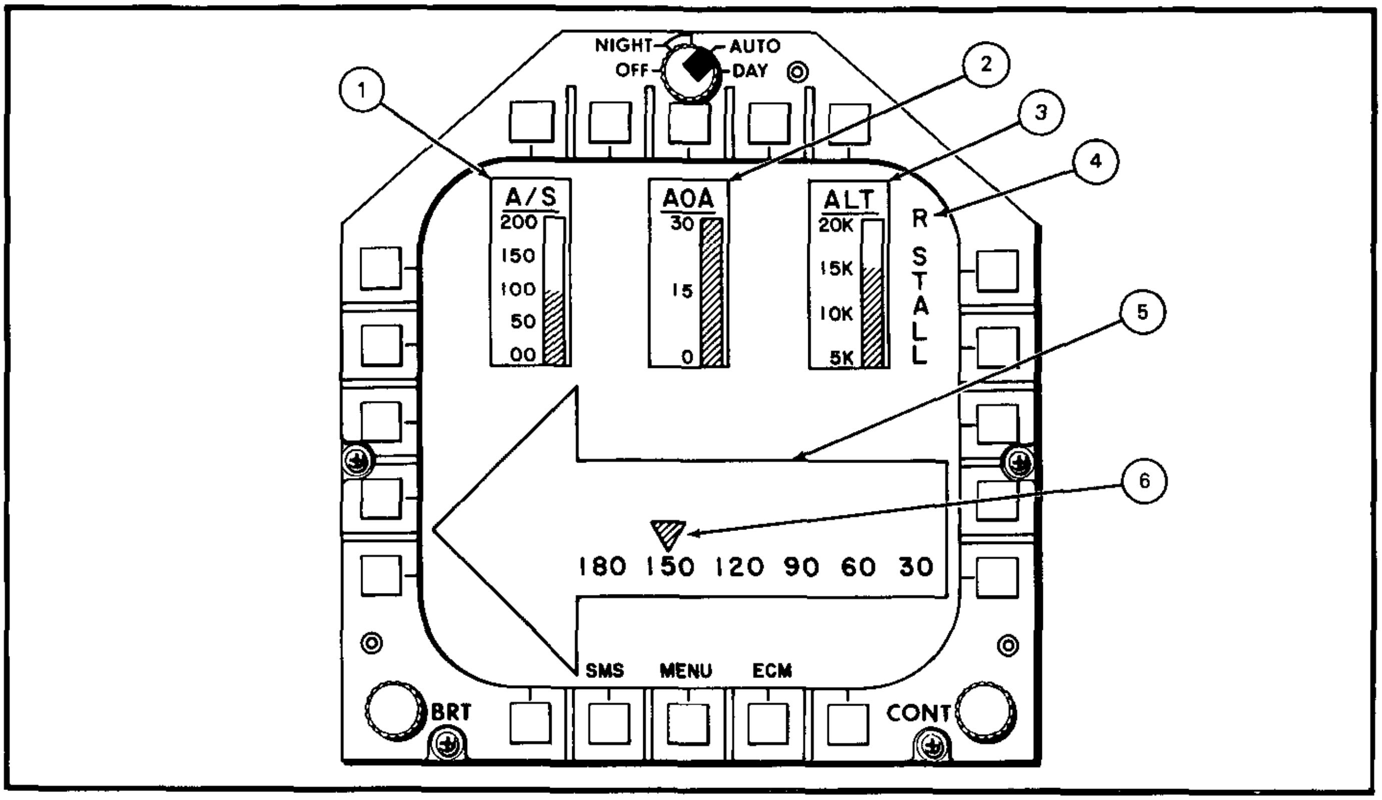
2.33.9.1.2 ECM Format. If the pilot and/or RIO ECM switches (Figure 2-83) are set to ORIDE and a threat is reported, the ECM format will override the present formats on MFD 2 and/or MFD 3. ECM override is enabled independently by pilot and RIO and may be deselected independently. When the threat is no longer being reported, the ECM format is replaced by the previous format. If MFD 2 is not on, the ECM format is established on MFD 1. Only the spin indicator format can override the ECM format.

The ECM format can also be selected manually by pushbutton selection. The ECM legend appears on all MFD formats above PB17. When selected, the legend is boxed. Pressing PB17 with ECM boxed returns the previous format to the display. For further information, refer to NAVAIR 01-F14AAD-1A.

2.33.9.2 Warning/Caution/Advisory, System Message, and Advisory Formats. Warning/caution/advisory indications and data-link advisory readouts appear as overlays on displays as required. Figure 2-105 shows the locations of these overlays and describes their control laws.

Warning/caution/advisory indications are displayed on the MFD in the upper left readout, and data-link JTIDS advisories are displayed in the upper right readout. The readouts have the capability to present up to four indications at a time with each indication consisting of up to eight characters in length. When more than four indications are designated for display within a readout, the indications will cyclically scroll up from the bottom at a rate of one indication per second. The warning/caution/advisory indications are capable of being acknowledged and removed from the display whereas the data-link/JTIDS advisories are not acknowledgeable. When a warning/caution is displayed, the MASTER CAUTION light flashes and the READ MFD caution lights come on.

Systems messages are generated by the mission computer to alert the crew of system conditions. Two categories of system messages are displayed: computer messages (those that can appear on any MFD format), and OBC messages (those that can only appear on the OBC and maintenance current-failure display formats). The OBC and maintenance current-failure display formats are capable of supporting both categories of system messages simultaneously. The messages are



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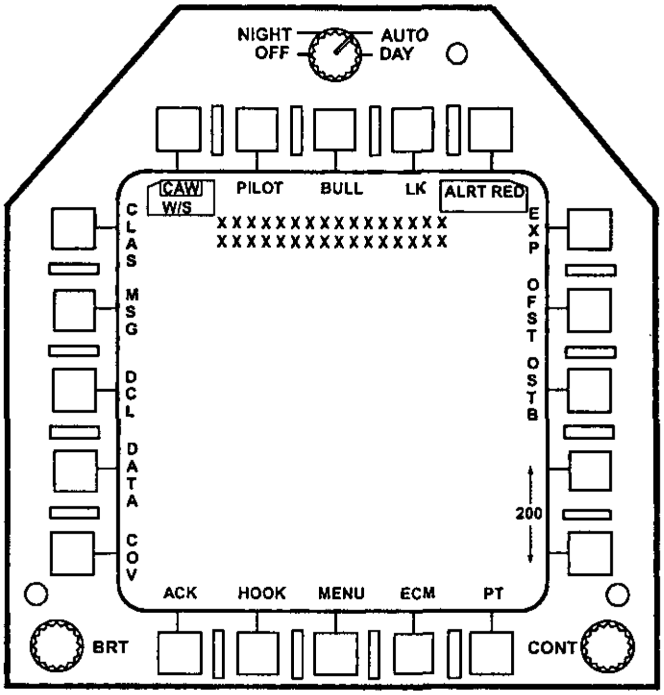
SYMBOL	FUNCTION
(1) Airspeed scale	Presents indicated airspeed in knots on a vertical tape.
(2) AOA scale	Presents angle–of–attack in units on a vertical tape.
(3) Altitude scale	Presents altitude in thousands of feet on a vertical tape. The display flashes when altitude is below 10,000 feet MSL.
(4) Engine stall indicator	Displays either R STALL on right side of MFD or L STALL on left side of MFD to indicate a stalled engine.
(5) Spin arrow	Displays an arrow pointing either left or right indicating direction of spin.
(6) Yaw rate scale	Moving carat indicates yaw rate in degrees per second against a stationary scale.

Figure 2-104. MFD Spin Indicator Display



SYMBOL	FUNCTION
(1) Warning/caution/ advisory readout	The warning/caution/advisory readout is referred to as the CAW box. The CAW box is selected on and off via PB6. When the CAW box is not displayed, the CAW select legend is displayed and boxed (CAW). The CAW box displays warning messages steady and bright, cautions at normal intensity flashing at a 3 Hz rate, and advisories at normal intensity and steady. If the caution is displayable in the pilot cockpit, pressing the MASTER CAUTION light causes the caution message to become steady.
(2) Computer message	The first row of ASCII characters is used to display the computer messages for all display formats. See figure 2−81.24 for a listing of these messages.
(3) Data link/JTIDS advisory readout	Provides display of data link/JTIDS advisories. The data link JTIDS advisory indications are not acknowledgeable. Indications that will be presented on the HUD and MFD and their logic are described in NAVAIR 01−F14AAD−1A.

Figure 2-105. MFD Warning/Caution/Advisory and Message Overlays (Sheet 1 of 2)

SYMBOL	FUNCTION
(4) OBC messages	The second row of ASCII characters is used to display the OBC messages on the OBC and maintenance current failure formats. See figure 2−81.24 for a listing of these messages.
(5) Acknowledge (ACK) pushbutton	The ACK pushbutton legend appears whenever a system message is displayed. When the ACK pushbutton is pressed the message will be removed from the MFD. System messages must be acknowledged before new messages can be displayed.

Figure 2-105. MFD Warning/Caution/Advisory and Message Overlays (Sheet 2 of 2)

displayed on the upper center portion of the MFD and consist of two rows of 19 ASCII characters, each row displaying a category of system messages. System messages (Figure 2-106) appear as required on the MFDs.They may be computer or OBC messages. When a system message is displayed an ACK (acknowledge) legend appears above PB20. System messages remain displayed until the ACK button is pressed. Should a subsequent message be sent while one is already being displayed, the first must be acknowledged before the next will be displayed.

2.33.9.3 Alphanumeric (Data) Formats. Many MFD formats have no symbols, but rather display navigation, alignment, weapon, avionics, and diagnostic data. Takeoff and landing checklists may also be selected. Use of such formats is explained in the chapter where it pertains. Data formats are identified by titles displayed just below the upper pushbutton legends. When a format is selected, its pushbutton legend is boxed. The following paragraphs describe these formats and how they are selected. Figure 2-107 shows a typical format.

1. RECON DATA — This format permits selection of reconnaissance waypoint and steering mode (point-to-point, commanded course, map) to waypoint; displays selected waypoint and mission data; and displays camera status. It is selected via PB8 from formats MENU2, RECON WPT DATA 1 and RECON WPT DATA 2.

2. RECON WPT DATA 1 — This format displays waypoint information for waypoints 1 through 10 as well as latitude, longitude, and altitude information for the selected waypoint. It is selected via PB7 (R-1) from formats RECON DATA and RECON WPT DATA 2.

3. RECON WPT DATA 2 — This format displays waypoint information for waypoints 11 through 20 as well as latitude, longitude, altitude information for the selected waypoint. It is selected via PB9 (R-2) from formats RECON DATA and RECON WPT DATA 1.

Note

See Chapter 22 for more information on reconnaissance formats.

4. TAKEOFF CHECKLIST — This format lists the items to be checked before takeoff; it is selected via PB9 (CHKLST) and PB7 (T/O) on the LANDING CHECKLIST format.

5. LANDING CHECKLIST — This format lists the items to be checked before landing; it is selected via PB7 (LDG) on the TAKEOFF CHECKLIST format.

6. OWN A/C formats — These formats consist of basic, ground, CVA (carrier align), and IFA (inflight align). OWN A/C basic displays own-ship data such as latitude, longitude, altitude, groundspeed, magnetic variation, true airspeed, navigation quality, wind speed and direction, barometer (altimeter) setting, and true heading. The other OWN A/C formats are alignment related and add alignment information to the basic format, including an alignment quality indicator scale. These formats are selected via PB1 (DATA) on MENU1, VDI, HSD, NAV AID, and SAHRS ALIGN formats. The format displayed depends on the alignment mode. As transitions occur between alignment modes, the formats will automatically change. On MFD 3, an alignment or INS mode transition will cause the current format to be replaced by an OWN A/C, CV DATA, or IFA format.

COMPUTER MESSAGE	PRIMARY MFD	SECONDARY MFD
NOT OPERATIONAL	(Note 7)	—
WAYPOINT INVALID	(Note 7)	—
TCN STEER INVALID	(Note 9)	—
SEL TACAN STEERING	(Note 7)	—
TEST COMPLETE–GGGGG (Note 1)	(Note 7)	—
PREFLT OBC COMPLETE	1,3	2 (Note 8)
INFLT OBC COMPLETE	1,3	2 (Note 8)
ALIGN SUSPENDED	1,3	2 (Note 8)
RETEST COMPLETE	1,3	2 (Note 8)
OBC SEQ ABORTED	1,3	2 (Note 8)
RETEST ABORTED	1,3	2 (Note 8)
OBC FAIL DETECTED	1,3	2 (Note 8)
INVALID WWWWW LOAD (Note 2)	1,3	2 (Note 8)
MC1 ERROR CODE XXX (Note 3)	1,3	2 (Note 8)
MC2 ERROR CODE XXX	1,3	2 (Note 8)
E BLOCK ADD SSSS (Note 4)	3	—
E FLYCH ADD SSSS	3	—
FLYCH EXISTS SSSS	3	—
E TRAP ADD SSSS NN (Note 5)	3	—
E 4 TRAPS SSSS NN	3	—
E TRAP VAR SSSS NN	3	—
E TRAP ALGO SSSS NN	3	—
E FLYCH INC SSSS	3	—
N FLYCH IN SSSS	3	—
E FLYCH DEC SSSS	3	—
NO TRAP NO. SSSS NN	3	—
TRAP TRU INB SSSS NN	3	—
ILS STEER INVALID	(Note 9)	—
ACL STEER INVALID	(Note 9)	—
D/L STEER INVALID	(Note 9)	—
TACAN NOT AVAIL	(Note 7)	—
SET PARKING BRAKE	1,3	2 (Note 8)
NO IFA/NO VEL	3	—
32 PLOTLINE DEFINED	3	—
E NOT AVAIL SSSS	3	—
DEST STEER INVALID	(Note 9)	—
MAN STEER INVALID	(Note 9)	—
DATA REQUIRED	13	2
PILOT OBC DISABLE	1	2

Figure 2-106. Computer and OBC Messages (Sheet 1 of 4)

COMPUTER MESSAGE	PRIMARY MFD	SECONDARY MFD
INTERLOCK ABORT	1,3	2 (Note 8)
RDR ALLOTMENT GFL	3	2
CHALLENGE IFF	3	2
INVALID PLOT WPT	3	2
VIDEO REC NOT AVAIL	3	—
VIDEO SWITCH ERROR	3	—
VIDEO REC LOST	3	—
ECM DATA INVALID	(Note 9)	—
BAD RWR LOAD	1,3 (Note 9)	2 (Note 8)
RDR CFL	3	—
ASPJ CFL GO TO SA	3	—
ASPJ CFL GO TO PH	3	—
ASPJ CFL GO TO SD	3	—
ASPJ CFL	3	—
AAAAA ALGN COMPL (Note 6)	3,1	2 (Note 8)
GB–NORM	3	—
GB–INIT ALIGN	3	—
GB–SLEW	3	—
GB–CARD ALIGN	3	—
GB–GND CAL COMPL	3	—
GB–SEA CAL COMPL	3	—
NO AIC – DSS LOAD	3	2 (Note 8)
NO AIC – NET ENTRY	3	2 (Note 8)
NO AIC – XMIT MODE	3	2 (Note 8)
NO AIC – NO RESPONSE	3	2 (Note 8)
NO AIC – REQ DENIED	3	2 (Note 8)
JTIDS NOT AVAIL	3	2 (Note 8)
NO LOAD – NEED DSS	3	2 (Note 8)
NO LOAD – DSS FAIL	3	2 (Note 8)
LOAD ERROR – JTIDS	3	2 (Note 8)
JTIDS FAIL DETECTED	3	2 (Note 8)
MCS FULLUP ENTERED	3,1	2 (Note 8)
MCS FULLUP AVAIL	3,1	2 (Note 8)
MCS COLD START	3,1	2 (Note 8)
NO CHNG RECON WPTS	1, 3	2 (Note 8)

Figure 2-106. Computer and OBC Messages (Sheet 2 of 4)

COMPUTER MESSAGE	PRIMARY MFD	SECONDARY MFD

Notes:

(1) through (6) indicates the range of the ADVISORY DATA from the application function and the corresponding ASCII strings:

(1) GGGGG		(3) XXX		0–999
1	AUX			
2	CD	(4) SSSS		
3	CNI		6	MDS1
4	FLT		8	CIU
5	NAV		9	DEU
6	EW		10	MC1
7	TAC		11	MDS2
8	IRST		12	ADAS
(2) WWWWW			13	SMS
1	MC1		15	MC2
2	MC2		16	IRST
4	DEU		17	SDIS
5	MDS1		18	JTIDS
6	MDS2	(5) NN	0–99	
7	RDR	(6) AAAAA		
8	CIU			
9	SAHR		1	INS
10	SMS		2	SAHRS
11	ADAC			
12	DSS			
13	ASPJ			
14	PWR			
15	IRST			
16	SDIS			

(7) The MFD these messages are presented on is the MFD from which the pushbutton causing the message is received or on other MFDs when unique display conditions exist.

(8) MFD 2 is secondary only when MFD 1 fails.

(9) These computer messages are displayed on all MFDs displaying a VDI format. If no VDI format is displayed on MFD 1 and MFD 2, this computer message is displayed on MFD 1 (provided no repeat format is displayed) with MFD 2 as a secondary when MFD 1 fails.

Figure 2-106. Computer and OBC Messages (Sheet 3 of 4)

COMPUTER MESSAGE	PRIMARY MFD	SECONDARY MFD
OBC/CSS Messages Removed After 3 Seconds WOW NOT SATISFIED TAS NOT SATISFIED MULTI INTLK NOT MET EQUIPMENT CONFLICT NO COMMAND BIT OBC SEQ IN PROGRESS RETEST IN PROGRESS		
OBC/CSS Messages Removed When Condition Change MASTER TEST NOT SET HANDBRAKE NOT SET		

Figure 2-106. Computer and OBC Messages (Sheet 4 of 4)

7. CV DATA formats — These formats consist of CV MAN DATA and CV SINS DATA. Data presented is similar to OWN A/C except that it includes additional information from manual entry or the ship's SINS. These formats are selected via PB3 (CV) on OWN A/C CVA and SAHRS ALIGN formats. The format displayed depends on whether or not data link is providing SINS data. PB5 (MAN) on the CV DATA format toggles between MAN and SINS.

8. IFA — This format presents similar data to OWN A/C and also provides for selection of inflight alignment. It is selected via PB4 (IFA) on the OWN A/C IFA format.

9. WPT DATA — This format displays latitude, longitude, and altitude data for the 100 system waypoints as well as own-aircraft and CVA INS/SAHRS data. It is selected via the WPTS PB (PB6) on any of the own-aircraft formats. It is also automatically displayed upon selecting ENT on the surface waypoint format. The format consists of 10 pages that present 10 waypoints each. The pages are selected via the "<_" and " _>" PBs (PB9 and PB10).

10. INS UPDATE — This format is used to update and correct INS information. Update data may be selected via radar, tacan, visual sighting, JTIDS, or HUD hooking. The format is selected via PB13 (UPDT) on the HSD formats as well as PB15 (SWP) on the SURFACE WPT format.

11. SURFACE WPT — This format permits the creation of new waypoints or the update of existing waypoints. It is selected via PB15 (SWP) on the INS UPDATE format.

12. NAV AID formats — The NAV AID formats, which consist of NAV AID OPTIONS, NAV AID CORRECTIONS, and NAV AID ENABLE, permit updating of navigational information for greater accuracy. The formats are selected via PB2 (NAV) on the HSD, OWN A/C, CV DATA, or IFA formats. The format displayed depends on the selection or deselection of alignment mode, continuous data source, and whether ENABLE (PB8 on NAV AID CORRECTIONS) was previously selected. PB7 (GEO/REL) is used to select which JTIDS navigation data is used for track corrections and continuous position updates.

13. SAHRS ALIGN formats — These formats SAHRS ALIGN (NORM, MAG, and SHDG) and SAHRS ALIGN (CV), permit selection of data to be used in SAHRS alignment. They are selected via PB2 (NAV) on the HSD, OWN A/C, CV DATA, or IFA formats. The format presented depends on alignment mode selection and SAHRS test status. Also, the display automatically transitions to a SAHRS ALIGN format from a NAV AID format when align mode changes from none or IFA to an alignment mode.

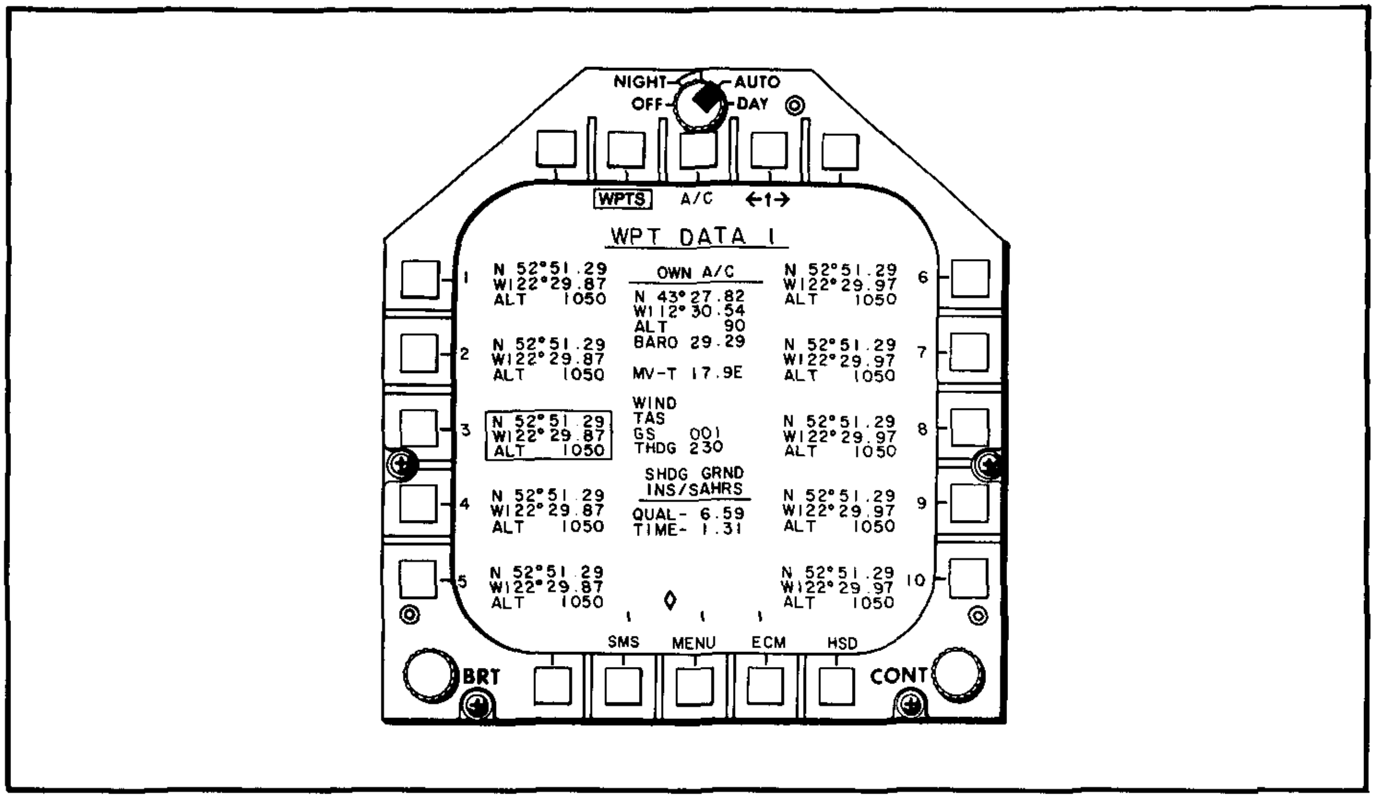


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Figure 2-107. Typical MFD Alphanumeric Format

Note

Refer to Chapter 20, for more information on navigation related formats.

14. MISSILE SUBSYSTEM formats — Two formats display the status of the missiles; refer to NAVAIR 01-F14AAD-1A.

15. OBC formats — There are 10 OBC formats. They are used to initiate BIT of the avionics equipment and to display test results. OBC basic presents an overall view of subsystem test results and allows for selection of the other OBC formats. It is selected via PB8 on the MENU1 format. It may also be selected from the other OBC formats by pressing the pushbutton for the boxed legend (the format being displayed). The legends on OBC basic show which groups of subsystems may be selected. The OBC subsystem formats display failures to the WRA level. A WRA legend is brightly displayed when awaiting test, is flashing during test, and is displayed at normal brightness after test. An alignment quality indicator appears on all OBC formats to inform the crew of the progress of the alignment while tests are being performed.

16. MAINTENANCE — Displays a list of current WRA failures. It is selected via PB9 (FAULT) on the OBC formats. It is also selected via PB3 (FHF) on the FAILURE HISTORY FILE and PB4 (CSS) on the COOPERATIVE SOFTWARE SUPPORT format. These legends appear boxed before selection.

17. FAILURE HISTORY FILE — The FHF format lists the WRA failures, the type of failure, if this information is available to the MCS, and the time of up to 10 failure occurrences since the file was cleared. This format is available via PB3 (FHF) on the MAINTENANCE and CSS formats.

18. COOPERATIVE SOFTWARE SUPPORT — The CSS format is a diagnostic tool that can be used by maintenance personnel to troubleshoot system and WRA anomalies. It is selected via PB4 (CSS) on the MAINTENANCE and FHF formats.

Note

Chapter 38 includes a complete description of the OBC, MAINTENANCE, FHF, and CSS formats with a discussion of their use and interpretation.

19. IRSTS SUMMARY — This format, which is used in conjunction with other IRSTS formats, provides information on the hooked IRSTS target. It can be selected via PB13 (SMY) on the IRSTS NORMAL and IRSTS CSCAN formats.

20. JTIDS DATA formats — There are four alphanumeric JTIDS data formats. They are the OWN A/C DATA, F-14D PPLI, Non-F-14D PPLI, and TARGET formats. The OWN A/C format displays own-ship PPLI data and JTIDS status. The PPLI formats display the data received for the hooked PPLI. The TARGET format displays data associated with a hooked target (radar, IRST, or JTIDS). The PPLI and TARGET formats are available for a hooked symbol on either the TSD or TID.

2.33.9.4 VDI Formats. The VDI presentation on the MFD provides essentially the same information as that displayed on the HUD. However, in order to more easily distinguish between ground, horizon, and sky, shading simulation is used. The format is generated by internal raster scanning with the sky being presented lighter than the ground.

VDI formats consist of TLN basic, TLN AWL, TLN data link, TLN destination, TLN manual, TLN tacan, A/A basic, A/A Phoenix search, A/A Phoenix track, A/A Sparrow search, A/A Sparrow track, A/A Sidewinder search, A/A Sidewinder track, A/A gun, A/G, and TWS and recon overlays.

2.33.9.4.1 VDI TLN Formats. With TLN selected on the PDCP (TLN MODE button depressed), selecting VDI via PB5 on the MENU1 or RECON DATA formats presents one of a number of TLN formats on the MFD from which the selection was made. The format displayed will depend on whether a steering mode has been previously selected. Initially TLN basic, the MFD 1 default format, is used to select the steering mode. When any steering mode (all weather landing, tacan, destination, data link, or manual) is selected, formats on both the HUD and MFD change to accommodate the selection. These other VDI TLN formats have pushbutton selections to change the steering mode. When steering is selected, a heading command scale is added as well as steering aids such as steering vectors, indicators, range, and breakaway symbols. There is one level of declutter on VDI formats that adds a waterline symbol and removes information such as airspeed, altitude, barometric pressure setting, etc. Figure 2-108 identifies and describes TLN symbol functions in various steering and tracking modes. The last example in Figure 2-108 illustrates VDI declutter. Refer to Figure 2-108 for a listing of symbols available on VDI TLN formats in normal and declutter modes.

2.33.9.4.2 VDI Air-to-Air (A/A) Formats. With A/A selected on the PDCP (A/A MODE button depressed), one of a number of VDI A/A formats will appear when VDI is selected on an MFD from the MENU1 or RECON DATA format. The actual format that is presented depends on which weapon has been selected. With no weapon selected, the A/A basic format is presented. Most symbols are common between VDI formats and have been shown in Figure 2-109. Figure 2-110 describes additional target symbology and data that is provided in VDI A/A formats.

Unlike HUD A/A formats that have unique search symbols depending on weapon selection, all VDI A/A search formats are identical except for the weapon select legends. VDI basic, gun, and missile track formats add a steering "T," range bar, and target aspect symbols as well as target range, altitude, and closing velocity and DD selected range digital information. The missile tracking formats also add maximum, optimum, and minimum range symbols to the range bar and an allowable steering error circle. Figure 2-111 lists the symbols available on VDI A/A formats.

2.33.9.4.3 VDI Air-to-Ground (A/G) Formats. When VDI is selected from the MENU1 or RECON DATA format with the A/G MODE button on the PDCP selected, that MFD displays the VDI A/G format. Unlike HUD A/G formats, the VDI A/G format does not have target, aiming, gun, or pullup information, nor does it have any unique VDI symbols other than the A/G select legend. Figure 2-111 shows the A/G symbol set and Figure 2-112 shows the format.

Note

In A/G mode the basic VDI symbology and format will generally be the same as TLN with the following differences: (1) selection of manual, tacan, and all-weather landing steering modes will not be provided; (2) the waterline reference dot and the heading and course select settings will not be displayed; and (3) the pitch/flightpath ladder will be compressed and modified.

2.33.9.4.4 VDI Overlay Formats. The MFD VDI overlay formats are track while scan (TWS), infrared search and tracking system-TWS (IRSTS-TWS), and reconnaissance.

TLN BASIC

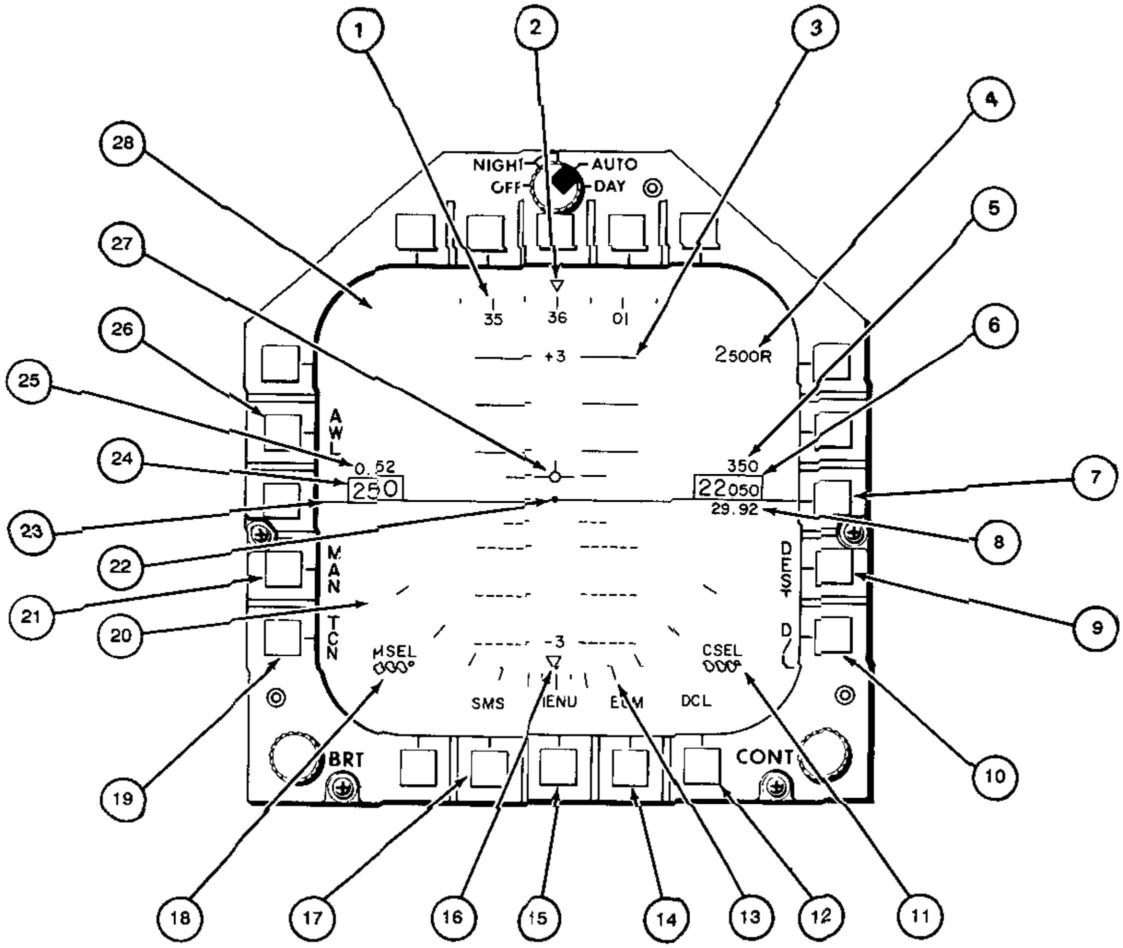

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Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 1 of 9)

SYMBOL		FUNCTION
1	Heading scale	Aircraft magnetic heading is indicated by the moving 360° heading scale. In TLN, the major divisions are numbered every 10 degrees.
2	Heading pointer	Actual aircraft heading is displayed below the stationary heading pointer.
3	Pitch/flight path ladder	Ladder displays aircraft climb/dive angle and roll angle. Aircraft vertical flight path angle is indicated by the position of the flight path marker on the pitch/flight path ladder. Positive pitch lines are solid and negative pitch lines are dashed. To aid in determining flight path angle when it is changing rapidly, the pitch lines are angled toward the horizon at an angle half that of the flight path angle. For example, in a 40° climb, the pitch lines are angled 20° toward the horizon. UP appears at +90° and DOWN appears at −90°.
4	Radar altitude indicator	Displays radar altitude when the aircraft is below 5,000 ft AGL. When radar altitude is selected for display on the HUD and MFD (via the switch located on the pilot display control panel) the radar altitude indicator will be decluttered from the display.
5	Vertical velocity	Displays aircraft rate of climb/descent. Descent will be indicated by a *negative (−) sign.*
6	Altitude	Barometric or radar altitude may be displayed depending on the source of data. When the ALTITUDE switch is in BARO, barometric altitude is displayed. When the ALTITUDE switch is in RDR, radar altitude is displayed and is identified by an R next to the altitude. If the radar altitude is invalid, barometric altitude will be displayed and a B next to the altitude will be flashed to indicate that barometric altitude is being displayed rather than radar altitude. The bottom of the altitude box is positioned at the waterline *reference position.*
7	BARO pressure setting pushbutton	Enables display of the barometric pressure setting used by the display system and the weapon system. Successive depression of the pushbutton will cause the setting to alternately appear and disappear.
8	Barometric pressure setting	The barometric pressure setting used by the display system and the weapon system is the value set via pilot's barometric altimeter. When the BARO setting is changed , the BARO setting will be momentarily displayed for 5 seconds after the change is made.
9	DEST steering pushbutton	Enables selection of the destination steering mode.
10	D/L steering pushbutton	Enables selection of the data link steering mode.
11	Course select setting	Indicates the magnetic course selected by the pilot via the COURSE knob.
12	DCL pushbutton	In TLN, selection of the declutter button removes the airspeed Mach number, altitude, vertical velocity and heading and course line settings, and adds waterline reference indicators. Selection of the declutter option is indicated by a box around the pushbutton.

Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 2 of 9)

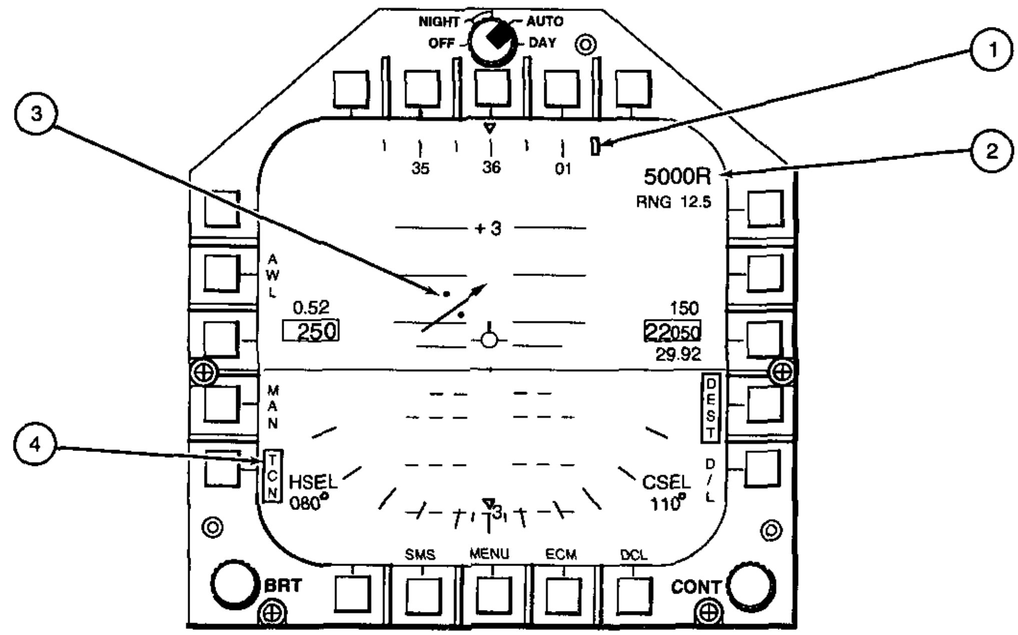
SYMBOL	FUNCTION
(13) Bank scale	Provides indication of bank angle to 60°. Marks are provided at 0°, 5°, 10°, 20°, 30°, 45° and 60°.
(14) ECM display pushbutton	Enables the presentation of the threat display. Once depressed, subsequent depression of the ECM pushbutton will return the display to the VDI display. This will permit a quick look at the threat display and provide a quick return to the VDI display.
(15) MENU display pushbutton	Depression of menu will result in the MENU list to appear in the border area of the VDI display for subsequent selection.
(16) Bank angle pointer	Moving pointer provides indication on aircraft bank angle. At bank angles in excess of 65° the pointer will be removed from the display.
(17) SMS display pushbutton	Enables the presentation of the SMS display. Once depressed, subsequent depressing of the SMS pushbutton will return the display to the VDI display. This will permit a quick look at the SMS display and provide a quick return to the VDI display.
(18) Heading select setting	Indicates the magnetic heading selected by the pilot.
(19) TCN steering pushbutton	Enables selection of the tacan steering mode.
(20) Ground plane	The dark shaded ground plane.
(21) MAN pushbutton	Enables selection of the manual steering mode.
(22) Waterline reference dot	In TLN, fixed dot appears at the optical center to denote the waterline reference position.
(23) Horizon	Denotes demarcation between the ground and the sky. It represents the horizon with respect to the aircraft and changes orientation with any change in aircraft pitch or roll.
(24) Airspeed	Provides display of indicated airspeed. The bottom of the airspeed box is positioned at the waterline reference position.
(25) Mach number	Provides display of aircraft speed in mach to the nearest hundredth.
(26) AWL steering pushbutton	Enables selection of the all weather landing (AWL) steering mode. Selection permits option to display either ACL, ILS, both or no steering information on the VDI and/or HUD. **Note** With VDI on MFD 3, AWL selection is possible, but deselection is inhibited.

Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 3 of 9)

SYMBOL	FUNCTION
(27) Flight path marker	The vertical position of the flight path marker with respect to the flight path ladder indicates the vertical flight path angle of the aircraft.
(28) Sky plane	The shaded area represents the sky.
TLN TACAN STEERING	**Note** The following changes or additions occur when tacan steering is selected.
(1) Command heading marker	Command heading marker is positioned relative to the magnetic heading scale. Where commanded heading is beyond display scale limits, the marker will be pegged at the edge nearest to the commanded heading.
(2) Tacan range	Indicates distance to the selected tacan station.
(3) Course arrow	The course arrow represents the pilot selected course to the tacan station. Two dots will appear on the side of the flight path marker toward the course arrow and perpendicular to the arrow. The dot closest to the flight path marker represents a deflection of 4° off course, while the outermost dot represents a deflection of 8° off course. When the aircraft crosses the selected course, the arrow moves to the opposite side of the flight path marker and the dots would appear on that side. For deviations of more than 9°, the arrow pegs. If the arrow is centered on course, the dots disappear. flight path marker centered over the course arrow indicates being on course. For tacan bearings aft of +90°, the arrow will be dashed.
(4) Tacan steering mode selection	Box around TCN pushbutton legend indicates the tacan steering mode has been selected.
TLN DEST STEERING	**Note** The following changes or additions occur when destination steering is selected.
(1) Command heading marker	Indicates the heading required to steer to the waypoint destination selected by the RIO. Where commanded heading is beyond display limits, the marker will be pegged at the edge nearest to the commanded heading.
(2) Destination range	Indicates distance to the selected waypoint.
(3) DEST steering mode selection	Box around dest pushbutton legend indicates the destination steering mode has been selected.

Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 4 of 9)

TLN TACAN STEERING



TLN DESTINATION STEERING

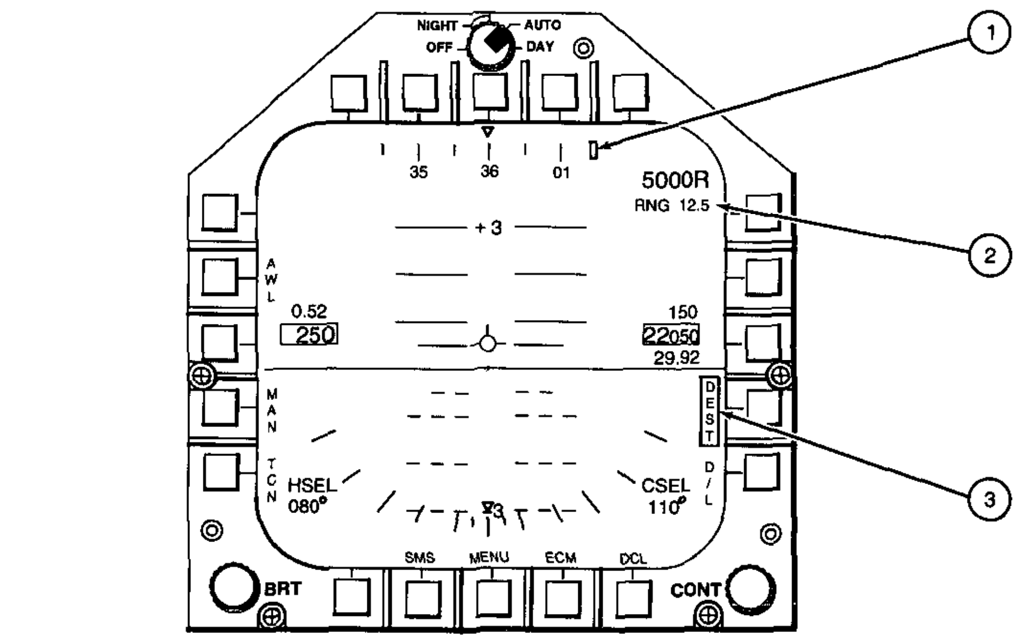


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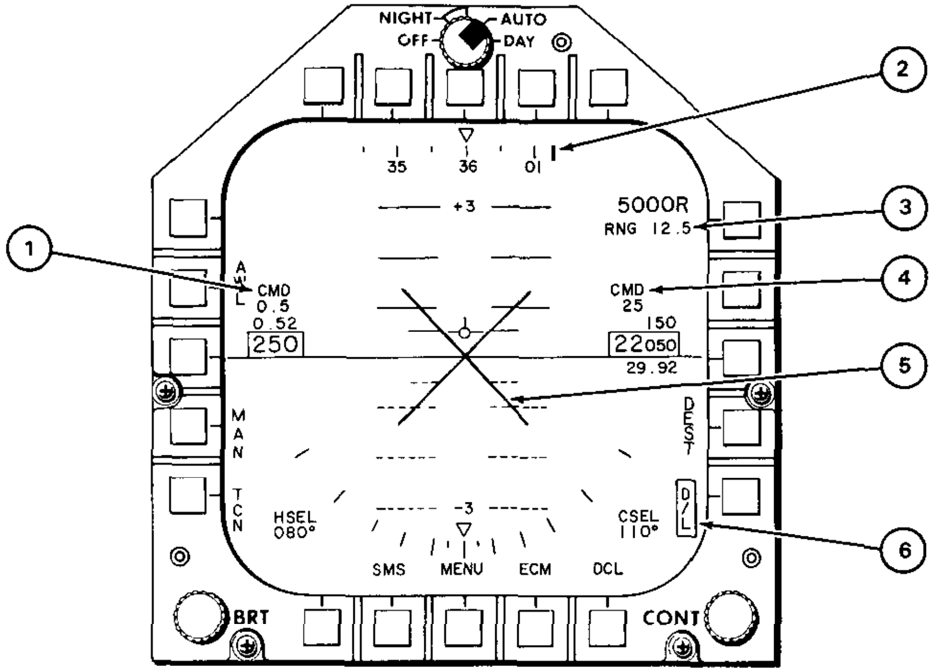
Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 5 of 9)

TLN DATA LINK STEERING



TLN AWL STEERING

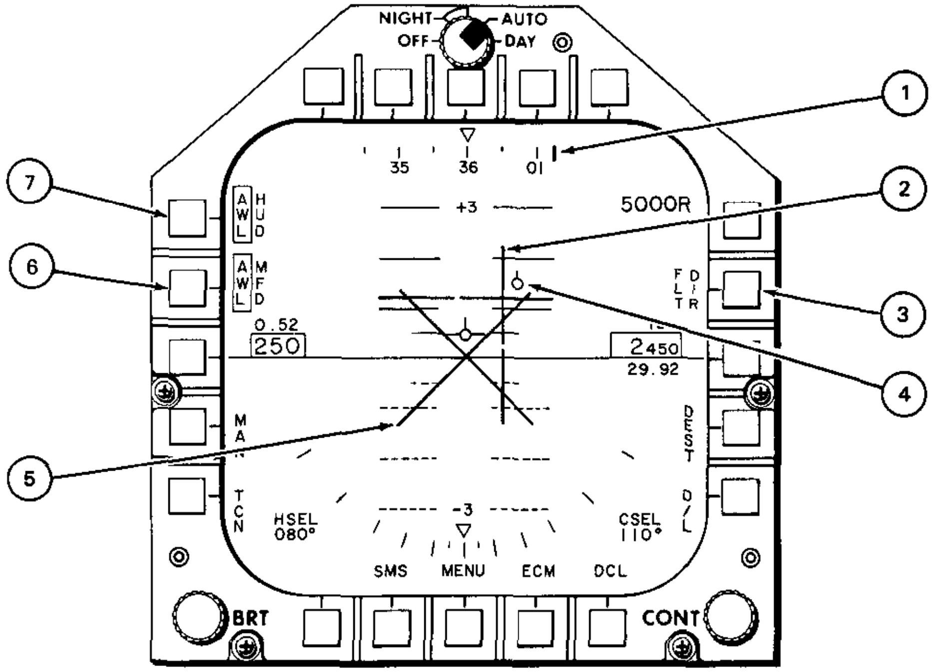


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Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 6 of 9)

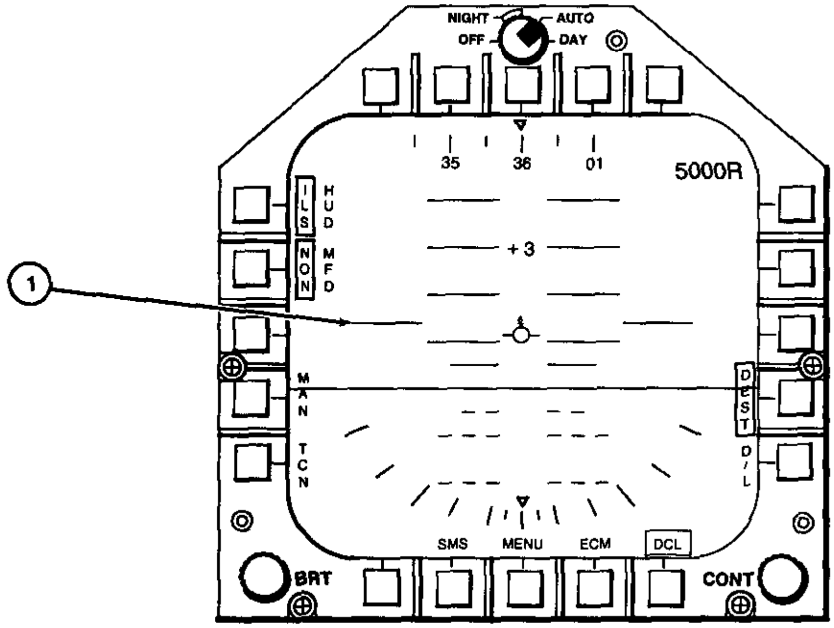
SYMBOL	FUNCTION
TLN DATA LINK STEERING	**Note** The following changes or additions occur when data link steering is selected.
(1) Command Mach Indicator	Indicates data link commanded mach number.
(2) Command heading marker	Command heading marker is positioned relative to the magnetic heading scale to indicate data link command heading. Where commanded heading is beyond display scale limits, the marker will be pegged at the edge nearest to the commanded heading.
(3) Data link range	Indicates data link commanded range.
(4) Command altitude indicator	Indicates data link commanded altitude. The two digits displayed represent thousands of feet.
(5) Breakaway	Appears as a flashing symbol in the center of the display. Symbol is commanded by data link to indicate an immediate change in flight path is warranted.
(6) D/L steering mode selection	Box around D/L pushbutton legend indicates the data link steering mode has been selected.

Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 7 of 9)

SYMBOL	FUNCTION
TLN AWL STEERING	**Note** The following changes or additions occur when AWL steering is selected.
(1) Command heading marker	Positioned relative to the magnetic heading scale to indicate ACL data link command heading. Where commanded heading is beyond display scale limits, the marker will be pegged at the edge nearest to the commanded heading.
(2) Precision course vectors	Consist of two independent vectors (vertical and horizontal) which form a cross pointer. The horizontal vector responds to ILS glide slope error and the vertical vector responds to ILS localizer error. Null/center indications are provided to enable the pilot to null the error and keep the vertical and horizontal needles centered.
(3) Flight Director select	The pilot's FLT DIR pushbutton controls the display of the flight director on the HUD. The FLT DIR pushbutton legend is displayed on the AWL VDI format when valid navigation data is available and a/c vector or ACL data link mode is selected. The pushbutton will toggle between boxed and unboxed upon selection if the data link mode is ACL. The HUD flight director is displayed when the FLT DIR pushbutton is boxed if the autopilot is not engaged and MODE I control commands are being sent to the aircraft. Boxing the FLT DIR legend enables display of the flight director.
(4) ACL steering indicator	Provides ACL steering commands driven by the ASW−27C data link.
(5) Waveoff	During carrier landings, a large X will appear flashing in the center of the display to indicate a waveoff command.
(6) MFD AWL display select	Permits option to display AWL (both ACL and ILS), ACL, ILS or no steering information on the MFD. Initial selection of the AWL steering mode on the basic VDI format displays both ACL and ILS steering information on the MFD. This will be indicated by AWL in the box adjacent to the MFD legend. Successive depression of the pushbutton cycles AWL, ACL, ILS and no steering information on the MFD in that order.
(7) HUD AWL display select	Permits option to display AWL (both ACL and ILS), ACL, ILS, or no steering information on the HUD. Initial selection of the AWL steering mode on the basic VDI format displays both ACL and ILS steering information on the HUD. The HUD flight director is displayed when the FLT DIR pushbutton is boxed (only available when the autopilot is not engaged) and flight director commands are being sent to the aircraft. Boxing the FLT DIR legend enables display of the flight director. If the pilot intends to make a MODE I approach, he must advise the ground controller of his intentions. The ground controller will then disable the flight director commands and enable the autopilot commands. Until this is done, the pilot will not have the capability to couple the autopilot to the ACLS commands. The only information that is displayed on the HUD during MODE I approaches is the ACLS tadpole situation information and the ILS needles situation information.

Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 8 of 9)

TLN AWL DECLUTTER



NOTE

SELECTION OF THE DECLUTTER OPTION IN THE TLN AWL STEERING MODE REMOVES THE AIRSPEED, MACH NUMBER, ALTITUDE, VERTICAL VELOCITY AND HEADING AND COURSE LINE SETTINGS, AND ADDS THE WATERLINE REFERENCE BARS.

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SYMBOL	FUNCTION
TLN AWL DECLUTTER	
(1) Waterline reference indicators	The waterline reference indicators are displayed when DCL is selected and indicate the fuselage reference line.

Figure 2-108. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 9 of 9)

SYMBOL	FORMAT					
	BASIC	AWL	DATA LINK	DESTINATION	MANUAL	TACAN
Aircraft Readout & Box	(On all formats except when DECLUTTER)					
Altitude Readout and Box	(On all formats except when DECLUTTER)					
Bank Scale	+	+	+	+	+	+
Baro Setting Readout	(On all formats except when DECLUTTER)					
Course Line Setting–CSEL, #	(On all formats except when DECLUTTER)					
Heading Select Point Setting–HSEL, #	(On all formats except when DECLUTTER)					
Heading Scale	+	+	+	+	+	+
Horizon/Ground Plane	+	+	+	+	+	+
Ground/Sky Texture	+	+	+	+	+	+
Ground Perspective Lines	+	+	+	+	+	+
Mach Readout	(On all formats except when DECLUTTER)					
Pitch Ladder–VDI	+	+	+	+	+	+
Radar Altitude Readout	+	+	+	+	+	+
Flight Path Marker	+	+	+	+	+	+
Vertical Velocity Readout	(On all formats except when DECLUTTER)					
Altitude Source–'B' or 'R'	(On all formats except when DECLUTTER)					
MFD Cursor	+	+	+	+	+	+
VDI Center	+	+	+	+	+	+
Caution/Advisory/Warning	+	+	+	+	+	+
Breakaway Symbol	o	+	+	o	o	o
Command Heading marker	o	+	+	+	+	+
Command Alt Data Link–CMD, #	o	o	+	o	o	o

Figure 2-109. MFD VDI Symbology Available on TLN Formats (Sheet 1 of 2)

SYMBOL	FORMAT					
	BASIC	AWL	DATA LINK	DESTINATION	MANUAL	TACAN
Command Mach–CMD, #	o	o	+	o	o	o
MFD Steering Legend–AWL	+	o	+	+	+	+
MFD Steering Legend–TCN	+	+	+	+	+	+
MFD Steering Legend–D/L	+	+	+	+	+	+
MFD Steering Legend–MAN	+	+	+	+	+	+
MFD Steering Legend–DEST	+	+	+	+	+	+
MFD Steering Legend–AWL/HUD	o	+	o	o	o	o
MFD Steering Legend–AWL/MFD	o	+	o	o	o	o
HUD FLT DIR Legend–FLT DIR	o	+	o	o	o	o
VDI DECLUTTER Legend–DCL	+	+	+	+	+	+
Format Select Legend–SMS	+	+	+	+	+	+
Format Select Legend–MENU	+	+	+	+	+	+
Format Select Legend–ECM	+	+	+	+	+	+
Baro PB Legend–B	+	+	+	+	+	+
PB Legend Crossouts	+	+	+	+	+	+
Waterline	(Added to all formats during DECLUTTER)					
ILS Precision Course Vectors	o	+	o	o	o	o
Range Readout–RNG, #	o	o	+	+	o	+
ACL Steering Indicator Tadpole	o	+	o	o	o	o
Course Arrow & Deviation Dots	o	o	o	o	o	+

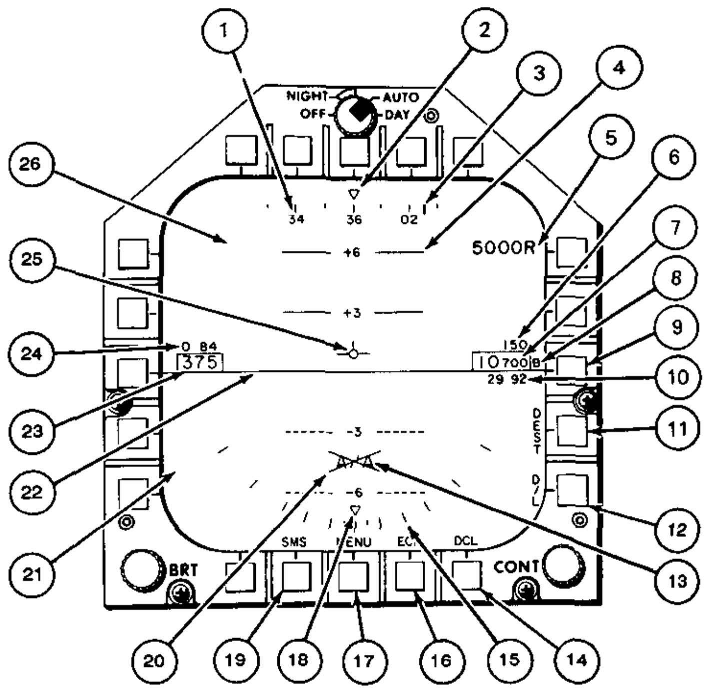
Note:

'+' indicates that the symbol is available for display on the selected format.

'o' indicates that the symbol is not available for display on the selected format.

Figure 2-109. MFD VDI Symbology Available on TLN Formats (Sheet 2 of 2)

A/A BASIC — SEARCH MODE



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SYMBOL	FUNCTION
A/A Basic – Search	**Note** In A/A search mode and no weapon selected, the basic VDI symbology and format will generally be the same as TLN with the following differences: (1) selection of manual, tacan and all weather landing steering modes will not be provided; (2) the waterline reference dot and the heading and course select settings will not be displayed; (3) the heading scale numerics will be provided at 20 degree intervals, and (4) the pitch/ flight path ladder will be compressed and modified.
1 Heading scale	Aircraft magnetic heading is indicated by the moving 360° heading scale in A/A. The major divisions are numbered every 20 degrees.
2 Heading pointer	Actual aircraft heading is displayed below the stationary pointer.
3 Command heading marker	Positioned along the heading scale to correspond with the command heading.

Figure 2-110. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 1 of 6)

SYMBOL	FUNCTION
(4) Pitch/flight path ladder	Ladder displays aircraft climb/dive angle and roll angle. Aircraft vertical flight path angle is indicated by the position of the flight path marker on the pitch/flight path ladder. Positive pitch lines are solid and negative pitch lines are dashed. To aid in determining flight path angle when it is changing rapidly, the pitch lines are angled toward the horizon at an angle half that of the flight path angle. For example, in a 40° climb the pitch lines are angled 20° toward the horizon. UP appears at +90 and DOWN appears at −90. The VDI pitch ladder will always be caged.
(5) Radar altitude indicator	Displays radar altitude when the aircraft is below 5,000 ft AGL. When radar altitude is selected for display on the HUD and MFD (via the switch located on the pilot display control panel), the radar altitude indicator will not be displayed.
(6) Vertical velocity	Displays aircraft rate of climb/descent in feet per minute. Descent will be indicated by a negative (−) sign. Absence of the negative sign indicates a positive value.
(7) Altitude	Barometric or radar altitude will be displayed depending on the source of data. When the ALTITUDE switch is in RDR, radar altitude will be displayed and will be identified by an R next to the altitude. If the radar altitude is invalid, barometric altitude will be displayed and a B next to the altitude will be flashed to indicate that barometric altitude is being displayed rather than radar altitude. The bottom of the altitude box will be positioned at the waterline reference position.
(8) Altitude source	Indicates source of altitude data.
(9) Barometric pressure setting pushbutton	In A/A and A/G, pushbutton enables momentary display of the barometric pressure setting on the pilot's altimeter. The setting will appear for 5 seconds each time the pushbutton is depressed. However, in TLN the barometric pressure setting will be displayed continuously on the HUD and VDI.
(10) Barometric pressure setting	The barometric pressure setting used by the display system and weapon system is the value entered. When the baro setting is changed on the DEU in the A/A and A/G mode, the baro setting will be momentarily displayed for 5 seconds after the change is made or will appear for 5 seconds when the barometric pressure setting pushbutton is depressed. It will also appear and flash for 5 seconds when the aircraft drops below 10,000 feet, 300 knots.
(11) DEST steering button	Enables selection of the destination steering mode.

Figure 2-110. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 2 of 6)

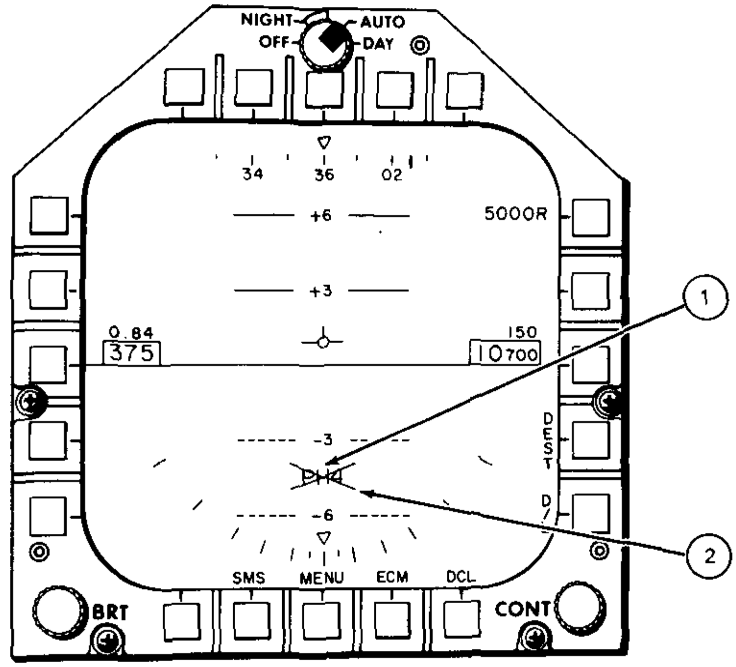
SYMBOL	FUNCTION
(12) D/L steering pushbutton	Enables selection of the data link steering mode.
(13) A/A mode selection legend	Indicates selection of the A/A mode.
(14) Declutter (DCL) pushbutton	In A/A, selection of the declutter option removes the indication of airspeed, Mach number, altitude and vertical velocity from the display, and adds waterline reference indicators. Selection of the declutter option is indicated by a box around the pushbutton legend.
(15) Bank scale	Provides indication of bank angle to ±60°. Marks are provided at 0°, ±5°, ±10°, ±20°, ±30°, ±45° and ±60°.
(16) ECM pushbutton	Enables the presentation of the threat display once depressed. Subsequent depression of the ECM pushbutton will return the display to the previous format. This will permit a quick look at the threat display and provide a quick return to the previous format.
(17) MENU pushbutton	Depression of MENU will result in the MENU list to appear in the border area of the display. Subsequent depression of the pushbuttion will result in the alternate presentation of the MENU1 and MENU2 list in the border area of the display.
(18) Bank angle pointer	Moving pointer provides indication of aircraft bank angle. At bank angles in excess of 65° the pointer will be removed from the VDI display.
(19) SMS pushbutton	Enables the presentation of the SMS display once depressed. Subsequent depression of the SMS pushbutton will return the display to the previous format. This will permit a quick look at the SMS display and provide a quick return to the previous format.
(20) Master arm switch safe indication	An X through the A/A mode selection legend indicates that the master arm switch is in the safe position.
(21) Ground plane	The dark shaded ground plane.
(22) Horizon	Denotes demarcation between the ground and the sky. It represents the horizon with respect to the aircraft and changes orientation with any change in aircraft pitch and roll.

Figure 2-110. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 3 of 6)

SYMBOL	FUNCTION
(23) Airspeed	Provides display of indicated airspeed. The bottom of the airspeed box is positioned at the waterline reference position.
(24) Mach number	Provides display of aircraft speed in Mach to the nearest hundredth.
(25) Flight path marker	The vertical position of the flight path marker with respect to the pitch ladder indicates the vertical flight path angle of the aircraft.
(26) Sky plane	The light shaded area represents the sky.
A/A Weapon – Search	**Note** When a weapon has been selected for launch in the A/A search mode the basic VDI symbology and format will generally be the same as A/A search mode with no weapon selected. The selection of the missile type and quantity of ready missiles will replace the A/A mode selection legend and the master arm switch safe indication will appear as appropriate.
(1) Selected weapon type and quantity indication	Indicates which missile has been selected for launch via the weapon select switch, the type and the quantity available for launch are displayed. Selections are PH (Phoenix), SP (Sparrow), SW (Sidewinder), and G (gun).
(2) Master arm switch safe indication	An X through the weapon type and quantity indicates that the master arm switch is in the safe position.
A/A Weapon – Radar STT	**Note** When a weapon has been selected for launch in the A/A radar single target track (STT) mode and the radar target is FONO 1, the basic VDI symbology and format will generally be the same as the A/A radar STT mode with no weapon selected. Selection of a missile in radar STT will enable the display of an allowable steering error (ASE) circle, range bar and DD range scale selection.
(1) Range bar	The range bar is a fixed length vertical bar range scale against which maximum, minimum and present range of the radar STT FONO 1 target may be displayed. Scaling changes are determined by DD selection. Scaling is for 200, 100, 50, 20, 10, and 5 miles. The range bar moves sideways as a function of target azimuth. The upper tic represents maximum range. The middle tic represents optimum range and the lower tic represents minimum range. The circle represents the target and moves vertically as a function of range. Target aspect is represented by a pointer which points in the direction of the aspect angle. Zero target aspect is straight down.

Figure 2-110. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 4 of 6)

A/A WEAPON — SEARCH MODE



A/A WEAPON — RADAR STT MODE

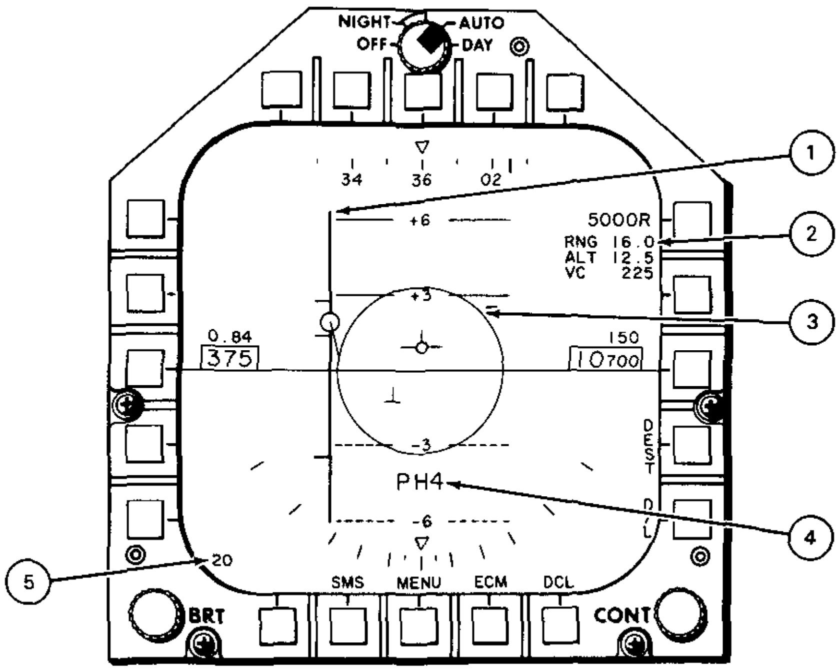


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Figure 2-110. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 5 of 6)

SYMBOL	FUNCTION
(2) Radar STT FONO 1 target data	Range, altitude and closing velocity of the radar STT FONO 1 target will be presented.
(3) Allowable steering error circle	ASE circle indicates the steering error allowed for launching a missile. Size of the circle is variable and is determined by the magnitude of the allowable error.
(4) Selected weapon type and quantity indication	When missiles are selected for launch via the weapon select switch, the type and the quantity available for launch are displayed. An X through the indication will signify that the master arm switch is in the safe position.
(5) DD range scale indication	Readout provides indication of RIO's DD range scale selection of 5, 10, 20, 50, 100, or 200 miles.

Figure 2-110. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 6 of 6)

SYMBOL	FORMAT							
	BASIC	PHOENIX		SPARROW		SIDEWINDER		GUN
		SEARCH	TRACK	SEARCH	TRACK	SEARCH	TRACK	
Aircraft Readout & Box	(On all formats except when DECLUTTER)							
Altitude Readout and Box	(On all formats except when DECLUTTER)							
Bank Scale	+	+	+	+	+	+	+	+
Baro Setting Readout	(On all formats except when DECLUTTER)							
Heading Scale	+	+	+	+	+	+	+	+
Horizon Line, Ground Plane	+	+	+	+	+	+	+	+
Command Altitude D/L	+	+	+	+	+	+	+	+
Command Mach	+	+	+	+	+	+	+	+
Pitch Ladder	+	+	+	+	+	+	+	+
Radar Altitude Readout	+	+	+	+	+	+	+	+
Flight Path Marker	+	+	+	+	+	+	+	+
Vertical Velocity Readout	(On all formats except when DECLUTTER)							
Altitude Source – 'B' or 'R'	(On all formats except when DECLUTTER)							

Figure 2-111. MFD VDI Symbology Available on Air-to-Air and Air-to-Ground Formats (Sheet 1 of 2)

SYMBOL	FORMAT							
		PHOENIX		SPARROW		SIDEWINDER		
	BASIC	SEARCH	TRACK	SEARCH	TRACK	SEARCH	TRACK	GUN
Mach Readout	(On all formats except when DECLUTTER)							
MFD Cursor	+	+	+	+	+	+	+	+
Warning/Caution/Advisory	+	+	+	+	+	+	+	+
Breakaway Symbol	+	+	+	+	+	+	+	+
Command Heading Marker	+	+	+	+	+	+	+	+
Select Legends, Weapon–Qty	A/A	PH#	PH#	SP#	SP#	SW#	SW#	G#
Sky Texture	+	+	+	+	+	+	+	+
Push Button Legend–SMS	+	+	+	+	+	+	+	+
Push Button Legend–MENU	+	+	+	+	+	+	+	+
Push Button Legend–ECM	+	+	+	+	+	+	+	+
Push Button Legend–D/L	+	+	+	+	+	+	+	+
Push Button Legend–DEST	+	+	+	+	+	+	+	+
Push Button Legend–DCL	+	+	+	+	+	+	+	+
BARO PB Legend – B	+	+	+	+	+	+	+	+
PB Legend Crossout	+	+	+	+	+	+	+	+
Master Arm Safe Cue	+	+	+	+	+	+	+	+
Waterline	(Added to all formats during DECLUTTER)							
Steering Range–RNG, #	o	+	+	+	+	+	+	+
Steering Tee	+	o	+	o	+	o	+	+
Range Bar	+	o	+	o	+	o	+	+
Max/Min/Opt* Range	o	o	+	o	+	o	+	o
Target Range Heading	+	o	+	o	+	o	+	+
Target Range Numeric	+	o	+	o	+	o	+	+
Target Closing Velocity	+	o	+	o	+	o	+	+
A/A Target Altitude	+	o	+	o	+	o	+	+
DD Selected Range	+	o	+	o	+	o	+	+
ASE Circle	o	o	+	o	+	o	+	o

Note

'+' indicates that the symbol is available for display on the selected format.

'o' indicates that the symbol is not available for display on the selected format.

* Sidewinder does not display opt range.

Figure 2-111. MFD VDI Symbology Available on Air-to-Air and Air-to-Ground Formats (Sheet 2 of 2)

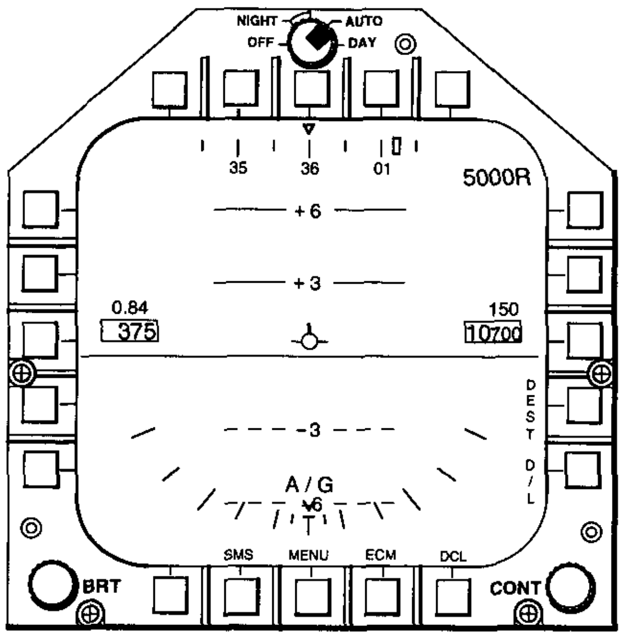

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Figure 2-112. MFD VDI Air-to-Air (A/G) Format

When RECON is selected from the RECON DATA formats, reconnaissance symbols are overlaid on the HUD and any MFD (Figure 2-113) that is displaying a VDI format. An exception is when a weapon has been selected; then only the MFD displays the overlay.

When radar detects a valid target, a priority target diamond is overlaid on VDI formats. The diamond's lateral position indicates the target's position relative to own aircraft and the angular scaling is the same as the VDI A/A pitch ladder. The diamond vertical position indicates target altitude relative to own aircraft and the scaling is 10,000 feet/0.8 inch. (The distance between pushbuttons is 0.8 inch.) A target at the horizon line would be at the same altitude as own aircraft. Up to four target diamonds may be displayed at one time. Unlike the HUD diamonds, which are sized to indicate target proximity, VDI target diamonds are the same size. Target range in nautical miles is shown by the numbers appearing directly above the symbol. The radar target overlay example in Figure 2-114 shows the radar TWS mode and is overlaid on an A/A basic format.

When the IRSTS detects valid targets, IRSTS triangles are overlaid on VDI formats. Position scaling is the same as that of radar priority target diamonds. However, since range cannot be accurately determined by the IRSTS, no range information is presented on this overlay.

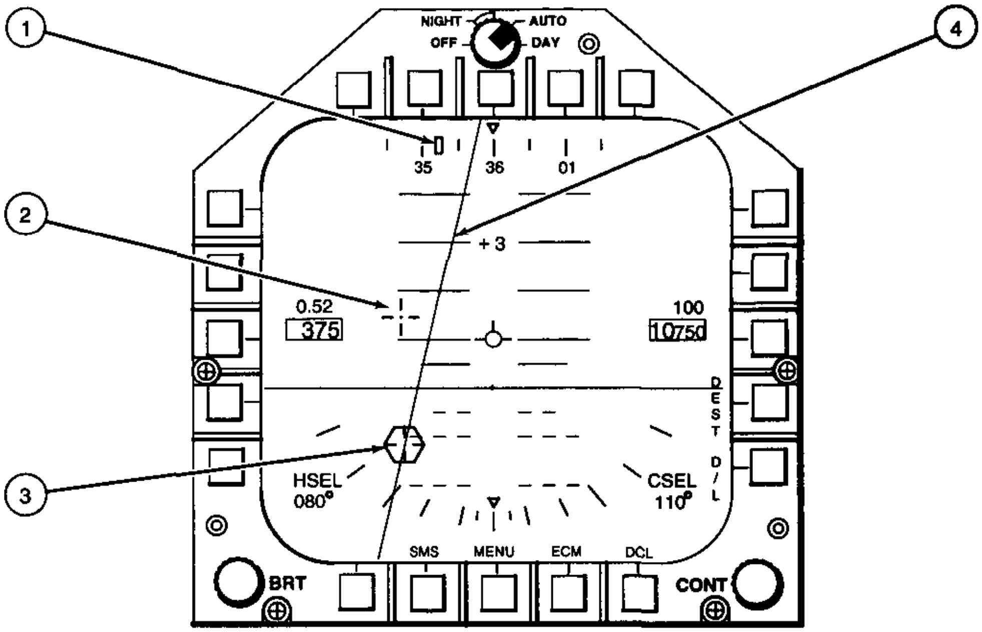
Both target diamonds and IRSTS triangles may be overlaid at the same time on VDI A/A or A/G formats.

2.33.9.5 HSD Formats. The HSD formats provide system navigation information such as magnetic heading, magnetic course, wind direction and speed, true airspeed, groundspeed, waypoint data, and tacan data.

The HSD format family consists of HSD waypoint, tacan, and tacan CDI. Selection of PB16 from the MENU, OWN A/C, CV, IFA, WPT DATA, RECON DATA, INS UPDATE, NAV AID, SURFACE WPT, or SAHRS ALIGN formats will place the previously selected HSD format on the MFD. After a cold start, the HSD waypoint format is shown. Figure 2-115 describes HSD symbols. Figure 2-116 illustrates the activation of the plot line display and shows the selected course line that appears when a steering mode (in this case, destination steering) has been selected.

The HSD tacan format is selected by PB16 (HSD) if the previously selected HSD format was tacan, or PB11 (X/Y) on HSD waypoint, or PB14 (boxed CDI) on HSD tacan CDI. Figure 2-117 shows HSD tacan when tacan steering has not been selected and also illustrates the selected course line that appears after tacan steering selection. This format allows for the selection of tacan CDI (Figure 2-118) via PB14 (CDI).

Chapter 20 describes the use of the HSD formats.



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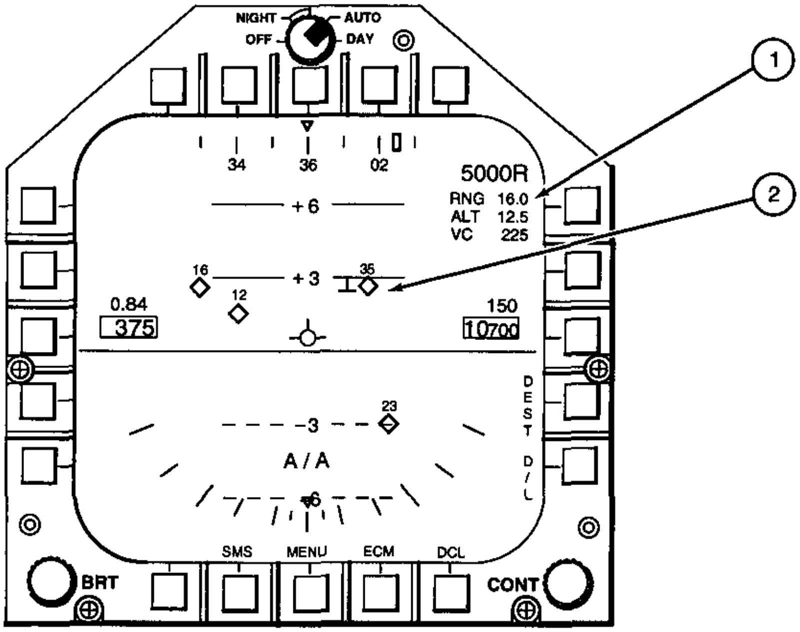
SYMBOL	FUNCTION
(1) Recon Command Heading Marker	Indicates the magnetic heading for Recon steering.
(2) Recon Steering Symbol	Provides elevation and azimuth steering information when in reconnaissance mode. When steering symbol is coincident with flight path marker, the aircraft is flying the bank command to the dynamic steering point.
(3) Target Designator, Hexagon	Displays target position. Positioned by on-board sensors or data link. When displayed on VDI formats, the degrees per inch scaling of the symbol corresponds to the scaling of the rungs of the pitch ladder of the format being overlaid (TLN, A/G, or A/A).
(4) Command Ground Track Line	Displays the path of the command ground track. When displayed on VDI formats the degree scaling of rotation corresponds to the scaling of the rungs of the pitch ladder for the format being overlaid (TLN, A/G, A/A).

Figure 2-113. MFD VDI Recon Overlay Format

RADAR TARGET OVERLAY



IRSTS TARGET OVERLAY

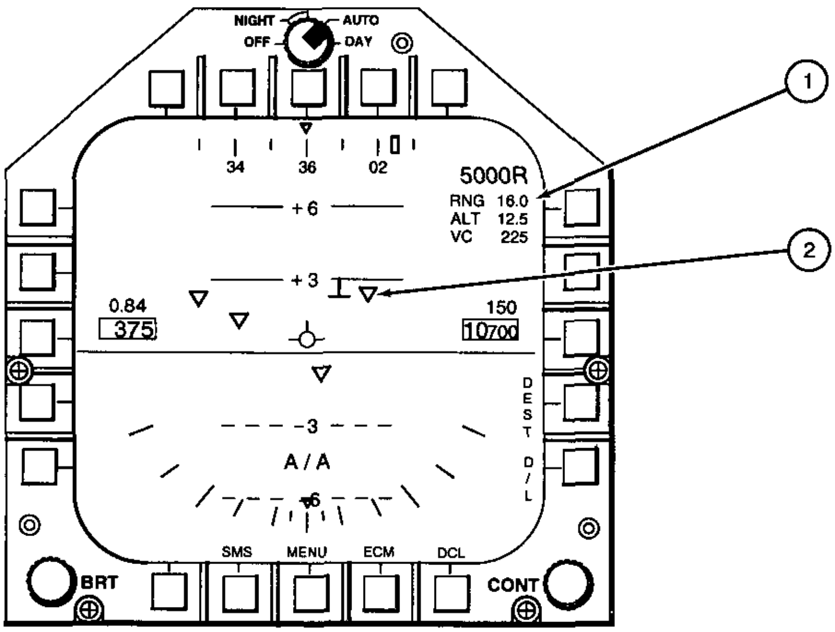


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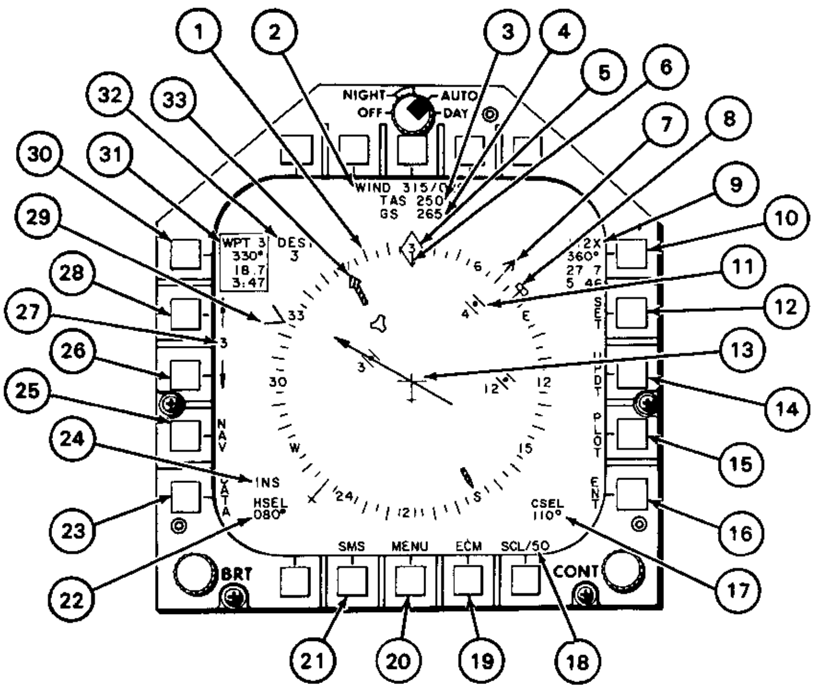
Figure 2-114. MFD VDI Radar and IRSTS Overlay Formats (Sheet 1 of 2)

SYMBOL	FUNCTION
Radar Target Overlay	**Note** In the A/A radar track while scan (TWS) mode and no weapon selected the basic VDI symbology and format will generally be the same as A/A radar single target track except that up to 4 target priority diamonds may be displayed to show direction and relative altitude of the 4 closest radar targets. IRST TWS targets may be displayed simultaneously with radar TWS targets. When this situation occurs, the target data will pertain to the closest radar TWS targets.
(1) Radar target data	Range, altitude, and closing velocity of the closest radar TWS target will be presented.
(2) Radar TWS target priority diamonds	Up to 4 target priority diamonds may be displayed to show direction and relative altitude of the 4 closest radar targets. The numerics above the diamonds indicate the target range to the nearest nautical mile.
IRSTS Target Overlay	**Note** In the A/A IRST track while scan (TWS) mode and no weapon selected the basic VDI symbology and format will generally be the same as A/A radar track while scan except that up to 4 target priority triangles may be displayed to show direction and relative altitude of the 4 closest IRST targets. IRST TWS targets may be displayed simultaneously with radar TWS targets. When this situation occurs, the target data will pertain to the closest radar TWS targets.
(1) Target data	Range, altitude, and closing velocity of the closest IRST TWS target will be presented.
(2) IRST TWS target priority triangles	Up to 4 TWS target priority triangles may be displayed to show direction and relative altitude of the 4 closest IRST targets.

Figure 2-114. MFD VDI Radar and IRSTS Overlay Formats (Sheet 2 of 2)

WAYPOINT, NON-STEEERING



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SYMBOL	FUNCTION
(1) Compass rose	The compass rose is a circular magnetic scale that consists of major divisions at 10 degree intervals, minor divisions at 5 degree intervals, numerics at 30 degree increments and cardinal points at 90 degree increments.
(2) Wind	Displays wind direction in degrees and wind speed in knots.
(3) True airspeed	Displays true air speed in knots.
(4) Ground speed	Displays ground speed in knots.
(5) Lubber line	The lubber line indication (diamond) is fixed at the top of the compass rose and indicates aircraft magnetic heading.
(6) Ground track line	The ground track line rotates inside the compass rose to represent the ground track.
(7) ADF pointer	The ADF symbol shows the direction of the nearest automatic direction finder station.

Figure 2-115. MFD HSD Format (Sheet 1 of 3)

SYMBOL	FUNCTION
(8) Heading select pointer	Displays selected or commanded heading. The symbol rotates outside the compass rose when manually controlled by the heading potentiometer knob located in the pilot's crew station.
(9) Tacan data	Displays the range, bearing, and time–to–go to the tacan station selected by the aircrew. This information is displayed in the readout as well as the corresponding tacan station channel number. X or Y channel may be displayed.
(10) Tacan display option pushbutton	This pushbutton enables the presentation and activation of tacan related symbology and display options. Selection of this option enables the presentation of the tacan situation symbol, selects tacan steering mode, results in the appearance of the tacan, course deviation indication (CDI) pushbutton selection, and AWL pushbutton selection. Selection of this option will be indicated by a box around the tacan data.
(11) Waypoint symbol	**The numbers (1 to 100) adjacent to the symbol identify the waypoint and are located on the display to provide an indication of relative range and bearing from own A/C.**
(12) Set pushbutton	Depression of the SET pushbutton will enable the establishment of a waypoint at the designated cursor position on the HSD.
(13) Aircraft symbol	The stationary aircraft symbol is positioned in the center of the compass rose. The symbol in conjunction with the compass rose indicates magnetic heading.
(14) Update (UPDT) pushbutton	Depression of the UPDT pushbutton enables the display of the INS update format on the MFD.
(15) Plot pushbutton	The PLOT pushbutton enables/disables the display of plotted lines between waypoints on the HSD waypoint format.
(16) Enter (ENT) pushbutton	Depression of the ENT pushbutton enters selection of a new waypoint for destination steering. The waypoint number is selected via the waypoint number increment/decrement pushbuttons on the HSD format.
(17) Course line setting	Indicates selected course in degrees.
(18) Scale (SCL XXX) pushbutton	Enables range scale selection (200, 100, 50, 25, and 10 nautical miles). The scale is the distance from the aircraft symbol to the inside edge of the compass rose. Successive depressions of the pushbutton causes the range scale to decrement and then start again at 200 miles.
(19) ECM pushbutton	Enables the presentation of the threat display. Once depressed, subsequent depression of the ECM pushbutton will return the display to the previous format. This will permit a quick look at the threat display and provide a quick return to the previous format.

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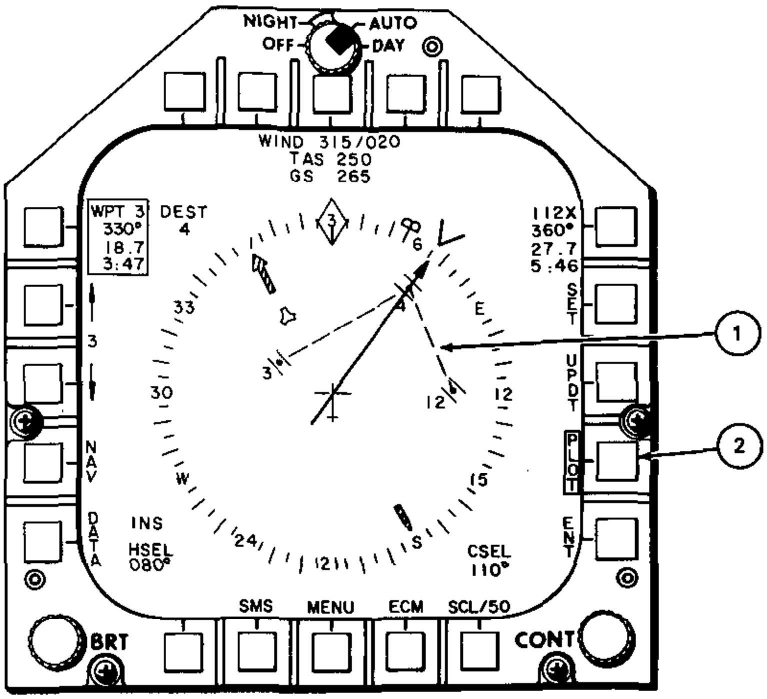
Figure 2-115. MFD HSD Format (Sheet 2 of 3)

SYMBOL		FUNCTION
20	MENU pushbutton	Enables the presentation of the MENU displays. Depression of MENU will result in the MENU1 list to appear in the border area of the display. Subsequent depression of the pushbutton will result in the alternate presentation of the MENU2 and MENU1 list in the border area of the display.
21	SMS pushbutton	Enables the presentation of the SMS display. Once depressed, subsequent depression of the SMS pushbutton will return the display to the previous format. This will permit a quick look at the SMS display and provide a quick return to the previous format.
22	Heading select setting	Indicates the magnetic heading selected.
23	DATA pushbutton	Enables the display of the own A/C data format.
24	Attitude source	Indicates the source (INS or SAHRS) of ownship pitch and roll angles.
25	NAV pushbutton	Enables the display of the appropriate NAV AID or SAHRS ALIGN format as determined by the mission computer.
26	Waypoint decrement (down arrow) pushbutton	Enables the decrement of the waypoint number of the associated waypoint data display and is used for the selection of the waypoint for destination steering.
27	Waypoint number	Indicates the selected waypoint number (via the increment/decrement pushbuttons) of the associated waypoint data display and the desired waypoint for destination steering.
28	Waypoint increment (up arrow) pushbutton	Enables the increment of the waypoint number of the associated waypoint data display and is used for the selection of the waypoint for destination steering.
29	Waypoint bearing pointer	Provides bearing indication of the waypoint entered by the aircrew for destination steering.
30	Waypoint (WPT) display option pushbutton	This pushbutton enables the presentation and activation of waypoint related symbology and display options. Selection of this option enables the destination steering and results in the appearance of the plot line display selection. Selection of this option is indicated by a box around the waypoint data.
31	Waypoint data	Displays the range, bearing and time–to–go to the waypoint selected by the aircrew via the increment/decrement pushbuttons. This information is displayed in the readout.
32	Waypoint DEST readout	Provides an indication of the waypoint number entered for destination steering.
33	Tacan bearing pointer head and tail	Provides bearing indication to and from the selected tacan station.

Figure 2-115. MFD HSD Format (Sheet 3 of 3)

PLOT LINES



SELECTED COURSE LINE

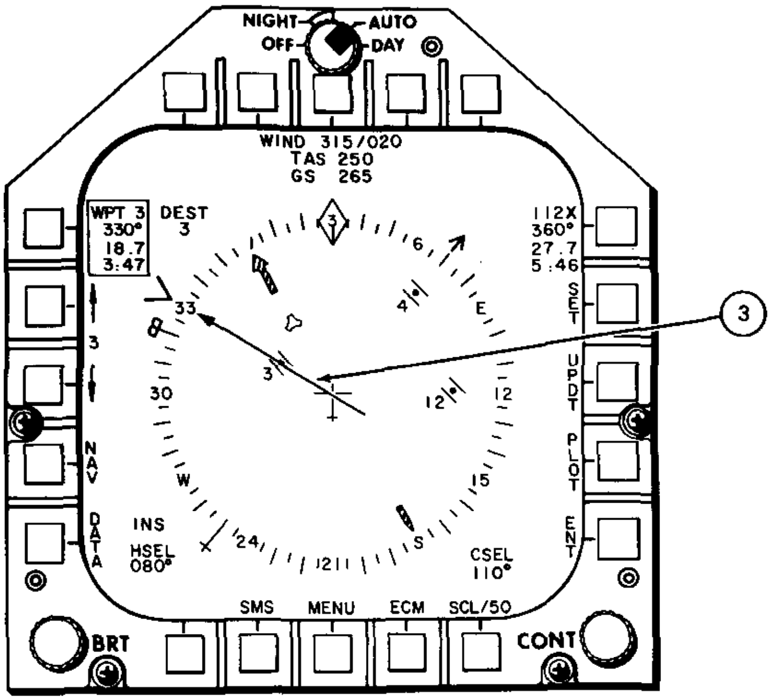


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Figure 2-116. Plot Line and Course Line Displays (Sheet 1 of 2)

SYMBOL	FUNCTION
(1) Plot lines	Dashed plot lines are drawn between waypoints to aid in navigation. The waypoints for plotting are selected via the DEU.
(2) PLOT pushbutton	Box around the PLOT pushbutton legend indicates the display of plotted lines between waypoints has been enabled.
(3) Selected course line	The course line rotates within the compass circle and depicts the aircraft commanded course during the destination steering mode.

Figure 2-116. Plot Line and Course Line Displays (Sheet 2 of 2)

2.33.9.6 SMS Formats. Selection of the SMS formats may be made from any format via PB19 (SMS). Depressing PB19 a second time returns the previously selected display. This toggle action permits the crewmember to check the weapon status quickly. The MC determines the wingform configuration that will be displayed. The CAP/attack and fighter configurations are shown in Figure 2-119.

For SMS symbols, configurations, and phases of launch, including an explanation of the AIM-54 MOAT and DMA results, refer to NAVAIR 01-F14AAD-1A.

2.33.9.7 Engine Monitor Format. The engine monitor format (Figure 2-120) is selected via PB15 (ENG) on the OWN A/C formats. This format includes a representation of the aircraft engine instruments, displaying instrument readings for left and right engines, fuel endurance (based on existing conditions), and any engine exceedance conditions. Rpm is provided as N1 and temperature as turbine blade temperature (TBT not EGT). Fuel flow is shown as either main (M) or total (T), depending on power setting (either nonafterburner or afterburner range). This information is provided by the FEMS. Engine monitor format is not provided while in SEC mode. Refer to FEMS in this chapter for additional information.

2.33.9.8 IRSTS Formats. There are three dedicated IRSTS formats in the IRSTS format family. They are IRSTS normal, IRSTS CSCAN, and IRSTS summary (refer to NAVAIR 01-F14AAD-1A). Other IRST information and symbols appear on the HUD, VDI, and TSD formats.

2.33.9.9 TSD Format. The TSD format is chosen via the TSD legend on MENU1. The format consists of five distinct legend sets that appear in response to crew MFD inputs. Refer to NAVAIR 01-F14AAD-1A for a description of the TSD format and associated symbols.

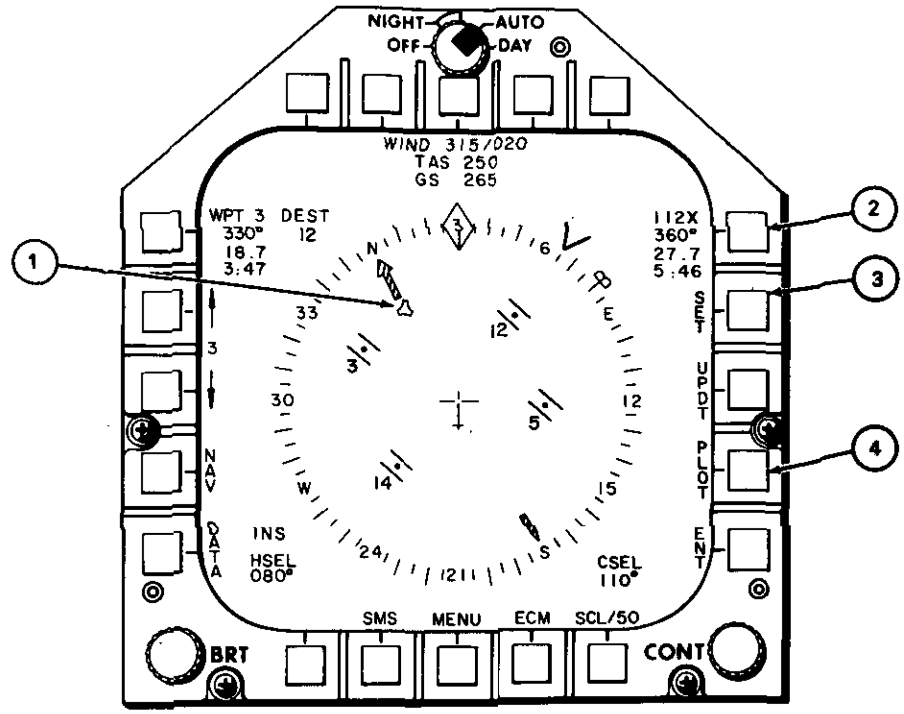
2.33.9.10 JTIDS Data Readout Formats. Refer to NAVAIR 01-F14AAD-1A.

2.34 DATA ENTRY UNIT

The DEU (Figure 2-121) on the RIO right vertical console provides manual data entry and control of certain mission functions. The DEU is a remote terminal that communicates with the mission computers via the multiplex buses. The DEU is powered by the 28-Vdc main bus. The DEU consists of a DEU control knob, data entry display, 20 option keys, and four option display legends. The DEU control knob controls power, brightness, and the test function. The option display legends display the options for the function or parameter selected. The option keys enable selection of the desired menu functions and entry of required mission parameters. The data entry display is a two-line display. The top line indicates the currently selected parameter while the bottom line (scratchpad) is used to enter data. The scratchpad consists of a 14-character display. The character locations are often denoted by underlines that, as data is keyed in, disappear.

2.34.1 Data Entry Unit Operating Modes. As selected by the RIO, the DEU operates in one of two modes: slaved to the RIO multifunction display (MFD3) or independent of MFD3. Initially, when the DEU is powered on, it defaults to the slave mode. The slave and independent modes are toggled by pressing the SLV/INDP option key. When operating in the slave mode, the data entry display on the main menu page reads MENU-DEU SLV (Figure 2-121). When the MFD displays a format to which the DEU is slaved, the DEU configures the corresponding page (Figure 2-102). However, when the MFD

TACAN, NON-STEERING



TACAN — STEERING

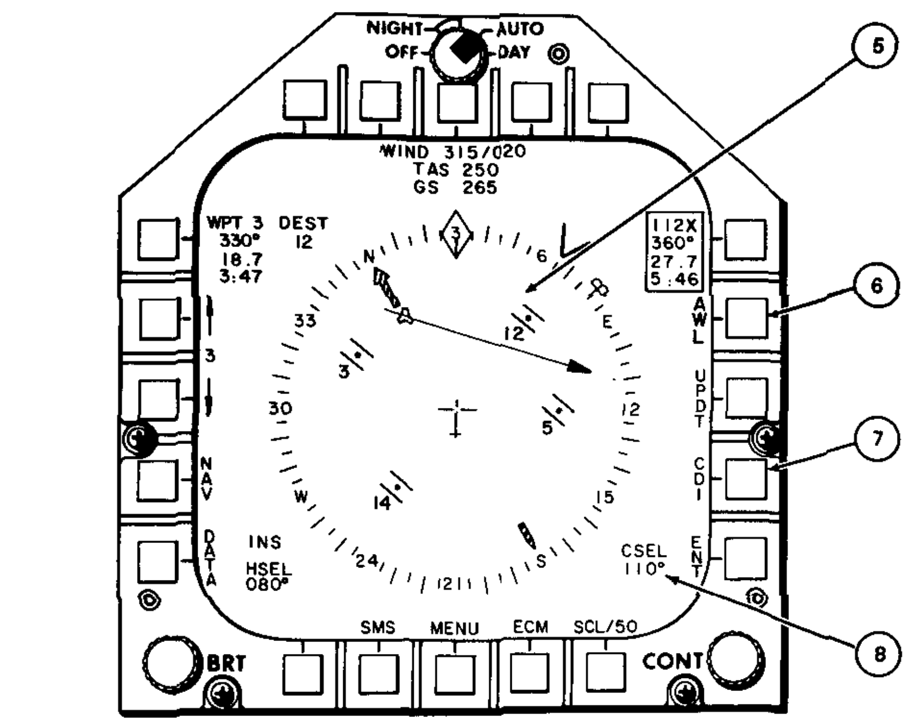


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Figure 2-117. MFD HSD Tacan Displays (Sheet 1 of 2)

SYMBOL	FUNCTION
1 Tacan situation symbol	Provides indication of relative range and bearing to the tacan station from ownship.
2 Tacan display option pushbutton	The box around the tacan data indicates that the tacan steering option has been selected.
3 SET pushbutton	Pressing the SET pushbutton enables the establishment of a waypoint at the designated cursor position on the HSD.
4 PLOT pushbutton	Pressing the PLOT pushbutton enables/disables the display of plotted lines between waypoints on the HSD waypoint format.
5 Selected course line	Moves within the compass rose to depict the selected tacan course during tacan steering.
6 AWL pushbutton	The AWL display is enabled by this pushbutton.
7 CDI pushbutton	The course deviation indicator (CDI) display is enabled by this pushbutton.
8 Course line setting	With the command pointer set, the CSEL readout indicates the magnetic course setting in degrees.

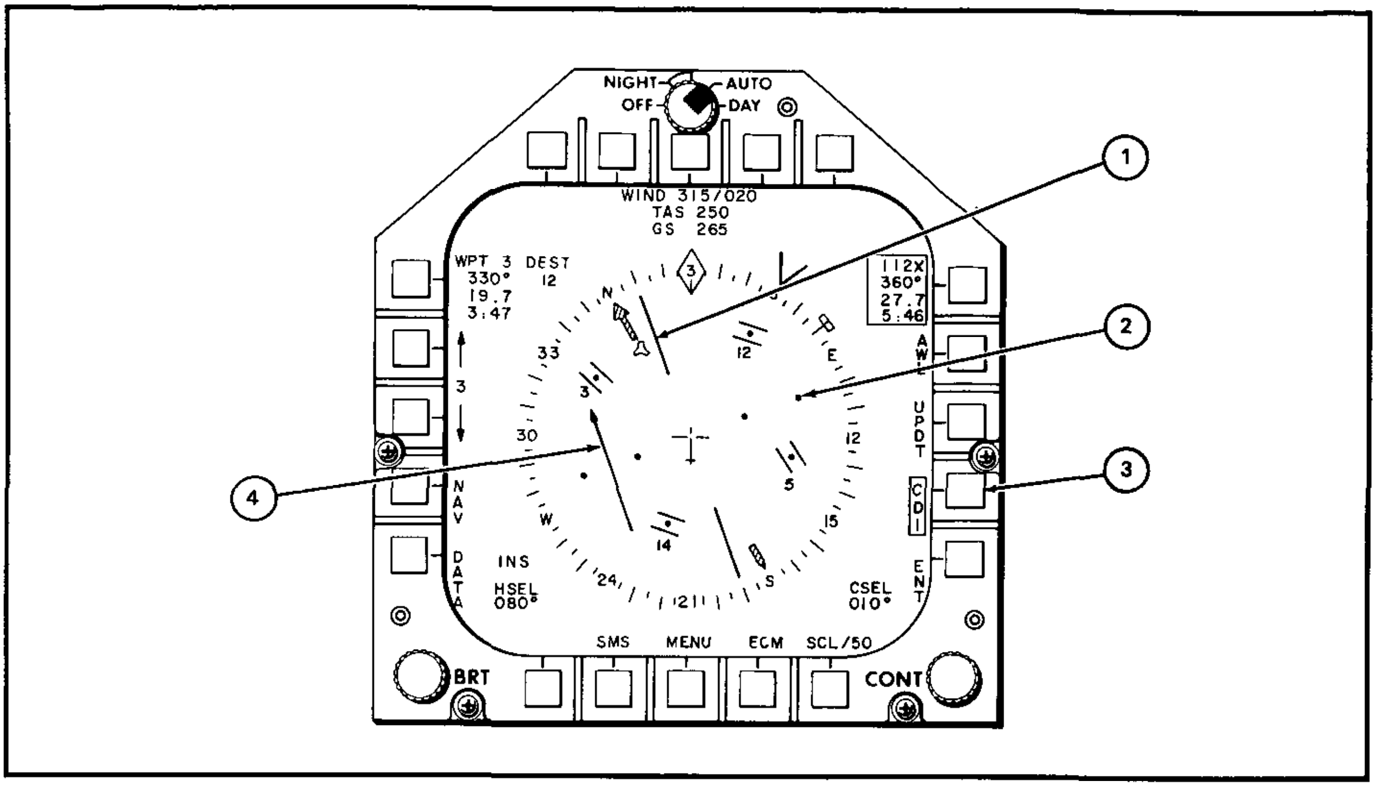
Figure 2-117. MFD HSD Tacan Displays (Sheet 2 of 2)

displays a format to which the DEU cannot slave, the DEU remains on whatever format it is displaying. Operating in the independent mode enables access to all menu options without being affected by changes to the MFD3 display. When the MENU option key is pressed, the main MENU page is displayed with the present DEU mode displayed on the scratchpad.

2.34.2 DEU Menu Pages. The DEU consists of the following menu pages.

2.34.2.1 Main Menu Page. The main menu page (Figure 2-121) enables access to the various subpages. Pressing the desired option key on the main menu displays the desired subpage. The subpages are as follows:

1. SMS — Stores management system.
2. OWN A/C — Own aircraft.
3. WPT — Waypoint.
4. CV ALGN — Carrier align.
5. NAV AID — Navigation aid.
6. NAV GRID — Navigation grid.
7. JTID RNAV — JTIDS relative navigation.
8. JTID COMM — JTIDS communications.
9. JTID PPLI — JTIDS precise participant location identification.
10. JTIDS MODE — JTIDS mode.
11. DOWN LOAD — JTIDS initialization.
12. IFT — Nonfunctional.
13. PLOT — Plot.
14. CSS — Cooperative support software.
15. SLV/INDP — Slave/independent.
16. ALT MENU — When available.



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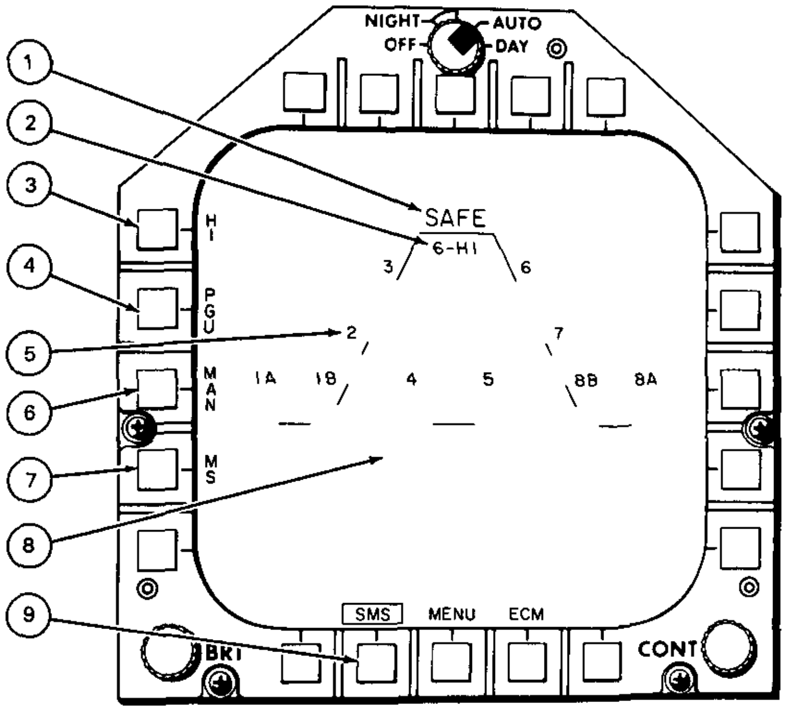
SYMBOL	FUNCTION
(1) Tacan Course indication	Indicates tacan course and deviation from tacan track.
(2) Course deviation scale	Displays deviation from selected course. Each dot represents 4 degrees.
(3) CDI pushbutton	Boxed CDI legend indicates that tacan CDI display has been selected.
(4) Course deviation indicator	Displays deviation from selected course against deviation scale.

Figure 2-118. HSD Tacan CDI Format

CAP/ATTACK CONFIGURATION WINGFORM



FIGHTER CONFIGURATION WINGFORM

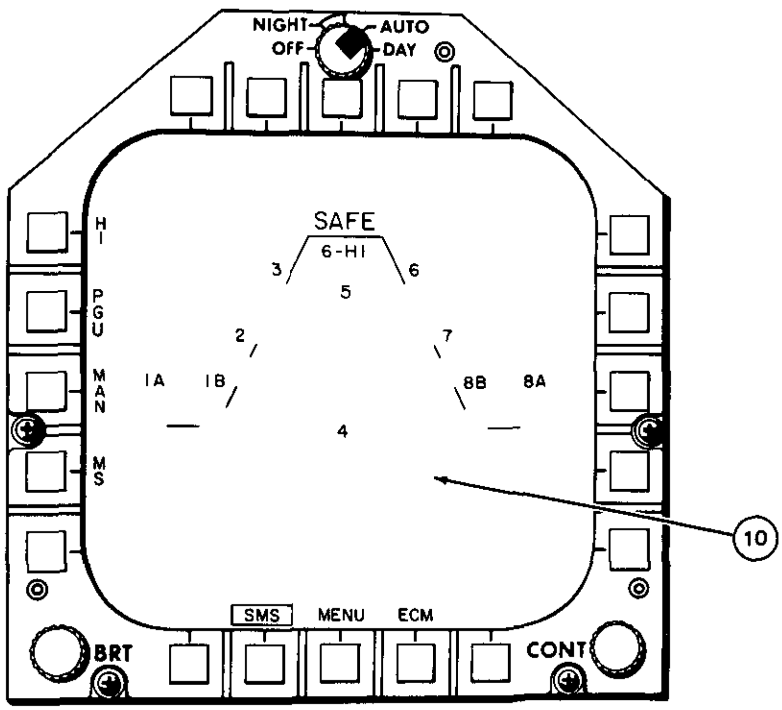


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Figure 2-119. MFD SMS Format — CAP/Attack, Fighter Wingforms (Sheet 1 of 2)

SYMBOL	FUNCTION
(1) ARM/SAFE status indicator	SAFE or ARM is displayed to indicate the status of the master arm switch.
(2) Rounds remaining	Rounds remaining is indicated in hundreds (6, 5, 4, 3, 2, 1 and 0) by a single digit. An X will appear when the gun is empty. HI or LO indicates the rate at which the rounds are fired.
(3) HI/LO gun rate pushbutton	Enables the selection of the HI or LO rate of gun fire. HI rate is default mode. Pressing the pushbutton will toggle rate of fire between HI and LO.
(4) PGU/M56	Enables selection of PGU or M56 round. Pressing the pushbutton will toggle between PGU and M56.
(5) Store station numbers (1A, 1B, 2, 3, 4, 5, 6, 7, 8A, and 8B)	Indicate the location of the stores (weapons and fuel tanks) carried on the aircraft.
(6) Manual (MAN) gun mode pushbutton (A/G only)	Enables manual selection of the manual option during air–to–ground operations. CCIP mode is the primary gun mode and is obtained immediately upon gun selection. A box will appear around the pushbutton legend to indicate the manual option has been selected. Refer to NAVAIR 01–F14AAD–1A.
(7) Missile status (MS) pushbutton	Enables the presentation of the missile status display.
(8) CAP/attack wingform	Wingform provides a plan view of the stores carried on an aircraft configured for the CAP/attack role.
(9) SMS pushbutton	Box around the SMS pushbutton legend indicates the SMS display is selected. Once selected, a subsequent depression of the SMS pushbutton will enable the return to the previous display.
(10) Fighter wingform	Wingform provides a plan view of the stores carried on an aircraft configured for the fighter role.

Figure 2-119. MFD SMS Format — CAP/Attack, Fighter Wingforms (Sheet 2 of 2)

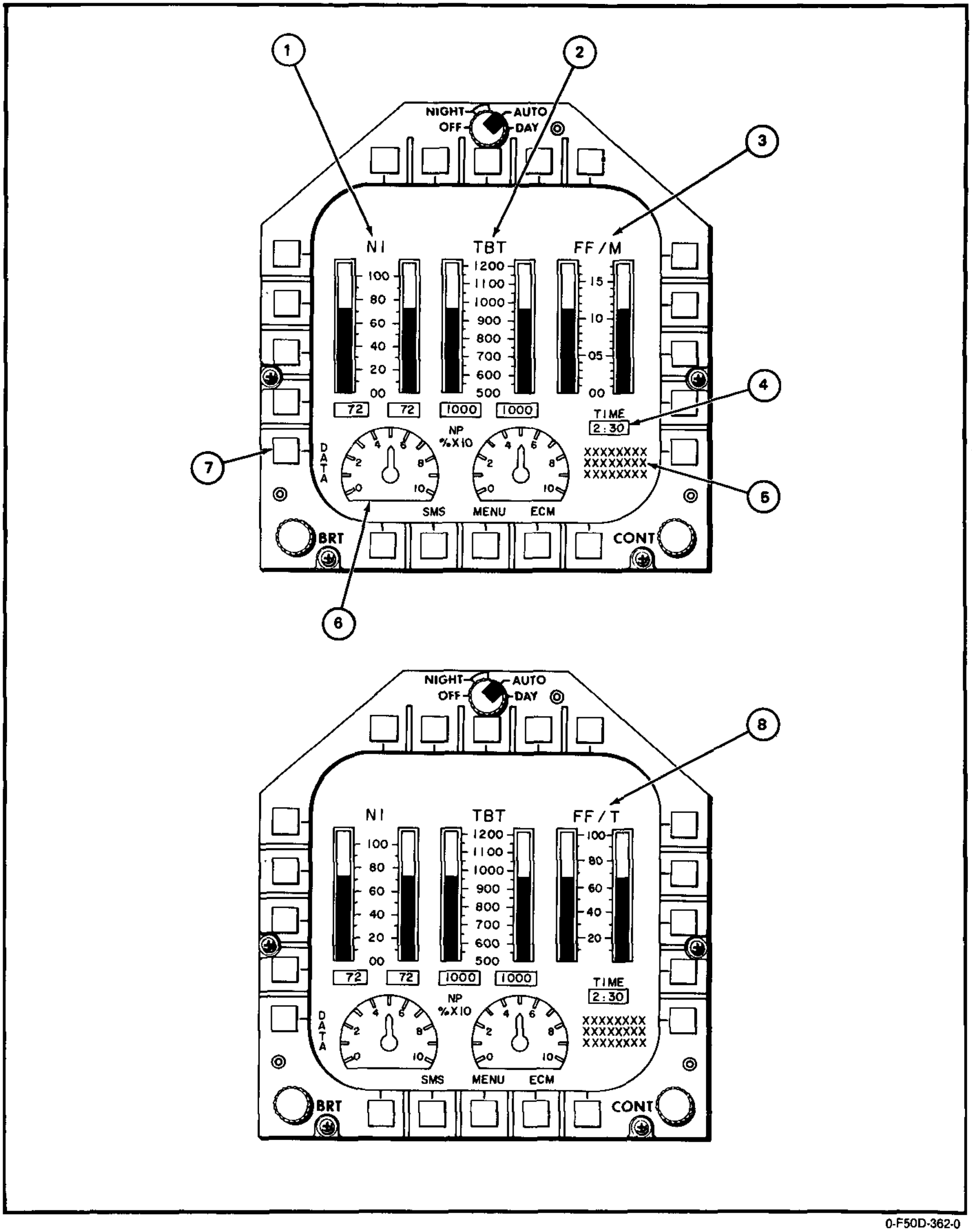
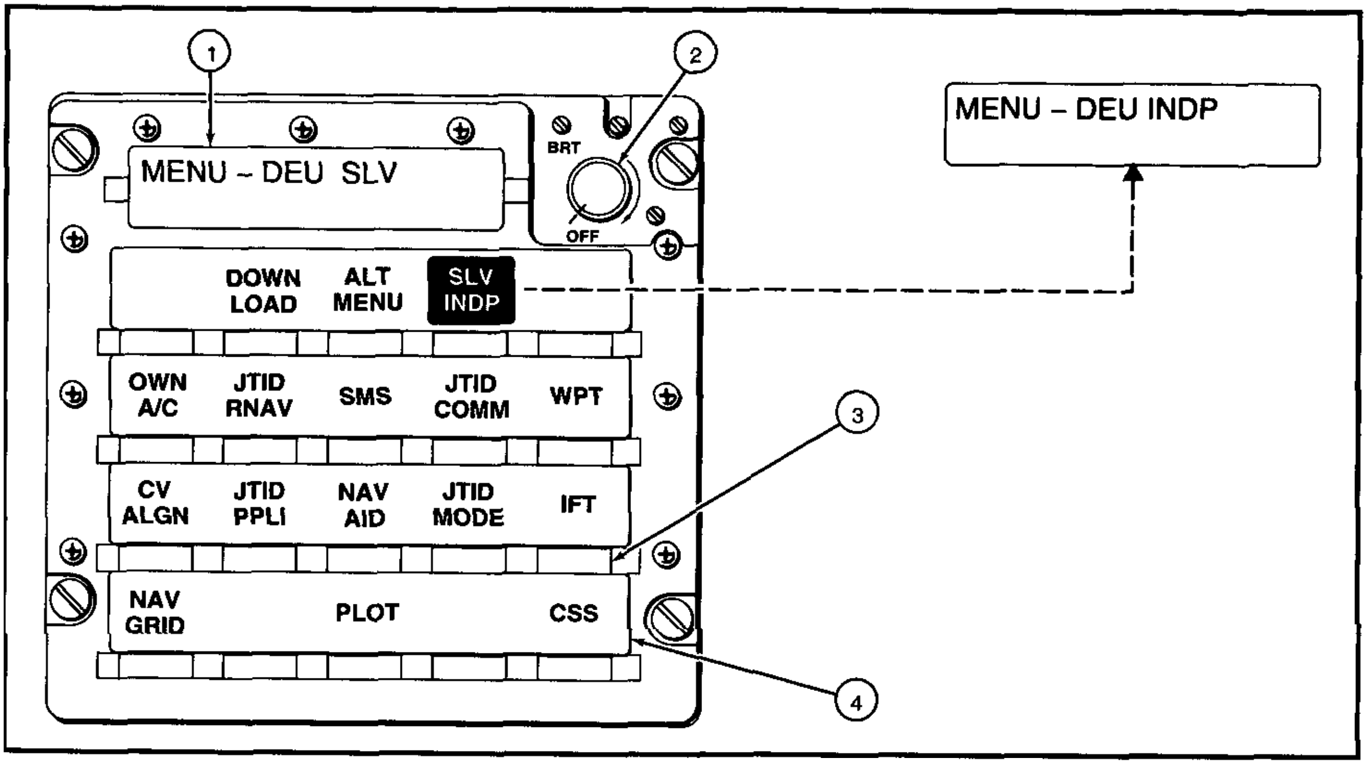


Figure 2-120. MFD Engine Monitor Format (Sheet 1 of 2)

SYMBOL	FUNCTION
(1) Rotor speed	Left and right rotor speeds (N1) are displayed both in an analog and digital format in percent RPM. The digital indications are located immediately below the corresponding analog scale.
(2) Turbine blade temperature	Left and right engine turbine blade temperature (TBT) are displayed both in an analog and digital format. The analog scale ranges from 500 to 1200 degrees Fahrenheit. The digital indications are located immediately below the corresponding analog scale.
(3) Main fuel flow	Left and right main fuel flow (FF/M) are displayed in an analog format in thousands of pounds per hour (PPH). The analog scale ranges from 0 to 17,000 PPH.
(4) Fuel endurance	Readout provides an indication of the flight time remaining in hours and minutes. The readout is based on the existing fuel supply for the selected engine condition (normal or afterburner).
(5) Engine exceedance conditions	Up to three engine exceedance conditions are capable of being displayed at a time. The indications will scroll upward at a 1 rate when more than three exceedance conditions exist. The indications may be: L/R MACH #, L/R LO THR, L/R A/ICE, L/R OIL LO, or L/R AUG.
(6) Nozzle position	Left and right engine nozzle positions (NP) are displayed in an analog format between 0 and 100 percent to indicate relative position from fully closed to fully open, respectively.
(7) Data pushbutton	Enables the presentation of the OWN A/C DATA display. **Note** When afterburner condition is selected, the total fuel flow consists of main and augmented fuel. This format illustrates the afterburner condition where total fuel flow are displayed.
(8) Total fuel flow	Left and right engine total fuel flow (FF/T) are displayed in an analog format in thousands of pounds per hour (PPH). The analog scale ranges from 0 to 100,000 PPH. **Note** Engine data is not provided while in SEC mode.

Figure 2-120. MFD Engine Monitor Format (Sheet 2 of 2)



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NOMENCLATURE	FUNCTION
1 Data Entry Display	Displays the name of the page selected and provides a scratchpad used to enter and change data as required.
2 DEU control knob	Initial clockwise rotation past the detent turns system power on; continued rotation increases brightness of scratchpad display and option legend placarding. When depressed, a self–test of the panel is completed.
3 Option keys (twenty)	Enables selection of desired menu options and entry of required mission data.
4 Option legend	Displays the various menu options for the function or parameter selected. Option legends vary with page selection.

Figure 2-121. Data Entry Unit/Main Menu Page

2.34.2.2 Subpages. The operating characteristics of the subpages are as follows: Parameters requiring input often have associated limits and qualifiers. Data entry parameters are shown in Figure 2-122. All data input left to right is validated character by character. This includes the parameter of latitude, longitude, and time. Data input from right to left is validated upon depression of the ENT option key. When latitude and longitude are input from left to right, leading zeroes must be entered but trailing zeroes for minutes and minute fractions are not required. Keying additional numerics after the dedicated character locations are filled will not change the initial keyed-in data. The applicable east, west, north, or south (E, W, N, S) can be keyed in before, during, or after numerical data entry. The backspace option key (BKSP) is used to delete data in the reverse order of entry. The return option key (RTN) is used to display the next higher level page in the branch category.

2.35 FLIGHT INSTRUMENTS

2.35.1 Standby Attitude Indicator. A 3-inch standby gyro horizon indicator on the left side of the pilot instrument panel and another on the left side of the RIO instrument panel are for emergency use should the system (INS or SAHRS) attitude information become unreliable. It is a self-contained, independent gyro that displays aircraft roll and pitch from the horizontal and includes a standard turn-and-slip indicator.

The presentation consists of a miniature aircraft viewed against a rotating gray and black background, which represent sky and ground conditions, respectively. Caging should be accomplished at least 3 to 4 minutes before takeoff to allow the spin axis to orient to true vertical. After the gyro has erected to vertical, the miniature aircraft reference may be raised or lowered +5°, -10° to compensate for pitch trim by turning the adjustment knob in the lower right corner of the instrument. Electrical power should be applied for at least 1 minute before caging. The unit should be caged prior to engine start during cockpit interior inspection. In flight, recaging should be initiated only when error exceeds 10° and only when the aircraft is in a wings-level normal cruise attitude. Errors of less than 10° will automatically erect out at a rate of 2.5° per minute.

Electrical power is supplied by the essential ac buses. An OFF flag appears on the right side of the instrument face when power is removed or when the gyro is caged, but the gyro is capable of providing reliable attitude information (within 9°) for up to 3 minutes after a complete loss of power. The gyro can be manually caged by pulling the pitch trim knob on the lower right corner of the instrument. Depressing TEST centers the ARA-63 needles and the turn-and-slip pointer deflects to the right and lines up with the fixed marker.

2.35.1.1 Turn-and-Slip Indicator. The standby attitude indicator includes a standard needle and ball turn-and-slip indicator. The pointer is tested when the TEST button is pressed and it deflects to the right and lines up with the fixed marker.

2.35.2 Standby Airspeed Indicator. The standby airspeed indicator on the pilot and RIO instrument panels is a pitot-static instrument that displays indicated airspeed from 0 to 800 knots. The indicator is graduated in 10-knot increments up to 200 knots, then in 50-knot increments.

Note

The indicated airspeed displayed is not corrected for position error.

2.35.3 Standby Altimeter. Both the pilot and RIO standby altimeters display altitude up to 99,000 feet on the five-digit counter, but only the left two digits are moveable. The pointer moves about a dial calibrated from 0 to 1,000 feet in 50-foot increments.

A BARO setting knob, on the bottom left, is used to set in the local atmosphere pressure (INCHES HG) between 28.10 to 30.99 inclusive. The four-digit counter displays the BARO setting. The BARO setting from the pilot standby altimeter is provided to the mission computers via the converter interface unit and can be displayed on the HUD and the MFDs.

2.35.4 AN/APN-194(V) Radar Altimeter System. The radar altimeter is a low-altitude (0 to 5,000 feet), pulsed, range-tracking radar that measures the surface or terrain clearance below the aircraft. Altitude information is developed by radiating a short-duration radio frequency pulse from the transmit antenna to the Earth's surface and measuring elapsed time until radio frequency energy returns through the receiver antenna. The altitude information is continuously presented to the pilot, in feet of altitude, on an indicator dial. The system also outputs a digital signal for display of radar altitude on the HUD from 0 to 5,000 feet during takeoff and landings.

The radar altimeter has two modes of operation. In the search mode, the system successively examines increments of range until the complete altitude range is searched for a return signal. When a return signal is detected, the system switches to the track mode and tracks the return signal to provide continuous altitude information.

VARIABLE INPUT NAME	UNITS	LIMITS	SIGN	FIELD/PROMPT	DIR OF ENTRY
ALTITUDE	FT	−5000 to +131071	± (1)	QXXXXXX	(2) RT to LT (5)
Baro pressure	IN HG	25 to 35	NONE	XX.XX	RT to LT
Bearing	DEG	1 to 360	NONE	XXX	RT to LT
Channel number	—	0 to 127	NONE	XX	RT to LT
Coverage	DEG	0 to 180	NONE	XXX	RT to LT
Direction	DEG	1 to 360	NONE	XXX	RT to LT
Heading	DEG	1 to 360	NONE	XXX	RT to LT
Latitude	DEG, MIN	−90 to +90	S, N (3)	QbXXbXX.XX	(4) LT to RT
Longitude	DEG, MIN	−180 to +180	W, E (3)	QbXXXbXX.XX	(5) LT to RT
Magnetic variation	DEG	−180 to +180	W, E (3)	XXX.XbQ	RT to LT
IFT number	—	0 to 31	NONE	XX	RT to LT
Waypoint number	—	1 to 20	NONE	XX	RT to LT
Weapon option	—	0 to 6	NONE	X	RT to LT
Range	NMI	0 to 500	NONE	XXX.X	RT to LT
Sector	—	1 to 6	NONE	X	RT to LT
Carrier speed	KNOTS	0 to 64	NONE	XX	RT to LT
IFT TGT speed	KNOTS	0 to 2047	NONE	XXXX	RT to LT
Wind speed	KNOTS	0 to 200	NONE	XXX	RT to LT
Time	HRS MIN, SEC	0 to 23 0 to 59	NONE	XXXXbXX	(4) LT to RT (5)
Vertical lever arm	FT	0 to 128	NONE	XXX	RT to LT
Map lines	—	0 to 99	NONE	XX	RT to LT
Map offset	FT	± 131071	± (1)	QXXXXXX	RT to LT
Target length	NMI	0−2048	NONE	XXXX.X	RT to LT
Command course	DEG	1−360	NONE	XXX	RT to LT

Notes:

(1) If a sign is not input, the number is assumed positive.

(2) Prompt underscores disappear as numerics are input. Pressing 'BKSP' will delete a keyed−in numeric and the underscore will reappear. Continued backspacing will delete inputs in the reverse order in which they were input. If the prompt is a single underscore, it disappears upon the first keyed entry. When backspacing, it will reappear when the first keyed entry has been deleted.

(3) Qualifiers 'S', 'N', 'E', 'W', '+' and '−' can be keyed in before, after or during keying of numeric data. 'BKSP' will not delete these symbols; however, they can be overwritten. The last keyed symbol will be implemented. Depression of 'CLR' will also reset the total scratchpad.

(4) Trailing zeroes for minutes and seconds will be assumed if not entered from keypad.

(5) 'b' implies blank or space; 'Q' implies qualifier (S, N, E, W, +, −).

Figure 2-122. Data Entry Parameters

When the radar altimeter drops out of the track mode, an OFF flag appears and the pointer is hidden by a mask. The altimeter remains inoperative until a return signal is received, at which time the altimeter will again indicate actual altitude above terrain.

Reliable system operation in the altitude range of 0 to 5,000 feet permits close altitude control at minimum altitudes. The system will operate normally in bank angles up to 45° and in climb or dives except when the reflected signal is too weak.

The system includes a height indicator (altimeter), a test light on the indicator, a low-altitude warning tone, a radar receiver-transmitter under the forward cockpit, and two antennas (transmit and receive) one on each side of the IR fairing, in the aircraft skin. During descent, the warning tone is heard momentarily when the aircraft passes through the altitude set on the limit index. When the aircraft is below this altitude, the red low-altitude warning light on the indicator stays on.

Note

If radar altitude is unreliable, only the OFF flag is present.

The radar altimeter receives power from the ac essential bus No. 1 through the RADAR ALTM circuit breaker (4B3) and from dc essential bus No. 1 through the ALT LOW WARN circuit breaker (7B6). The radar altimeter has a minimum warmup time of 3 minutes. During this time, failure indications and erroneous readouts should be disregarded.

2.35.4.1 Radar Altimeter. The radar altimeter (FO-12) on the pilot instrument panel has the only controls for the system. The indicator displays radar altitude above the Earth's surface on a single-turn dial that is calibrated from 0 to 5,000 feet in decreasing scale to provide greater definition at lower altitudes. The control knob in the lower right corner of the indicator is a combination power switch, self-test switch, and positioning control for the low-altitude limit bug.

2.35.4.2 Altimeter BIT. Depressing and holding the control knob energizes the self-test circuitry; the green test light illuminates, the indicator reads 100 ±10 feet, and the HUD altitude scale reads approximately 100 feet. If the indicator passes below the altimeter limit bug setting, the aural and visual warnings are triggered. Normal operation is resumed by releasing the control knob.

2.35.4.3 Low-Altitude Aural Warning. A low-altitude aural warning alarm provides a 1000 Hz tone, modulated at two pulses per second, lasting for 5 seconds. The tone is available to both crewmembers when the aircraft descends below the altitude set on the low-altitude limit bug.

2.35.5 Vertical Velocity Indicator. The vertical velocity indicator on the left side of the pilot and RIO instrument panel is a sealed case connected to a static pressure line through a calibrated leak. It indicates rate of climb or descent. Sudden or abrupt changes in attitude may cause erroneous indications because of the sudden change of airflow over the static probe.

2.35.6 Standby Compass. A conventional standby compass is above the pilot instrument panel. It is a semi-float-type compass suspended in compass fluid.

2.35.7 Clock. A mechanical 8-day clock is on the instrument panel in each cockpit. It incorporates a 1-hour elapsed-time capability. A winding and setting selector is in the lower left corner of the instrument face. The knob is turned in a clockwise direction to wind the clock and pulled out to set the hour and minute hands. An elapsed time selector in the upper right corner controls the elapsed time mechanism. This mechanism starts, stops, and resets the sweep second and elapsed time hands.

2.36 ANGLE-OF-ATTACK SYSTEM

The AOA system measures the angle between the longitudinal axis of the aircraft and the relative wind. This is used for approach monitoring and to warn of an approaching stall. Optimum approach AOA is not affected by gross weight, bank angle, density altitude, or load configuration (see Figure 2-123 for AOA conversions).

The system includes a probe-type transmitter, approach lights, an indicator, and an indexer. The indexer and approach lights are controlled by the indicator, which is electrically slaved to the sensor probe transmitter. In flight, the probe, which is on the left side of the fuselage, aligns itself with the relative airflow like a weather vane.

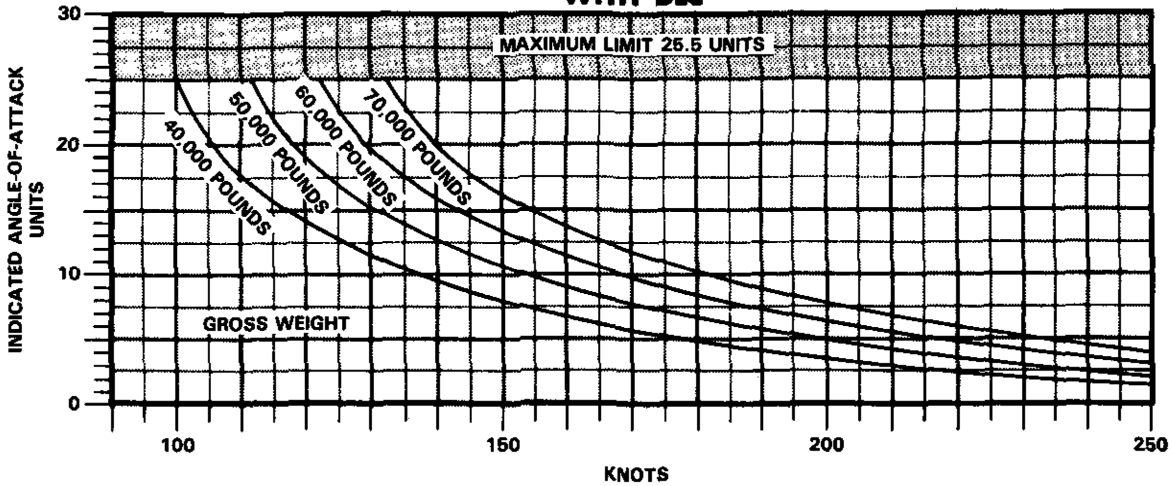
Probe anti-icing is provided by means of a 115-Vac heating element along the probe and probe housing. The heating element is controlled by the ANTI-ICE switch on the pilot right console. During ground operation, probe heat is on with the landing gear handle down and the switch in ORIDE/ON. With weight on wheels, the position OFF/OFF and AUTO/OFF deactivate the probe heating element.

DATE JANUARY 1974
DATA BASIS: FLIGHT TEST

SEA LEVEL

AIRCRAFT CONFIGURATION:
FLAPS AND SLATS, GEAR DOWN,
SPEED BRAKES EXTENDED,
FOUR AIM-7F

WITH DLC



WITHOUT DLC

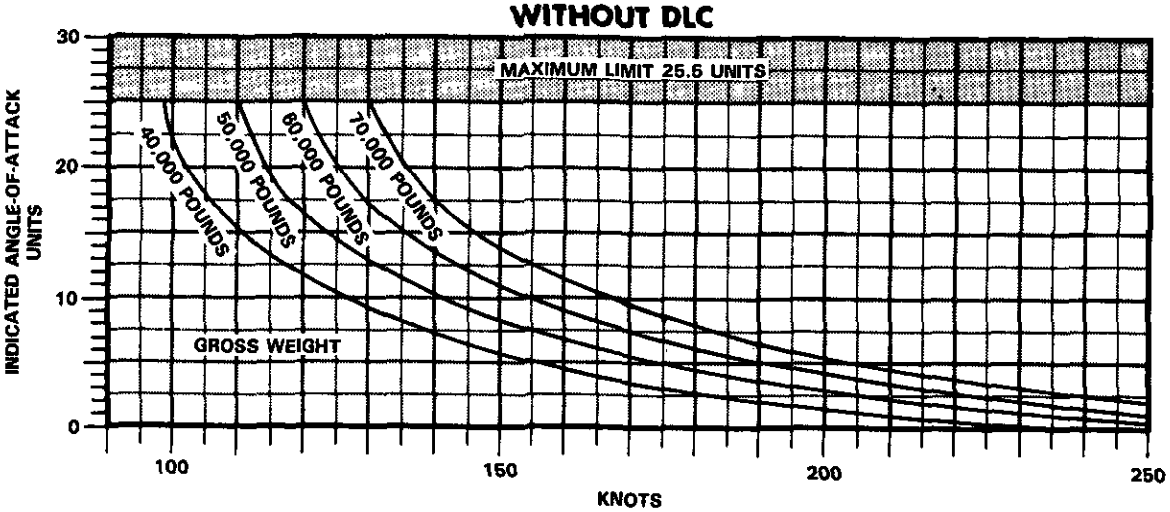


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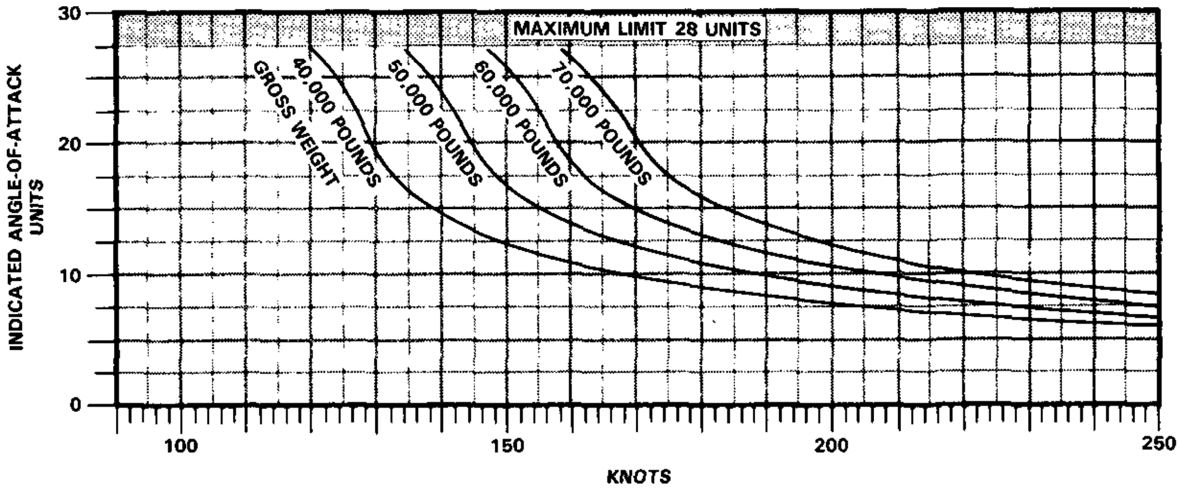
Figure 2-123. Angle-of-Attack Conversion (Sheet 1 of 2)

DATE JANUARY 1974
DATA BASIS: FLIGHT TEST

SEA LEVEL INDICATED PRESSURE ALTITUDE 35,000 FEET

AIRCRAFT CONFIGURATION:
FLAPS/SLATS UP, GEAR UP, SPEED BRAKES RETRACTED — CADC OPERATIONAL (4)
AIM-7F



INDICATED PRESSURE ALTITUDE EQUALS 35,000 FEET

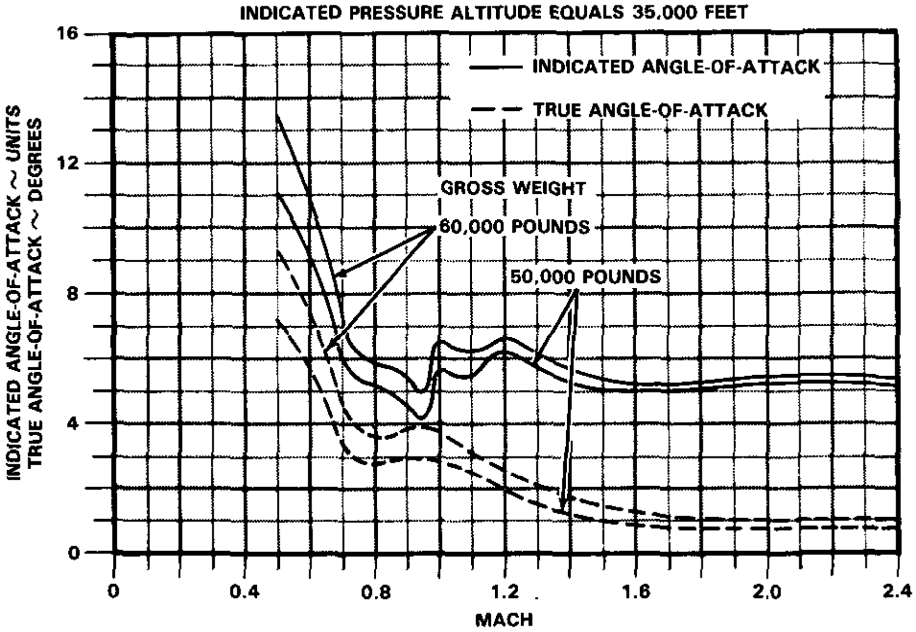


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Figure 2-123. Angle-of-Attack Conversion (Sheet 2 of 2)

2.36.1 AOA Test. A safety of flight check of the AOA indicator and other aircraft instruments can be performed while in flight or on the deck. When INST is selected on the pilot's MASTER TEST switch, the reference bar on the AOA indicator should indicate 18.0 ±0.5 units. A check of the indexer can be made by selecting LTS on the MASTER TEST switch.

2.36.2 AOA Indicator. This indicator (Figure 2-124) displays the aircraft AOA and provides a stall warning reference marker, a climb bug, cruise bug, and an AOA approach reference bar for landing approach.

AOA is displayed by a vertical tape on a calibrated scale from 0 to 30 units, equivalent to a range of -10° to +40° of rotation of the probe. The approach reference bar is provided for approach (on speed) AOA at 15 units. The AOA indexer and approach lights will automatically follow the indicator.

The climb reference marker is set at 5.0 units, the cruise marker at 8.5 units, and the stall warning marker at 29 units. These reference markers are preset to the optimum AOA values and cannot be changed by the pilot.

2.36.3 AOA Indexer. The AOA indexer on the pilot glareshield (Figure 2-124) has two arrows and a circle illuminated by colored lamps to provide approach information. The relay-operated contacts in the AOA indicator also control the AOA indexer. The upper arrow is for high AOA (green), the lower arrow is for low AOA (red), and the circle is for optimum AOA (amber). When both an arrow and a circle appear, an intermediate position is indicated.

2.36.3.1 Indexer Lights. The indexer lights function only when the landing gear handle is down. A flasher unit causes the indexer lights to pulsate when the arresting hook is up and the HOOK BY-PASS switch is in CARRIER. The intensity of the indexer lights is controlled by the INDEXER thumbwheel control on the pilot MASTER LIGHT panel.

2.36.4 Approach Lights. The approach lights consist of red, amber, and green indicator lights above the nosegear strut. The lights are actuated by the AOA indicator and provide qualitative AOA information to the landing signal officer during landing approaches. A flasher unit in the AOA system will cause the approach lights to pulsate when the arresting hook is up with the landing gear down and the HOOK BY-PASS switch is in the CARRIER position. When the FIELD position of the HOOK BY-PASS switch is selected, the flasher unit is disabled.

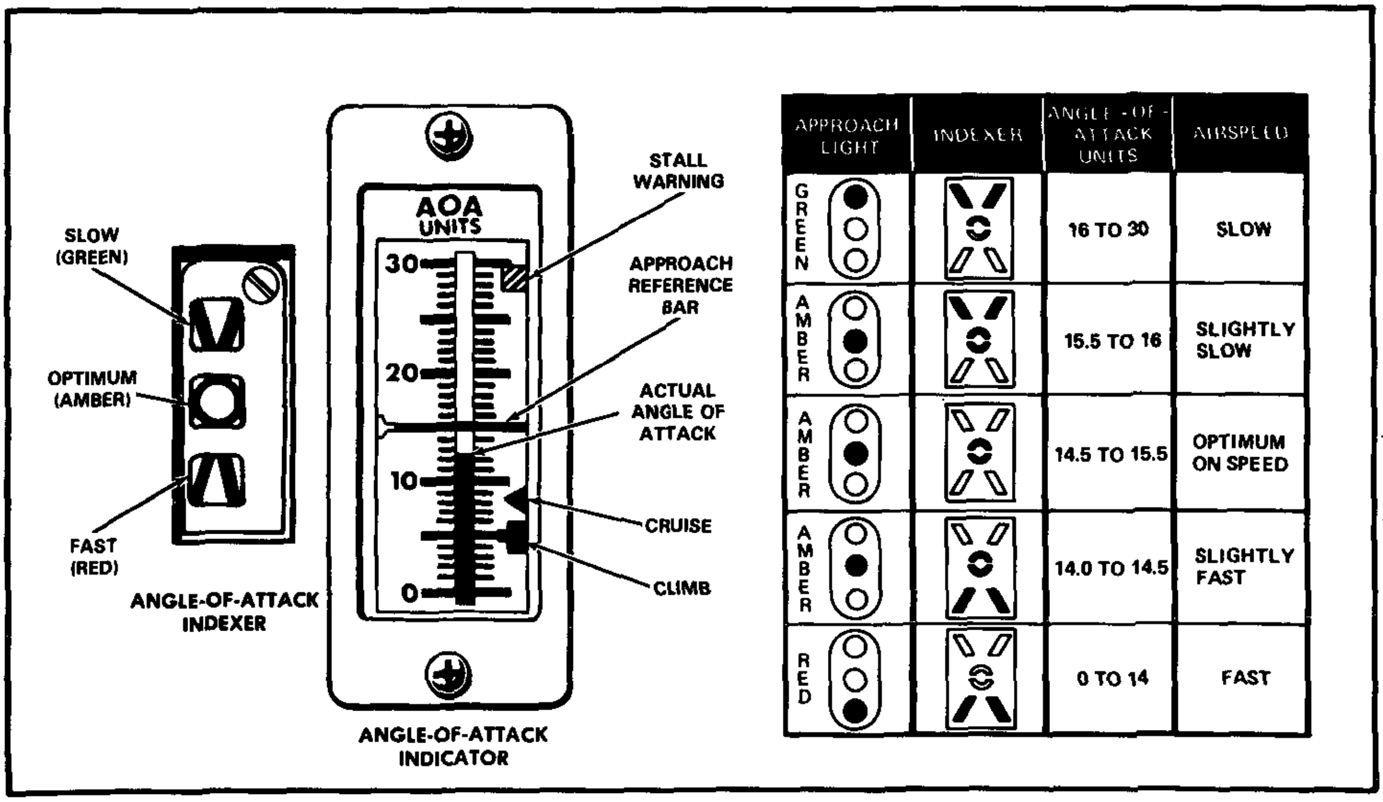

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Figure 2-124. Angle-of-Attack Displays

A green approach light indicates a high AOA, slow airspeed; an amber light indicates optimum AOA; and a red approach light indicates a low AOA, fast airspeed.

2.37 CANOPY SYSTEM

The cockpit is enclosed by a one-piece, clamshell, rear-hinged canopy. Provisions are included to protect the pilot and RIO from lightning strikes by the installation of aluminum tape on the canopy above the heads of the crew. Normal opening and closing of the canopy is by a pneumatic and hydraulic actuator with a separate pneumatic actuator for locking and unlocking. The canopy can be opened to approximately 25° for ingress and egress in approximately 8 to 10 seconds. In emergencies, the canopy can be jettisoned from either crew position or externally from either side of the forward fuselage. For rescue procedures, see paragraph 12.1.6.

CAUTION

The maximum permitted taxi speed and headwind component with the canopy open is 60 knots.

Note

An occasional howl inside the canopy may occur in some aircraft when subjected to an approximate 4g maneuver. The howl has been attributed to the canopy rain seals; when they are removed the howl disappears. A canopy howl in aircraft with rain seals installed does not limit aircraft operation.

The canopy system is controlled with the canopy control handle under the right forward canopy sill at each crew position. An external canopy control handle is on the left side of the fuselage directly below the boarding ladder. A CANOPY caution light on the RIO CAUTION ADVISORY panel illuminates when the canopy is not locked. A LAD/CNPY caution light on the pilot CAUTION ADVISORY panel illuminates when the canopy is not locked or the ladder is not stowed. Electrical power for the caution lights is supplied from the essential dc bus No. 2, through the CAN/LAD/CAUTION/EJECT CMD IND circuit breaker (8C5). A 1-inch by 2-inch white stripe is painted on the canopy frame and sill above the canopy control handle panel. Alignment of this stripe provides an additional visual guide that the canopy is in a closed-and-locked position.

Pneumatic pressure for normal canopy operation is stored in a high-pressure, dry-nitrogen reservoir. Servicing is accomplished externally through the nose wheelwell. Normal pressure should be serviced to 3,000 psi. A pressure gauge in the nose wheelwell should be checked during preflight. A fully charged nitrogen bottle provides approximately 10 complete cycles (open and close) of the canopy before the system is reduced to a minimum operating pressure of 225 psi. If pneumatic pressure drops below 225 psi, the canopy control module automatically prevents further depletion of the main reservoir and the canopy must be opened by the auxiliary mode.

2.37.1 Canopy Operation

2.37.1.1 External Canopy Controls. Access to the external canopy control is obtained through an access door on the left fuselage directly below the boarding ladder. Pulling the handle out and rotating it counterclockwise to NORM CL closes the canopy. Rotating further counterclockwise to the BOOST close position will allow the canopy to be closed under a high headwind or cold-weather conditions. If BOOST is used to close the canopy, the handle should be returned to NORM CL. Rotating it clockwise to NORM OPEN opens the canopy under normal operating conditions and rotating it further to AUX OPEN allows the canopy to be opened manually.

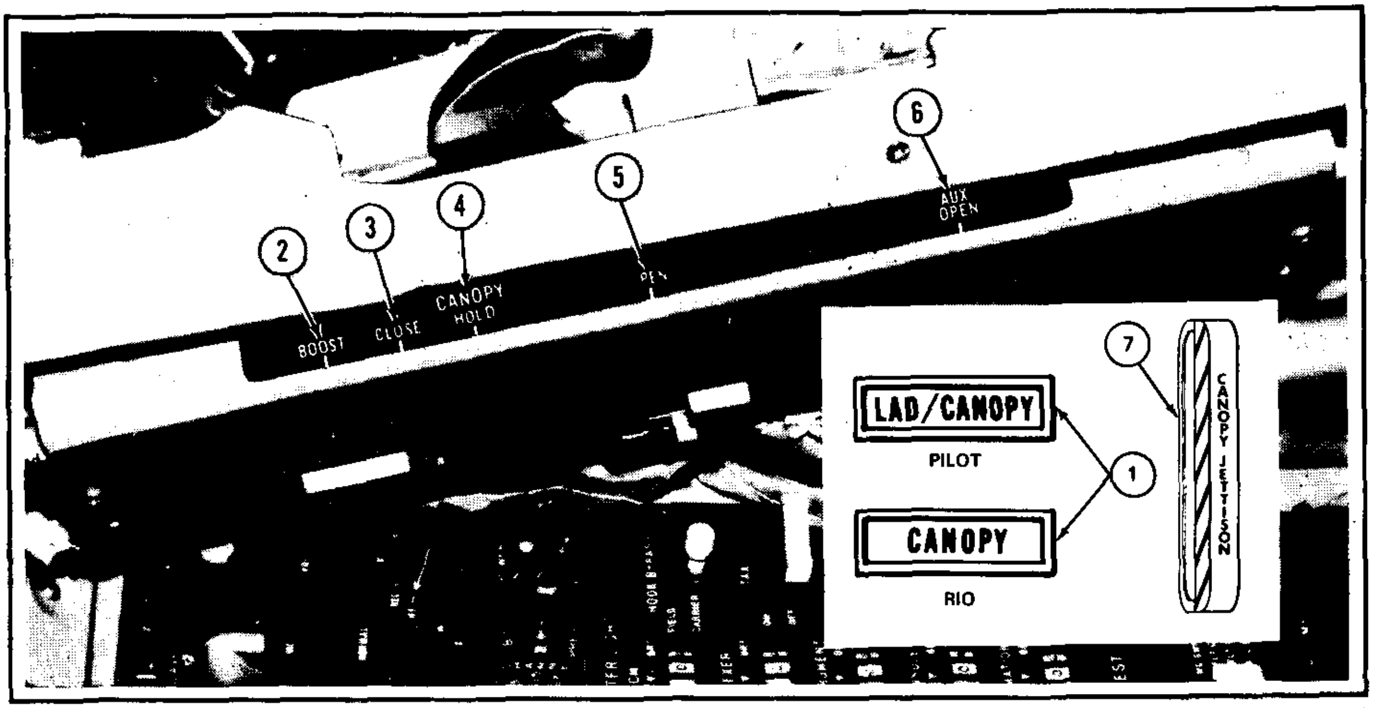
Note

NORM OPEN is not detented; therefore, do not rotate the handle further clockwise unless the AUX OPEN position is desired. Using AUX OPEN unnecessarily will deplete the auxiliary uplock nitrogen bottle.

2.37.1.2 Cockpit Canopy Controls. The canopy pneumatic and hydraulic system is operated by actuation of either of the cockpit control handles (Figure 2-125), or the external control handle, which positions valves within the pneumatic control module to open or close the canopy. The canopy pneumatic and pyrotechnic systems are shown on FO-15. Modes of operation available are: OPEN, AUX OPEN, HOLD, CLOSE, and BOOST.

WARNING

Flightcrews shall ensure that hands and foreign objects are clear of front cockpit handholds, top and sides of ejection seat headboxes, and canopy sills to prevent personal injury and/or structural damage during canopy opening or closing sequence. Foreign objects can catch ejection system initiators on the right aft side of the ejection seat headboxes causing inadvertent ejection even with seat locking handles safe. Only minimum clearance is afforded when canopy is transiting fore or aft.



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NOMENCLATURE	FUNCTION
(1) CANOPY caution light (RIO)	Advises RIO canopy is not in a down and locked position.
(1) LAD/CANOPY caution light (pilot)	Advises pilot boarding ladder is not in the up and locked position or that the canopy is not in the down and locked position.
(2) BOOST	Used to close the canopy in cold or hot weather or when headwinds are greater than 30 to 60 knots.
(3) CLOSE	Used under all flight conditions.
(4) HOLD	Used to hold canopy in any position other than closed.
(5) OPEN	Used to open the canopy under normal conditions.
(6) AUX OPEN	Used to open canopy manually, which is required when nitrogen bottle pressure drops below 225 psi.
(7) CANOPY JETTISON handle	Used to jettison canopy.

Figure 2-125. Cockpit Canopy Control Handle and Indicator Lights

2.37.1.2.1 Open. When OPEN is selected, nitrogen is ported to the locking actuator through the control module and the canopy is moved aft disengaging the canopy hooks from the sill hooks. Pneumatic pressure is then ported to the canopy actuator to raise the canopy.

2.37.1.2.2 Hold. Selection of CANOPY HOLD during transition of the canopy stops the canopy in any intermediate position between closed and open by pressurizing the lock valves in the canopy actuator. These lock valves stop the transfer of hydraulic fluid.

With the canopy in any intermediate (CANOPY HOLD) position, moving the handle slowly toward OPEN will allow the canopy to begin to close until the handle is finally in OPEN. This occurs because the first motion of the handle moves the selector valve cam, which vents pressure from the lock valves and allows the canopy weight to transfer hydraulic fluid. Once the selector valve cam is completely moved to OPEN, pressure is then applied to the open side of the canopy actuator.

CAUTION

If the canopy handle is left in an intermediate position for an extended period, the canopy will slowly close.

2.37.1.2.3 Close. In CLOSE it allows the canopy to close under normal conditions (30-knot headwind) using its own weight without an expenditure of stored nitrogen. When the control handle is set to CLOSE, both sides of the canopy actuator are vented to the atmosphere, allowing the canopy to lower itself. The final closing motion actuates a pneumatic timer, which directs pressure from the control module to the locking actuator and the canopy is moved forward to engage the canopy hooks in the sill hooks.

To close the canopy under high headwind conditions (30 to 60 knots) or when difficulty is experienced because of hot or cold temperatures, BOOST is used. The BOOST mode is activated by rotating the canopy control handle outboard past the CLOSE stop and pushing the handle forward. With the control handle in this position, the control module ports additional regulated pneumatic pressure to the closed side of the canopy actuator. If BOOST is used to close the canopy, the handle should be returned to CLOSE.

2.37.1.3 Auxiliary Canopy Opening. When the main pneumatic reservoir pressure is reduced to 225 psi, the canopy control module automatically prevents further depletion of reservoir pressure and the canopy must be opened manually. Actuation of the auxiliary mode can be affected from either the pilot or RIO canopy control handle or from the ground external canopy control. To open the canopy from the cockpit in this mode, the canopy control handle in the cockpit must be rotated outboard to move the handle past the OPEN stop and then pulled aft to AUX OPEN. This activates a pneumatic valve, which admits regulated pneumatic pressure from an auxiliary nitrogen bottle to the locking actuator and moves the canopy aft out of the sill locks. When the canopy is unlocked, pneumatic pressure from the main reservoir is ported to the open side of the canopy actuator to counterbalance the weight of the canopy, allowing the canopy to be manually opened or closed by the flightcrew.

Before leaving the cockpit, the control handle should be returned to HOLD. If left in AUX OPEN, the canopy's own weight or a tailwind could force the canopy down with low pressure in the main reservoir. Once the auxiliary canopy unlock bottle is used, the canopy will not return to the normal mode of operation and cannot be locked closed until the auxiliary pneumatic selector valve on the aft canopy deck is manually reset (lever in vertical position).

The auxiliary canopy unlock nitrogen bottle is on the turtleback behind the canopy hinge line (refer to FO-15). Servicing of the auxiliary bottle is through the small access panel immediately behind the canopy on this turtleback. A fully charged bottle will provide approximately 20 canopy cycling operations in the auxiliary open mode.

2.37.1.4 Canopy Jettison. The canopy can be jettisoned from either cockpit or from external controls on each side of the fuselage. An internal control handle in each cockpit (Figure 2-125) is on the forward right side of each flightcrew instrument panel and is painted yellow and black for ease of identification. To activate the jettison control handle, squeeze the inner face of the handle and then pull.

The length of pull is approximately one-half to three-quarter inch, and the handle comes free of the aircraft when actuated. Pulling either CANOPY JETTISON handle actuates an initiator that ignites the canopy separation charge and actuates the canopy gas generator. The canopy separation charge ignites the expanding, shielded, mild-detonating cord lines, routed through the canopy sill hooks, breaking the sill hook frangible bolt. This allows the hooks to rotate upward, releasing the canopy. The canopy gas generator produces high-pressure gas that forces the canopy hydraulic actuator shaft upward, ballistically removing the canopy.

Ejection through the canopy can result in injury and is provided only as a backup method; therefore, the canopy is jettisoned as part of the normal ejection sequence. An upward pull on the ejection seat firing handle jettisons the canopy prior to ejection.

2.37.1.4.1 External Canopy Jettison Handles. There are two external emergency jettison handles located on the lower left and right fuselage below the pilot cockpit, appropriately marked for rescue. Opening either access door and pulling the T-handle fires an initiator that detonates the canopy separation charge and actuates the canopy gas generator. The sequence is the same as when the cockpit handles are pulled. The jettison control handles require squeezing the inner face of the handle and then pulling for actuation. The length of pull is approximately one-half to three-quarter inch and the T-handle comes free on the aircraft when actuated. Refer to Chapter 12 for canopy external jettisoning procedures.

2.38 EJECTION SYSTEM

The aircraft is equipped with an automatic electronically sequenced command escape system incorporating two Navy aircrew common ejection seat (SJU-17(V) 3/A (pilot) and SJU-17(V) 4/A (RIO)) rocket-assisted ejection seats. Both seats are identical in operation and differ only in nozzle direction of their lateral thrust motors, which provide a divergent ejection trajectory away from the aircraft path. When either crewmember initiates the command escape system, the canopy is ballistically jettisoned and each crewmember is ejected in a preset-time sequence. The RIO is ejected to the left and the pilot to the right.

Safe escape is provided for most combinations of aircraft altitude, speed, attitude, and flightpath within an envelope from zero airspeed, zero altitude in a substantially level attitude to a maximum speed of 600 KCAS between zero altitude and 50,000 feet. Preflight procedures are shown in Chapter 7 of this manual; ejection procedures are discussed in Chapter 16. Ejection sequence is illustrated in FO-16 and FO-17.

WARNING

Loose gear in the cockpit is a FOD and missile hazard, especially during carrier operations, maneuvering flight, or ejection sequences. Carriage of gear that cannot be contained in the cockpit storage compartment shall be kept to a minimum consistent with mission requirements and the mission environment.

2.38.1 Ejection Seat. The NACES seat (Figure 2-126) is provided with a rocket-deployed 6.5 meter (20-foot), aeroconical, steerable parachute that is packed with a ribbon extraction drogue in a container behind the seat occupant's head. The seat bucket holds the survival kit and also has the seat firing handle and other operating controls. The parachute risers attach to the crewmember's torso harness by means of seawater-activated release switches. Normal ejection includes canopy jettison before the seats are catapulted out of the cockpit; however, the parachute container is fitted with canopy penetrators. This permits a backup ejection through the canopy after a time delay in the event of safe-and-arm unit failure or failure of the canopy to separate from the aircraft.

After ejection has been initiated, two pitot heads mounted next to the parachute container are deployed. Airspeed and altitude are provided to the battery-operated electronic sequencer mounted under the parachute container. The sequencer, which also receives static pressure, uses the information to determine the proper sequencing of deployment of the seat drogue and parachute and release of the harness locks. Depending on seat altitude and airspeed, the seat drogue, which is catapult-deployed from a canister on the back of the seat and has a three-point attachment bridle, can be used to stabilize the seat, slow its descent, or be jettisoned before the parachute deployment rocket is fired. To ensure parachute deployment and man-seat separation, a barostatic release operates to fire the parachute deployment rocket and release the harness locks in the event of complete or partial sequencer failure. As a further backup, operating the manual release handle on the seat bucket will also fire the parachute deployment rocket and release the harness locks.

2.38.1.1 Seat Firing Handle. Ejection is initiated by pulling up on the seat firing handle on the front of the seat bucket between the crewmember's thighs. This action operates linkage that withdraws the sears from the two seat initiator cartridges, commencing the ejection sequence.

2.38.1.2 SAFE/ARMED Handle. The SAFE/ARMED handle on the right side of the seat bucket forward of the manual override handle is the only control for arming and safing the seat. (On the ground, a safety pin is also installed in the seat firing handle.) The handle locks in the selected position. It is operated by releasing a catch to remove the locking plunger. When the handle is rotated forward (up) to safe the seat, the SAFE legend is displayed on a white background and a safety plunger is inserted into the firing handle linkage so that the handle cannot be pulled up, rendering the seat inoperative. Rotating the handle aft (down) displays the ARMED

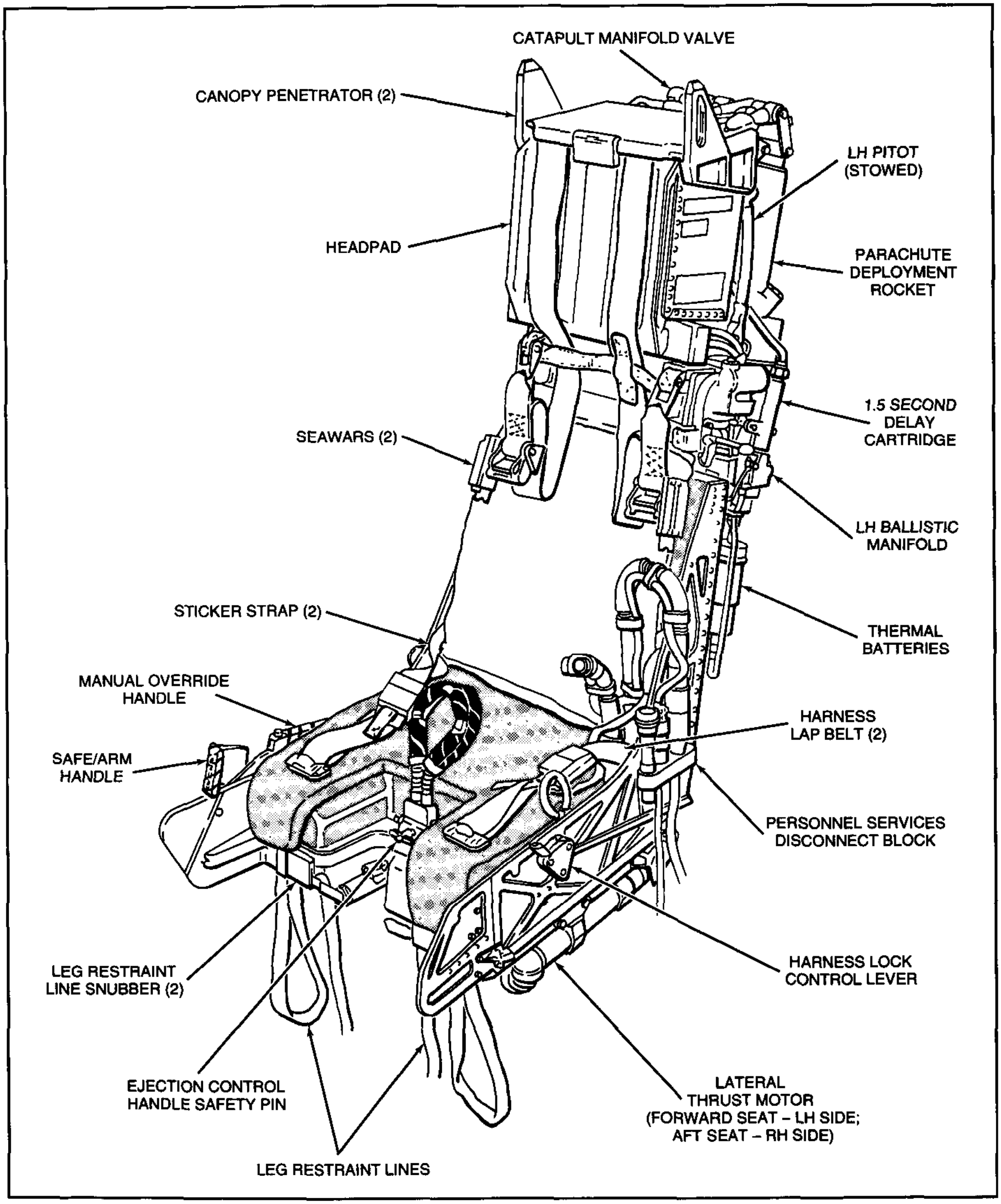

Figure 2-126. Ejection Seat (Sheet 1 of 2)

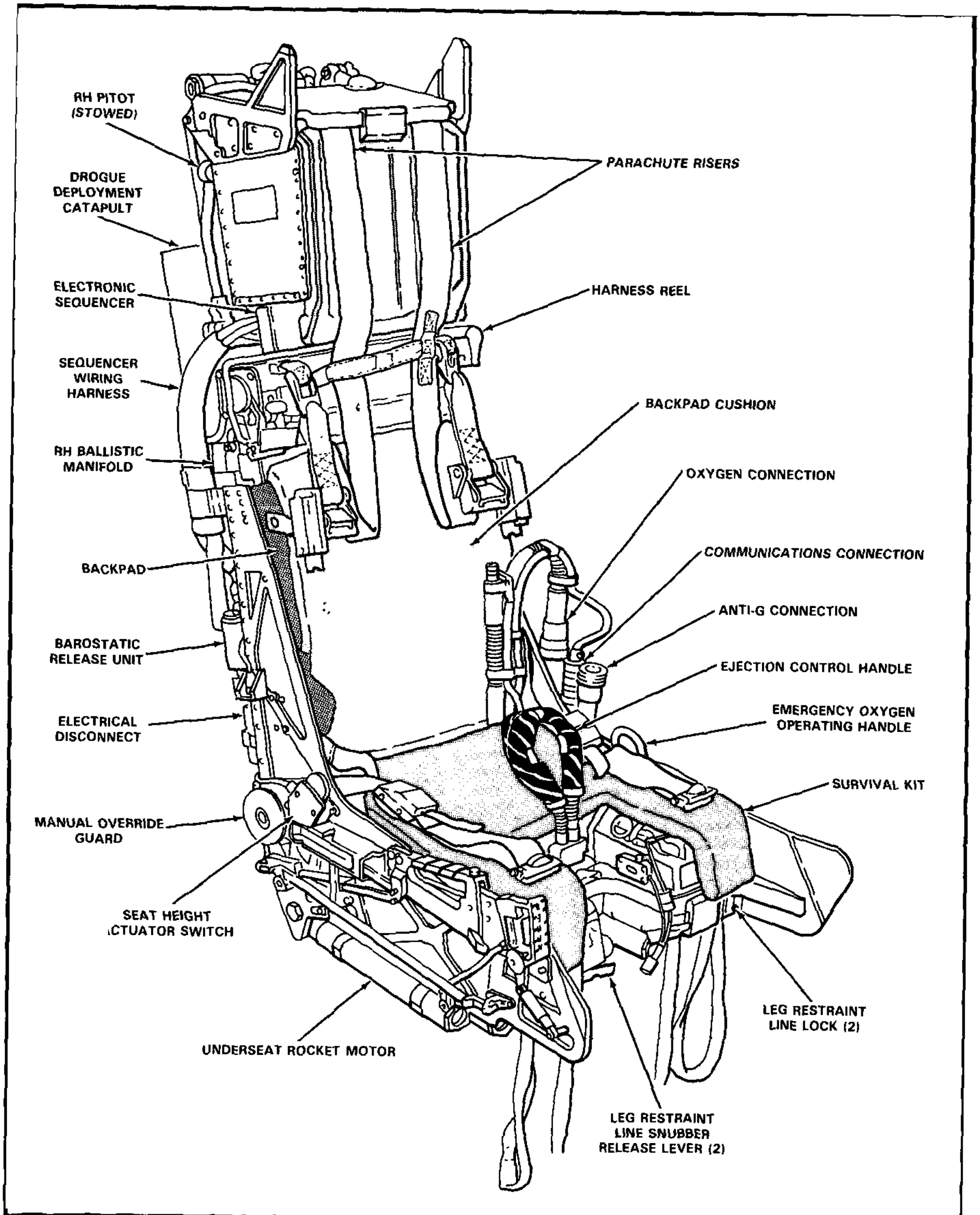

Figure 2-126. Ejection Seat (Sheet 2 of 2)

legend on a yellow-black striped background. This pulls the safety plunger from the firing handle linkage, freeing the handle and allowing the seat to be fired. With the canopy closed, the SEAT UNARMED caution light in the RIO cockpit is illuminated if the SAFE/ARMED handle on either seat is in the SAFE position.

2.38.1.3 Manual Override Handle. The manual override handle on the right side of seat bucket behind the SAFE/ARMED handle is connected by linkage to the lower harness lock release mechanism and to an initiator in the seat bucket. The handle is locked in the down position by a catch operated by a thumb button at the forward end of the handle. Depressing the thumb button allows the handle to be rotated aft. Operating the handle also rotates the SAFE/ARMED handle to the SAFE position. A catch in the lower part of the manual release handle must be reset before the handle can be returned to the down position. With the seat in the aircraft, operation of the handle linkage is restricted by the pin puller and releases only the lower locks, negative-g strap, and the leg restraint line locks to permit emergency ground egress with the survival kit attached.

Note

The parachute risers and personnel services must be disconnected manually.

After ejection, the pin puller disengages permitting further movement of the linkage so that operating the handle releases the lower harness locks and fires the manual override initiator that provides gas pressure to release the upper torso harness locks and fire the parachute deployment rocket in the event of automatic sequencing failure.

2.38.1.4 Torso Harness. The torso harness is worn by the crewmember and takes the place of a separate lapbelt and shoulder harness. The upper torso harness is connected by release fittings (Koch fittings) to the inertial reel via straps passed through roller yokes attached to the parachute risers. The release fittings incorporate SEWARS to allow automatic release on saltwater entry. A fitting on the lower part of the torso harness connects to the negative-g strap, and two buckles connect to the seat lapbelt fittings. Lapbelt girth can be adjusted to accommodate the individual crewmember by adjusting each belt strap.

2.38.1.5 Harness Lock Control Lever. The harness lock control lever on the left side of the seat bucket has two detented positions. In the forward (locked) position, forward movement of the occupant is restricted and any slack created by rearward movement is taken up by the inertial reel. The control is locked in this position by a detent. In the aft position, the occupant can move forward freely, unless the reel locks owing to excessive forward velocity. When the forward velocity decreases sufficiently, the inertia straps are released without the necessity of repositioning the manual control. Both straps feed from the same shaft, and it is impossible for one to lock without the other. If the reel is locked manually the control must be positioned aft to the unlocked position to release the straps.

2.38.1.6 Leg Restraints. The leg garters and restraint cords keep the occupant's leg firmly against the leg rests during ejection. The garters are placed around the leg below the calf and above the knee.

The leg-restraint cords are attached to the aircraft deck and routed through the seat snubber box structure. They are then passed through garter rings and snapped into the leg-line locks. The garter rings are snapped into the bayonet fitting when strapping in. Leg-line release is accomplished by pulling the manual override handle. Leg restraints may be adjusted by pulling the tab on the inner side of each leg-line snubber box.

2.38.1.7 Negative-G Strap. The negative-g strap is not incorporated in the F-14D NACES ejection seat.

2.38.1.8 Seat Height Adjustment Switch. Seat height is adjusted by an actuator driven by a single-phase 115-Vac electric motor. Operation of the actuator is controlled by a three-position switch on the right aft side of the seat bucket marked RAISE, OFF, and LOWER. The switch is spring loaded to the center OFF position; RAISE is aft and LOWER is forward. Electric power is supplied from phase B of the right main ac bus through the ACM LT/SEAT ADJ/STEADY POS LT circuit breaker (2I4).

CAUTION

The seat height actuator motor has a maximum duty cycle of 1 minute on in any 8-minute period.

2.38.1.9 Survival Kit. The survival kit (Figure 2-127) forms the sitting platform for the crewmember and consists of a fabric survival-aids container covered by a contoured, rigid platform with a cushion on top to provide a firm seat and additional comfort for the crewmember. The kit is retained in position by pivot fittings at the front and lugs attached to the lower harness locks at the rear. Attached to the lower harness lock lugs are two adjustable harness lap straps with integral lapbelt release fittings.

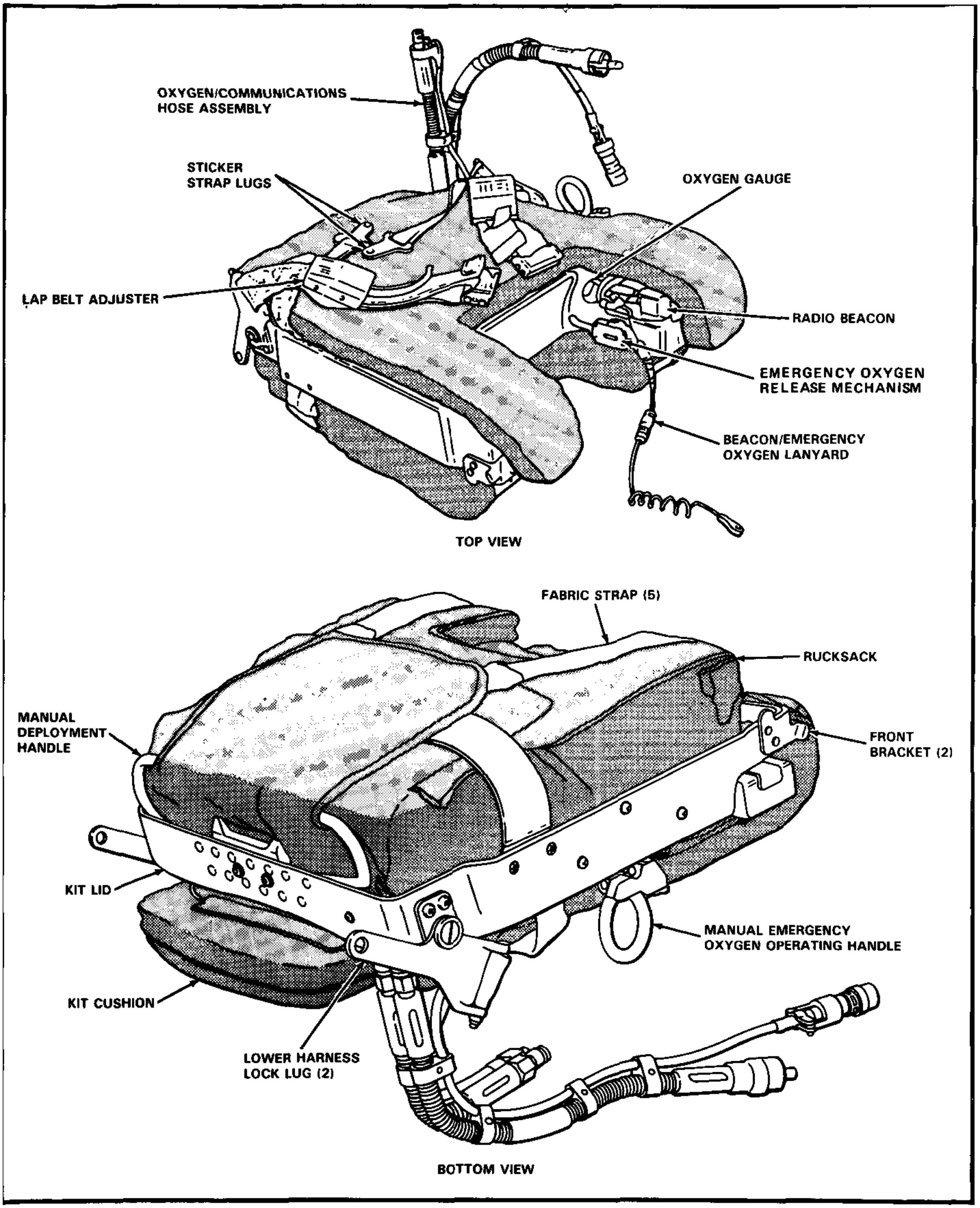

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Figure 2-127. Survival Kit

The survival kit accommodates a liferaft, an emergency oxygen cylinder, and the survival aids. The emergency oxygen cylinder is mounted to the underside of the platform, a pressure gauge is on the left thigh support, and a green manual operating handle is on the left side of the platform. The emergency oxygen is also automatically activated during ejection by a static line connected to the cockpit floor.

Note

Flow of oxygen from the emergency cylinder can be stopped by reseating the manual actuation handle.

A URT-33C radio locator beacon is in a cutout in the left thigh support and is connected to the cockpit floor by a static operating cable so that it can be automatically actuated during ejection (if desired). The fabric survival-aids container can be deployed on a lowering line after ejection by pulling on either of the two yellow handles located on the back side. The liferaft is automatically inflated when the survival-aids container is deployed. Contents of the survival-aids container may vary depending on the area of operation, but the following is a typical list:

1. Liferaft dye markers
2. Signal flares
3. Morse code and signal card
4. Space blanket
5. Desalter kit or canned water
6. 50 feet of nylon cord
7. Bailing sponge
8. SRU-31/P flightcrew survival kit.

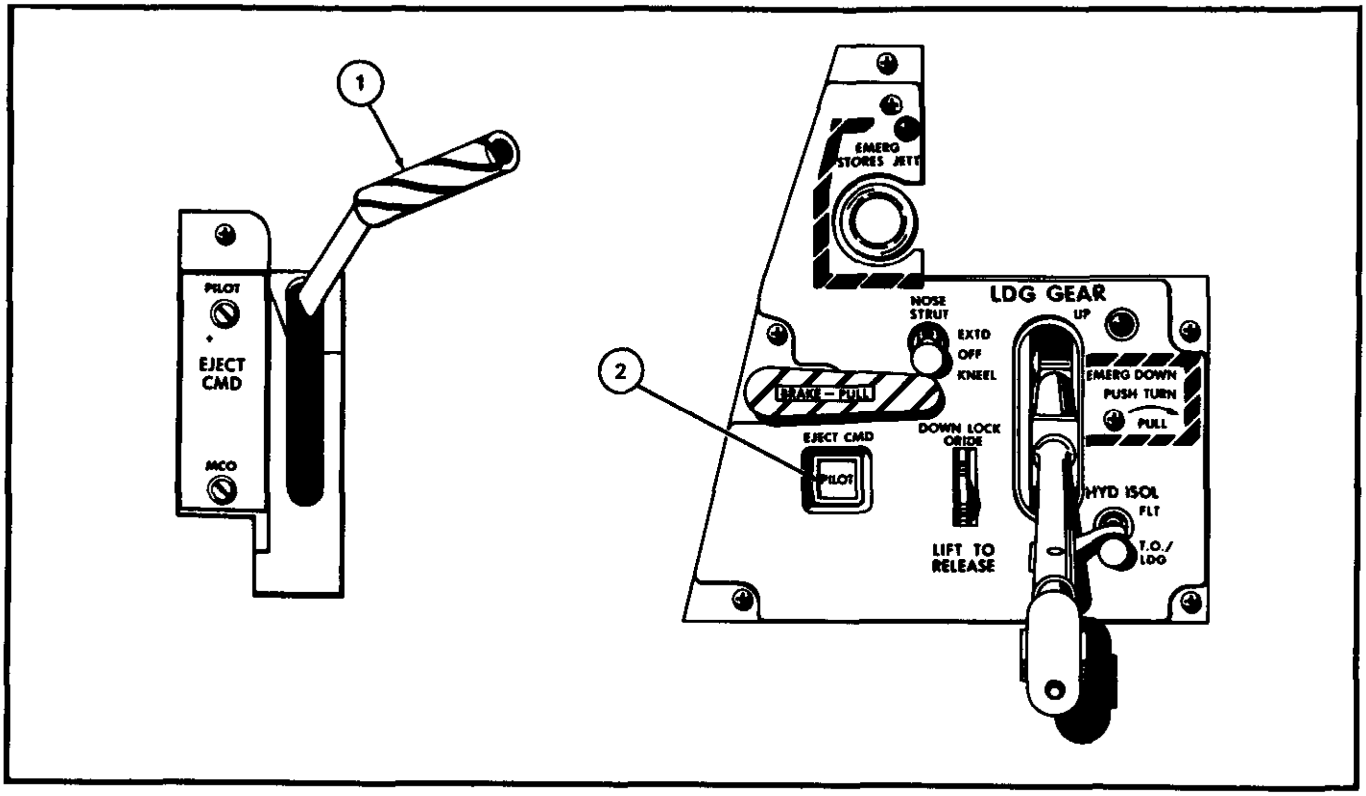
If over water, the survival-aids container should be deployed on its lowering line before reaching the surface to make the raft immediately available on landing. If over land, it should not be deployed. This will reduce the risk of entanglement and protect against injury.

2.38.1.10 Rocket Motor. The rocket motor is on the bottom of the seat bucket. It is ignited by a lanyard attached to the cockpit floor as the catapult nears the end of its stroke. The rocket thrust is approximately 4,800 pounds for .25 second and sustains the thrust of the catapult to carry the seat to a sufficient height for a safe zero/zero ejection from a level attitude. The rocket motor nozzles are inclined so that the thrust passes close to the cg of the seat and occupant. The motor also includes a lateral thrust nozzle that imparts a divergent trajectory carrying the seat away from the aircraft flightpath.

2.38.2 Command Ejection Lever. A command ejection lever (Figure 2-128) above the RIO left outboard console allows the RIO to select either pilot or RIO control of the command ejection system. Each position has an internal locking detent. The handle is unlocked by lifting upward and moved by a forward or aft motion. If the handle is released before reaching the aft position, it is spring loaded to return forward. It will automatically lock in the forward position; however a downward motion is required to positively lock it into the aft position. To select MCO command ejection position, raise the handle and pull aft. An EJECT CMD flip-flop-type indicator on the landing gear panel indicates the command mode selected. The RIO may eject individually when the command ejection lever is in the pilot control position. When the command ejection lever is in the MCO command position, the RIO can initiate ejection of both seats. Regardless of the position of the command ejection lever, an ejection initiated by the pilot will always eject both crewmen. Command ejection by either crewmember will eject the RIO first and the pilot 0.4 second later. Depending on aircraft dynamics, the total time for command ejection of both seats in the normal (safe and arm device) mode is from 0.4 to 0.9 second; in the backup initiator mode, the total time is 1.5 second.

2.38.3 Ejection Initiation. With the SAFE/ARMED handle in the ARMED (down) position, pulling the seat firing handle upward to the extent of its travel begins the ejection by pulling the sears on the seat initiators. The following events occur:

1. Canopy jettison is initiated.
2. The powered inertia reel retracts, pulling the crewmember back in the seat.
3. The delay initiators are activated. These initiators have built-in delays of 1.0 second for the RIO seat and 1.5 seconds for the pilot seat.
4. The restriction is removed from the manual override mechanism.
5. The 4.0-second delay cartridge for the barostatic release is initiated.
6. The safe and armed device is armed.



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NOMENCLATURE	FUNCTION
1 EJECT CMD lever (RIO cockpit)	PILOT – Ejection initiated by the pilot will eject himself and RIO (RIO first). Ejection initiated by the RIO will eject only the RIO. Pilot eject command indicator –PILOT. MCO – Ejection initiated by the pilot will eject himself and RIO (RIO first). Ejection initiated by the RIO will eject himself and pilot (RIO first). Pilot eject command indicator –MCO.
2 EJECT CMD (flip–flop) indicator	PILOT – Indicates command ejection lever is in PILOT. Only the pilot can eject himself and RIO –RIO–initiated ejection will eject only himself. MCO – Indicates command ejection lever is in MCO. Both pilot and RIO can eject both flightcrew members –RIO will eject first.

Figure 2-128. Command Ejection Lever

When canopy jettison is complete, a lanyard attached to the canopy pulls a sear, firing the safe and arm device. This initiates the thermal batteries that power the seat electronic sequencer and fires the two-stage catapult, ejecting the seat. The RIO seat is fired immediately on firing of the safe and arm device, while the pilot seat is delayed 0.4 second. The IFF switch is actuated when the pilot seat is fired.

If the canopy fails to separate or the safe and arm device does not fire, the backup initiators operate at the expiration of their delays, firing the RIO seat 1.0 second after firing handle actuation and the pilot seat 0.5 second later, through the canopy.

As the seat ascends the guide rails, the following events occur:

1. The multipurpose initiator lanyards begin to withdraw.

2. Personnel services between seat and aircraft are disconnected.

3. The emergency oxygen supply is initiated.

4. The emergency locator beacon is activated.

5. The leg restraint lines are drawn through the snubbers and restrain the crewmember's legs to the front of the seat bucket. When the leg restraint lines become taut, the break ring in each line fails and the lines are freed from the aircraft. The snubbers prevent forward movement of the legs.

At the end of the catapult stroke (approximately 35 inches of seat travel), the multipurpose initiator lanyards become taut and withdraw the firing unit sears. This routes gas pressure to the electronic sequencer start switches, beginning sequencer timing to the pitot deployment mechanisms and to the rocket motor, firing it. The electronic sequencer determines the proper mode of seat operation based on altitude and airspeed.

2.38.4 Seat Operation After Ejection. Postejection operation (FO-16 and FO-17) begins at the end of catapult travel when the rocket motor fires and the start switches actuate. In normal operation, the electronic sequencer selects the operating mode depending on altitude and airspeed. A barostatic release unit provides an automatic backup for electronic operation. Four seconds after the seat firing handle is pulled, the barostatic unit is armed permitting parachute deployment and harness release as determined by the barostat setting if the sequencer has not functioned. As a further backup, the crewmember can manually fire the parachute deployment rocket and release the harness locks by using the manual override handle.

2.38.4.1 Electronic Sequencing. In all modes, following start switch actuation, the pitot heads extend, environmental sensing for mode selection commences, and the seat drogue is deployed on its three-point bridle to stabilize and slow the seat. While this is occurring, the sequencer selects one of the five operating modes (FO-16 and FO-17) from its lookup tables based on sensed altitude and airspeed. The modes are described as follows:

1. Mode 1 — This is the low-altitude, low-airspeed mode. The drogue bridle releases operate immediately; the parachute deployment rocket fires to extract and deploy the parachute; and the harness locks are released. The occupant is held in the seat momentarily by the sticker clips.

2. Modes 2, 3, and 4 — These modes are for low to medium altitudes at airspeeds in excess of 350 knots. The drogue is retained to slow and stabilize the seat. Then, the parachute deployment rocket is fired to extract and deploy the parachute, the drogue bridle releases the drogue; and the harness locks are released. The occupant is held in the seat momentarily by the sticker clips.

3. Mode 5 — This mode is selected at high altitude. The lower drogue bridle releases operate, retaining the drogue by the upper attach point only. Environmental sensing restarts, and the seat is allowed to fall to 18,000 feet before the sequence continues. Then the upper drogue release operates, freeing the drogue, the parachute deployment rocket is fired to extract and deploy the parachute, and the harness locks are released. The occupant is momentarily held in the seat by the sticker clips.

In all modes, parachute deployment lifts the crewmember and survival kit from the seat, pulling the sticker straps from the clips.

2.38.4.2 Barostatic Release. To ensure that the parachute is deployed and the harness locks are released, the barostatic release unit, consisting of a barostat and a cartridge, provides an independent automatic backup to the electronic sequencer. The cartridge is fired one of three ways: electrically by the sequencer at a preset altitude of 18,000 feet (FO-16 and FO-17), mechanically by the barostatic release unit between 14,000 and 16,000 feet; or mechanically by gas pressure from a 4-second delay cartridge when the manual override handle is pulled. After the time delay, gas pressure is applied to the barostat cartridge firing mechanism. Above the barostat altitude setting, the mechanism is restricted from moving; at or below the altitude it is free to move and fire the cartridge if it has not already been fired electrically. When fired, the barostat cartridge provides gas pressure to fire the parachute deployment rocket and operate the harness lock release.

2.38.4.3 Manual Override. After ejection, the manual override handle provides a further backup to both the electronic sequencer and the barostatic release. Pulling the handle fires a cartridge that provides gas pressure to fire the parachute deployment rocket and operate the harness lock release.

2.39 LIGHTING SYSTEM

2.39.1 Exterior Lights. The exterior lights include position lights, formation lights, anticollision lights, a taxi light, approach lights, and an air refueling probe light. All exterior lighting controls, except for the air refueling probe light and approach lights, are located on the MASTER LIGHT panel on the pilot right console. The exterior lights master switch on the outboard throttle must be on for any exterior light to function (except for approach lights). The pilot light control panel is shown in Figure 2-129. A two-channel flasher unit is used for flashing lights. One channel flashes the anticollision and position lights and has circuit protection from the ANTICOLL/SUPP POS/POS LTS circuit breaker (2I1). The second flasher channel flashes the AOA indexer and approach lights and has circuit protection from the ANGLE OF ATTK IND AC circuit breaker (3F3).

Note

The anticollision, position, and supplementary position, formation, and taxi lights are inoperative when operating on emergency generator.

2.39.1.1 Position Lights. The position lights consist of a red light on the left wingtip, a green light on the right wingtip, and a white position light in the left fin cap assembly. Supplemental position lights include upper and lower red lights on the left wing glove and upper and lower green lights on the right wing glove. When the wind-sweep angle is forward of 25°, the wingtip position lights are operational; when the wings are swept aft of 25°, the wingtip position lights are disabled and the glove position lights are operational. When operating in steady mode with the nosegear down and locked and the wings forward of 25°, both the wingtip position lights and the glove position lights are operational. The position lights are powered from the right main ac bus through the exterior lights master relay.

Note

When the anticollision lights are on, the flasher for the position lights is disabled and the lights revert to steady.

2.39.1.2 Anticollision Lights. There are three red, flashing anticollision lights. One anticollision light is installed in the bottom of the infrared pod on the lower forward fuselage. Another anticollision light is installed in the top forward part of the left vertical stabilizer. The third anticollision light is on the top aft part of the right vertical stabilizer and directs its anticollision beacon up and down.

The lower fuselage forward anticollision light remains off during takeoff and landing with the nosewheel door open. With the nosewheel door closed, the lower fuselage forward anticollision light will operate with the ANTI COLLISION light switch set to ON. The anticollision lights are powered through the right main bus with circuit protection on the RIO ac right main circuit breaker panel TAXI/FORM LT (3A2).

2.39.1.3 Formation Lights. The formation lights consist of wingtip lights on each wing, fuselage lights, and vertical fin tip lights on both sides of the aircraft.

All formation lights are green. Intensity of the lights is controlled by the FORMATION thumbwheel on the MASTER LIGHT panel. Electrical power is supplied through the right main bus with circuit protection on the RIO ac right main circuit breaker panel TAXI/FORM LT (3A2).

2.39.1.4 Taxi Light. The taxi light installed on the nosewheel is a fixed-position light. A limit switch on the nosegear door will turn the light off when the gear is retracted. A two-position, ON and OFF, switch is on the MASTER LIGHT panel. Electrical power is supplied through the right main bus with circuit protection on the RIO circuit breaker panel TAXI/FORM LT (3A2).

2.39.2 Interior Lights. The interior lighting of the cockpit consists of red instrument panel and console panel lights, red and white floodlights for additional console and instrument panel lighting, and utility/map lights for each flightcrew station. At the pilot station, the interior lights are controlled from the MASTER LIGHT panel on the right outboard console. The RIO can control the interior lighting from the interior light panel on the RIO right outboard console.

2.39.2.1 Instrument and Console Panel Lights. All flight instruments in the pilot and RIO instrument panel and console panel lights are lighted by white lighting. Individual thumbwheel controls are

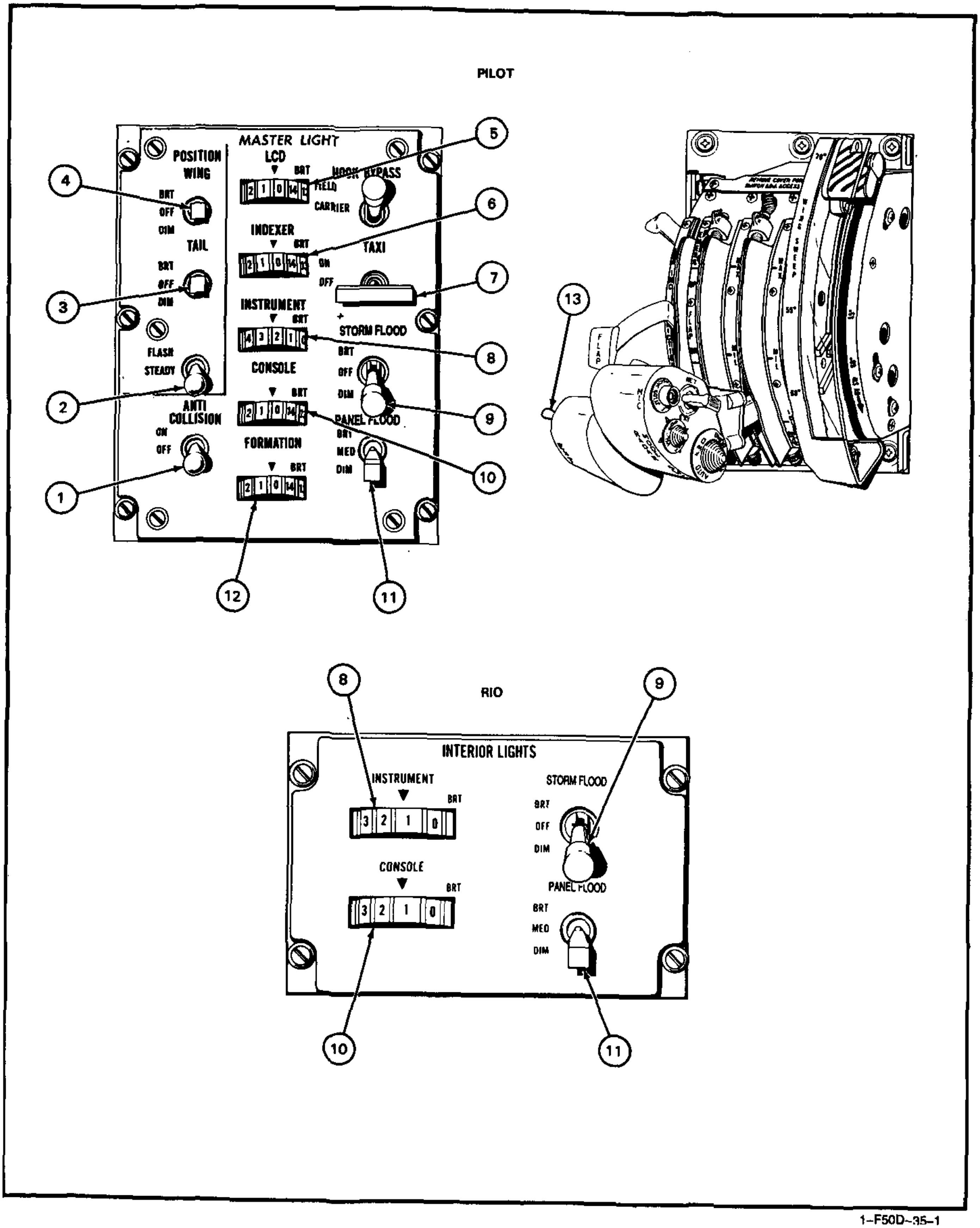

Figure 2-129. Cockpit Light Controls (Sheet 1 of 3)

NOMENCLATURE	FUNCTION	
1 ANTI COLLISION light switch	ON and OFF –	Energizes or deenergizes the anticollision lights. When anticollision lights are on, the flasher unit for the position lights is disabled.
2 POSITION lights flasher switch	FLASH –	Causes the wing or supplementary tail and position lights to operate in a flashing mode with landing gear up. With gear down supplementary lights operate steady only.
	STEADY –	With the wing and tail (or either) position lights on, lights are on steady.
3 TAIL POSITION light switch	BRT –	Bright tail light
	OFF –	Deenergizes tail position light
	DIM –	Dim tail light
4 WING POSITION light switch	BRT –	Bright wing lights
	OFF –	Deenergizes wing lights
	DIM –	Dim wing lights
5 LCD panel light thumbwheel	0 to 1 –	Dims pilot's liquid crystal display brightness. EIG white backlighting on.
	1 to 14 –	Night variable intensity
6 INDEXER thumbwheel	0 to 14 –	Variable increase in intensity of indexer lights.
7 TAXI light switch	ON –	Nose gear must be down and locked and the master exterior light switch must be on.
	OFF	Turns light off.
8 INSTRUMENT lights thumbwheel	0 to 1 –	Turns instrument panel lights on.
	1 to 14 –	Variable increase of intensity to a maximum brightness at 14.
9 STORM FLOOD lights switch	BRT –	Bright light.
Note	DIM –	Dim light.
Switch must be pulled out to be moved to BRT or DIM.	OFF –	Turns light off.
10 CONSOLE lights thumbwheel	0 to 1 –	Turns console lights and console white floodlights on.
	1 to 14 –	Variable increase of console lights intensity to maximum brightness at 14.
11 PANEL FLOOD lights switch	BRT	Bright white instrument flood and console floodlights only.
	MED	White console floodlights only.
	DIM –	Dim white console floodlights only.

Figure 2-129. Cockpit Light Controls (Sheet 2 of 3)

NOMENCLATURE	FUNCTION	
(12) FORMATION lights thumbwheel	0 to 1 –	Turns formation lights on.
	1 to 14 –	Variable increase of light intensity to maximum of 14.
(13) Exterior lights master switch	ON	Enables all exterior lights except approach lights. Dims approach lights to night intensity.
	OFF	Permits pilot to turn off all exterior lights except approach lights. Sets daylight intensity on approach lights.

Figure 2-129. Cockpit Light Controls (Sheet 3 of 3)

provided for the pilot and RIO instrument and console lighting. The thumbwheels have 14 variable selections from 0 to 14. Initial rotation from 0 to 1 activates the circuitry and provides a low-intensity light. Further rotation up to a maximum intensity (14) increases the brightness. The INSTRUMENT thumbwheel also controls the intensity of the CAUTION ADVISORY panels, the left and right vertical consoles, and the digital data indicator lights, which consist of high- and low-intensity lighting. The console lights thumbwheel turns power on for both the console lights and the floodlights. The pilot and RIO instrument and console lights are protected by circuit breakers on the RIO ac circuit breaker panels (2I2, 3A1, 3A2, and 3A5). Lighting for the pilot turn-and-slip indicator is controlled by the INSTRUMENT lighting thumbwheel. The engine indicator group uses integral white lighting for daylight operations, and liquid crystal display brightness is controlled by the LCD thumbwheel.

2.39.2.2 Floodlights. The floodlights consist of 4.2-watt and 20-watt white lights that illuminate the instrument and console panels. When navigating around thunderstorms, the storm floodlights should be turned on bright to assist in preventing temporary blindness from lighting. The STORM FLOOD toggle switch on the pilot master light panel and another on the RIO light panel are safety interlock switches that must be pulled up to be positioned to BRT or DIM. In DIM, low-intensity floodlighting is provided.

Note

When the storm floodlights are on (BRT or DIM), the intensity of the CAUTION and ADVISORY panel lights is increased to day (bright) illumination mode.

Console and instrument panel floodlights are available in BRT. In the MED and DIM, only console floodlights are available. The panel floodlights are protected by a FLOOD LTS circuit breaker (4A6) on the RIO ac essential No. 1 circuit breaker panel (4A6). The white floodlights are protected by the STORM FLOOD LT circuit breaker (2I6) on the RIO ac right main circuit breaker panel.

2.39.2.3 Utility and Map Lights. The pilot utility and map light is on a bracket above the right outboard console. The RIO utility and map light is in a bracket above and midway along the right and left console. Each light has a rheostat control including an ON and OFF on the rear of the lamp. A red filter may be selected by rotating the face of the lamp. Pressing the locking button on top of the lamp permits rotating the face of the lamp to reselect a white light with a flood or spot illumination option. An alligator clip and swivel mounting allow the light to be positioned on a clipboard or other convenient location. A flasher button on the heel of the lamp allows either crewmember to use the light as a signal lamp. The utility and map lights are supplied electrical power from the ac essential No. 2 bus and are protected by the UTILITY LTS circuit breaker (3A6).

2.39.3 Warning and Indicator Lights. Warning, caution, and advisory lights (Figures 2-130 and 2-131) are provided in both cockpits to alert the pilot and RIO of aircraft equipment malfunctions, unsafe operating conditions, or that a particular system is in operation.

Warning lights illuminate red with black letters to warn of hazardous conditions that require immediate corrective action. Caution lights show yellow letters on an opaque background to indicate an impending dangerous condition. The lower half of the CAUTION ADVISORY panel consists of advisory lights that show green letters on opaque background. Advisory lights indicate degraded operations that may require corrective action.

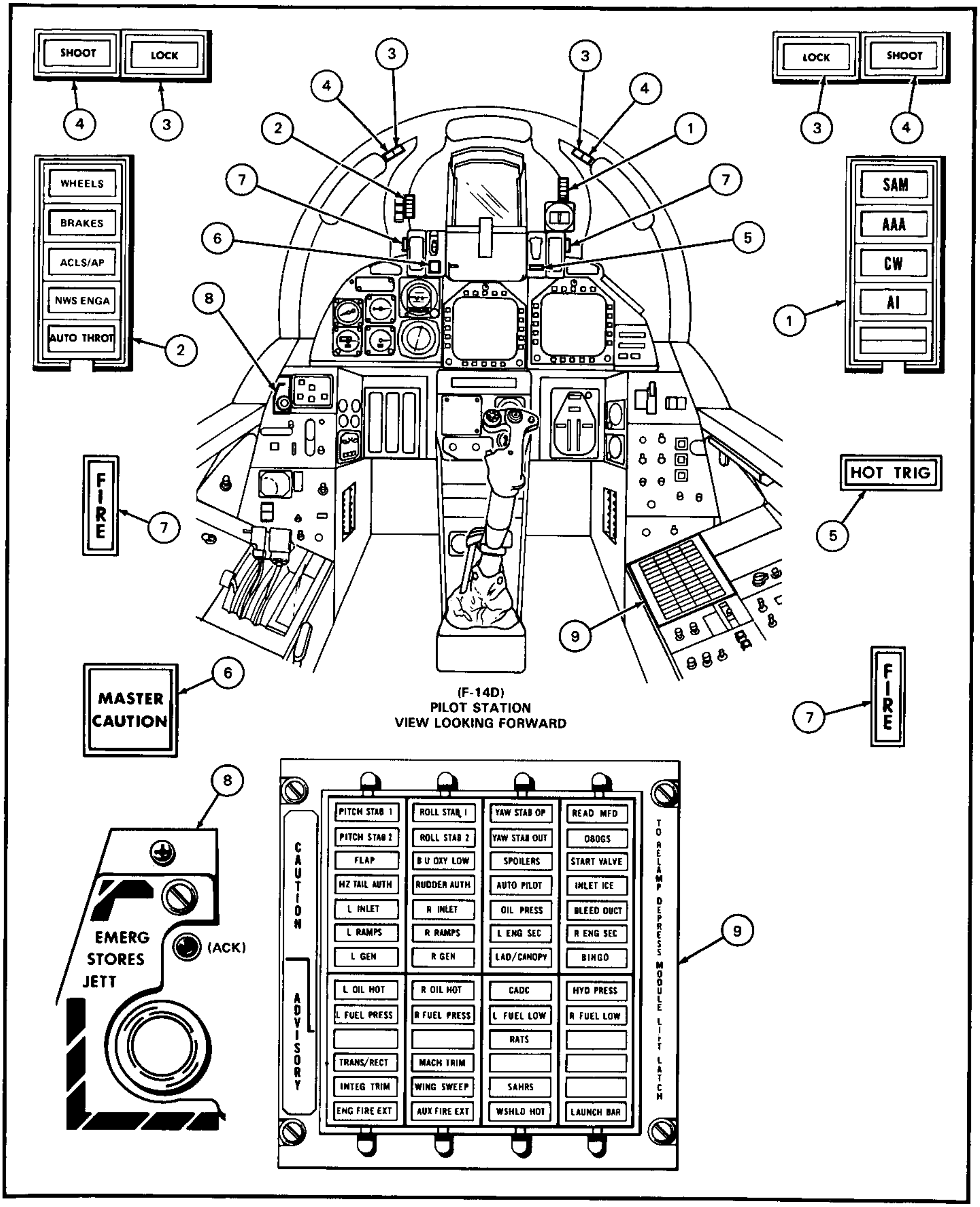

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Figure 2-130. Pilot Indicator Lights (Sheet 1 of 5)

NOMENCLATURE	FUNCTION
1 SAM (warning)	Steady illumination when a surface–to–air missile tracking radar is detected. Flashing when a missile has been launched.
AAA (warning)	Steady illumination when an anti–aircraft tracking radar is detected. Flashing when an AAA radar firing signal is detected.
CW (warning)	Indicates continuous wave emitter detected.
AI (warning)	Steady illumination indicates an airborne interceptor tracking is detected.
2 WHEELS (warning)	Flashes with flaps down more than 10°, either throttle below approximately 85%, and any landing gear not down and locked.
BRAKES (warning)	Indicates antiskid failure or failure of priority valve in the brake power module to switch to combined hydraulic system (operating in AUX brake mode). Illuminates when parking brake is pulled.
ACLS/AP (caution)	Auto pilot and automatic carrier landing system mode disengaged.
NWS ENGA (caution)	Indicates nosewheel steering is engaged and will respond as a function of rudder pedal displacement. Automatically centers with hook down.
AUTO THROT (caution)	Indicates APC has been disengaged by means other than the THROTTLE MODE switch.
3 LOCK (advisory)	Indicates radar locked on target.
4 SHOOT (advisory)	Indicates target meets specified LAR requirements.
5 HOT TRIG (warning)	Indicates that firing logic conditions are available. Pilot's trigger or bomb button and RIO's launch button will fire or release ordnance when actuated.
6 MASTER CAUTION (caution)	Flashes when any light on the pilot's CAUTION ADVISORY panel illuminates.
7 FIRE (warning)	Fire/overheat condition in engine nacelle.
8 EMERG STORES JETT/ACK (warning)	Indicates EMERG STORES JETT pushbutton is activated. **Note** The following lights on the CAUTION ADVISORY panel are in alphabetical order

Figure 2-130. Pilot Indicator Lights (Sheet 2 of 5)

NOMENCLATURE	FUNCTION
9 AUTO PILOT (caution)	Indicates failure of one or more pilot relief modes.
AUX FIRE EXT (advisory)	Indicates low pressure (approximately 90 psi below the nominal 600 psi) in the auxiliary fire extinguishing agent container.
BINGO (caution)	Indicates total fuel quantity indicator is less than BINGO preset value.
BLEED DUCT (caution)	Indicates bleed air leak sensing elements detect temperatures greater than 575°F between engine and primary heat exchanger. Also indicates hot air leak detection (excess of 255° F) between primary heat exchanger and ECS turbine compressor.
B/U OXY LOW (caution)	Indicates backup oxygen system pressure is 200 psi or less.
CADC (caution)	Indicates failure associated with air data computer.
ENG FIRE EXT (advisory)	Indicates low pressure (approximately 90 psi below the nominal 600 psi) in the fire extinguishing agent container.
L ENG SEC R ENG SEC (caution)	Indicates augmenter fan temperature controller (AFTC) is in secondary mode. Afterburner is inoperative and thrust levels can vary from as little as 65% to as much as 116% of primary mode MIL thrust.
FLAP (caution)	Indicates: Disagreement between main and/or auxiliary flap position, or asymmetry lockout. CADC failure. WG SWP DR NO. 2/MANUV FLAP (LE1) circuit breaker pulled. Landing flaps down and airspeed greater than 225 knots.
L FUEL LOW R FUEL LOW (caution)	Indicates fuel thermistors uncovered in aft and left or forward and right fuel feed group (approximately 1,000 pounds remaining in individual fuel feed group).
L FUEL PRESS R FUEL PRESS (caution)	Indicates insufficient discharge pressure (less than 9 psi) from respective turbine driven boost pump.
L GEN R GEN (caution)	Indicates that corresponding generator is inoperative because of fault in generator, control unit, or electrical distribution system.
HYD PRESS (caution)	Indicates hydraulic pressure from either engine-driven pump is less than 2,100 psi.
HZ TAIL AUTH (caution)	Indicates failure of lateral tail authority actuator to follow schedule or CADC failure.

Figure 2-130. Pilot Indicator Lights (Sheet 3 of 5)

NOMENCLATURE	FUNCTION
R INLET L INLET (caution)	Indicates AICS programmer and/or system failure.
INLET ICE (caution)	Indicates ice accumulated on ice detector in left inlet with ENG/PROBE/AICS ANTI–ICE switch in AUTO/OFF or ORIDE/ON selected.
INTEG TRIM (advisory)	Indicates a discrepancy between input command signal and actuator position, or an electrical power loss within the computer.
LAD/CANOPY (caution)	Advises that the boarding ladder is not in an up and locked position or that canopy is not in down and locked position.
LAUNCH BAR (advisory)	Weight–on–Wheels: • Aircraft kneeled, either throttle less than MIL, launch bar not up and locked (normal indication until MRT checks). Weight–off–Wheels: • Launch bar not up and locked. • Launch bar not within ±15° of center, cocked nosegear. • Nose strut not fully extended.
MACH TRIM (advisory)	Indicates failure of Mach trim actuator to follow schedule.
OBOGS (caution)	Indicates a switchover to backup oxygen or OBOGS switch OFF.
L OIL HOT R OIL HOT (caution)	Indicates oil temperature too high. May be an indication of the high–scavenge oil temperature; continued engine operation will result in reduced gearbox life and lubrication degradation.
OIL PRESS (caution)	*Indicates left or right engine oil pressure is 11 psi or less.*
READ MFD (caution)	Indicates any or all of the following warning/caution legends that appear on the upper left corner of the MFD. L N2 OSP R N2 OSP L N1 OSP R N1 OSP L TBT OT R TBT OT L FLMOUT R FLMOUT L IGV SD R IGV SD W/S

Figure 2-130. Pilot Indicator Lights (Sheet 4 of 5)

NOMENCLATURE	FUNCTION
L RAMPS R RAMPS (caution)	Indicates ramps are neither positioned in stow nor trail locks during critical flight conditions. (See figure 2−5.)
PITCH STAB 1 PITCH STAB 2 (caution)	Indicates inoperative pitch channel.
RATS (advisory)	RATS operation is enabled.
ROLL STAB 1 ROLL STAB 2 (caution)	Indicates inoperative roll channel (roll SAS failure).
RUDDER AUTH (caution)	Indicates disagreement between position and command failure of rudder authority actuators to follow schedule, or CADC.
SAHRS (advisory)	Indicates attitude or heading information from SAHRS is unreliable.
SPOILERS (caution)	Indicates spoiler failure causing a set of spoilers to be locked down.
START VALVE (caution)	Starter solenoid air valve open after start. Starter overspeed and/or destruction possible.
TRANS/RECT (advisory)	Indicates one operable transformer−rectifier is powering the total dc load, or dual transformer−rectifier failure.
WING SWEEP (advisory)	Indicates failure of a single channel in the system.
WSHLD HOT (advisory)	Indicates center windshield is overheated.
YAW STAB OP (caution)	One yaw channel inoperative.
YAW STAB OUT (caution)	Two yaw channels inoperative (yaw SAS failure).

Figure 2-130. Pilot Indicator Lights (Sheet 5 of 5)

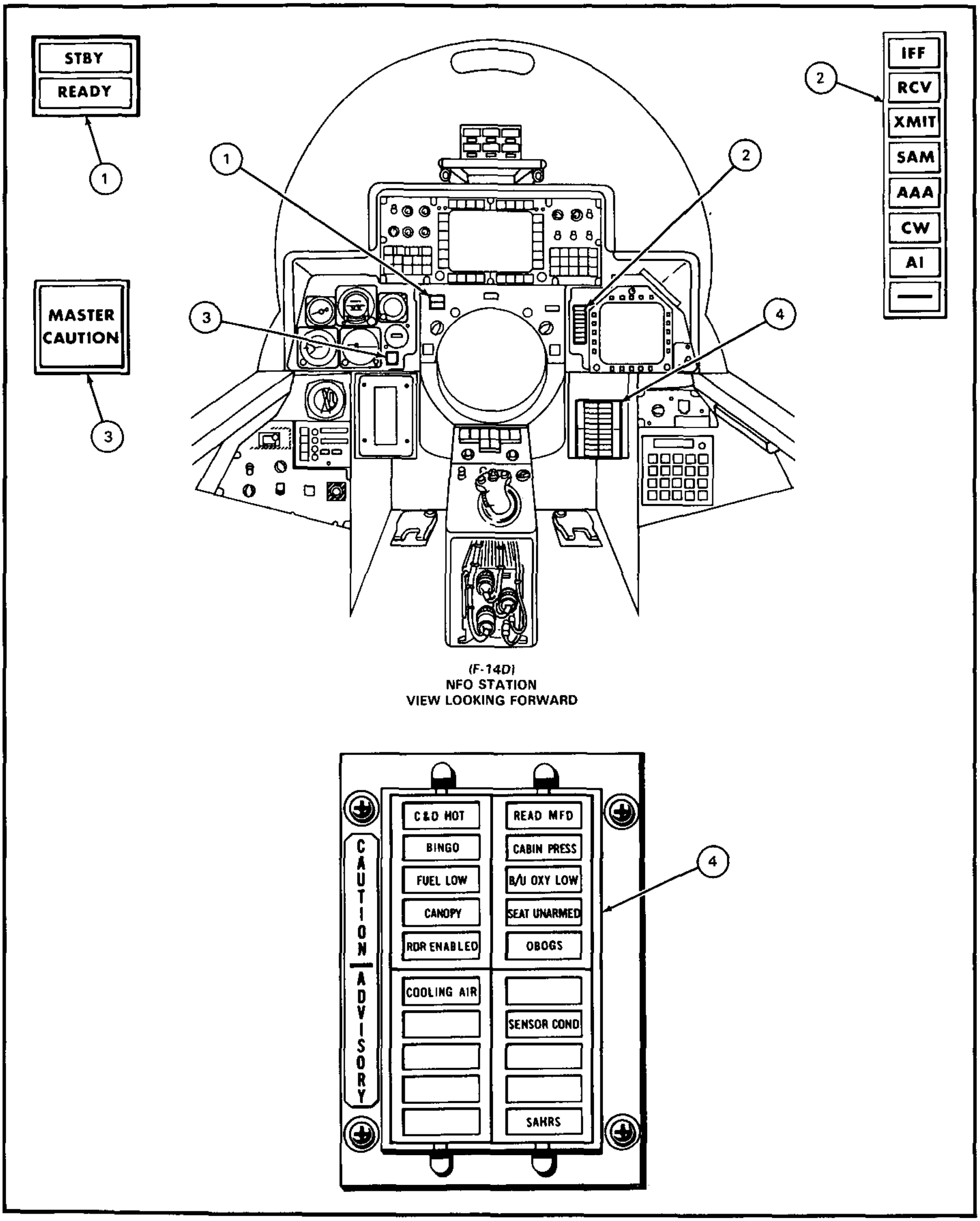

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Figure 2-131. RIO Indicator Lights (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
1 INS status indicators	Not operational.
2 IFF (advisory)	Indicates mode 4 interrogation was received, but system has not generated reply.
RCV (advisory)	Indicates ALQ−165 is receiving a threat identification signal.
XMIT (advisory)	Indicates ALQ−165 is transmitting.
SAM (warning)	Steady illumination when a surface−to−air missile tracking radar is detected. Flashing when a missile has been launched.
AAA (warning)	Steady illumination when an anti−aircraft tracking radar is detected. Flashing when an AAA radar firing signal is detected.
CW (warning)	Indicates a continuous wave emitter is detected.
AI (warning)	Steady illumination indicates an airborne interceptor tracking is detected.
3 MASTER CAUTION (caution)	Flashes when any caution light on the RIO's CAUTION ADVISORY panel illuminates.
4 C&D HOT (caution)	Indicates DD and/or TID controls and displays are overheating.
CABIN PRESS (caution)	Indicates aircraft cabin pressure has dropped below 5−psi pressure differential or cockpit altitude is above 27,000 feet.
FUEL LOW (caution)	Indicates fuel thermistors uncovered in aft and left or forward and right fuel feed group (approximately 1,000 pounds) remaining in individual fuel feed group.
B/U OXY LOW (caution)	Indicates backup oxygen system pressure is 200 psi or less.
CANOPY (caution)	Indicates that canopy is not in down and locked position.

Figure 2-131. RIO Indicator Lights (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
(4) SEAT UNARMED (caution)	Indicates either seat is in the SAFE position.
RDR ENABLED (caution)	Indicates that radar operation on the ground is possible or failure of right main landing gear safety switch or wiring.
READ MFD (caution)	Indicates any or all of the following warning, caution, or advisory legends that appear on the upper left corner of the MFD. SDU ALARM — IMU ASPJ HOT — CIU HOT JTID HOT — DP1 HOT RWR — DP2 HOT FWD ASPJ — SMS HOT AFT ASPJ — AFT CG MC1 — HUD HOT MC2 — RWR HOT MC1 HOT — DSS HOT MC2 HOT — DEKI HOT CIU — IRST HOT INS
BINGO (caution)	Indicates total fuel quantity indicator is less than BINGO preset value.
SENSOR COND (advisory)	Indicates coolant temperature exiting heat exchanger is 104°F, radar coolant pump output pressure is below 60 psi, or the overtemperature switch has shutdown the coolant pump.
COOLING AIR (advisory)	Indicates an overtemperature condition exists in the electronic forced air cooling system. With degraded cabin pressure or flow, indicates possible bleed duct failure forward of primary heat exchanger and 400° modulating valve.
OBOGS (caution)	Indicates a switchover to backup oxygen or OBOGS switch OFF.
SAHRS (advisory)	Indicates attitude or heading information from SAHRS is unreliable.

Figure 2-131. RIO Indicator Lights (Sheet 3 of 3)

WARNING

Radiation hazard exists on deck when the RDR ENABLED caution light is illuminated. The light indicates that the RADAR TEST ENABLE switch (maintenance switch) is in the "A" (radiate and scan) position. This condition permits the weight-on-wheels interlock to be bypassed, allowing the transmitter to radiate out the antenna when RADAR XMIT is selected on the hand control unit. Illumination of the light does not indicate a weight-on-wheels failure.

2.39.3.1 MASTER CAUTION Light. The pilot MASTER CAUTION light is centrally located on the master caution/master arm control panel, and, in the aft cockpit, the RIO MASTER CAUTION light is on the left instrument panel. When the lights are illuminated, yellow letters show on an opaque background. Individual MASTER CAUTION lights flash whenever a caution light on the respective caution and advisory panel illuminates. A MASTER CAUTION light may be turned off by depressing its lens. This will activate a reset switch that rearms the master circuit for a subsequent caution light. A caution light lit on the caution and advisory panel will not be turned off by resetting the MASTER CAUTION light.

2.39.3.2 Indicator Lights Test. A check of all indicator lights can be performed while airborne or during on-deck operations. The pilot caution and advisory lights, the MASTER CAUTION light, and all associated circuitry are tested through the MASTER TEST panel. The test is initiated by selecting LTS and pressing the master test knob. Electrical power is routed through the circuitry to provide simulated failure signals to the caution and advisory lights. Illumination of each warning, caution, and advisory light verifies proper continuity of the indicator lights. A malfunction is indicated by failure of a light to illuminate.

Illumination of any caution light causes the MASTER CAUTION light to flash. If the MASTER CAUTION light illuminates steadily during the LTS test, it indicates a failure of the MASTER CAUTION light, primary power failure, failure of the flasher module, or that failure has been detected by the BIT circuits.

The following indicator lights are also illuminated by the LTS test through the MASTER TEST panel:

1. ACLS/AP
2. Approach indexer
3. AUTO THROT
4. BRAKES
5. EMER STORES
6. FIRE
7. GO/NO GO
8. HOOK light
9. HOT TRIG
10. LDG GEAR transition light
11. LOCK
12. NWS ENGA
13. RATS
14. JETT
15. Refueling probe transition light
16. SAM
17 SHOOT
18. WHEELS.

Note

The DATA LINK power switch must be on to check the DDI lights.

The RIO caution and advisory lights are tested in the same manner on the TEST panel on the right console.

2.40 STORES MANAGEMENT SYSTEM/ JETTISON

The SMS is the interface between aircraft stores and the mission computer system. It provides signal processing and logic control required for inventory and identification of all stores; preparation and test of missiles; and weapon select, arm, and launch functions. The emergency generator (1 kVA mode) provides backup power (28 Vdc essential) for emergency jettison. The SMS has extensive self-test capabilities and reports failures to the MCS for display to the crew.

2.40.1 SMS Weapons Replaceable Assemblies. The SMS consists of the following WRAs:

1. Stores management processor
2. Fuel tank jettison unit
3. Type 1 decoders
4. Type 2 decoders
5. Gun control unit
6. Missile power relay unit
7. Missile power supply
8. AWW-4.

2.40.1.1 Stores Management Processor. The SMP is a programmable, digital computer that provides the central processing and command functions of the SMS. It operates as a remote terminal on MBUS-2. The SMP communicates with the SMS WRAs and acts as the bus controller on the armament bus. The SMP controls emergency jettison, the gun, and some AIM-9 functions via discretes that are independent of the ARMBUS. The SMP also controls weapon select, SMS and weapon BIT, monitors aircraft safety interlocks, and controls the launch-to-eject sequence.

2.40.1.2 Fuel Tank Jettison Unit. Two FTJUs, one each for stations 2 and 7, are located in the engine nacelles. The FTJUs provide eject pulses to the squibs in the jettison release mechanism for emergency, ACM, or selective jettison of the fuel tanks.

For a description of Type 1 decoders, Type 2 decoders, gun control unit, missile power relay unit, missile power supply, AWW-4, and SMS functions, refer to NAVAIR 01-F14AAD-1A.

2.40.2 Multistatus Indicator. The MSI (Figure 2-132) is a liquid crystal display located below MFD 1. The MSI is powered by the HUD subsystem. MSI displays are dependent on the MCS. When the HUD PWR switch is set to TEST, all LCD segments on the MSI are displayed. The MSI displays weapon type and status of each store station. The upper row of the display identifies the weapon. The lower row displays weapon status. Two horizontal dashed lines at a store station indicate that the missile at that station has FAILED or is HUNG. A blank display on a station indicates no weapon is loaded or the weapon loaded is not recognized.

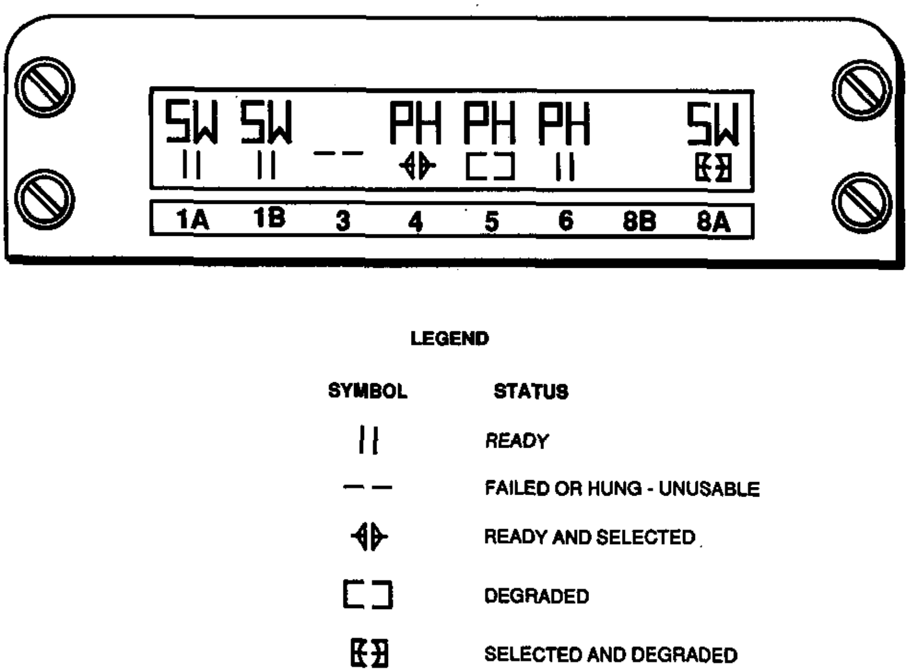


Figure 2-132. Multistatus Indicator

2.40.3 Stores Jettison Modes. Four jettison modes are available:

1. Emergency (EMER)
2. Air combat maneuver (ACM)
3. Selective (SEL)
4. Auxiliary (AUX).

Weapon arming and fuzing and missile motor ignition are safed/disabled during all jettison release modes.

External fuel tanks, Phoenix, and Sparrow missiles can be released in EMERG, ACM, and SEL jettison modes only. Air-to-ground (A/G) weapons loaded on BRU-32 bomb racks can be released in all four jettison modes. ITERs and weapons loaded on ITERs cannot be released from their parent BRU-32 bomb racks in any of the jettison modes. Sidewinder missiles (rail launched) cannot be jettisoned.

WARNING

- Stores shall be jettisoned above the minimum fragmentation clearance altitude, when possible, even though weapon arming and fuzing is safed/disabled in all jettison modes.
- Jettisoning A/G stores during a normal release train may result in store-to-store collision in near proximity to the aircraft.
- If jettisoned during a takeoff emergency, external fuel tanks may collide with the aircraft because of their unstable characteristics.
- If a jettison or delivery condition existed such that A/G stores were released from stations 3 and 6 and not from stations 4 and 5, an AFT CG advisory on the MFDs will not be posted.

2.40.3.1 Emergency Jettison. Emergency jettison is used to separate all jettisonable stores from the aircraft as fast as possible. The only interlock requirement for jettisonable stores is weight off wheels. The emergency jettison circuit is electrically isolated from all other release functions of the SMP and has a separate electrical path to each jettisonable store station. The mode is initiated by depressing the EMER STORES JETT pushbutton on the landing gear control panel with weight off wheels (Figure 2-133). Emergency jettison has priority over all other SMS functions. This momentary, nonlatching pushbutton and the EMERG STORES JETT (ACK) light are illuminated for 5 seconds by the SMP to indicate emergency jettison has been commanded. For single stores loaded on a station, stores will be jettisoned at 100-millisecond intervals in the following sequence:

1. Stations 2 and 7 simultaneously
2. Stations 1B and 8B simultaneously
3. Station 4
4. Station 5
5. Station 3
6. Station 6.

After the release sequence is completed, the SMS updates the stores inventory. Unlike other jettison modes or launch attempts, a store that is not released is not declared a HUNG store and is eligible for subsequent jettison or launch.

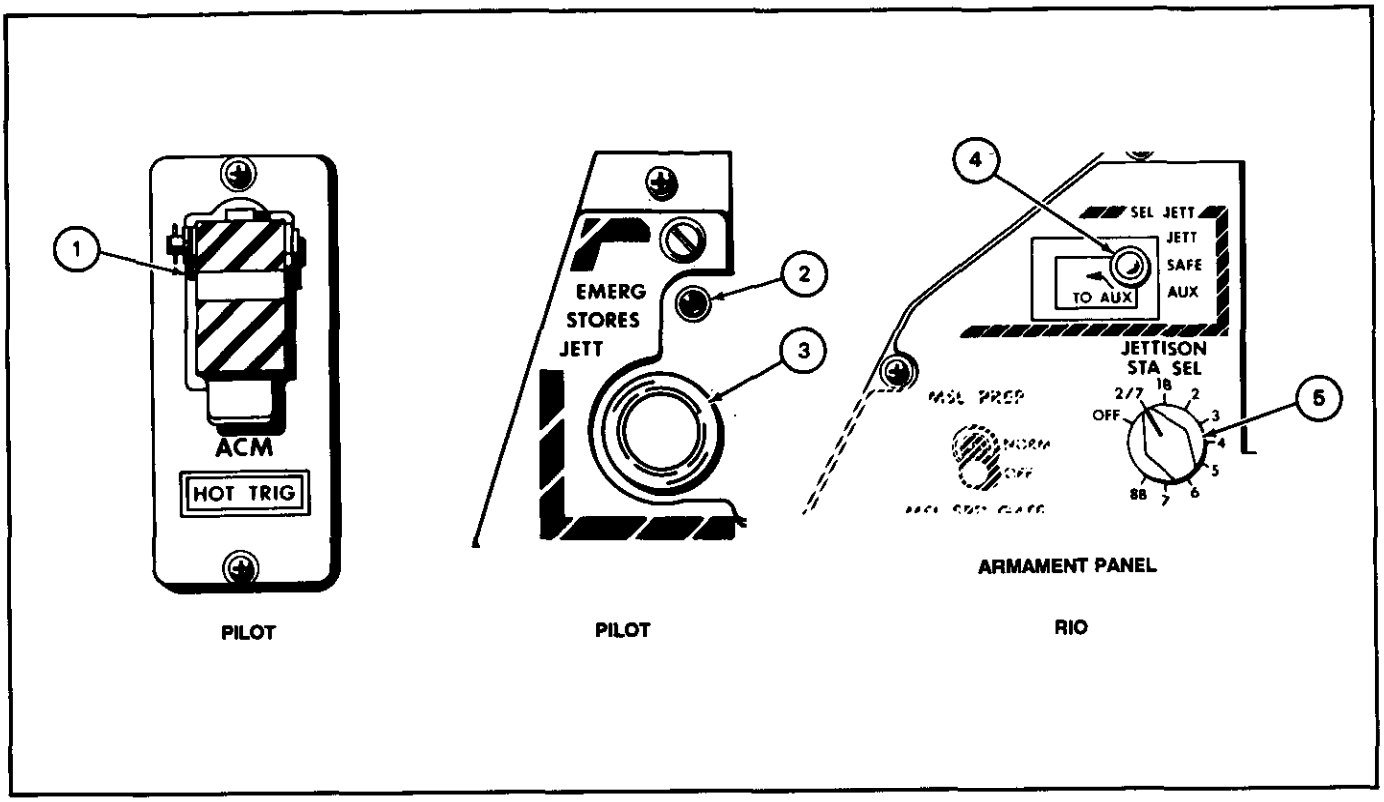
2.40.3.2 ACM Jettison. ACM jettison provides for rapid release of any preselected combination of jettisonable stores. In addition to RIO selection of those stations to be separated, the only ACM jettison interlock is the LDG GEAR handle UP.

Stations are selected for jettison via the DEU. Figure 2-134 illustrates selection and display of external fuel tanks for ACM jettison. Only those stations having a jettisonable store loaded that have not been declared failed are available for ACM jettison selection.

Each depression of a station button causes that button display to toggle between JETT and SAFE. The DEU selections are not forwarded to the SMS until the enter button is depressed. Selected stations are indicated on the MFD SMS format with an inverted "V" above the station number. The symbol is removed if deselected by the RIO and upon completion of an ACM jettison attempt or successful jettison.

Note

ACM JETT selections are retained in SMP nonvolatile memory. This allows selections to be retained and enables ACM JETT without an operable MCS. However, ACM JETT designations must be reselected after performing system reset to restore ACM JETT symbology on the MFD SMS format.



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DISPLAY INDICATION	FUNCTION
1 ACM JETT pushbutton	Enables ACM jettison. Pushbutton is under ACM switch cover. When pressed, only those stores selected via the DEU are jettisoned. To ensure release of all selected stores, the ACM JETT pushbutton must be depressed and held for at least 2 seconds.
2 ACK light	Redundant indicator for emergency jettison activation. Illuminates for 5 seconds, indicating the SMP has acknowledged the emergency stores jettison command.
3 EMER STORES JETT pushbutton/light	Enables emergency jettison. When depressed with weight off wheels, activates emergency stores jettison signal to the SMS and illuminates light for 5 seconds, indicating the SMP has acknowledged the emergency stores jettison command. Jettison function is disabled with weight on wheels.
4 SEL JETT switch	Allows RIO to jettison from selected station(s). It is a three-position, lever-locked switch with guarded positions. JETT — Actuates normal selective jettison of the store(s) located at the station(s) designated by the JETTISON STA SEL switch. SAFE — Normal operating position. Inhibits jettison in selective mode. AUX — Releases all A/G stores loaded on BRU-32s from the station selected on the JETTISON STA SEL switch with a single switch movement.
5 JETTISON STA SEL switch	Allows selective jettison of Phoenix or Sparrow missiles and auxiliary tanks. Allows selective or auxiliary jettison of air-to-ground stores. OFF — Inhibits selective and auxiliary jettison. Station — Selects store(s) for jettison.

Figure 2-133. Jettison Controls

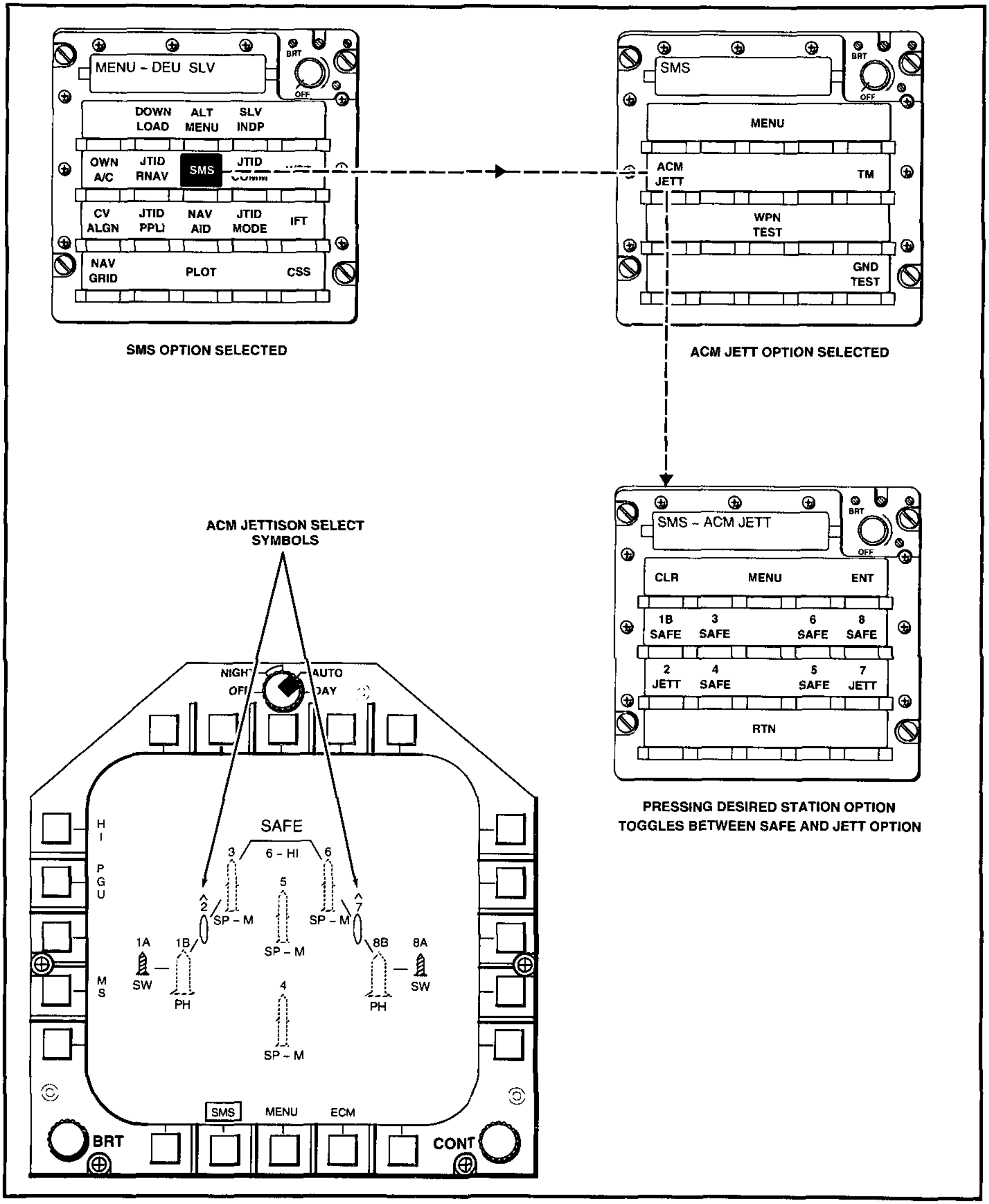

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Figure 2-134. ACM Jettison Selection and Display

ACM jettison is initiated by the pilot raising the ACM guard (Figure 2-133) and depressing the ACM JETT pushbutton. For single stores loaded on a station, stores will be jettisoned at 100-millisecond intervals in the following sequence:

1. Stations 2 and 7 simultaneously
2. Stations 1B and 8B simultaneously
3. Station 4
4. Station 5
5. Station 3
6. Station 6.

After the release attempt is completed, the SMS updates the stores inventory. Unlike emergency jettison, a store that is not released is declared HUNG. Such stores are not eligible for launch but are still eligible for emergency or selective jettison. Additionally, A/G stores loaded on BRU-32s will still be eligible for auxiliary jettision.

2.40.3.3 Selective Jettison. Selective jettison is used to separate single jettisonable stores station-by-station and also allows simultaneous jettison of both fuel tanks. The RIO selects the desired station(s) for selective jettison.

Selective jettison is accomplished by placing the MA ARM switch to ON, the LDG GEAR handle UP, the JETTISON STA SEL knob set to the desired station, and the SEL JETT switch to JETT. After the release attempt is completed, the SMS updates the stores inventory. Unlike emergency jettison, a store that is not released is declared HUNG. Such stores are not eligible for launch, but are still eligible for emergency or selective jettison. A/G stores loaded on BRU-32s will still be eligible for auxiliary jettison.

CAUTION

Do not attempt jettison of external fuel tanks until wing fuel tanks are depleted. Wing fuel may be lost if the external tank quick-disconnect valve sticks in the open position.

2.40.3.4 Auxiliary (AUX) Jettison. Auxiliary jettison is a nonejection release mode for single A/G stores loaded on BRU-32s. Like selective jettison, this mode requires the MA ARM switch to be set to ON and the LDG GEAR handle UP. This mode is activated by the RIO selecting the station to be jettisoned via the jettison STA SEL switch and then selecting AUX on the SEL JETT switch. Auxiliary jettison of an A/G store loaded directly on a BRU-32 is via gravity force only.

WARNING

Since auxiliary jettison for single A/G stores loaded directly on BRU-32s is a gravity drop rather than an ejection separation, the aircraft will be restricted in its flight envelope when jettisoning through this mode.

2.41 MISCELLANEOUS EQUIPMENT

2.41.1 Boarding Ladder. A boarding ladder consisting of three folding sections is housed in the left fuselage between the two cockpits. It is held in the closed position by two mechanical locking pins actuated by the ladder control handle in the face of the boarding ladder. The ladder must be manually released or stowed from the ground level. Unfolding the remaining two sections places the ladder in a fully extended position. The bottom rung of the ladder is approximately 26 inches above the deck when in a fully extended position, with the nosegear unkneeled, and 12 inches above the deck if the nosegear is kneeled. A LAD/CANOPY caution light on the pilot caution advisory panel advises the pilot that the boarding ladder is not in a full up-and-locked position.

2.41.1.1 Boarding Steps and Handhold. There are two positive locking board steps, one on either side of the boarding ladder directly below each cockpit. They may be opened or closed from either cockpit or while standing on the boarding ladder. A single handhold is directly above the boarding ladder. It is a spring-loaded door that fairs with the fuselage when released.

2.41.2 Nose Radome. The nose radome is attached to the aircraft by a top hinge and bottom mounted latches, permitting it to be rotated up for access and maintenance. A jury strut attached to the lower part of the dome can be fastened to the aircraft bulkhead to hold the dome open. A minimum overhead clearance of 16 feet is required when opening the radome. The radar antenna must be stowed before opening the radome. Antenna stow position is 0° azimuth and 60° tilted down.

Note

After the nose radome is raised and the jury strut fastened in position, release hydraulic pressure to take the load off the hydraulic system.

2.41.3 Systems Test and System Power Ground Panel. The SYS TEST and SYS PWR ground check panel (Figure 2-135) is on the RIO right console panel (accessible from the boarding ladder with the canopy open) for controlling the activation of electrical circuits using ground external power. The panel cover is designed so that, when it is closed, the switches inside are in the proper position for flight. In addition, when the landing gear handle is in UP, all switches are deactivated. The panel serves a maintenance and preflight purpose and is not intended for use by the flightcrew.

2.41.4 External Baggage Container (CNU-188/A). The external baggage container (Figure 2-136) is a modified Aero ID 300-gallon fuel tank that incorporates forward and aft baggage compartments. Each compartment has an access door (forward, left side; aft, right side), a shelf, and a baggage tiedown harness. The tiedown harness consists of two sets of seatbelt straps that form a crossover pattern to secure baggage to the shelf. The external baggage container may be loaded with any equipment that fits within the confines of the shelf, does not exceed the shelf weight, and maintains the cg limits. Locate baggage as near the center of the shelf as possible. Care should be taken to ensure that straps are tight to preclude any significant shift of cargo.

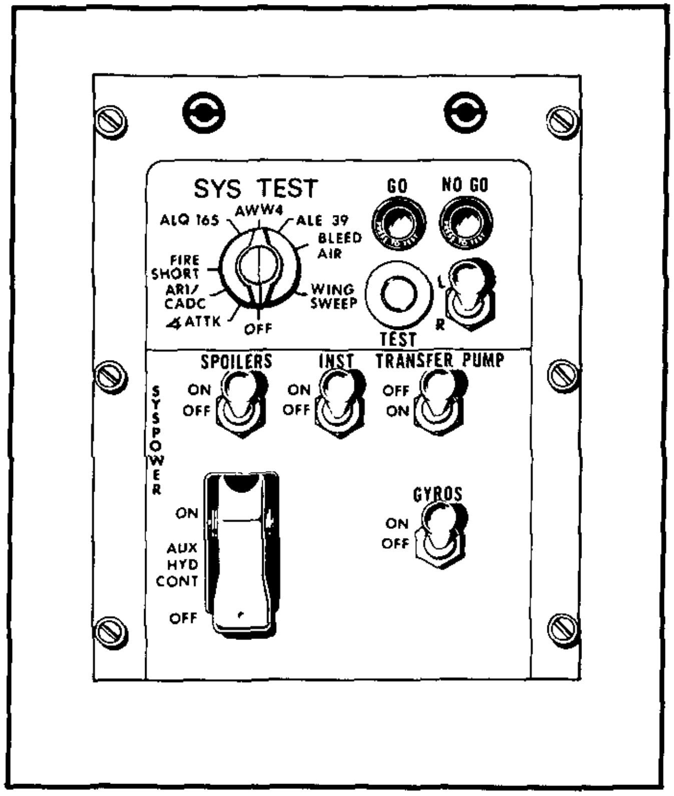

Figure 2-135. Systems Test and System Power Ground Panel

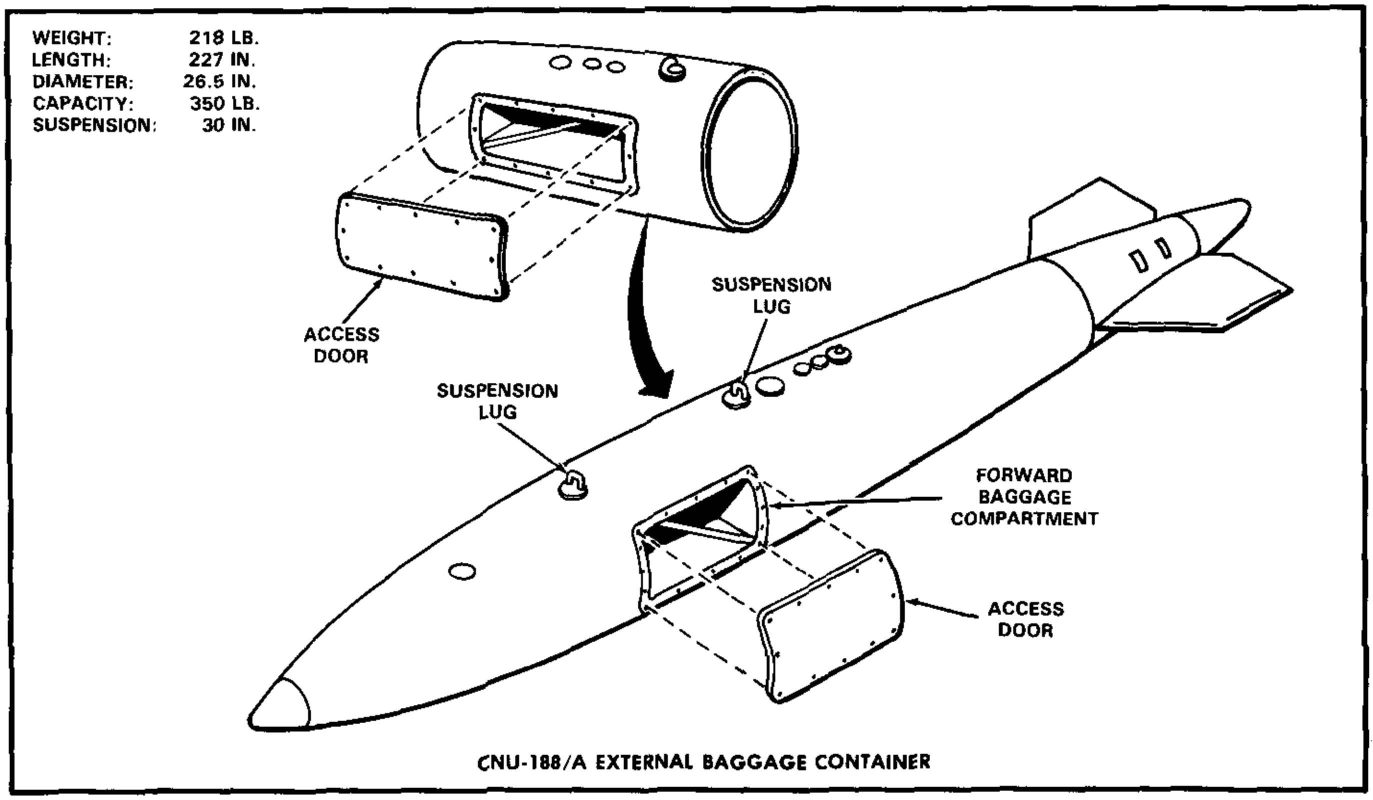

Figure 2-136. CNU-188/A External Baggage Container

CHAPTER 3

Servicing and Handling

3.1 SERVICING DATA

The following servicing data is for use by the flightcrew and maintenance crews who are unfamiliar with servicing the aircraft (Figure 3-1). When operating in and out of military airfields, consult the current DOD IFR Supplement for compatible servicing units, fuel, etc. Figure 3-2 contains a tabulation of servicing data and power units required to support the aircraft.

3.1.1 Ground Refueling. Single-point refueling is provided for pressure filling of all aircraft fuel tanks through a standard refueling receptacle on the lower right side of the forward fuselage. Ground refueling is controlled by two precheck selector valves and the vent pressure gauge adjacent to the refuel receptacle on the ground refuel and defuel panel. Positioning of these valves can be used for selective ground refueling of either the fuselage or wing and drop tanks. The direct reading vent pressure gauge indicates pressure in the system vent lines. When aircraft fuel tanks are full, fueling stops automatically. For hot refueling procedures, refer to paragraph 7.6. For defueling procedures, refer to NAVAIR 01-F14AAD-2-1.

The maximum refueling rate is approximately 500 gpm at a pressure of 50 psi. Nominal and minimum pressure is approximately 15 psi; maximum pressure is 50 psi.

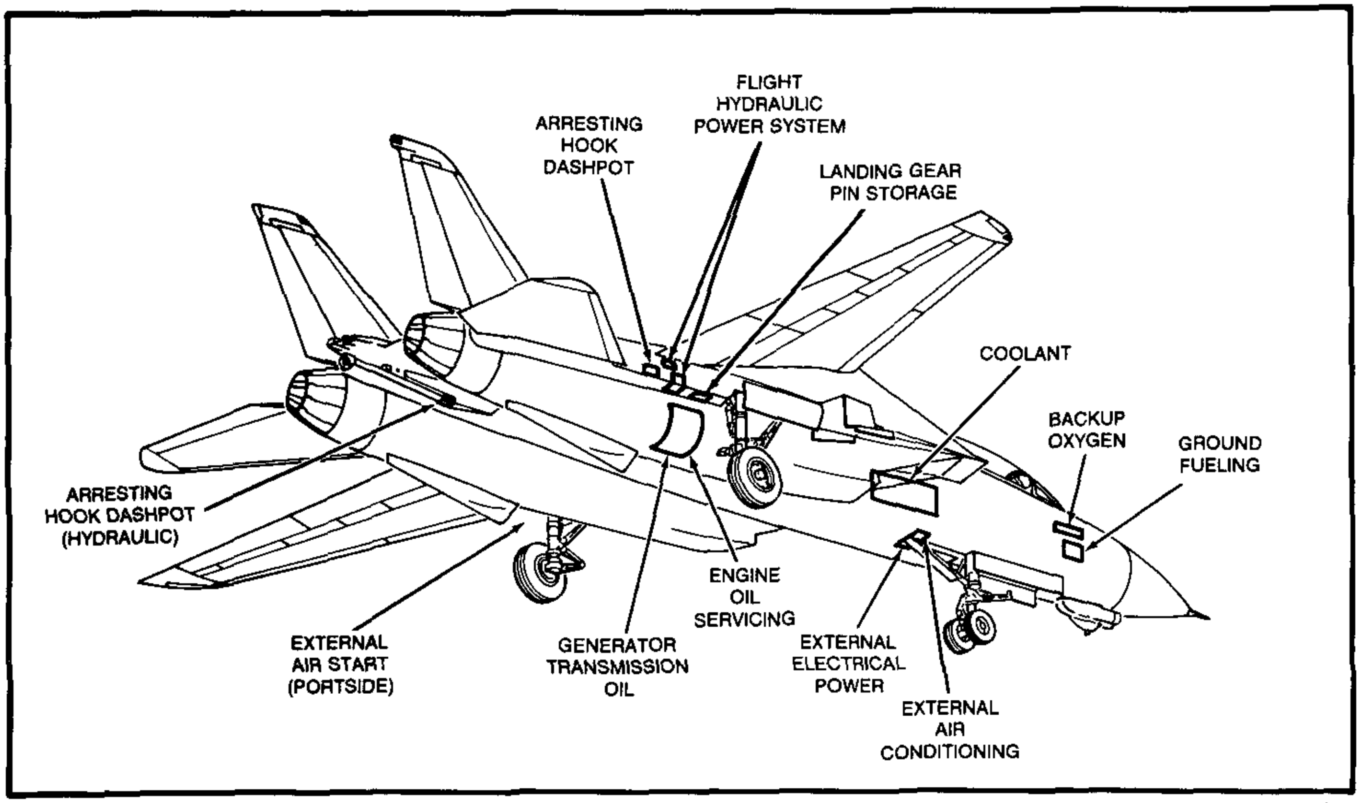

Figure 3-1. Aircraft Servicing Locations

ITEM	DESIGNATION SPECIFICATION	NATO CODE	COMMERCIAL EQUIVALENT	DOD IFR SUPPLEMENT CODE	REMARKS
FUEL	MIL-T-5624 (JP-5) MIL-T-5624 (JP-4) MIL-T-83133 (JP-8)	F-44 F-40 F-34	Jet A Jet B Jet A-1	JP-5 JP-4 JP-8	Density selector (main engine control) shall be set for type fuel in use. (JP-8 is equivalent to JP-5.)
Engine oil	MIL-L-23699 MIL-L-7808	0-156 0-148	None None	0-156 0-148	Use MIL-L-7808 when ground temperature is -40°F (-40°C).
Integrated Drive Generator (IDG) *Transmission oil*	MIL-L-23699 MIL-L-7808	0-156 0-148	None None	0-156 0-148	Use MIL-L-7808 when ground temperature is -40°F (-40°C).
Hydraulic fluid	MIL-H-83282	None	None	None	
Oxygen *(Gaseous)*	MIL-O-27210 Type I	None	None	HPOX LPOX	Survival kit shall be *removed from aircraft for* servicing emergency oxygen bottle.
Nitrogen	BB-N-411 (Type I, Grade A)	None	None	None	Use clean, oil-free filtered dry air, if nitrogen is not available.
Liquid Coolant	Coolant 25, 25R (Monsanto Chemical Co) Chevron Flo-Cool 180 (Chevron Chemical Co)	None None	NA NA	None None	Either coolant may be mixed without adverse reaction.
Wipe On Rain Repellant Fluid	MIL-W-6882	None	None	None	Clean and dry windshield. Apply with cloth using overlapping wipes. After 1-minute drying, wipe clean with soft cloth.

Figure 3-2. Aircraft Servicing Data (Sheet 1 of 2)

	POWER			
	PNEUMATIC/ GAS TURBINE STARTING	ELECTRICAL POWER	AIR CONDITIONING	HYDRAULIC
Acceptable USN Units	ASHORE: NCPP−105 RCPT−105 A/M47A−4 AFLOAT: A/S47A−1	NC8A MD−3 MD−3A MD−3M MA−3MPSU A/M32A−60 A/M32A−60A	NR 5C (Electrical) NR 8 (diesel) MA−1 MA−1A A/M32C−5 A/M32C−6	AHT−63/64 TTU−228/E (AHT−73) MJ−3
Ground Support Equipment Requirements	200 lb/min at 75 ± 3 psi (STD. DAY)	115 ± 20 V ac, 400 ± 25 Hz, 60 kVA, 3 phase rotation	70 lb/min at 3 psi and 60°F	50 gal/min maximum at 3,000 psi

PNEUMATIC PRESSURE	
SYSTEM	PRESSURE
Emergency Landing Gear	3,000 psi at 70°F
Combined Hydraulic	1,800 psi at 70°F
Flight Hydraulic	1,800 psi at 70°F
Canopy Normal (1,200 psi Minimum)	3,000 psi at 70°F
Canopy Auxiliary (800 psi Minimum)	3,000 psi at 70°F
Wheel brake accumulators (2)	1,900 psi at 70°F
Arresting Hook Dashpot	800 ± 10 psi
Main Gear Shock Struts (2)	980 psi
Nose Gear Shock Strut	1,300 psi

TIRES		
TYPE	OPERATION	PRESSURE
Nose (2) 22 X 6.6−10 20 Ply	Ashore Afloat	105 psi 350 psi
Main (2) 37 X 11.50−16 28 Ply	Ashore Afloat	245 psi 350 psi

Note

Dry nitrogen, specification BB−N−41B, Type 1, Grade A, is preferred for tire inflation and charging pneumatic systems since it is inert, and therefore will not support combustion.

Figure 3-2. Aircraft Servicing Data (Sheet 2 of 2)

WARNING

Ensure that both the fueling unit and the aircraft are properly grounded, bonding cable is connected between aircraft and refueling source, and that fire extinguishing equipment is readily available.

CAUTION

During ground refueling operations, the direct-reading vent pressure indicator shall be observed and refueling stopped if pressure indication is in the red band (above 4 psi).

Note

- If the aircraft is being regularly serviced with JP-4 type fuel, the main fuel-control, fuel-grade (specific gravity adjustment) selector on each engine should be reset to the JP-4 position. If the aircraft is being regularly serviced with JP-8 or JP-5 fuel, the fuel-control, fuel-grade (specific gravity adjustment) selector on each engine should be reset to the JP-8 or JP-5 position. Satisfactory engine performance depends upon trimming of the engine fuel controls to ensure rated thrust, to prevent exceeding engine temperature limits, and to ensure airflow compatibility with the air inlet duct opening.

- Removal of JP-8 type fuel from the aircraft is not required before refueling with JP-5. If removal of JP-8 from the aircraft aboard ship is necessary, it shall not be defueled into the storage tanks containing JP-5.

3.1.2 Engine Oil. Engine oil level is proper when overflow oil starts to exit the discharge port during servicing. For normal servicing, the sight gauge on the oil storage tank is the primary indicator determining when servicing is required. During servicing, overflow oil exits the overflow discharge port when the tank is properly serviced (Figure 3-3, sheet 2). Servicing is accomplished using PON-6 servicing cart. Normal oil consumption is 0.03 gallon per hour with the maximum being 0.1 gallon per hour. For oil servicing procedures, refer to NAVAIR 01-F14AAD-2-1. The protrusion of a bypass indicator underneath the oil scavenge pump indicates a clogged filter element and requires replacement.

WARNING

- Lubricating oil (MIL-L-23699) is toxic and flammable. Protection includes chemical splashproof goggles, gloves, and good ventilation; keep sparks, flames, and heat away. Keep lubricating oil off skin, eyes, and clothes; do not breathe vapors. Wash hands thoroughly after handling.

- Do not overservice oil storage tank. Overservicing can cause scavenge pump failure and subsequent engine failure.

Note

Engine oil level should be checked within 30 minutes of engine shutdown, otherwise run engine at 80 percent or greater for 10 minutes to ensure proper servicing.

3.1.3 Integrated Drive Generator Oil. The IDG has a filter bypass indicator at the bottom of the filter bowl (Figure 3-3, sheet 2). Extension of the indicator indicates contamination of the filter and the need for filter element replacement. Refer to NAVAIR 01-F14AAD-2-1 for IDG oil filter replacement and servicing.

IDG oil level is checked at the IDG mounted on the forward right side of the forward accessory gearbox of each engine. It is serviced at the pressure fill port on the right side.

3.1.4 Hydraulic Systems. The main hydraulic systems are serviced at the flight and combined hydraulic system ground servicing panels. A hydraulic pressure filling cart is required to service the systems with fluid, and an air-nitrogen cart is required to preload the reservoirs. The outboard spoiler backup module is serviced at the servicing panel on the outboard nacelle of the port engine. Additional hydraulic servicing is required at the main landing gear shock strut (Figure 3-3, sheet 2), the nosewheel shock strut (Figure 3-3, sheet 2), and the arresting hook dashpot (Figure 3-3, sheet 1).

The flight reservoir fill and ground hydraulic power access panel and the flight system filter module (Figure 3-3, sheet 1) are on the starboard side. The combined hydraulic system reservoir fill and filter module (Figure 3-3, sheet 3) are on the port side of the aircraft. Indication of hydraulic system fluid contamination can be detected by the position of the buttons on the Delta-P type filter units.

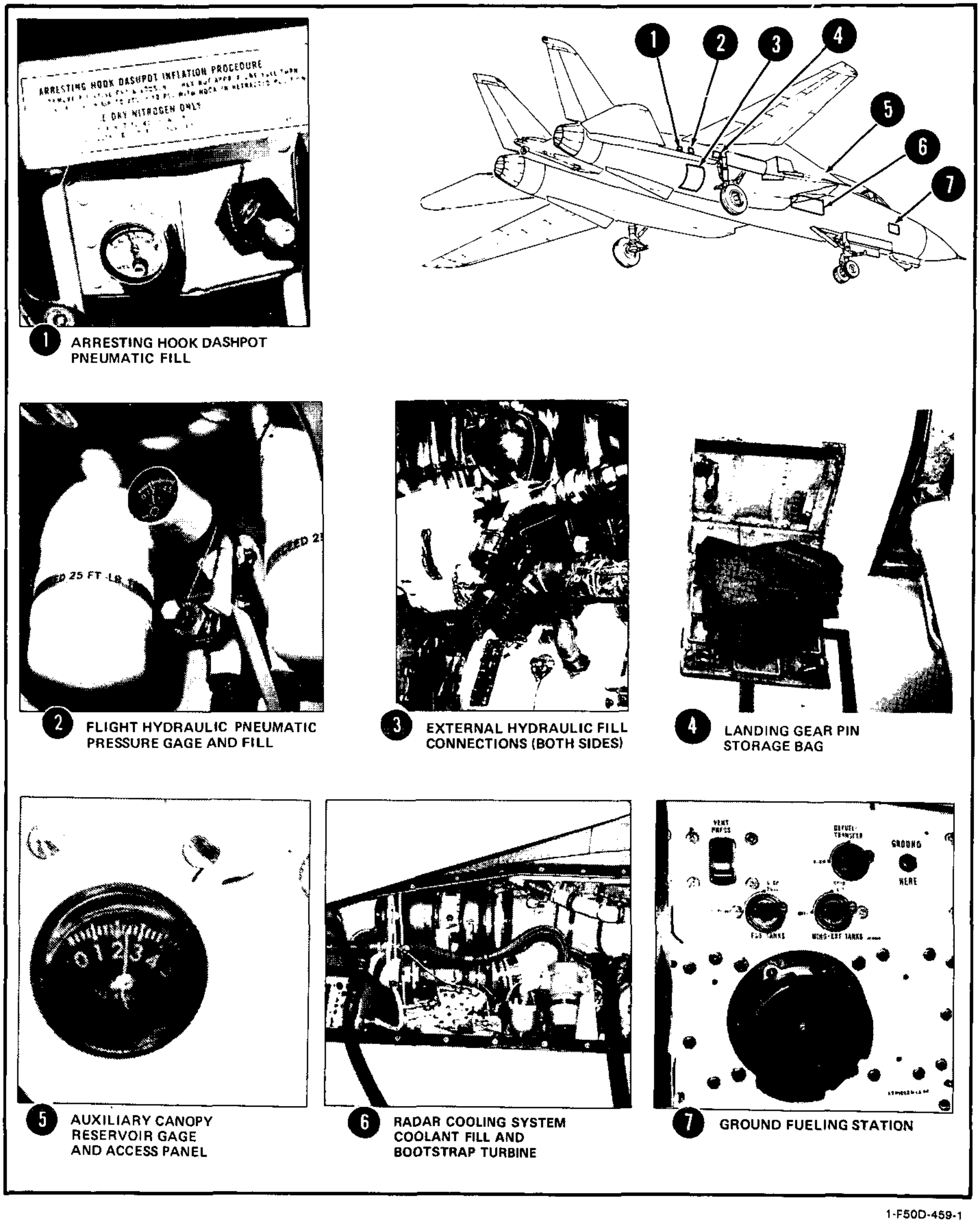

Figure 3-3. Aircraft Servicing (Sheet 1 of 3)

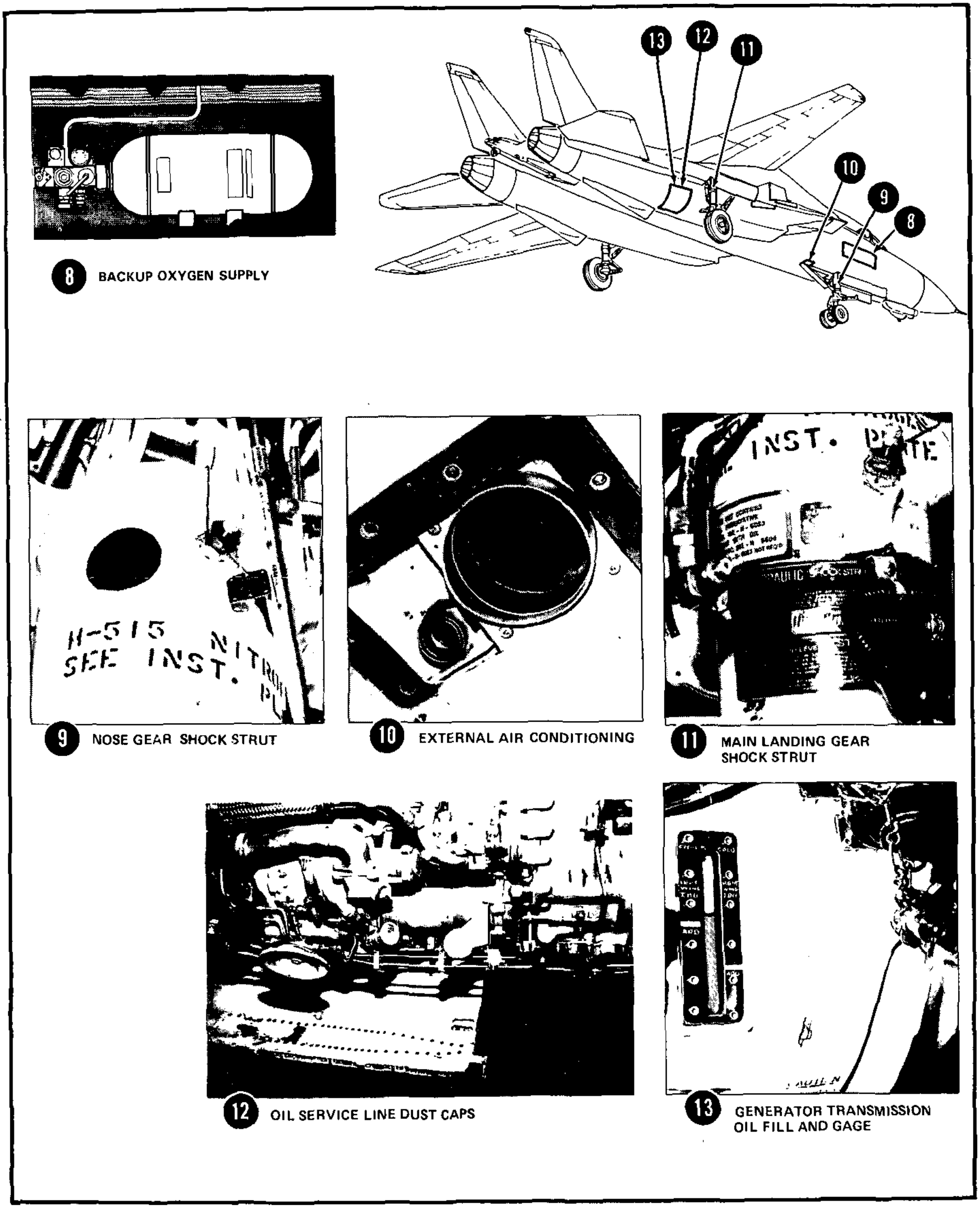

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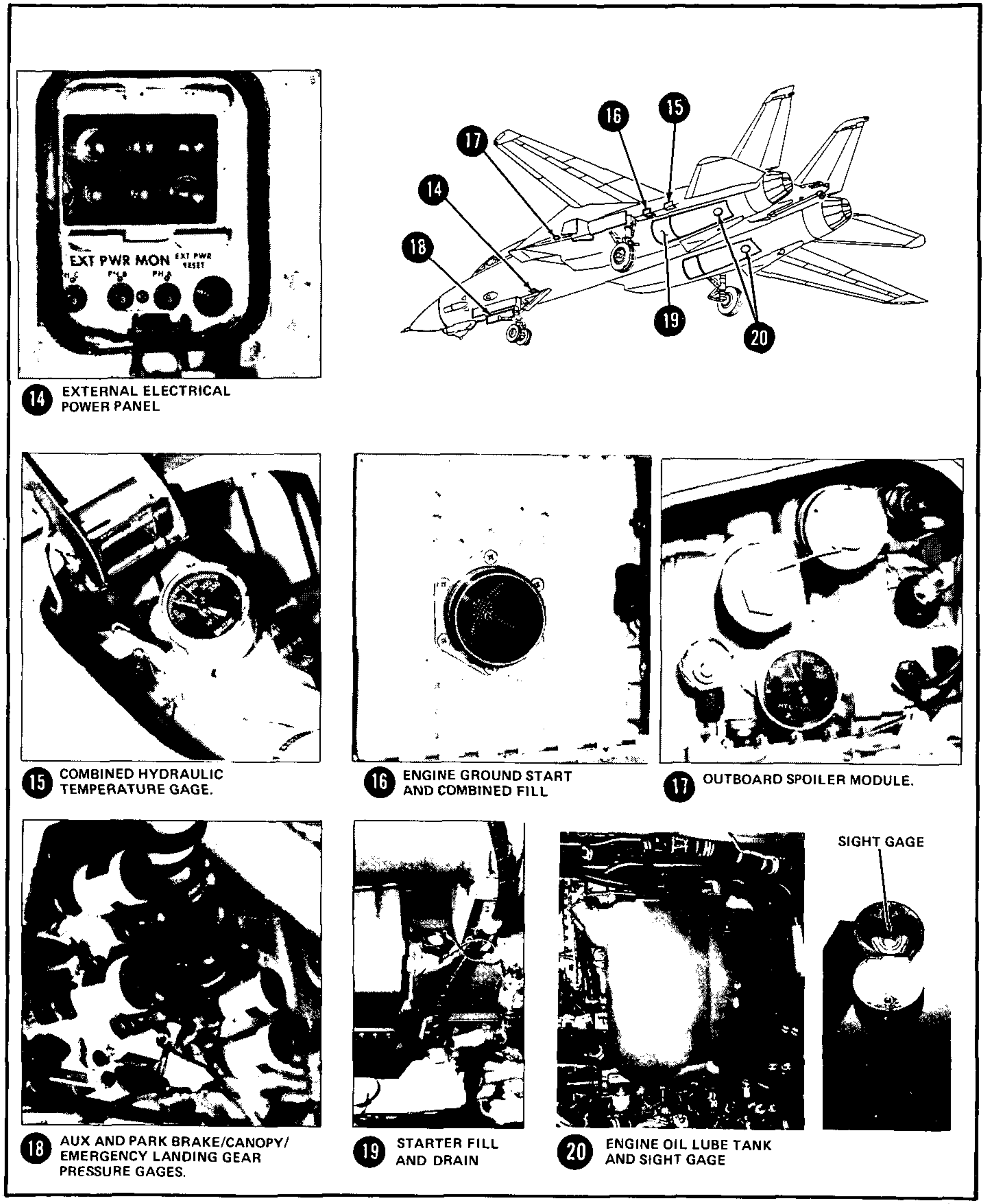
Figure 3-3. Aircraft Servicing (Sheet 2 of 3)



2-F50D-459-3L

Figure 3-3. Aircraft Servicing (Sheet 3 of 3)

Temperature recording gauges at the filter modules indicate the maximum temperature attained by the hydraulic fluid during the last turnup or flight. After a reading has been taken, the temperature gauges must be reset prior to the next turnup.

3.1.5 Pneumatic Systems. The pneumatic power supply systems, which provide for normal operation of the canopy and for emergency extension of the landing gear, are ground charged through a common filler in the nose wheelwell (Figure 3-3, sheet 3). The auxiliary canopy open pneumatic bottle is in the turtleback behind the cockpit (Figure 3-3, sheet 1). Additional pneumatic servicing points are at both hydraulic systems servicing panels, brake systems, and arresting hook.

Individual pneumatic servicing points and pressure gauges are provided for the auxiliary and parking brake systems.

Note

Dry nitrogen, specification BB-N-411B, Type 1, Grade A, is preferred for tire inflation and for charging pneumatic systems since it will not support combustion.

3.1.6 Backup Oxygen Supply. The backup gaseous oxygen supply is serviced to a maximum of 2,100 psi from an access in the forward right side of the fuselage. Servicing pressure can be observed on a gauge in the pilot's cockpit.

3.2 GROUND HANDLING

3.2.1 Danger Areas. Engine exhaust and intake danger areas are shown in Figure 3-4. Noise danger areas are shown in Figure 3-6. (Figure 3-4 shows temperature distribution with afterburners at maximum nozzle opening for idle, military, and maximum power.) Figure 3-4 shows exhaust jet wake velocity distribution with afterburner at maximum nozzle opening for idle, military, and maximum power.

WARNING

- The high temperature and velocity of the engine exhaust is extremely dangerous. Stay outside engine exhaust area included within a 90° cone extending 900 feet behind the aircraft.
- Suction at the air intake is strong enough to kill or seriously injure personnel by drawing them into or against the inlet.
- All personnel in the immediate area shall wear ear protection whenever an engine is operating.

Note

- If engines are run up in front of a blast deflector, exhaust jet wake is deflected up and to the sides resulting in distortion of the patterns shown.
- At maximum afterburner power, nozzles are nearly fully open; at military power, the nozzles are nearly fully closed.

3.2.2 Radar Radiation Areas. The following paragraphs describe the hazards to personnel, hazards of electromagnetic radiation to ordnance, and fuel ignition hazards generated during AN/APG-71 radar operation.

WARNING

Illumination of RDR ENABLE caution light on RIO CAUTION ADVISORY panel indicates possible radar radiation on deck.

3.2.2.1 Hazards to Personnel. Minimum safe distances for personnel from ground operation radar are indicated in Figure 3-5, sheets 1 and 2. When the planar array radar antenna is not radiating, minimum safe distance from other radiating antennas is 6 feet.

3.2.2.2 HERO Condition. HERO conditions exist when ordnance or weapons containing electroexplosive devices are present. Hazard to personnel and equipment is greater because of the lower power density level at which EED react to radio frequency radiation. The requirement to maintain a minimum safe distance from ground operating radar causes the RF radiation hazard area to increase in size, thereby overlapping into previously safe areas for personnel. During HERO conditions, minimum safe distances (personnel) from ground operating radar (Figure 3-5, sheets 1 and 2) shall not be considered safe. Minimum safe distances during HERO conditions are shown in Figure 3-5, sheets 3 and 4.

HERO unsafe ordnance conditions include assembly/disassembly of ordnance systems, tests involving electrical connections to the ordnance, such as primer resistance check, continuity checks, bare squibs, primers, blasting caps, and other EED having exposed wire leads and unshielded ordnance subassemblies such as rocket motors, warheads, and exercise heads.

WARNING

AT HIGH THRUST SETTINGS, THE SUCTION DANGER AREA AROUND ENGINE INLETS MAY EXTEND AS FAR AS 4 FEET AFT OF THE INLET DUCT LOWER LIP.
EAR PROTECTION SHALL BE WORN AT ALL TIMES.

NOTE

- THIS ILLUSTRATION CONTAINS ESTIMATED EXHAUST JET WAKE VELOCITY AND TOTAL TEMPERATURE DISTRIBUTION OF F110-GE-400 MIXED FLOW AUGMENTED (AFTER-BURNING) TURBOFAN ENGINE. THIS IS IN ACCORDANCE WITH GENERAL ELECTRIC GEK 92500 OPERATION AND SERVICING MANUAL WITH MAXIMUM OPENING FOR IDLE POWER AND FULLY CLOSED (MINIMUM OPENING) FOR MILITARY POWER.
- IF ENGINES ARE RUN UP IN FRONT OF BLAST DEFLECTOR, EXHAUST JET WAKE IS DEFLECTED UP AND TO SIDES, RESULTING IN DISTORTION OF PATTERNS SHOWN.

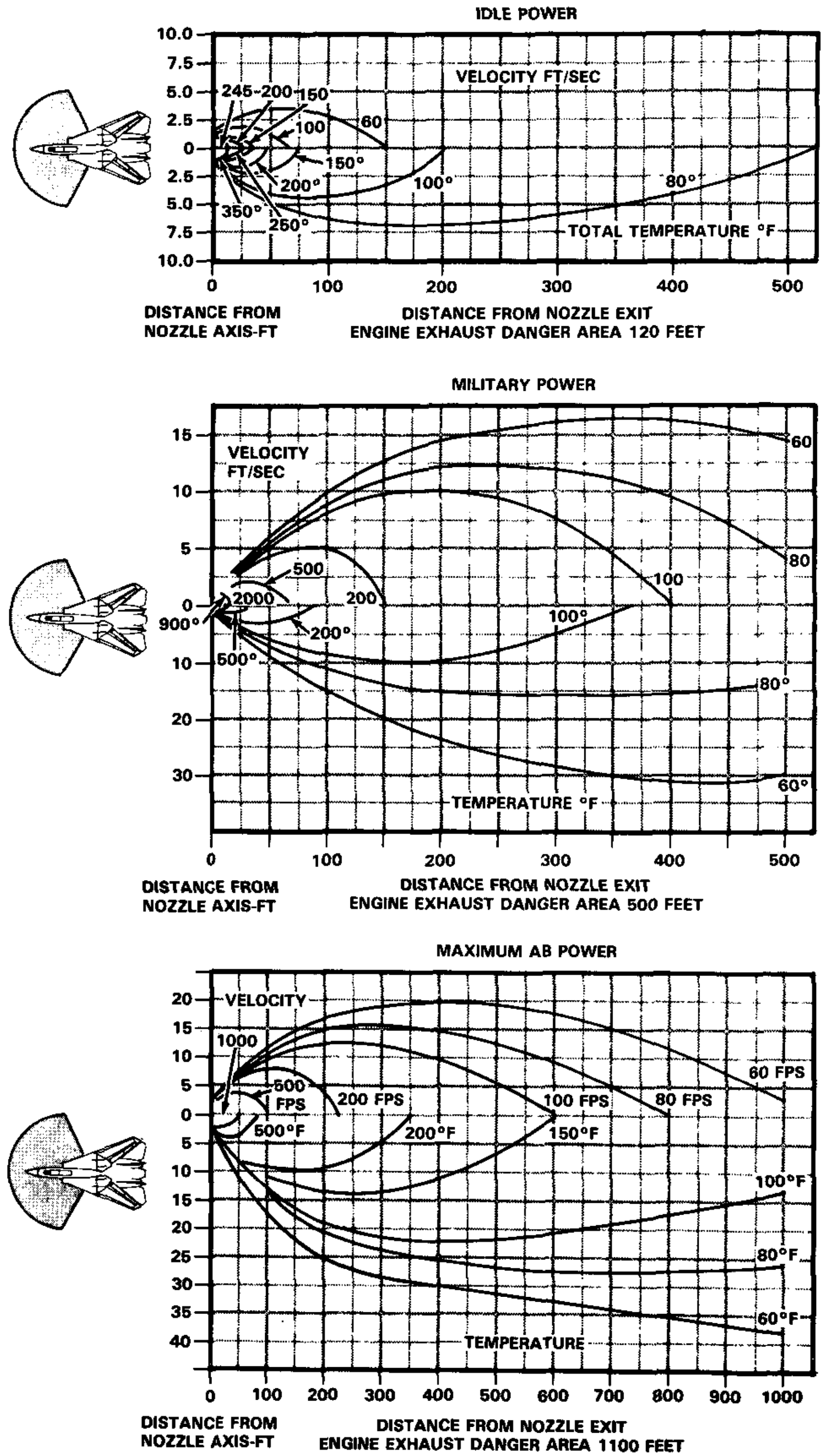


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Figure 3-4. Runup Danger Areas — Exhaust Jet Wake Velocity and Temperature

HAZARDS TO PERSONNEL

MINIMUM SAFE DISTANCES

1. MINIMUM SAFE DISTANCES FOR PERSONNEL FROM GROUND OPERATING RADAR ARE LOCATED OUTSIDE THE RF RADIATION HAZARD AREAS. DO NOT ENTER RF RADIATION HAZARD AREAS, ESPECIALLY THAT OF THE MAIN BEAM.

2. DURING HERO (HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE) CONDITIONS, MINIMUM SAFE DISTANCES FOR PERSONNEL FROM GROUND OPERATING RADAR SHALL NOT BE CONSIDERED SAFE.

WARNING

WHEN THE APG-71-(XN-1) RADAR IS NOT RADIATING, OR IS RADIATING INTO A DUMMY LOAD, MINIMUM SAFE DISTANCE FOR PERSONNEL FROM ONBOARD RADIATING ANTENNAS SHALL BE 6 FEET.

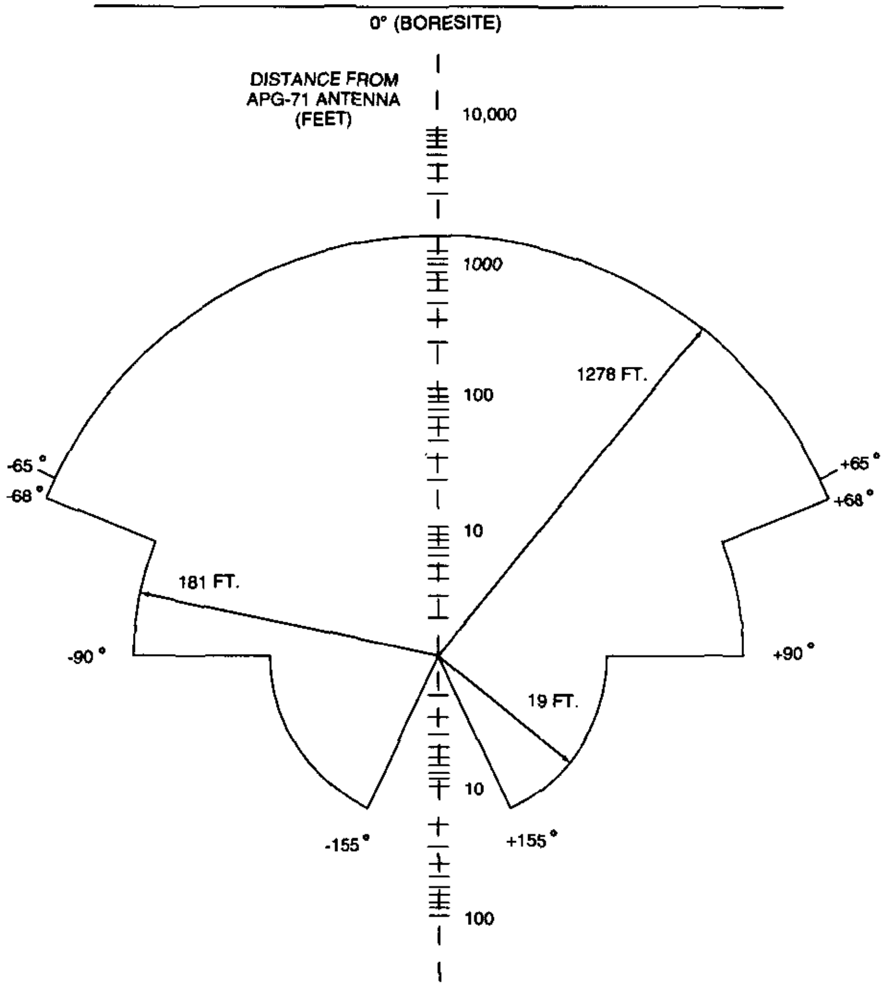
NOTES

- DISTANCES INCLUDE 6 dB SAFETY FACTOR.
- HERO CONDITIONS EXIST WHEN ORDNANCE OR WEAPONS CONTAINING EED (ELECTRO-EXPLOSIVE DEVICES) ARE PRESENT. HAZARD TO PERSONNEL AND EQUIPMENT IS OF A HIGHER DEGREE BECAUSE OF THE LOWER LEVEL OF POWER DENSITY AT WHICH EED REACT TO RF RADIATION. THE REQUIREMENT TO MAINTAIN A MINIMUM SAFE DISTANCE FROM GROUND OPERATION RADAR CAUSES THE RF RADIATION HAZARD AREAS TO INCREASE, THEREBY OVERLAPPING PREVIOUS SAFE AREAS FOR PERSONNEL, AS SHOWN IN THE HAZARDS TO PERSONNEL DIAGRAM.
- ANTENNA AZIMUTH CENTER SCANNED ±65°
- ANTENNA ELEVATION SCAN CENTER FIXED AT 0°

LEGEND:

☐ RF RADIATION HAZARD AREAS SHOWN ARE BASED ON 5 mW/cm² POWER DENSITY.

APG-71 PLANAR ARRAY PERSONNEL RADIATION HAZARD DISTANCE VS. AZIMUTH



2-F50D-302-1

Figure 3-5. Radar Radiation Hazard Areas (Sheet 1 of 4)

HAZARDS TO PERSONNEL

MINIMUM SAFE DISTANCES

1. MINIMUM SAFE DISTANCES FOR PERSONNEL FROM GROUND OPERATING RADAR ARE LOCATED OUTSIDE THE RF RADIATION HAZARD AREAS. DO NOT ENTER RF RADIATION HAZARD AREAS, ESPECIALLY THAT OF THE MAIN BEAM.

2. DURING HERO (HAZARDS OF ELECTROMAGNETIC RADIATION TO ORDNANCE) CONDITIONS, MINIMUM SAFE DISTANCES FOR PERSONNEL FROM GROUND OPERATING RADAR SHALL NOT BE CONSIDERED SAFE.

WARNING

WHEN THE APG-71-(XN-1) RADAR IS NOT RADIATING, OR IS RADIATING INTO A DUMMY LOAD, MINIMUM SAFE DISTANCE FOR PERSONNEL FROM ONBOARD RADIATING ANTENNAS SHALL BE 6 FEET.

NOTES

- DISTANCES INCLUDE 6 dB SAFETY FACTOR.
- HERO CONDITIONS EXIST WHEN ORDNANCE OR WEAPONS CONTAINING EED (ELECTRO-EXPLOSIVE DEVICES) ARE PRESENT. HAZARD TO PERSONNEL AND EQUIPMENT IS OF A HIGHER DEGREE BECAUSE OF THE LOWER LEVEL OF POWER DENSITY AT WHICH EED REACT TO RF RADIATION. THE REQUIREMENT TO MAINTAIN A MINIMUM SAFE DISTANCE FROM GROUND OPERATION RADAR CAUSES THE RF RADIATION HAZARD AREAS TO INCREASE, THEREBY OVERLAPPING PREVIOUS SAFE AREAS FOR PERSONNEL, AS *SHOWN IN THE HAZARDS TO PERSONNEL DIAGRAM.*
- ANTENNA ELEVATION SCAN CENTER MANUALLY SCANNED 0° TO +58°
- ANTENNA AZIMUTH SCAN CENTER FIXED AT 0°.

LEGEND:

OVER-THE-SIDE TRANSMISSION ABOARD CARRIER. (hatched)

RF RADIATION HAZARD AREAS SHOWN ARE BASED ON 5 mW/cm2 POWER DENSITY. (open)

APG-71 PLANAR ARRAY PERSONNEL RADIATION HAZARD DISTANCE VS ELEVATION

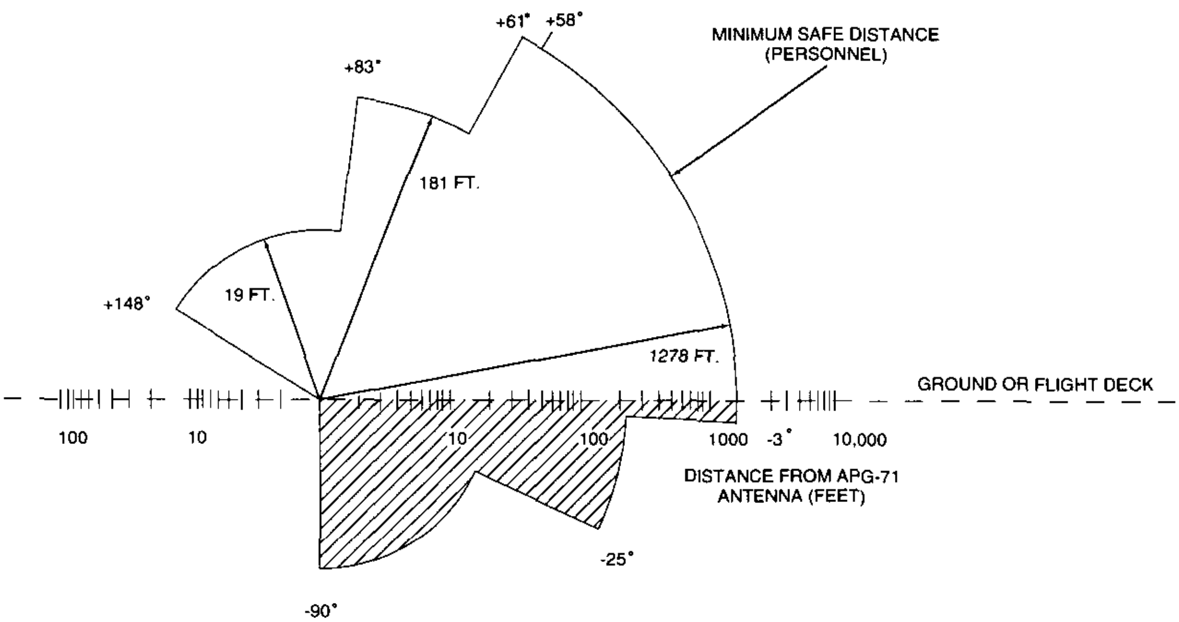


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Figure 3-5. Radar Radiation Hazard Areas (Sheet 2 of 4)

HAZARDS TO ORDNANCE - HERO

HERO UNSAFE ORDANCE

1. ORDNANCE ASSEMBLY OR DISASSEMBLY SUCH AS REPAIR, UPKEEP, PARTS EXCHANGE, OR DEARMING, DEFUZING, OR UNLOADING OF ORDNANCE.
2. TESTS INVOLVING ADDITIONAL ELECTRICAL CONNECTIONS TO THE ORDNANCE, SUCH AS PRIMER RESISTANCE CHECK AND CONTINUITY CHECKS.
3. BARE SQUIBS, PRIMERS, BLASTING CAPS, AND OTHER EED HAVING EXPOSED WIRE LEADS UNSHIELDED AND/OR UNFILTERED, SUCH AS FLASH SIGNALS, IGNITERS, AND TRACKING FLARES.
4. UNSHIELDED ORDNANCE SUCH AS ROCKET MOTORS, WARHEADS, AND EXERCISE HEADS.

WARNING

WHEN THE APG-71-(XN-1) RADAR IS NOT RADIATING, OR IS RADIATING INTO A DUMMY LOAD, MINIMUM SAFE DISTANCE FOR ORDNANCE FROM ONBOARD RADIATING ANTENNAS SHALL BE 160 FEET.

NOTES

- DISTANCE INCLUDES 6 db SAFETY FACTOR
- APG-71 ANTENNA AZIMUTH SCAN CENTER SCANNED ± 65°
- ANTENNA ELEVATION SCAN CENTER FIXED AT 0°

HERO SUSCEPTIBLE ORDNANCE SYSTEMS

ANY ORDNANCE PROVEN (BY TESTS) TO CONTAIN EED THAT CAN BE ADVERSELY AFFECTED BY RF ENERGY TO THE POINT THAT THE SAFETY AND/OR RELIABILITY IS IN JEOPARDY WHEN THE SYSTEM IS EMPLOYED IN EXPECTED RF ENVIRONMENTS. SOME ARE SUSCEPTIBLE TO THE RF ENVIRONMENT FOR ONLY A PART OF THE STOCKPILE TO LAUNCH SEQUENCE. FOR EXAMPLE, THE CONNECTION OF AN UMBILICAL CABLE IN THE LOADING PROCEDURE MAY BE THE ONLY TIME ORDNANCE IS CONSIDERED SUSCEPTIBLE. AT ALL OTHER TIMES, IT MAY BE CONSIDERED HERO SAFE ORDNANCE.

HERO SAFE ORDNANCE

ANY ORDNANCE THAT IS SUFFICIENTLY SHIELDED OR OTHERWISE PROTECTED THAT ALL EED CONTAINED ARE IMMUNE TO ADVERSE EFFECTS THAT DEGRADE SAFETY OR RELIABILITY WHEN EMPLOYED IN AN RF ENVIRONMENT. THE ORDNANCE SHALL BE CONSIDERED HERO SAFE, PROVIDED THAT GENERAL HERO REQUIREMENTS HAVE BEEN COMPLIED WITH.

LEGEND:

- (crosshatched box) HERO UNSAFE ORDNANCE HAZARD AREAS SHOWN ARE BASED ON 2.025 mW/cm^2 POWER DENSITY.
- (blank box) HERO SUSCEPTIBLE ORDNANCE SYSTEMS HAZARD AREAS SHOWN ARE BASED ON 4.05 mW/cm^2 POWER DENSITY.

ORDNANCE RADAR SILENT ZONE RELATIVE TO APG-71 RADAR VS. AZIMUTH

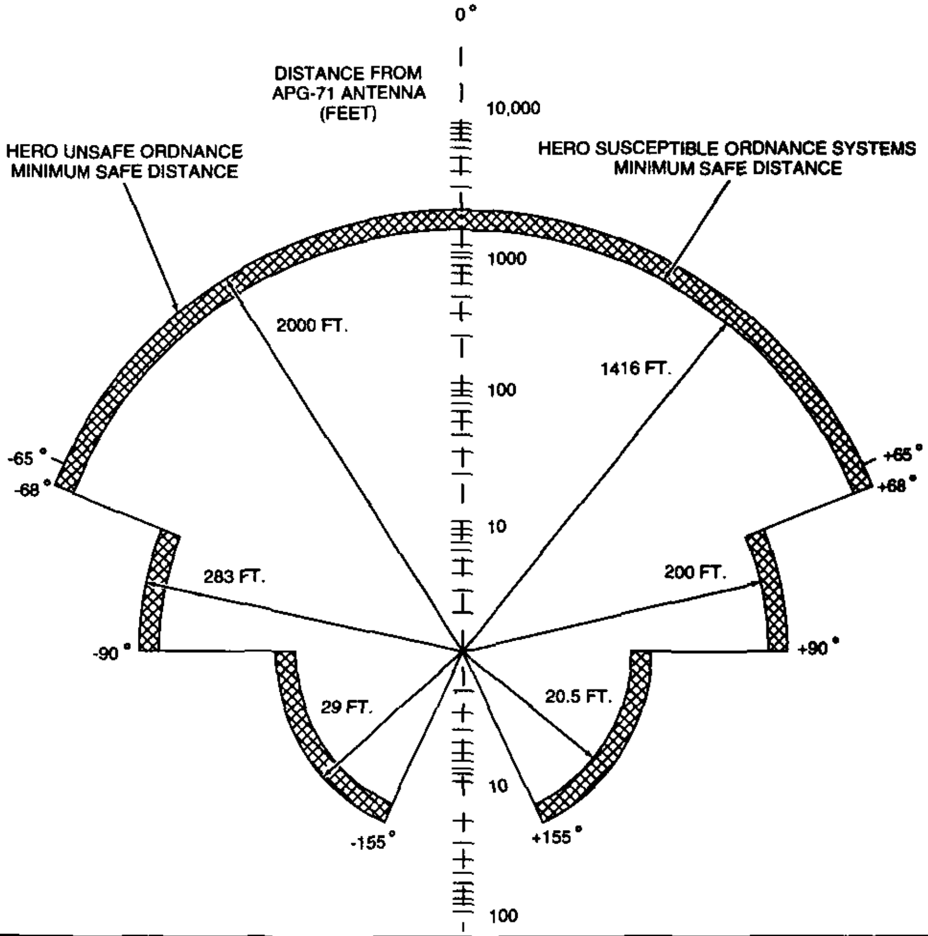

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Figure 3-5. Radar Radiation Hazard Areas (Sheet 3 of 4)

HAZARDS TO ORDNANCE - HERO

HERO UNSAFE ORDANCE

1. ORDNANCE ASSEMBLY OR DISASSEMBLY SUCH AS REPAIR, UPKEEP, PARTS EXCHANGE, OR DEARMING, DEFUZING, OR UNLOADING OF ORDNANCE.
2. TESTS INVOLVING ADDITIONAL ELECTRICAL CONNECTIONS TO THE ORDNANCE, SUCH AS PRIMER RESISTANCE CHECK AND CONTINUITY CHECKS.
3. BARE SQUIBS, PRIMERS, BLASTING CAPS, AND OTHER EED HAVING EXPOSED WIRE LEADS UNSHIELDED AND/OR UNFILTERED, SUCH AS FLASH SIGNALS, IGNITERS, AND TRACKING FLARES.
4. UNSHIELDED ORDNANCE SUCH AS ROCKET MOTORS, WARHEADS, AND EXERCISE HEADS.

WARNING

WHEN THE APG-71-(XN-1) RADAR IS NOT RADIATING, OR IS RADIATING INTO A DUMMY LOAD, MINIMUM SAFE DISTANCE FOR ORDNANCE FROM ONBOARD RADIATING ANTENNAS SHALL BE 160 FEET.

NOTES

- DISTANCE INCLUDES 6 db SAFETY FACTOR
- ANTENNA ELEVATION SCANNER CENTER SCANNED 0° TO 58°
- ANTENNA AZIMUTH SCAN CENTER FIXED AT 0°

HERO SUSCEPTIBLE ORDNANCE SYSTEMS

ANY ORDNANCE PROVEN (BY TESTS) TO CONTAIN EED THAT CAN BE ADVERSELY AFFECTED BY RF ENERGY TO THE POINT THAT THE SAFETY AND/OR RELIABILITY IS IN JEOPARDY WHEN THE SYSTEM IS EMPLOYED IN EXPECTED RF ENVIRONMENTS. SOME ARE SUSCEPTIBLE TO THE RF ENVIRONMENT FOR ONLY A PART OF THE STOCKPILE TO LAUNCH SEQUENCE. FOR EXAMPLE, THE CONNECTION OF AN UMBILICAL CABLE IN THE LOADING PROCEDURE MAY BE THE ONLY TIME ORDNANCE IS CONSIDERED SUSCEPTIBLE. AT ALL OTHER TIMES, IT MAY BE CONSIDERED HERO SAFE ORDNANCE.

HERO SAFE ORDNANCE

ANY ORDNANCE THAT IS SUFFICIENTLY SHIELDED OR OTHERWISE PROTECTED THAT ALL EED CONTAINED ARE IMMUNE TO ADVERSE EFFECTS THAT DEGRADE SAFETY OR RELIABILITY WHEN EMPLOYED IN AN RF ENVIRONMENT. THE ORDNANCE SHALL BE CONSIDERED HERO SAFE, PROVIDED THAT GENERAL HERO REQUIREMENTS HAVE BEEN COMPLIED WITH.

LEGEND:

HERO UNSAFE ORDNANCE HAZARD AREAS SHOWN ARE BASED ON 2.025 mW/cm^2 POWER DENSITY.

HERO SUSCEPTIBLE ORDNANCE SYSTEMS HAZARD AREAS SHOWN ARE BASED ON 4.05 mW/cm^2 POWER DENSITY.

OVER THE SIDE TRANSMISSION ABOARD CARRIER

ORDNANCE RADAR SILENCE ZONE RELATIVE TO APG-71 RADAR VS ELEVATION

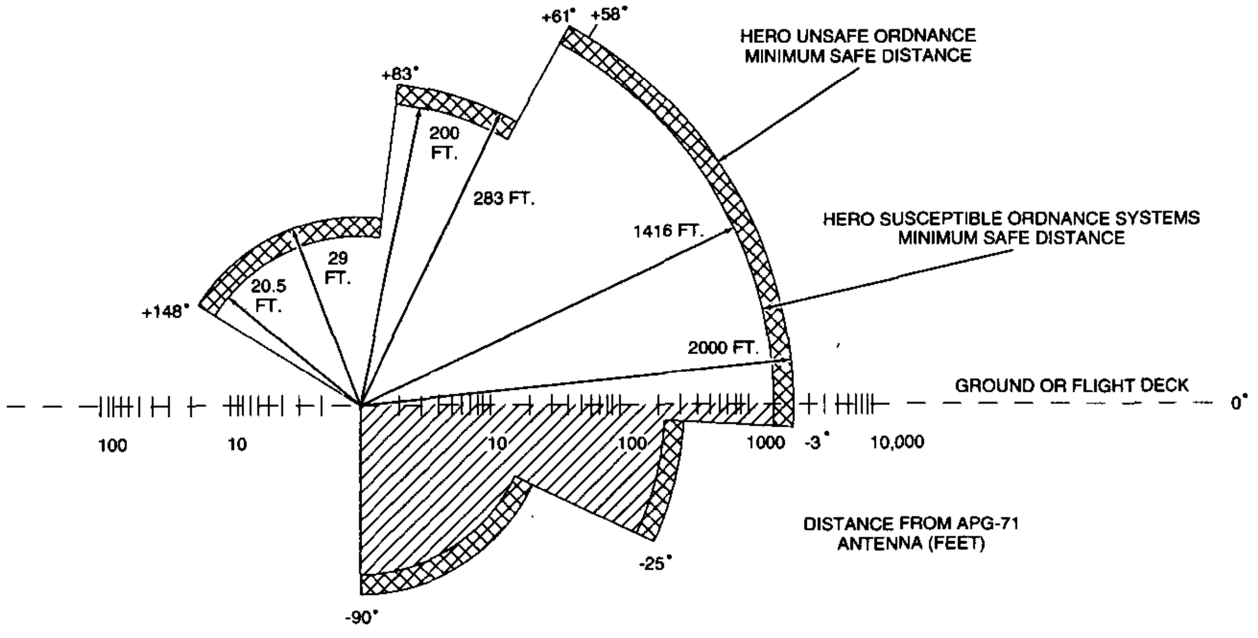

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Figure 3-5. Radar Radiation Hazard Areas (Sheet 4 of 4)

SOUND LEVELS IN dBA		
THIS TABLE CONTAINS ESTIMATED SOUND LEVELS FOR F110-GE-400 (MIXED FLOW) AUGUMENTED) AFTERBURNING TURBOFAN ENGINE. SOUND LEVEL CONTOUR LETTERS A, B, C, AND D (SHOWN IN THIS ILLUSTRATION) REPRESENT A SPECIFIC dBA VALUE. WHEN dBA VALUE IS IN THIS TABLE, IT SHALL BE SUBSTITUTED IN PLACE OF CONTOUR LETTER.		
CONTOUR	MAXIMUM AFTERBURNER POWER	MILITARY POWER
A	145	140
B	140	135
C	135	132
D	130	130

ALLOWABLE NOISE EXPOSURE SOUND LEVEL IN dBa (SLOW RESPONSE)							
TYPE EAR PROTECTIVE DEVICES	EXPOSURE TIME (HOURS)*						
	1/4	1/2	1	2	4	6	8
NO PROTECTION	109	104	99	94	89	86	84
EARPLUGS WITH AVERAGE SEAL	123	118	113	108	103	100	98
EARPLUGS AND EARMUFFS	129	124	119	114	109	106	104
*DURATION OF EXPOSURE PER DAY REF. BUMED INST 6260.6B, 5 MARCH 1970							

NOTE

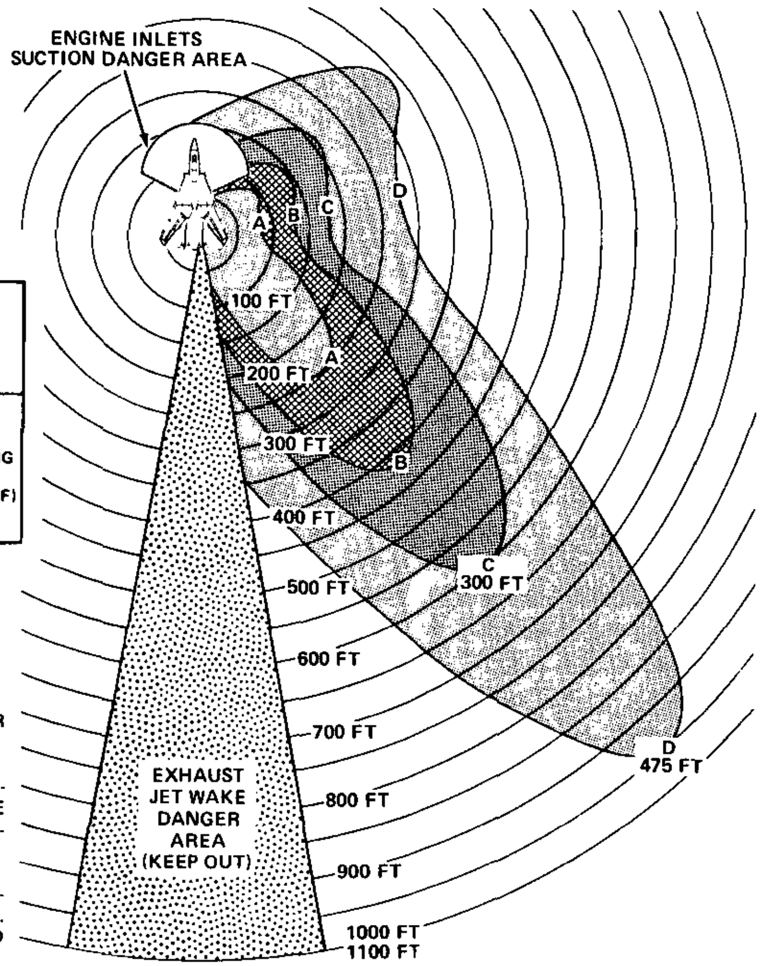
SOUND LEVEL CONTOURS SHOWN ARE FOR SINGLE-ENGINE OPERATION. CONTOURS ARE SYMMETRICAL ABOUT ENGINE CENTERLINES DURING DUAL-ENGINE OPERATION.

EAR PROTECTIVE DEVICES

			
UNIVERSAL FIT EARPLUG	EARPLUG V-51-R TYPE OR SIMILAR	TYPICAL EAR MUFF	FLIGHT DECK SOUND-ATTENUATING HELMET (INCLUDES EAR MUFF)

WARNING

- EARPLUGS AND EAR MUFFS SHALL BE WORN TOGETHER WHEN PERFORMING ENGINE RUNUP.
- IF ENGINES ARE RUN UP IN FRONT OF BLAST DEFLECTOR, EXHAUST JET WAKE AND SHOULD SHALL BE DEFLECTED UP AND TO SIDES, RESULTING IN DISTORTION OF CONTOUR PATTERNS SHOWN.
- AT MAXIMUM POWER, F110-GE-400 ENGINE AFTERBURNERS ARE AT MAXIMUM NOZZLE OPENING (ZONE 5). AT MILITARY POWER THE NOZZLES ARE FULLY CLOSED (MINIMUM OPENINGS).



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N2/97

Figure 3-6. Noise Danger Areas

HERO susceptible ordnance systems are any ordnance systems proven (by tests) to contain EED that can be adversely affected by RF energy to the point that the safety and/or reliability of the system is in jeopardy when the system is employed in expected RF environments. Some systems are susceptible to the RF environment for only a small part of the stockpile-to-launch sequence. For example, the connection of an umbilical cable in the loading procedure may be the only time the system is considered susceptible. At all other times in the system's life, it may be considered HERO safe ordnance. HERO safe ordnance are any ordnance sufficiently shielded or protected that all EED contained by the item are immune to adverse effects that degrade safety or reliability when employed in its expected RF environment (provided that general HERO requirements have been complied with).

3.2.2.3 Fuel Ignition Hazard. When performing fueling or defueling operations, use minimum safe distances outside of radiation hazard areas. Fuel ignition hazard occurs within 90 feet of the aircraft where RF radiation induced sparks could ignite flammable vapors of fuels. Fuel ignition hazard is based on 5W/cm^2 peak power density.

Good housekeeping operations are of utmost importance in areas where radar transmission is anticipated. RF radiation may cause steelwool to be set afire or metallic chips to produce sparks, which in turn may ignite spilled fuels or oils around aircraft and buildings. Keep all areas clean and refuse in approved containers.

3.2.2.4 Transmission Aboard Carrier. Radar transmission aboard carrier shall be limited to over-the-side operation at the discretion of the commander. The aircraft shall be spotted so the nose radome overhangs the side of the carrier. All necessary safety precautions shall be enforced to prevent injury to personnel and damage to equipment aboard the carrier and on adjacent ships that may accidentally stray into the main beam of the radar.

3.2.3 Towing Turn Radii and Ground Clearances. Forward and rearward towing (Figures 3-7 and 3-8) can be accomplished with a standard tow bar (NT-4 aircraft universal tow bar) and the tow tractor. The pilot cockpit shall be manned with qualified personnel during towing operations.

CAUTION

Before and during towing, ensure that the needle(s) in the AUX/PARK brake pressure gauge(s) remains in the green band to ensure sufficient pressure to lock the wheels.

3.2.4 Tiedown Points. Aircraft tiedown points are illustrated in Figure 3-9. When mooring a parked aircraft, do not depend upon chocks alone to hold the aircraft in position. Tiedowns shall be installed in a symmetrical pattern being careful not to chafe against the aircraft structure.

The normal six-point tiedown (Figure 3-9, sheet 1) locations permit all maintenance servicing, including engine removal, jacking, and weapons loading. Standard chain-type tiedowns are used for an 18-point symmetrical tiedown during heavy weather (Figure 3-9, sheet 2).

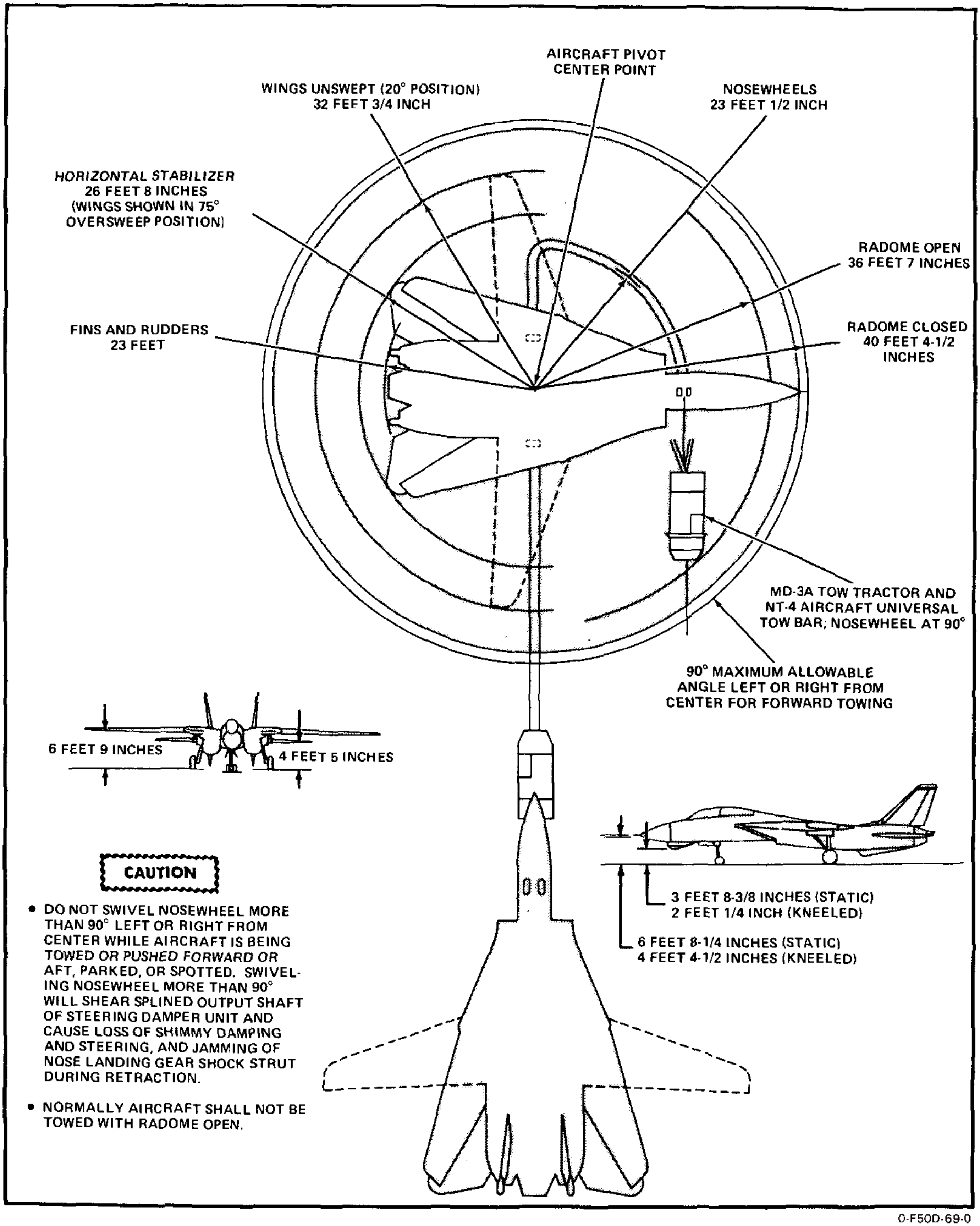

Figure 3-7. Towing Turn Radii

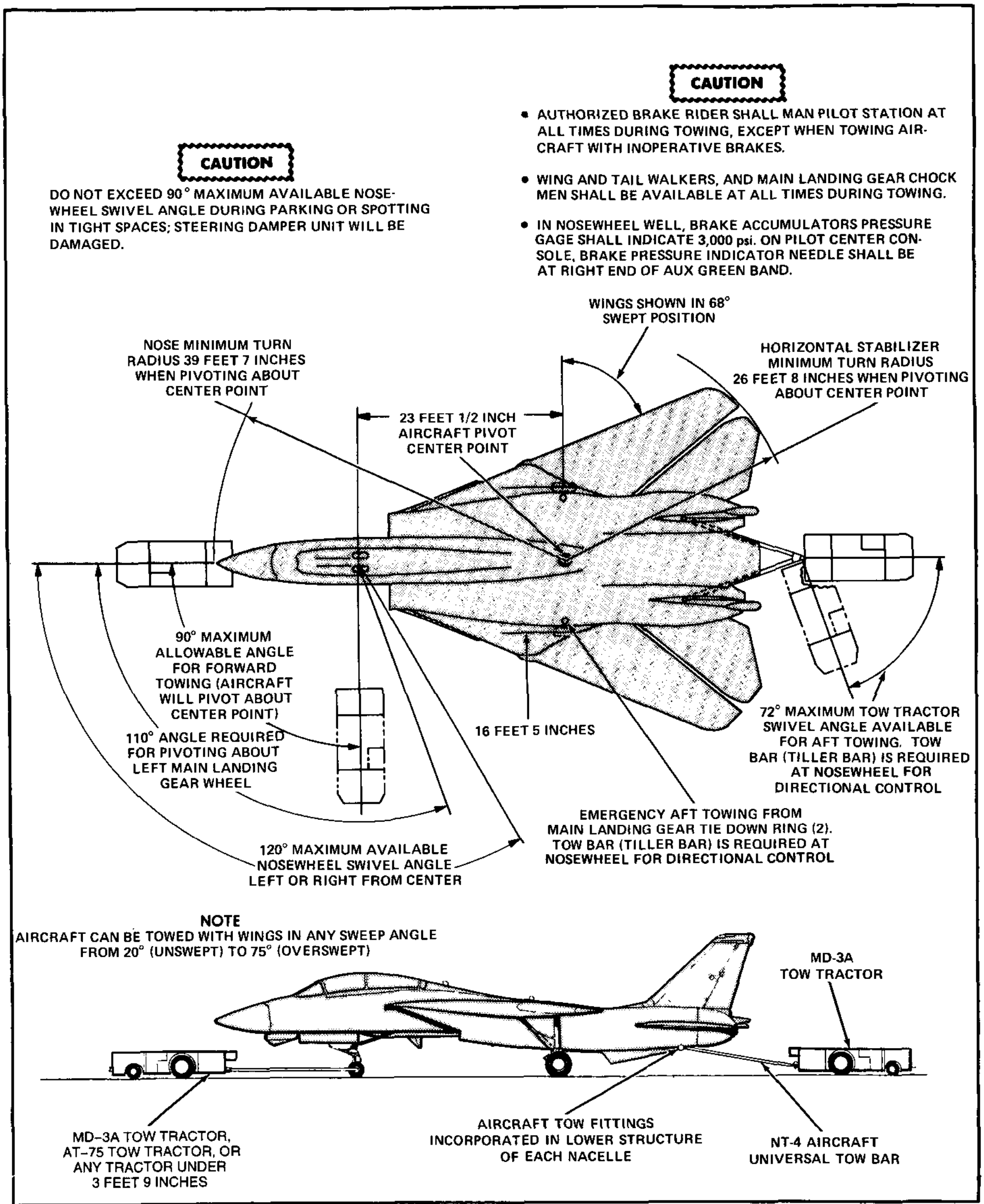

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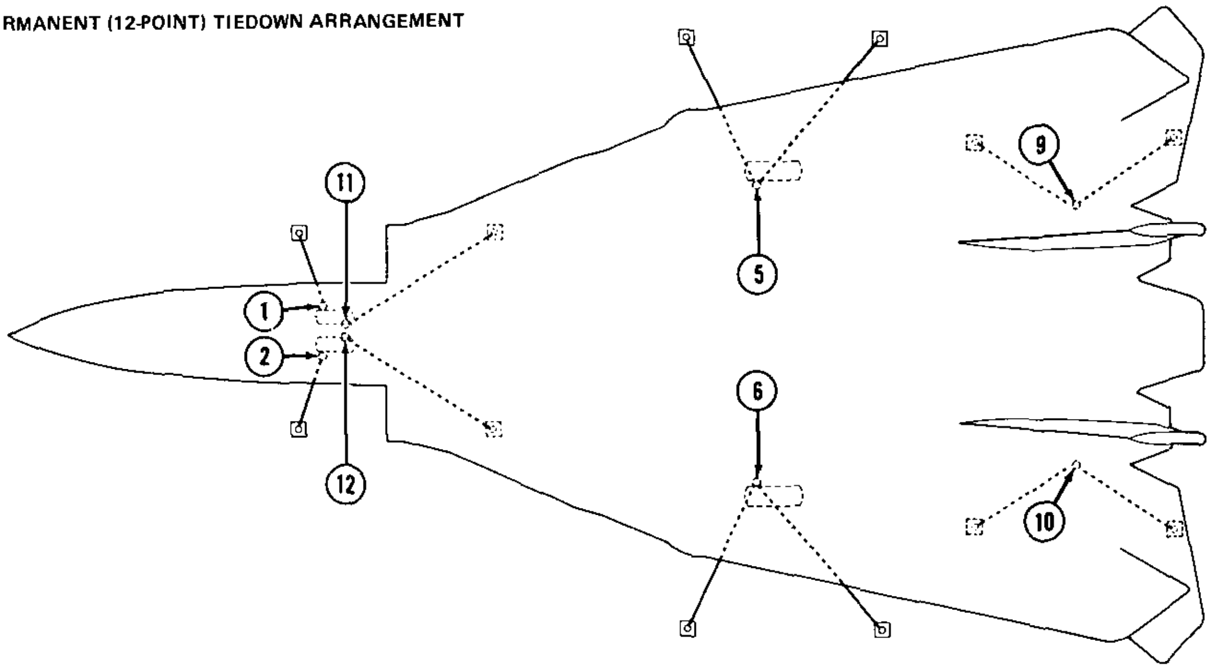
Figure 3-8. Towing

PERMANENT (12-POINT) TIEDOWN ARRANGEMENT



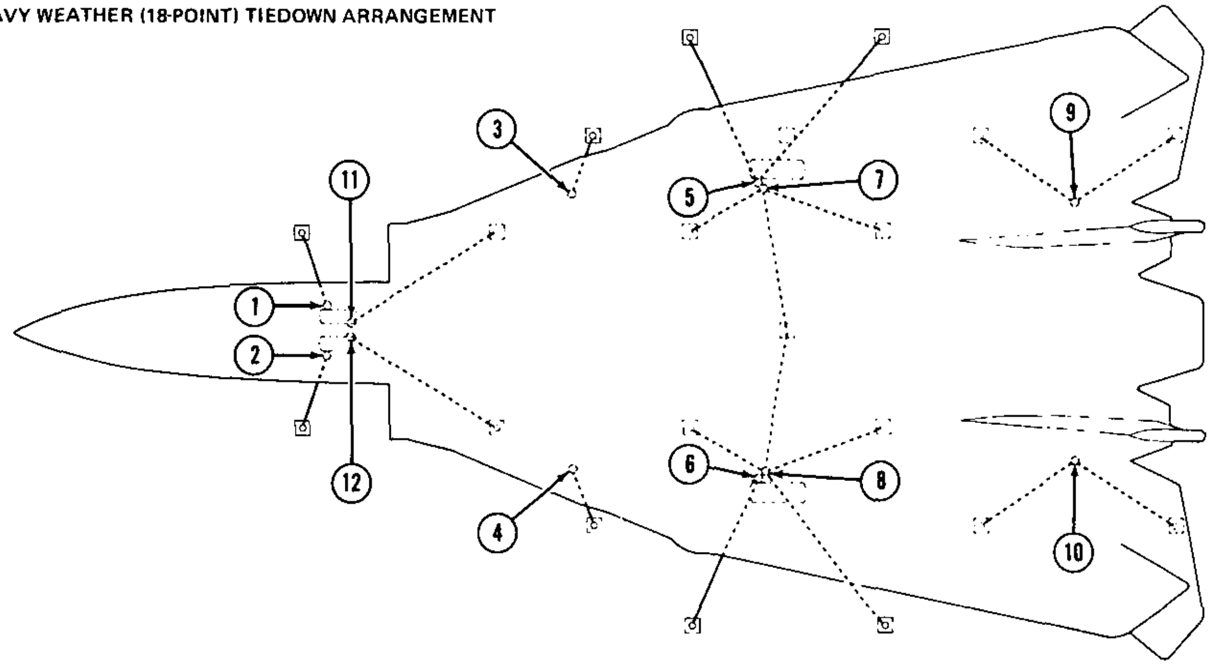
AIRCRAFT TIEDOWN FITTINGS

LOCATION	FITTING NO.	ACCESS NO.	HEIGHT ABOVE GROUND	FUSELAGE STATION
FUSELAGE	1	2221-4	62 INCHES	296.0
	2	1221-6		
MAIN GEAR SHOCK STRUT (OUTBOARD SIDE)	5	–	43 INCHES	567.0
	6			
MAIN GEAR SHOCK STRUT (LOWER INBOARD SIDE)	7	–	10.5 INCHES	569.0
	8			
SPONSON (BELOW HORIZONTAL STABILIZER)	9	6232-3	60 INCHES	747.0
	10	5232-3		
NOSE GEAR DRAG BRACE	11	–	44 INCHES	297.9
	12			

0-F50D-117-1

Figure 3-9. Tiedown Arrangement (Sheet 1 of 2)

HEAVY WEATHER (18-POINT) TIEDOWN ARRANGEMENT



AIRCRAFT TIEDOWN FITTINGS

LOCATION	FITTING NO.	ACCESS NO.	HEIGHT ABOVE GROUND	FUSELAGE STATION
FUSELAGE	1	2221-4	62 INCHES	296.0
	2	1221-6		
WING GLOVE	3	2233-5	85.3 INCHES	451.75
	4	1233-5		
MAIN GEAR SHOCK STRUT (OUTBOARD SIDE)	5	—	43 INCHES	567.0
	6			
MAIN-GEAR SHOCK STRUT (LOWER INBOARD SIDE)	7	—	10.5 INCHES	569.0
	8			
SPONSON (BELOW HORIZONTAL STABILIZER)	9	6232-3	60 INCHES	747.0
	10	5232-3		
NOSE GEAR DRAG BRACE	11	—	44 INCHES	297.9
	12			

0-F50D-117-2L

Figure 3-9. Tiedown Arrangement (Sheet 2 of 2)

CHAPTER 4

Operating Limitations

4.1 LIMITATIONS

This section includes the aircraft and engine limitations that must be observed during normal operations. The aerodynamic and structural limitations in this section apply only to F-14D aircraft for the store station configurations shown in Figure 4-1. Engine limitations apply to all aircraft with the F110-GE-400 engine.

4.1.1 Engine Limits. Engine instrument markings for various operation limitations are shown in Figure 4-2. Engine operating limitations are shown in Figure 4-3.

The engine secondary (SEC) mode may be intentionally selected in flight only under the following conditions:

1. Engine operating between 85-percent rpm and military power
2. Airspeed less than 1.0 TMN.

4.1.2 Starter Limits. The starter cranking limits are as follows:

1. Cross bleed — 2 minutes.
2. Start cart — 5 minutes.

When the time limit is reached, 10 minutes cooling is required between cranking.

4.1.3 Airstart Envelope. The engine spooldown and windmill airstart envelopes are shown in Chapter 14, Figure 14-3.

4.1.4 Crosswind Limits. Crosswind takeoffs and landings are permitted with a crosswind component not to exceed 20 knots at 90°.

4.1.5 Ground Operations Limits

1. Maximum tire speed — 190 knots.
2. Maximum canopy open speed — 60 knots.

WARNING

Use of antiskid must be in accordance with the following procedures:

a. Select antiskid while stopped on the runway in the takeoff position; after landing, turn antiskid off once slowed below 15 knots prior to clearing the runway.

b. Use only during landing or aborted takeoff.

c. Do not use antiskid while taxiing.

4.1.6 Ejection Seat Operation Limits. See ejection envelope curves, Chapter 16, Figure 16-1.

1. Maximum speed (seat) — 600 knots.

WARNING

Ejection above 350 knots is hazardous, the decision to exceed 350 knots rests with the aircrew.

4.1.7 Autopilot Limits. Autopilot should not be used under the following conditions:

1. Airspeeds greater than 400 KCAS/0.9 TMN
2. Altitude above 42,500 feet.

4.2 AIRSPEED LIMITATIONS

The limits and restrictions in this part represent the maximum capability of the aircraft commensurate with safe operations. Aerodynamic and structural excesses of

STORE CONFIGURATION	AIRCRAFT STORE STATION 1A	1B	2	3 4 5 & 6	7	8B	8A
1A(*)	–	–	–	–	–	–	–
1B1	AIM–9	AIM–9	–	–	–	AIM–9	AIM–9
1B2	AIM–9	–	–	–	–	–	AIM–9
1C	–	–	TANK	–	TANK	–	–
2A(*)	–	–	–	4 AIM–7	–	–	–
2B1	AIM–9	AIM–9	–	4 AIM–7	–	AIM–9	AIM–9
2B2	AIM–9	–	–	4 AIM–7	–	–	AIM–9
2B3	AIM–9	AIM–7	–	4 AIM–7	–	AIM–7	AIM–9
2B4	–	AIM–7	–	4 AIM–7	–	AIM–7	–
2C(*)	–	–	TANK	4 AIM–7	TANK	–	–
2C1	AIM–9	AIM–9	TANK	4 AIM–7	TANK	AIM–9	AIM–9
2C2	AIM–9	–	TANK	4 AIM–7	TANK	–	AIM–9
2C3	AIM–9	AIM–7	TANK	4 AIM–7	TANK	AIM–7	AIM–9
2C4	–	AIM–7	TANK	4 AIM–7	TANK	AIM–7	–
3A(*)	–	–	–	4 AIM–54	–	–	–
3B1	AIM–9	AIM–9	–	4 AIM–54	–	AIM–9	AIM–9
3B2	AIM–9	–	–	4 AIM–54	–	–	AIM–9
3B3	AIM–9	AIM–7	–	4 AIM–54	–	AIM–7	AIM–9
3B4	–	AIM–7	–	4 AIM–54	–	AIM–7	–
3B5	AIM–9	AIM–54	–	4 AIM–54	–	AIM–54	AIM–9
3B6	–	AIM–54	–	4 AIM–54	–	AIM–54	–
3C(*)	–	–	TANK	4 AIM–54	TANK	–	–
3C1	AIM–9	AIM–9	TANK	4 AIM–54	TANK	AIM–9	AIM–9
3C2	AIM–9	–	TANK	4 AIM–54	TANK	–	AIM–9
3C3	AIM–9	AIM–7	TANK	4 AIM–54	TANK	AIM–7	AIM–9
3C4	–	AIM–7	TANK	4 AIM–54	TANK	AIM–7	–
3C5	AIM–9	AIM–54	TANK	4 AIM–54	TANK	AIM–54	AIM–9
3C6	–	AIM–54	TANK	4 AIM–54	TANK	AIM–54	–

- (*) These store configuration limits also apply when multipurpose stub pylons are carried at stations 1 and 8.
- Flight operating limitations applicable to the above configurations are also applicable to down loadings, except down load of external tank to MXU–776/777 which shall be considered as a clean store station for limitation purposes.
- For captive carriage of inert or live AIM–54, installation of ejector cartridges in LAU–132 is mandatory in order to provide jettison capability.
- For captive carriage of inert or live AIM–7, installation of ejector cartridges in LAU–92 is mandatory in order to provide jettison capability. This does not apply to CATM–7F–2 missiles used for ballast (refer to NAVAIR 01–F14AAD–75 Weapon Stores Loading Manual).
- For shorebased operations all CATM–7F–1 (Sparrow training rounds) shall be configured with a modified shear wafer to preclude inadvertent activation of the guidance and control unit, and subsequent ejection of the missile.
- Simultaneous loading of AIM–7 on store station 4 and AIM–54 on store station 3 and 6 is an authorized configuration. Limitations of fuselage AIM–54 apply for carriage, individual missile limitations apply for launch/jettison.
- AIM-9 configurations include both LAU-7 and LAU-138 carriage.

WARNING

- *In all cases the center of gravity position must remain within limits. The aft limit can be easily exceeded if stations 3 and 6 are not loaded.*
- *With MA ARM ON and all conditions satisfied for AIM–54 launch, an ATM–54 (training round) will be ejected if the trigger or launch button is depressed.*
- *With MA ARM ON and all other conditions satisfied for AIM–7 launch, a CATM–7F–1 (Sparrow training round) will be ejected when the trigger or launch button is pressed unless a modified shear wafer is installed. Emergency/selective jettison of a CATM–7F–1 is still possible with a modified shear wafer installed.*

Figure 4-1. Store Station Configuration

N2/97

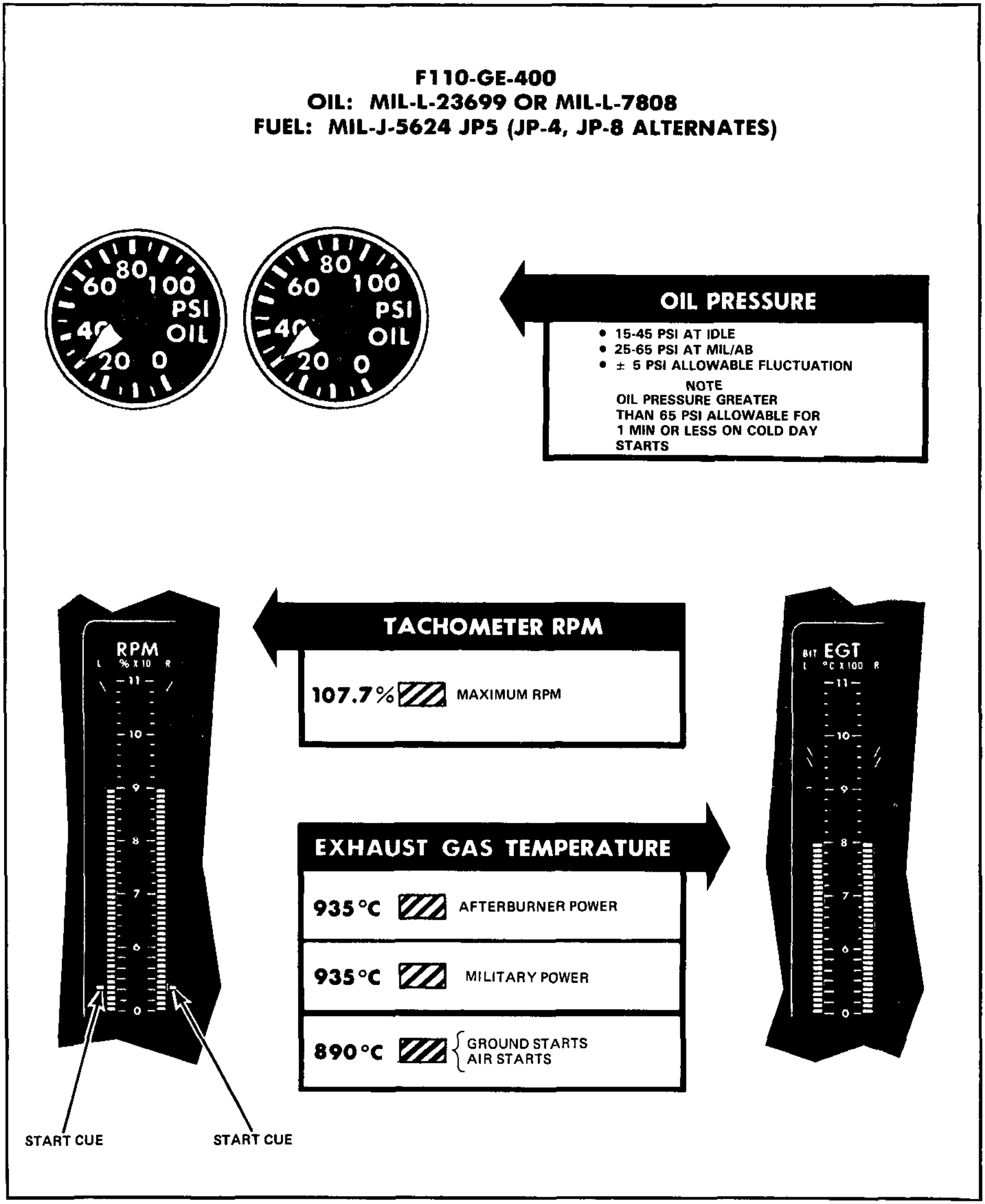


Figure 4-2. Instrument Markings

F110-GE-400

OIL: MIL-L-23699 OR MIL-L-7808
FUEL: MIL-J-5624 (JP-5) (JP-4, JP-8 ALTERNATES)

OPERATING CONDITIONS	OPERATING LIMITS	
THRUST SETTING	MAXIMUM MEASURED EXHAUST GAS TEMP (°C)	NORMAL OIL PRESSURE (PSIG)
MAXIMUM (AFTERBURNING)	935	25 TO 65
MILITARY	935	25 TO 65
IDLE STABILIZED	935	15 TO 45
STARTING (GROUND)	890	—
STARTING (AIRSTART)	890	—

NOTE
- OIL PRESSURE WILL INCREASE PROPORTIONATELY WITH RPM.
- UNDER COLD CONDITIONS, OIL PRESSURE MAY EXCEED 65 PSI FOR 1 MINUTE.

RPM LIMITS

ANY EXCEEDED LIMIT SHOULD BE REPORTED AS A DISCREPANCY AND MAXIMUM RPM, EGT, AND TIME NOTED.

OPERATING CONDITIONS	OPERATING LIMITS
STEADY STATE OR TRANSIENT	107.7% RPM

1-F50P-18-0

Figure 4-3. Engine Operating Limits

these limits shall be entered on the maintenance action form for appropriate maintenance action.

4.2.1 Maximum Airspeeds. Maximum speeds are presented in calibrated knots and true Mach number. These values are derived from the position-error-correction curves of the production pitot-static-operated airspeed and altitude system. AOA is presented utilizing the conventional indicated units AOA while sideslip angle limits are presented in terms of degrees rudder deflection.

Note

> Unless otherwise specified, the limits presented herein pertain to flight with the stability augmentation system on.

4.2.1.1 Cruise Configuration. With wing sweep in the MANUAL or AUTO mode, the maximum allowable airspeeds are shown in Figure 4-4.

In emergency wing-sweep mode, the following combination of Mach and wing-sweep schedule must be used:

1. ≤ 0.4 TMN — 20°.
2. ≤ 0.7 TMN — 25°.
3. ≤ 0.8 TMN — 50°.
4. ≤ 0.9 TMN — 60°.
5. > 0.9 TMN — 68°.

4.2.1.2 Approach Configuration

1. Landing gear — 280 KCAS.
2. Landing flaps and slats — 225 KCAS.

CAUTION

- With the landing gear extended or in transit, abrupt rolls or uncoordinated turns above 225 KCAS can cause structural failure of the landing gear doors.
- After takeoff, move the FLAP handle to the UP position passing 180 KCAS to ensure flap and slat airspeed limits are not exceeded.

4.2.1.3 In-Flight Refueling

1. Refueling probe — 400 KCAS/0.8 TMN.
2. In-flight refueling (cruise configuration) — 200 to 300 KCAS/0.8 TMN.
3. In-flight refueling (approach configuration) — 170 to 200 KCAS.

4.3 ACCELERATION LIMITS

Note

- Limits are based on a gross weight of 49,548 pounds. See Figure 4-5 for the variation of maximum load factor with gross weights greater than 49,548 pounds.
- Coordinated turns with small rudder and lateral stick inputs are defined as symmetrical flight.

4.3.1 Cruise Configuration. See Figures 4-5 and 4-9.

4.3.2 Approach Configuration

1. Landing gear and/or landing flaps and slats — 0 to 2.0g (symmetrical or rolling).

4.4 ANGLE-OF-ATTACK LIMITS

4.4.1 Cruise Configuration. AOA is limited by the maximum allowable load factor of Figure 4-5, the maneuvering limits of Figure 4-8, and the sideslip limits only under the following conditions:

WARNING

> With roll SAS on, departure resistance is reduced because of adverse yaw generated by roll SAS inputs. Subsonic maneuvering with roll SAS on shall not be conducted above 15 units AOA with landing gear retracted.

1. Wing sweep — AUTO.
2. Clean or all air-to-air store loadings except those that include wing-mounted AIM-54.

Under all other conditions, maneuvering is permitted only to the AOA limits of Figure 4-7 or the maximum allowable load factor of Figure 4-5, whichever occurs

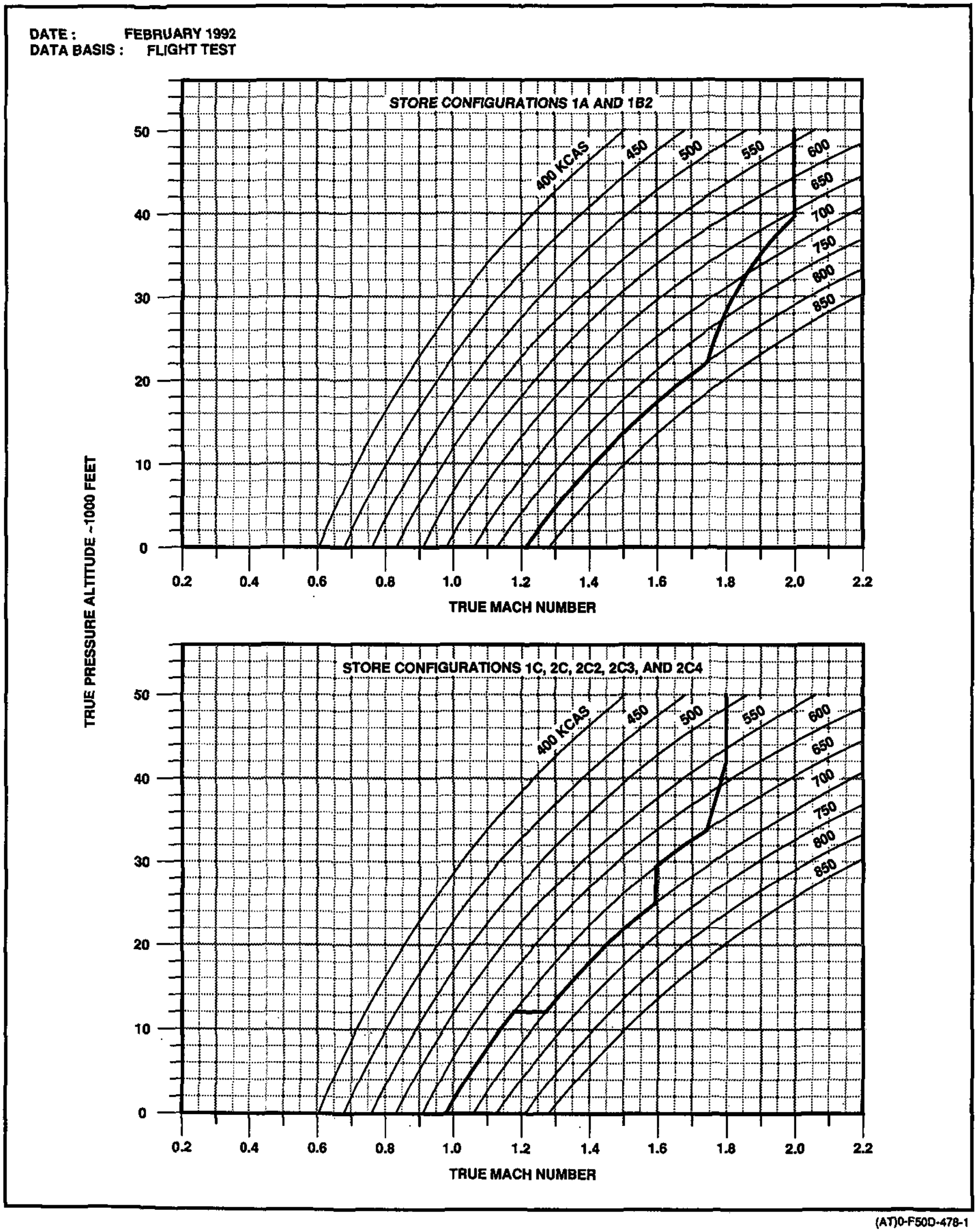


Figure 4-4. Maximum Allowable Airspeeds (Sheet 1 of 3)

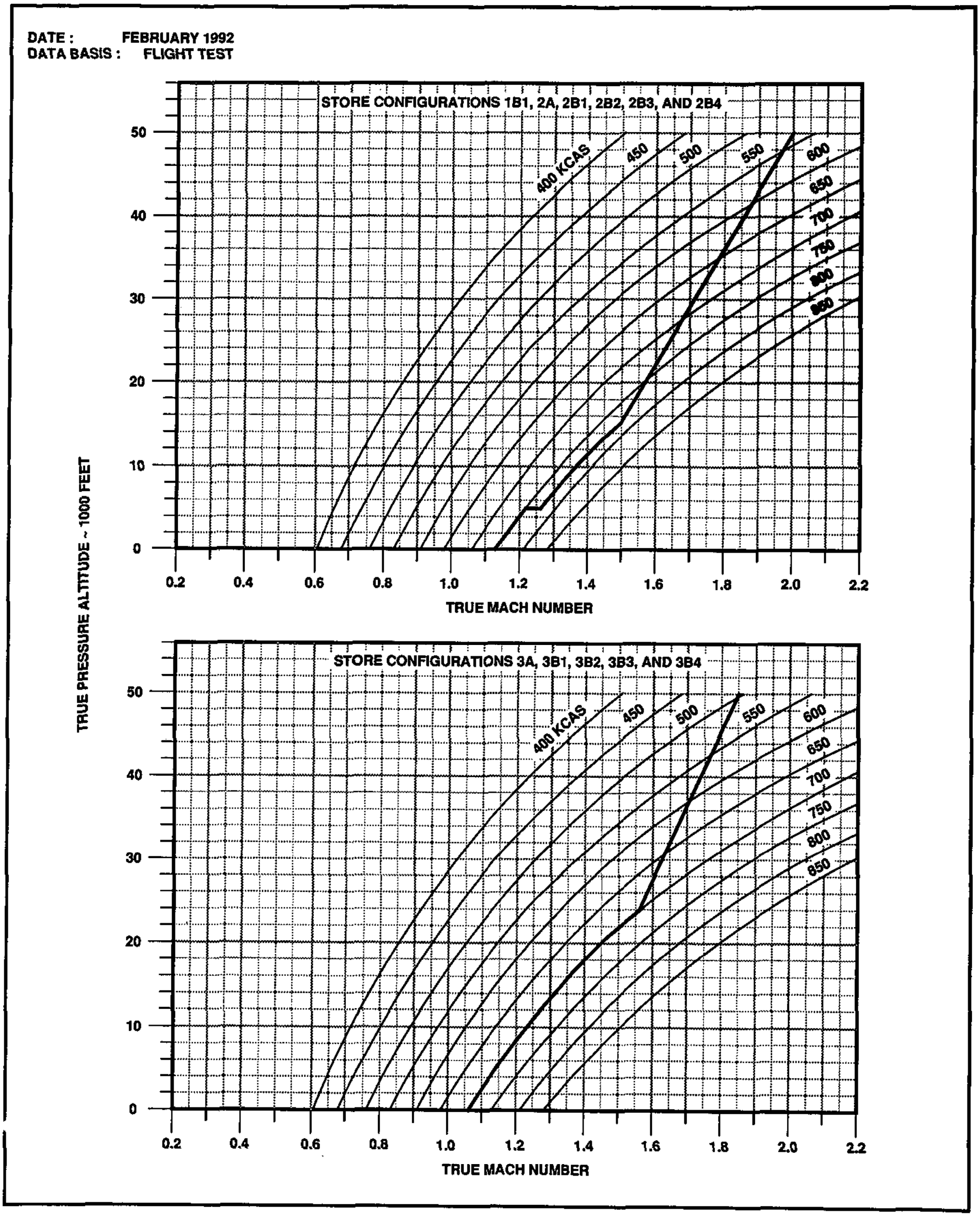


Figure 4-4. Maximum Allowable Airspeeds (Sheet 2 of 3)

DATE : FEBRUARY 1992
DATA BASIS : FLIGHT TEST

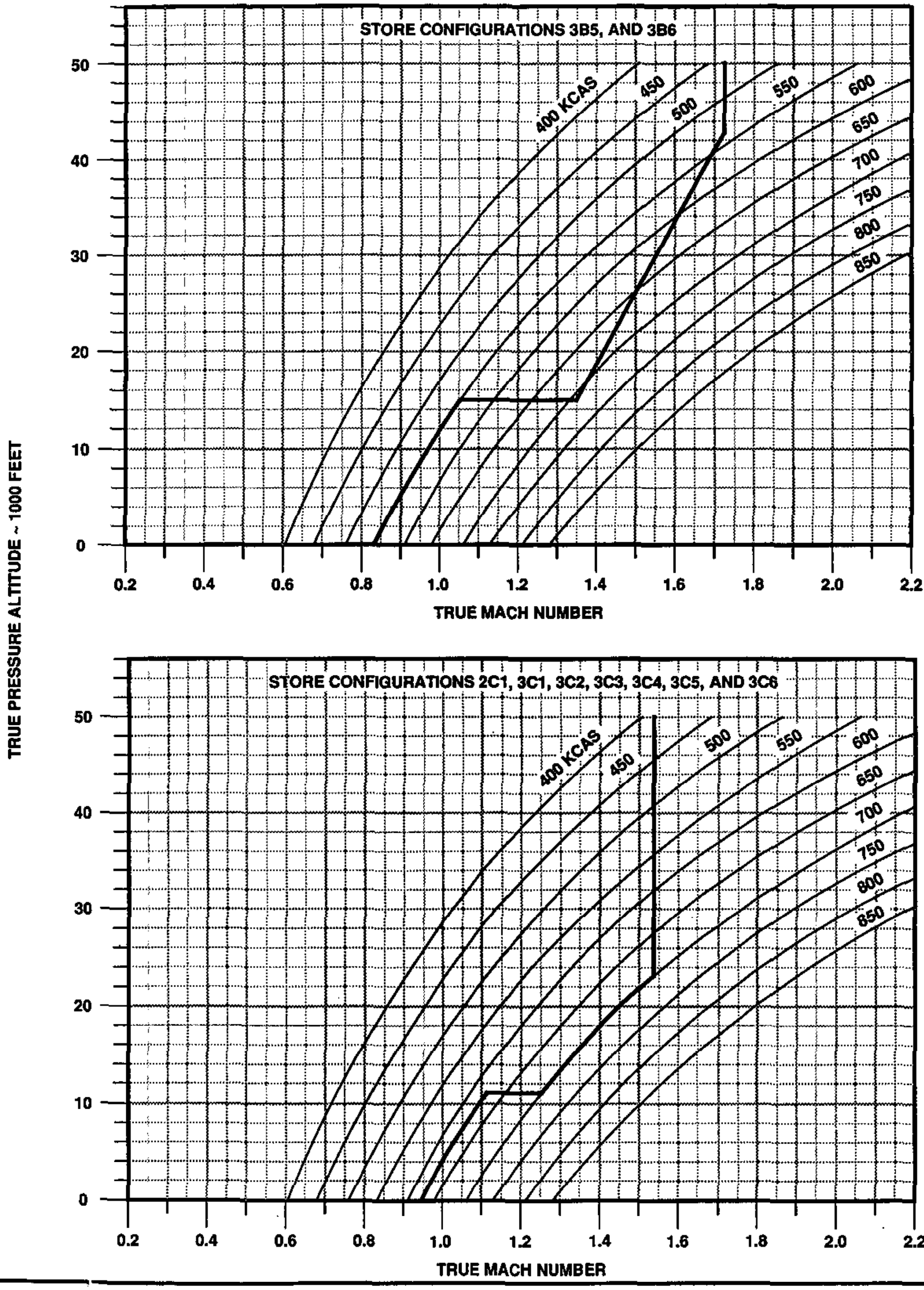


Figure 4-4. Maximum Allowable Airspeeds (Sheet 3 of 3)

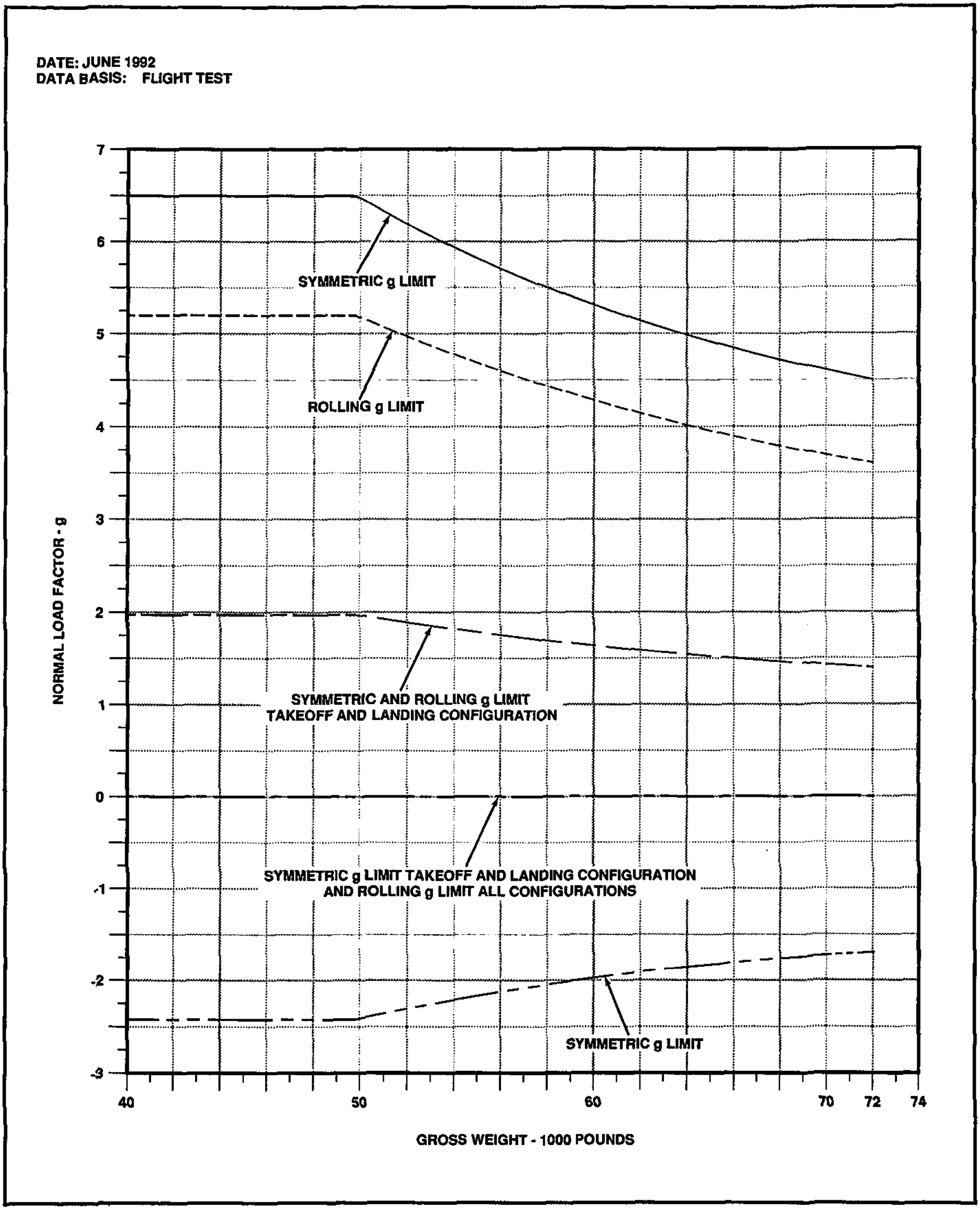


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Figure 4-5. Variation of Maximum Allowable Normal Load Factor With Gross Weight first, and the maneuvering limits of Figure 4-8 and the sideslip limits of Figure 4-6.

Note

Refer to High Angle-of-Attack Flight Characteristics and Engine Operating Characteristics in Chapter 11.

4.4.2 Approach Configuration. Maximum allowable AOA with landing gear and flaps extended is shown in Figure 4-6.

4.5 MANEUVERING LIMITS

4.5.1 Approach Configuration. With landing gear and/or landing flaps and slats extended, abrupt yaws are prohibited. Refer to Figure 4-6 for approach configuration sideslip limits.

With landing gear extended or in transit, abrupt rolls and uncoordinated turns shall not be performed above 225 KCAS.

4.5.2 Cruise Configuration. With maneuver slats/flaps extended, maximum allowable load factor is 6.5g or the limits of Figure 4-5, whichever is less.

Subsonic maneuvering with roll SAS on shall not be conducted above 15 units AOA with the landing gear retracted.

Cross control inputs shall not be used in the area of the flight envelope indicated in Figure 4-8.

When automatic maneuvering flaps/slats are not operating, uncoordinated lateral control inputs shall not be used in the area of the flight envelope indicated in Figure 4-8.

4.5.3 Rolling Limits. With maneuver slats and flaps extended, maximum allowable load factor is 5.2g or the limits of Figure 4-9 (roll SAS on or roll SAS off) whichever is less. Rolling limits are shown in Figure 4-9.

CAUTION

- Do not initiate full lateral stick inputs above 4.5g if a 5.2g limit applies or above 3.5g if a 4.0g limit applies. Control system dynamics may cause load factor to increase beyond limits.
- If outboard spoilers fail with airspeed greater than 400 KCAS and wing sweep less than 62°, limit lateral stick deflection to one-half pilot authority.

Note

AOA limitations shown in Figure 4-7 apply to designated configurations.

4.5.4 Sideslip Limits

4.5.4.1 All External Store Configurations

1. Below 0.7 TMN — Rudder inputs as required to maneuver aircraft at high AOA.
2. Above 0.7 TMN — Rudder inputs coordinated with lateral stick as required to educe or eliminate the effects of adverse yaw at high AOA.

CAUTION

Rapid rudder inputs cause noseup pitch and may generate snap roll departures.

3. Above 1.70 TMN — Intentional sideslips prohibited.

WARNING

If a supersonic engine stall and/or failure occurs, arrest roll rate with lateral stick only. Yaw SAS will maintain sideslip angle within acceptable limits.

Note

Use of full available rudder is permitted at all airspeeds if required to counteract adverse yaw encountered in maneuvering flight.

4.5.5 Prohibited Maneuvers. The following additional maneuvers are prohibited:

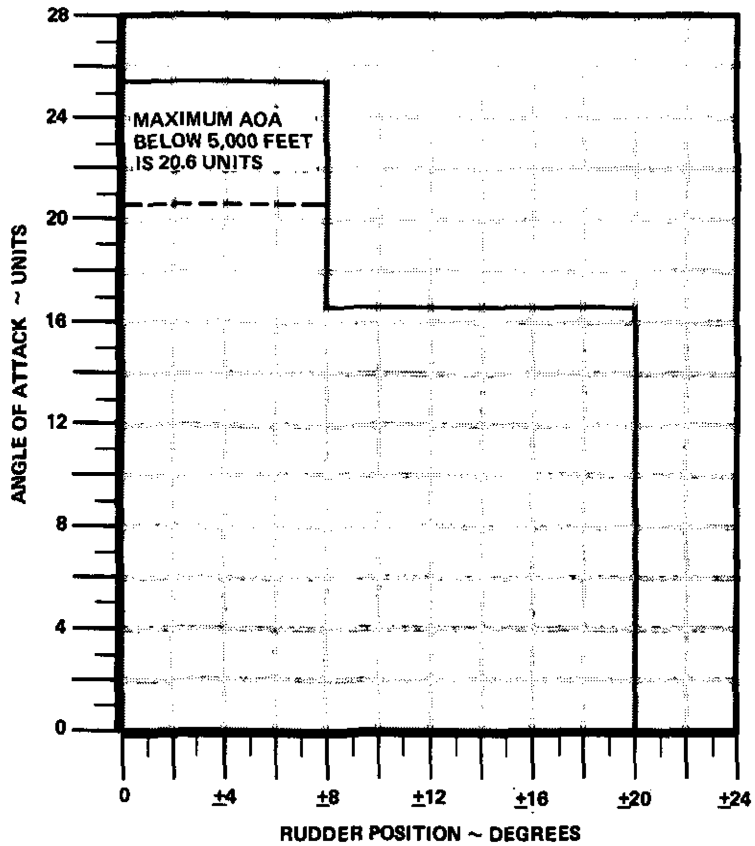
1. Intentional spins.
2. During afterburner operations:
   a. Sustained zero to negative 0.5g flight.
   b. Flight from negative 0.5g to negative 2.4g's for more than 10 seconds.
3. At MIL power or less: zero or negative-g flight for more than 20 seconds.

LANDING GEAR AND/OR FLAPS EXTENDED

DATE: MAY 1977
DATA BASIS: FLIGHT TEST

NOTE

- NORMAL STALL APPROACH IN 1.0 g FLIGHT AT NO GREATER THAN 1.0 KNOT PER SECOND DECELERATION RATE.
- LATERAL CONTROL INPUTS ABOVE 18 UNITS AOA WILL PRODUCE NOSE-UP PITCHING MOMENTS AND APPARENT STICK FORCE LIGHTENING
- NO INTENTIONAL SIDESLIPS OTHER THAN 1.0 g WINGS LEVEL.
- ABRUPT CONTROL REVERSALS PROHIBITED.
- ABRUPT YAWS (FULL ALLOWABLE CONTROL DISPLACEMENT IN LESS THAN 1.0 SECOND) PROHIBITED.
- NORMAL ±30° RUDDER DEFLECTION IS AVAILABLE AND PERMISSIBLE IN ORDER TO MAINTAIN AIRCRAFT CONTROL IN THE EVENT OF AN ENGINE FAILURE.
- DIVERGENT WING ROCK OCCURS ABOVE 25 UNITS AOA.



0-F50-56-0

Figure 4-6. Maximum Allowable Angle-of-Attack Rudder Deflections

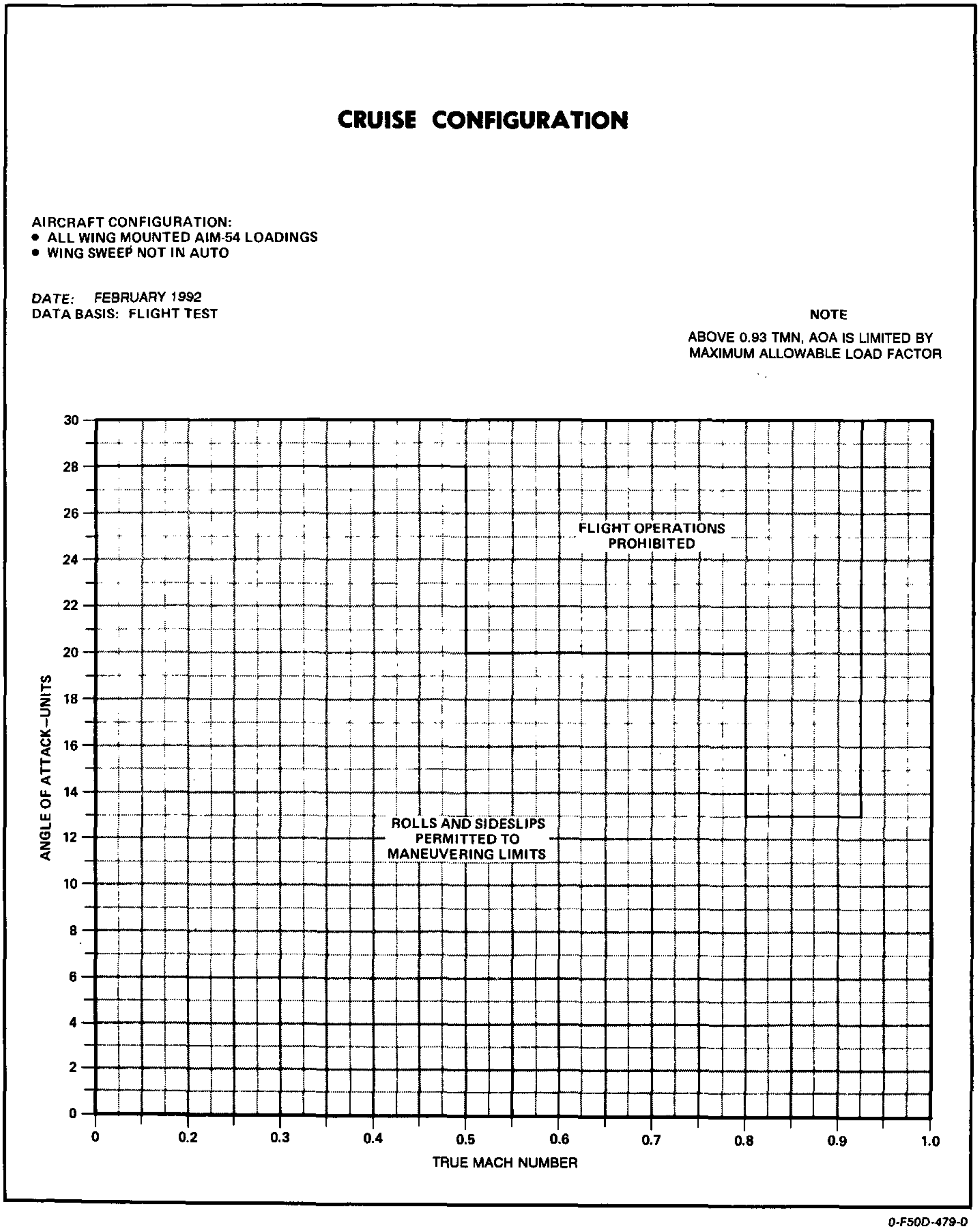


Figure 4-7. Angle-of-Attack Limits

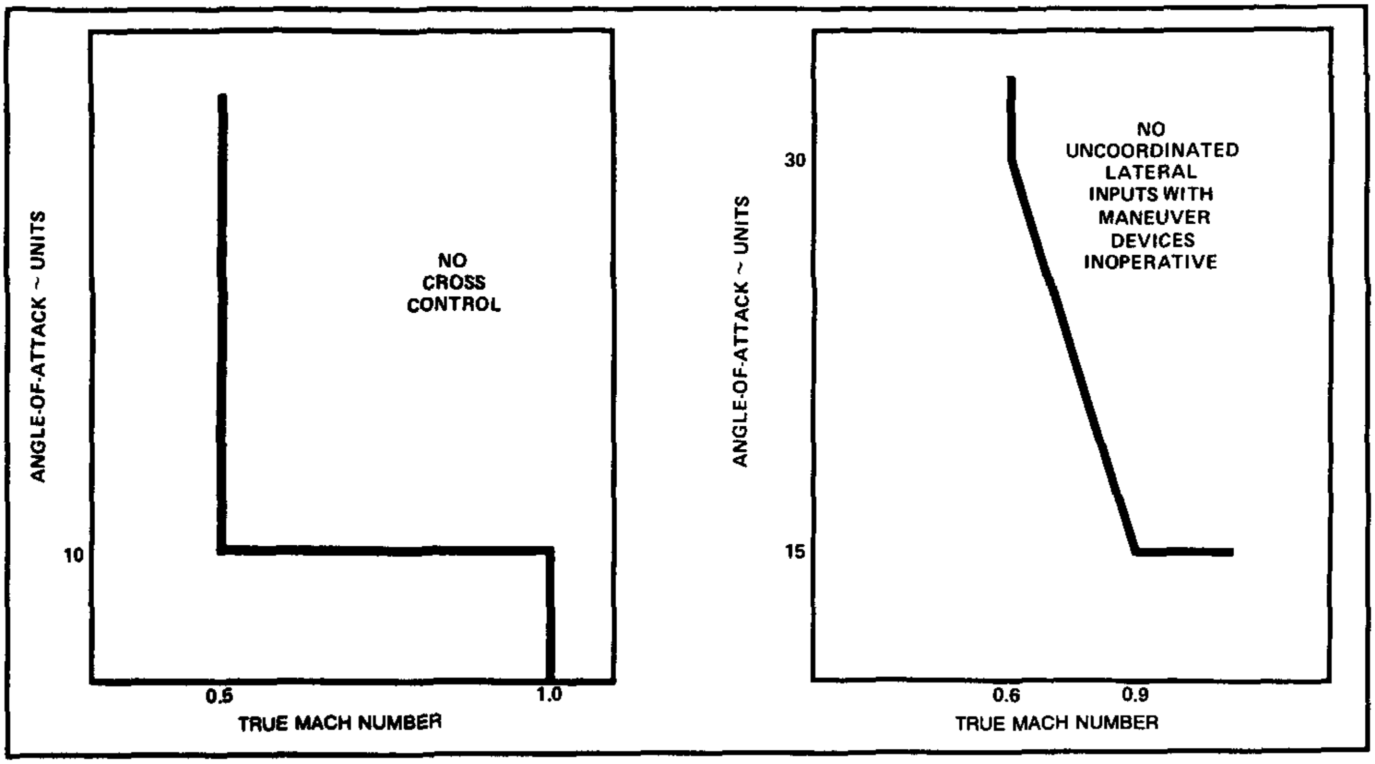


Figure 4-8. Maneuvering Limits — Cruise Configuration

4. AIM-9 launch with landing flaps and slats extended.

5. Fuel dumping with afterburner operating or with speedbrakes extended.

6. Dual-engine afterburner takeoffs, waveoffs, bolters, or catapult launches.

7. Single-engine maximum afterburner takeoffs, waveoffs, bolters, or catapult launches.

8. ACLS mode 1/1A approaches.

9. Rolling maneuvers with AOA change greater than 360° are prohibited.

4.6 SAS LIMITS

4.6.1 Cruise Configuration

1. Pitch SAS off — LBA.

2. Yaw SAS off — 1.0 TMN.

3. Roll SAS off — 1.0 TMN (wing-mounted AIM-54); 1.52 TMN (external tanks, fuselage AIM-54, A/G stores); 1.6 TMN (all other configurations).

4.6.2 Approach Configuration

1. Pitch SAS off — LBA.

2. Yaw SAS off — LBA.

3. Roll SAS off — Not permitted during takeoff and landing flap and slat transition.

Roll SAS must be left on for carrier landings with store asymmetry greater than 170,000 inch-pounds. (Example: weapon rail at station 6 and AIM-54 missile at station 8 equals 170,000 inch-pounds.)

4.7 TAKEOFF AND LANDING FLAP AND SLAT TRANSITION LIMITS

4.7.1 Clean and Symmetric Stores Loading. See Figure 4-10.

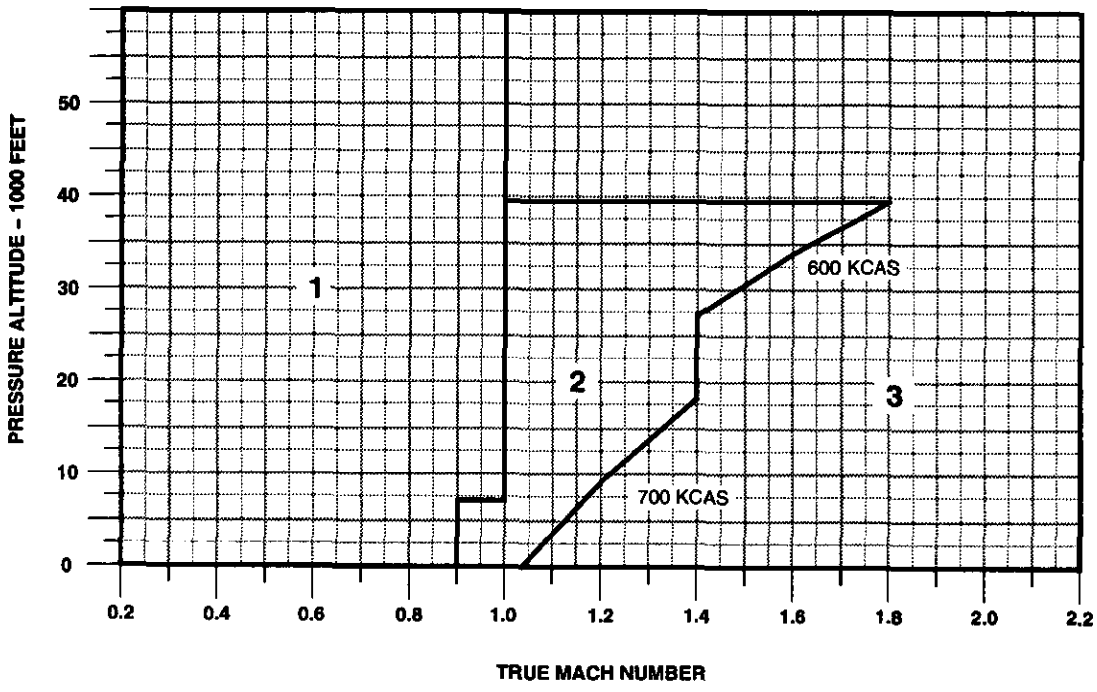
1. All transitions will be made in less than 45° bank angle, roll SAS on.

2. All normal (flaps and slats fully down) takeoff transitions will be initiated at a minimum altitude of 200 feet AGL.

3. All other transitions will be made at standard field operating altitudes, but no less than 800 feet AGL.

F-14D ROLL SAS ON
MANEUVERING ENVELOPE

DATE : SEPTEMBER 1994
DATA BASIS : ESTIMATED FLIGHT TEST



ROLLING MANEUVERS RESTRICTED TO:

REGION 1 – 360° MAXIMUM BANK ANGLE CHANGE AND:

4.0G – ALL CONFIGURATIONS WITH EXTERNAL FUEL TANKS OR WING-MOUNTED AIM-54
5.2G – ALL OTHER CONFIGURATIONS

REGION 2 – 360° MAXIMUM BANK ANGLE CHANGE AT 1G:

180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1G (4G MAXIMUM)

REGION 3 – NO ABRUPT STICK INPUTS:

360° MAXIMUM BANK ANGLE CHANGE AT 1G ONLY

NOTE:

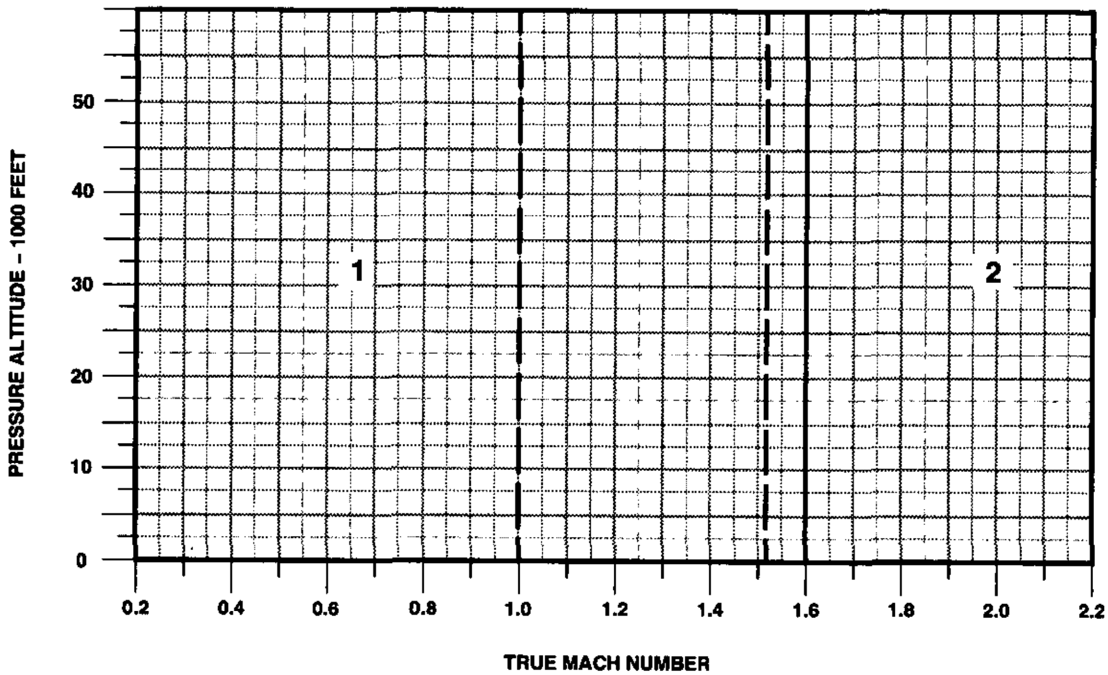
DO NOT EXCEED MAXIMUM ALLOWABLE AIRSPEED FOR STORE CONFIGURATION. NATOPS LIMITS OF FIGURE 4-4 APPLY.

(AT)2–F50D–481–1

Figure 4-9. Maneuvering Limits — Rolling (Sheet 1 of 2)

F-14D ROLL SAS OFF
MANEUVERING ENVELOPE

DATE : SEPTEMBER 1994
DATA BASIS : ESTIMATED FLIGHT TEST



ROLLING MANEUVERS RESTRICTED TO:

REGION 1 - 360° MAXIMUM BANK ANGLE CHANGE AT 1G
- 180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1G
(0G MINIMUM TO 5.2G MAXIMUM)

- FOR CONFIGURATIONS WITH WING-MOUNTED AIM-54:
ROLL SAS MUST BE ON ABOVE 1.0 TMN
REFER TO ROLL SAS ON MANEUVERING ENVELOPE

- FOR ALL OTHER CONFIGURATIONS WITH EXTERNAL FUEL TANKS, FUSELAGE MOUNTED AIM-54, OR AIR-TO-GROUND STORES:
ROLL SAS MUST BE ON ABOVE 1.52 TMN
REFER TO ROLL SAS ON MANEUVERING ENVELOPE

REGION 2 - ROLL SAS MUST BE ON
REFER TO ROLL SAS ON MANEUVERING ENVELOPE

NOTE:

DO NOT EXCEED MAXIMUM ALLOWABLE AIRSPEED FOR STORE CONFIGURATION. NATOPS LIMITS OF FIGURE 4-4 APPLY.

(AT)2-F50D-481-2

Figure 4-9. Maneuvering Limits — Rolling (Sheet 2 of 2)

STORE	FLAP LIMITATIONS (INCH–POUNDS)							
ORDNANCE/STATION	1A	1B	3	6	8B	8A	2	7
SIDEWINDER	27,220	24,820	–	–	24,820	27,220	–	–
SPARROW	–	63,000	10,500	10,500	63,000	–	–	–
PHOENIX	–	126,000	15,000	15,000	126,000	–	–	–
TANKS (EMPTY)	–	–	–	–	–	–	14,260	14,260
TANKS (FULL)	–	–	–	–	–	–	126,852	126,852
WING FUEL	WINGS 20° ONE WING FULL, OTHER EMPTY							431,405

Note

Do not attempt shipboard landing with inoperative roll SAS and greater than 170,000 in–lbs asymmetry unless divert field unavailable.

FLAP TRANSITIONS:

CLEAN OR SYMMETRICAL	UP TO 66,000 IN–LBS ASYMMETRY	GREATER THAN 66,000 IN-LBS ASYMMETRY
1. Less than 45° angle of bank	1. Wings level	1. Wings level
2. *Roll SAS on*	2. *Roll SAS on*	2. *Roll SAS on*
3. Minimum 200 feet AGL on takeoff	3. Minimum 200 feet AGL	3. Minimum altitude of 1,200 feet AGL for takeoff and landing
4. Dirty–up altitude minimum 800 feet AGL	4. Dirty–up at minimum 800 feet AGL	4. Minimum 180 knots.
5. Minimum 180 knots	5. Minimum 180 knots	**WARNING** Available roll control will be marginal to inadequate in event of asymmetric flap/slats without lockout. **Note** Incompatibility of flap transition limit with existing Case I procedures recognized. Although improvement of flap/slat system reliability has been accomplished, not enough data is available concerning failure mode/rate of improved asymmetry sensor. Minimum flap transition altitude may be *waived in cases of operational* necessity.

Figure 4-10. Flap Limitations

4. All flap and slat extensions and retractions will be made at a maximum of 12 units AOA.

4.7.2 External Stores Loading With up to 66,000 Inch-Pounds (5,500 Foot-Pounds) Asymmetry. AIM-7 on Stations 1B or 8B equals 64,000 inch-pounds.

1. All transitions will be made in wings-level flight with roll SAS on.
2. All normal (flaps and slats fully down) takeoff transitions will be initiated at a minimum altitude of 200 feet AGL.
3. All flap and slat extensions and retractions will be made at a maximum of 12 units AOA.

4.7.3 External Stores Loading With Greater Than 66,000 Inch-Pounds (5,500 Foot-Pounds) Asymmetry. All transitions will be made in wings-level flight with roll SAS on at a minimum altitude of 1,200 feet and at a maximum of 12 units AOA.

4.8 GROSS WEIGHT LIMITS — TAKEOFF, LAUNCH, AND LANDING

1. Catapult launch — 76,000 pounds.

WARNING

Single-engine rate of climb at 76,000-pound gross weight using optimum flight control technique is predicted to be between 300 and 600 fpm. Emergency jettison of stores may be required to establish adequate rate of climb.

1. Field takeoff and emergency landing (minimum rate of descent only) — 72,000 pounds.
2. Field landings — 60,000 pounds.
3. Field carrier landing practice or carrier landings — 54,000 pounds.
   a. Landing approaches to touchdown should not exceed 17 units AOA to avoid nozzle/ventral fin damage.
   b. Only minimum descent rate landings are permitted while carrying AIM-7E/F and/or AIM-9 on the multipurpose pylon, or AIM-7E/F missiles on fuselage stations until the following AAC are incorporated:
      (1) AAC 618 — Modifies multipurpose pylon.
      (2) AAC 673 — Modifies fuselage backup structure.
      (3) AAC 688 — Modifies pylon-mounted swaybraces.

4.9 BARRICADE ENGAGEMENT LIMITS

1. Wings at full forward sweep angle (20°) — 51,800 pounds (maximum).
   a. Flaps and slats extended or retracted.
   b. No external stores except AIM-7 or AIM-54 on fuselage stations only.
   c. Empty external fuel tanks permitted only for landing gear malfunction.
2. Wing-sweep angle greater than 20° up to 35° — 46,000 pounds (maximum).
   a. Flaps and slats extended or retracted.
   b. No external stores, except empty external fuel tanks for landing gear malfunction only.
3. Wing-sweep angle greater than 35° — Not permitted.

4.10 CENTER OF GRAVITY POSITION LIMITS

Unless otherwise stated, the following cg limits apply:

Store Configurations	Maximum Forward	Maximum Aft
1A, 2A	6.3% MAC	18.5% MAC
1B1, 1B2, 1C, TARPS, 2B1-4, 2C, 2C1-4	6.3% MAC	17.5% MAC
All other configurations	6.3% MAC	17.0% MAC

Throughout these flight operating limits, all cg positions are quoted at the following reference conditions:

1. Zero fuel gross weight (includes weight of stores carried on flight).

2. Wing-sweep angle = 20°.

3. Landing gear and flaps extended.

WARNING

The aft cg limit will be exceeded if all stations are configured for AIM-54 missiles or Mk 83/84 bombs and only stations 4 and 5 are loaded or remain as a result of firing, dropping, or jettison of stations 1, 3, 6, and 8. If the aft cg limit is exceeded, airspeed/AOA control may be difficult. Fuel states of 5,000 to 6,000 pounds result in the most favorable cg position. Slightly aft wing- sweep positions of 25° to 30° will move the neutral point aft and should restore normal longitudinal stability.

4.11 EXTERNAL STORES AND GUN LIMITS

4.11.1 280-Gallon External Fuel Tank Limits

1. Catapult launch with a partially filled external tank is not authorized because of surge load considerations.

2. Carriage of external tanks not incorporating AYC 598 is limited to 300 KCAS/0.72 TMN.

WARNING

CV arrestment, CV touch and go, or normal field landings with full or partial fuel in the external tanks is not authorized because of overload of the nacelle backup structure. Only minimum descent rate landings are authorized.

CAUTION

Dive angles in excess of 10° nose down with 900 pounds or more fuel in an external tank will result in fuel venting (dumping).

4.11.2 External Baggage Container (CNU-188/A). The external baggage container (blivet) may be carried on station 4 or 5 with all loadings authorized for the TARPS pod (Figure 4-11). Simultaneous carriage of a blivet and a TARPS pod or two blivets is not authorized. The blivet must be configured with a long tail cone and no fins.

1. Maximum airspeed — 520 KCAS/0.90 TMN.

2. Acceleration limit — LBA.

3. AOA limit — Figure 4-7.

4. Jettison — Not authorized.

5. Carrier operations — Authorized.

6. Maximum load:

   200 pounds maximum — forward shelf
   150 pounds maximum — aft shelf
   350 pounds total.

4.11.3 Gun Burst Limits

1. Burst limit — 200 rounds.

If two consecutive 200-round bursts are fired, a 30-second cooldown period is required.

4.11.4 Launch Limits. Maximum flight conditions for launch of external stores are listed in the following paragraphs.

4.11.4.1 AIM-7F/M

Note

Missiles with K-9 autopilot are identified by a segmented black line under the missile serial number or letters "POP" after the serial number.

1. Stations 1B and 8B — V_{min} to 1.3 TMN, all altitudes, +1g to limits of basic aircraft for non-zero bank angles and limits of basic aircraft for zero bank angle.

2. Stations 3 and 6 — V_{min} to V_{max} for 0g to +2g, V_{min} to 1.4 TMN for +2g to +4g, and V_{min} to 1.2 TMN greater than +4g, all altitudes, +1g to limits of basic aircraft for non-zero bank angles and 0g to limits of basic aircraft for zero bank angle.

3. Station 4 — V_{min} to 0.9 TMN for less than 15,000 feet MSL for 0g to +1g, V_{min} to V_{max} greater than 15,000 feet MSL for 0g to +1g, and V_{min} to V_{max} greater than +1g, all altitudes, +1g to limits of basic aircraft for non-zero bank angles, and 0g to limits of basic aircraft for zero bank angle.

4. Station 5 — V_{min} to 650 KCAS less than 30,000 feet MSL for 0g to +1g, V_{min} to V_{max} greater than 30,000 feet MSL for 0g to +1g, and V_{min} to V_{max} greater than +1g, all altitudes, +1g to limits of basic for non-zero bank angles, and 0g to limits of basic aircraft for zero bank angle.

4.11.4.2 AIM-9L/M

1. All stations — V_{min} to V_{max}, all altitudes, -1.0g to limits of basic aircraft.

WARNING

AIM-9 launch is prohibited with landing flaps and slats extended.

Note

Engine stall may result from firing of AIM-9 missiles. Engine exhaust gas temperature should be monitored after each firing.

4.11.4.3 AIM-54C

1. Stations 1B and 8B — V_{min} to V_{max}, all altitudes, +1g to limits of basic aircraft for non-zero bank angles, 0g to limits of basic aircraft for zero bank angle.

2. Stations 3 and 6 — V_{min} to V_{max} 0g to +2g and V_{min} to 1.4 TMN +2g to +6g, all altitudes, +1g to +6g for non-zero bank angles and 0g to +6g for zero bank angle.

3. Stations 4 and 5 — V_{min} to V_{max}, all altitudes, +1g to +5g for non-zero bank angles and 0g to +5g for zero bank angle.

4.11.5 Jettison Limits. Flight conditions for jettison (emergency only) of external stores are listed in the following paragraphs.

4.11.5.1 AIM-7F/M

1. Stations 1 and 8 — V_{min} to V_{max}, all altitudes, +1g to limits of basic aircraft for non-zero bank angles and 0g to limits of basic aircraft for zero bank angle.

2. Stations 3 and 6 — V_{min} to 350 KCAS, all altitudes, +1.0g for straight and level flight.

3. Stations 4 and 5 — V_{min} to 400 KCAS, all altitudes, +1.0g for straight and level flight.

WARNING

AIM-7 on stations 3 and 6 exhibit pronounced outboard movement when jettisoned.

4.11.5.2 AIM-54C

1. Stations 1B and 8B — V_{min} to V_{max}, all altitudes, +1g to +6g for non-zero bank angles and 0g to +6g for zero bank angle.

2. Stations 3 and 6 — V_{min} to 1.4 TMN, all altitudes, +1g for non-zero bank angles and 0g to +1g for zero bank angle.

3. Stations 4 and 5 — V_{min} to V_{max}, all altitudes, +1g for non-zero bank angles and 0g to +1g for zero bank angle.

Note

For zero bank angle, limit is V_{min} to V_{max}, all altitudes, 0g to limits of basic aircraft.

4.11.5.3 Capped 280-Gallon External Fuel Tank (Landing Gear and Flaps Retracted)

1. Full, partial, or empty tanks — Less than 0.90 TMN, all altitudes,+1g to +3g.

2. Landing gear and/or flaps extended (emergency only) — Less than 225 KCAS, all altitudes, +1g for straight and level flight.

4.12 BANNER TOWING RESTRICTIONS

1. Airspeed — 220 KCAS maximum recommended

2. Maximum angle of bank — 30°, 20° throttles at idle below 5,000 feet

3. Use of speedbrakes — Prohibited in flight.

Note

- During takeoff, adequate clearance exists to use speedbrakes for takeoff abort without contacting tow cable.
- The maximum aircraft gross weight for a shipboard banner launch is 67,000 pounds.

4.13 TACTICAL AIR RECONNAISSANCE POD SYSTEM LIMITATIONS

See Figure 4-11 for airspeed limits and store loadings authorized with TARPS pod.

4.13.1 Authorized Stores Loading

1. Downloading is authorized for store stations 1, 2, 7, and 8 only. Stations 3 and 6 must remain loaded for cg control.
2. Carrier and field arrestment operations are authorized.
3. Aft cg limit is 17.5-percent MAC, nonjettisonable (captive carry) AIM-7 missiles, specially configured interim AIM-7 missile or AIM-54 rails and fairings on stations 3 and 6 shall be carried for cg control (see Interim AIM-7 as ballast). Full ammunition pod, ALQ-100/126 or other authorized equipment substitution may be required along with AIM-7 missiles or AIM-54 fairings and rails to maintain cg within aft limit. Individual weight and balance calculations shall be performed to ensure cg limits are not exceeded.
4. Pulling MACH TRIM circuit breaker will eliminate stick force requirement during low-altitude, high-speed flight.

CAUTION

MACH TRIM circuit breaker should be reset prior to landing. Attempt reset below 0.6 TMN above 5,000 feet, if possible, to minimize trim change transients. Failure to reset circuit breaker may result in reduced nose-down longitudinal control authority. Reduced authority may degrade the pilot's ability to counter pitchup during waveoffs with aft cg.

5. AIM-54 carriage/launch is not authorized at any station.
6. Special weight and balance information for TARPS pod configuration is available. Refer to handbook of weight and balance (NAVAIR 01-1B-40).

4.13.2 Interim AIM-7 as Ballast. TARPS-equipped aircraft are authorized to use specially configured interim AIM-7 missiles as ballast. AIM-7 missiles specially configured for TARPS use will be designated as CATM-7E-2 or CATM-7F-2. Until then, R40293, R40268, R40302, R40264, R40144, R40298, R40674, R40297, R40274, R40267, and R40235 are authorized as TARPS ballast, and weight and balance information provided for AIM-7F missiles shall be used to determine weight and balance of aircraft.

1. CATM-7E-2 — 360 pounds per missile located at aircraft station 381.7.
2. CATM-7F-2 — 440 pounds per missile located at aircraft station 381.7.

AUTHORIZED STORES LOADING	ROLL SAS	MAXIMUM AIRSPEED
Stations 1 and 8: (2) AIM−7 and (2) AIM−9 or (4) AIM−9 Stations 2 and 7: (2) finless external fuel tanks Station 5: TARPS pod Stations 3 and 6: (2) AIM−54 Rail and fairings or (2) AIM−7/CATM−7	ON	Sea level to 11,000 feet mean sea level (MSL)−540 KCAS. Above 11,000 feet MSL−600 KCAS or 1.43 TMN, whichever is less.
Stations 1 and 8: (2) AIM−7 and (2) AIM−9 or (4) AIM−9 Station 2 and 7: (2) finless external fuel tanks Station 5: TARPS pod Stations 3 and 6: (2) AIM−54 Rail and fairings or (2) AIM−7/CATM−7	OFF	Sea level to 11,000 feet MSL−620 KCAS. Above 11,000 feet MSL−680 KCAS or 1.43 TMN, whichever is less.
Stations 1 and 8: (2) AIM−7 and (2) AIM−9 or (4) AIM−9. Station 5: TARPS pod Stations 3 and 6: (2) AIM−54 Rails and fairings or (2) AIM−7/CATM−7	ON	Sea level to 11,000 feet MSL−540 KCAS. Above 11,000 feet MSL−600 KCAS or 1.53 TMN, whichever is less.
Stations 1 and 8: (2) AIM−7 and (2) AIM−9 or (4) AIM−9. Station 5: TARPS pod Stations 3 and 6: (2) AIM−54 Rails and fairings or (2) AIM−7/CATM−7	OFF	680 KCAS or 1.33 TMN, whichever is less.

Figure 4-11. Tactical Air Reconnaissance Pod System Limitations

PART II

Indoctrination

Chapter 5 — Indoctrination

CHAPTER 5

Indoctrination

5.1 GROUND TRAINING SYLLABUS

5.1.1 Minimum Ground Training Syllabus. The ground training syllabus sets forth the minimum ground training that must be satisfactorily completed prior to operating the F-14D. If the aircrewmember has a current F-14A/B NATOPS qualification, the ground syllabus will consist of the F-14D unique systems. The 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. The minimum ground training syllabus for the pilot and the RIO is set forth in the following paragraphs.

5.1.1.1 Familiarization

1. Flight physiological training as appropriate
2. F-14D flightcrew academic course
3. F-14D MFT/WST (within 5 days).

5.1.1.2 Flight Support Lectures

1. F-14D flightcrew academic course.

5.1.1.3 Intercept Flight Support

1. F-14D flightcrew academic course.

5.1.1.4 Weapons Firing Flight Support Lectures

1. Weapons preflight procedures
2. Arming/dearming procedures
3. Firing procedures
4. Safety procedures
5. Jettison/dump areas.

5.1.1.5 Field Carrier Landing Practice/Carrier Qualification Flight Support Lectures

1. Mirror and Fresnel lens optical landing system
2. Day landing pattern and procedures
3. Night landing pattern and procedures
4. Shipboard procedures and landing patterns
5. CCA/ACLS procedures
6. In-flight refueling (day/night).

5.1.2 Waiving of Minimum Ground Training Requirements. All F-14D flight crewmembers shall be instructed on the differences from model in which qualified and comply with those items listed below, as directed by the unit commanding officer.

Where recent crewmember experience in similar aircraft models warrant, unit commanding officers may waive the minimum ground training requirements provided the flight crewmember meets the following mandatory qualifications:

1. Has obtained a current medical clearance
2. Is currently qualified in flight physiology
3. Has satisfactorily completed the NATOPS flight manual open- and closed-book examinations
4. Has completed at least one emergency procedure period in the MFT/WST (within 10 days)
5. Has received adequate briefing on normal and emergency operating procedures
6. Has received adequate instructions on the use and operation of the ejection seat and survival kit.

5.2 FLIGHT TRAINING SYLLABUS

5.2.1 Flightcrew Flight Training Syllabus. Before flight, all flight crewmembers will have completed the familiarization and flight support lectures previously prescribed. A qualified FRS instructor pilot will occupy the rear seat for the first familiarization flight. A qualified FRS instructor RIO can occupy the rear seat if the pilot in command has been previously NATOPS qualified in the F-14A/B. 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. The specific phases of training are listed in the following paragraphs.

5.2.2 Flightcrew Flight Training Phases

5.2.2.1 Familiarization

1. Military power takeoffs
2. Buffet boundary investigation
3. Approach to stalls
4. Slow flight
5. Acceleration run to Mach 1.3
6. Subsonic and supersonic maneuvering
7. Investigate all features of the AFCS/stab aug
8. Formation flight
9. Aerobatics
10. Single-engine flight at altitude and airstarts
11. Simulated single-engine landings
12. Landing with full and with no flaps
13. Acceleration runs at various altitudes.

5.2.2.2 Instruments

1. Basic instrument work
2. Penetration and approaches
3. Local area round-robin (day and night) flights.

An F-14D pilot is considered instrument qualified if currently instrument qualified in the F-14A/B.

5.2.2.3 Weapons System Employment. Qualification is in accordance with existing training and readiness directives.

5.2.2.4 Field Carrier Landing Practice and Carrier Qualifications. Qualification is in accordance with existing training and readiness directives.

5.3 OPERATING CRITERIA

5.3.1 Ceiling/Visibility Requirements. Before the pilot becomes instrument qualified in the aircraft, field ceiling, visibility, and operating area weather must be adequate for the entire flight to be conducted in a clear airmass according to visual flight rules. After the pilot becomes instrument qualified, the following weather criteria apply:

F-14D HOURS	CEILING and VISIBILITY (Feet) (Miles)
Less than 10	VFR
10 to 20	800 and 2; 900 and 1-1/2; 1,000 and 1
20 to 45	700 and 1; 600 and 2; 500 and 3
45 and above	Field minimums or 200 and 1/2, whichever is higher.

F-14A/B FLEET EXPERIENCED AIRCREW (F-14D HOURS)	CEILING and VISIBILITY (Feet) (Miles)
Less than 10	VFR
10 to 30	700 and 1; 600 and 2; 500 and 3
30 and above	Field minimums or 200 and 1/2, whichever is higher.

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:

1. Have a minimum of 10 hours combined time in the F-14A/B/D
2. Completed two simulated instrument sorties
3. Completed two satisfactory tacan penetrations

4. Completed five satisfactory ground-controlled approaches.

5.3.2 NATOPS Qualification and Currency Requirements. F-14 NATOPS qualifications are for a specific aircraft series. The following terms are defined for use in interpreting the F-14 qualification and currency requirements.

1. Aircraft type — The broadest classification of aircraft as to its physical characteristics (e.g., fixed wing or rotary wing).

2. Aircraft model — The basic mission symbol and design number of an aircraft (e.g., P-3, F-14, H-3).

3. Aircraft series — The specific version of an aircraft model (e.g., F-14A, F-14B, or F-14D).

5.3.2.1 Initial NATOPS Qualification in Aircraft Series. Initial F-14 NATOPS qualification in series shall include satisfactory completion of the following requirements:

1. Formal ground phase training.

2. The NATOPS open-book, closed-book, and boldface exams.

3. A flight syllabus at a fleet replacement squadraon. The syllabus shall include 10 flight hours under instruction, 4 hours of which may be flown in a CNO-approved flight simulator for the same aircraft series.

4. A separate NATOPS evaluation flight check is required if a CNO-approved simulator is not available.

   Fleet replacement squadron commanding officers may waive the flight hour requirement for radar intercept officers.

5.3.2.2 Continued NATOPS Qualification. To maintain a continued NATOPS qualification after initial qualification in aircraft series until currency is established, pilots and RIOs shall comply with the minimum flight hour requirements in each specific phase as determined by the unit commanding officer.

5.3.2.3 NATOPS Currency. Flight crewmembers who have more than 45 hours in F-14A/B/D aircraft model are considered current in aircraft series, provided they continue to satisfy the following requirements:

1. Have satisfactorily completed the ground phase of the NATOPS evaluation check, including OFT/COT/WST/MFT emergency procedures check (if available) and have completed a NATOPS evaluation check with a grade of Conditionally Qualified or better within the past 12 months.

2. Have flown 10 hours in aircraft model, 5 hours of which shall be in aircraft series, and made five takeoffs and landings in aircraft model within the last 90 days.

3. Are considered qualified by the commanding officer of the unit having custody of the aircraft.

Flight crewmembers who are current in the F-14A and F-14D may be considered current in the F-14B. NATOPS requalification for the F-14A, F-14B, and F-14D can be accomplished during the same evaluation check, provided the NATOPS open-book, closed-book, and boldface exams and currency requirements are met for each series.

5.3.2.4 Currency Renewal. Flight crewmembers who have not remained current shall complete the following requirements in order to reestablish currency:

1. Flight crewmembers who have not maintained 10 hours in model, 5 hours of which shall be in aircraft series, and five takeoffs and landings in aircraft model within the last 90 days) shall do the following:

   a. Complete a safe-for-flight simulator check with a squadron NATOPS instructor

   b. Be considered qualified by the commanding officer of the unit having custody of the aircraft.

2. Flight crewmembers who are current in series except for a NATOPS evaluation check within the last 12 months shall do the following:

   a. Complete a NATOPS evaluation check (including emergency procedures simulator check, NATOPS open-book, closed-book, and boldface examinations) with the squadron NATOPS instructor.

   b. Be considered qualified by the commading officer having custody of the aircraft.

3. Flight crewmembers without a current NATOPS evaluation check and who have not maintained 10 hours in model, 5 hours in aircraft series, and five takeoffs and landings in aircraft model within the last 90 days shall do the following:

a. If 6 months or less since last flight:

(1) Perform an emergency procedures and safe-for-flight check in a CNO-approved simulator

(2) Fly one flight with squadron NATOPS instructor

(3) Complete a NATOPS evaluation check (including NATOPS open-book, closed-book, and boldface examinations)

(4) Be considered qualified by the commanding officer of the unit having custody of the aircraft.

b. If greater than 6 months since last flight, a repeat of the initial NATOPS qualification requirements is required at the fleet replacement squadron.

5.3.3 Requirements for Various Flight Phases

5.3.3.1 Night — Pilot

1. Combined time in F-14A/B/D not less than 10 hours.

5.3.3.2 Night — RIO

1. Combined time not less than 3 hours in the F-14A/B/D as crewmember.

5.3.3.3 Cross Country — Pilot

1. Have a minimum of 15 hours total in the F-14A/B/D as first pilot or fly with a qualified instructor RIO

2. Have a valid instrument card

3. Have completed at least one night familiarization flight in the F-14A/B/D or fly with a qualified instructor RIO

4. Have completed maintenance checkout for servicing aircraft.

5.3.3.4 Cross Country — RIO

1. Have completed at least one night familiarization flight in the F-14A/B/D or fly with a qualified instructor pilot.

5.3.3.5 Air-to-Air Missile Firing — Pilot

1. Have a minimum of 15 hours combined time in the F-14A/B/D, 5 of which must have been flown in the F-14D

2. Be considered qualified by the commanding officer.

5.3.3.6 Air-to-Air Missile Firing — RIO

1. Have a minimum of 25 hours combined time in the F-14A/B/D as crewmember, 10 of which must be in the F-14D

2. Have satisfactorily completed a minimum of two intercept flights during which simulated firing runs were conducted utilizing the voice procedures and clear-to-fire criteria to be utilized in live firing

3. Be considered qualified by the commanding officer.

5.3.3.7 Carrier Qualifications. Each crewmember will have a minimum of 50 hours combined time in the F-14A/B/D (15 hours minimum in F-14D), of which 15 hours is night time (5 night hours in F-14D) and meet the requirements set forth in the CV NATOPS manual. Minimum hour requirement for radar intercept officers may be waived by the commanding officer based upon individual experience level and crew composition.

5.3.4 Mission Commander. The mission commander shall be a NATOPS-qualified pilot or RIO, qualified in all phases of the assigned mission, and designated by the unit commanding officer.

5.3.5 Minimum Flightcrew Requirements. The pilot and the RIO (or two pilots) constitute the normal flightcrew for performing the assigned mission for all flights. Unit commanders may authorize rear-seat flights for personnel other than qualified pilots and RIOs provided such personnel have received thorough indoctrination in the use of the ejection seat and oxygen equipment and in the execution of rear-seat functions and emergency procedures. Where operational necessity dictates, unit commanders may authorize flights with the rear seat unoccupied provided the requirement for such flights clearly overrides the risk involved and justifies the additional burden placed on the pilot. In no case is solo flight authorized for shipboard operations, combat, or combat training missions.

5.4 FLIGHT CREWMEMBER FLIGHT EQUIPMENT REQUIREMENTS

In accordance with OPNAVINST 3710.7, the flying equipment listed below will be worn or carried, as applicable, by flight crewmembers on every flight. All survival equipment shall be secured in such a manner that it will be easily accessible and will not be lost during ejection or landing. All equipment shall be the latest available as authorized by the Aircrew Personal Protective Manual, NAVAIR 13-1-6.

1. Protective helmet
2. Oxygen mask
3. Anti-g suit
4. Fire-retardant flightsuit
5. Steel-toed flight safety boots
6. Life preserver
7. Harness assembly
8. Shroud cutter
9. Sheath knife
10. Flashlight (for all night flights)
11. Strobe light
12. Pistol with tracer ammunition or approved flare gun
13. Fire-retardant flight gloves
14. Identification tags
15. Antiexposure suit in accordance with OPNAVINST 3710.7
16. Personal survival kit
17. Other survival equipment appropriate to climate of the area
18. Full pressure suit and Mk 4 life preserver on all flights above 50,000 feet MSL
19. Pocket checklist
20. Navigation packet.

PART III

Normal Procedures

Chapter 6 — Flight Preparation

Chapter 7 — Shore-Based Procedures

Chapter 8 — Carrier-Based Procedures

Chapter 9 — Special Procedures

Chapter 10 — Functional Checkflight Procedures

CHAPTER 6

Flight Preparation

6.1 PREFLIGHT BRIEFING

Preflight briefings shall be conducted immediately before the launch of scheduled flights and must be carried out in an expeditious but thorough manner. Ample time should be given for briefing with external assets as well as for conducting internal element briefs. When scheduling a brief, consideration should be made to ensure that enough time is given for the aircrew to finish briefing, don all flight gear, check out any special items required for the mission (authenticators, cameras, guns), read the aircraft discrepancy book, and man up the aircraft in order to make the scheduled launch time. For this reason, it is imperative that all pilots and RIOs be in flightsuits ready for the brief at the designated time.

The brief should optimally be conducted in a designated briefing room, free of distractions, with a white dry erase board and 1/72 scale aircraft models. A briefing board should be put up prior to the brief, depicting applicable admin items, mission objectives, flight conduct, special instructions, and necessary diagrams. Aircrew should utilize appropriate tactical manuals and current weapon school manuals and journals for mission planning. The brief shall include, but not be limited to, the following.

6.1.1 Admin. The following items should be covered for each flight, regardless of the mission.

1. Event number
2. Launch/recovery times/recovery order
3. Lineup/call signs/avionics plan
4. Mission assigned/alternate missions
5. External assets/call signs
6. Weather
    a. Base, en route, target, area, divert
    b. Water/air temperature, sea state
7. Ordnance and stores carried/preflight/restrictions on use
8. Communications plan
9. Area/NOTAMs
10. Clearance/NAVAIDs
11. Ground/deck procedures
12. Takeoff/departure/rendezvous
13. En route/formation
14. Tanking plan
15. Combat checks
16. Recovery procedures (VFR/IFR)
17. Joker/bingo fuel
18. NORDO procedures
19. Emergencies/diverts/SAR/birdstrike
20. Training rules
21. Contingencies.

6.1.2 Missions. Aircrew should brief each section that applies to their expected mission. Missions not specifically discussed in this chapter should be covered using the appropriate tactical manual.

6.1.2.1 Low-Level/Strike Ingress

1. Time hack
2. Controlling agency route brief
    a. Restrictions/hot areas

3. Current charts/CHUM
4. Entry/exit times
5. Formation/altitude/airspeed
6. Navigation mode/plan
7. Communications
8. Checkpoints/timing
9. Turnpoints/corrections
10. Radar plan/search contracts
11. Threat awareness (SAM, AAA, A/A)
12. DECM/RWR/expendables
13. Target area ingress IP — Target
14. Abort criteria/procedures
15. Safety.

6.1.2.2 Air-to-Ground/Strike

1. Time hack
2. A/G checklist complete
3. Range/area
4. Time on target
5. Communications
6. Swing fighter consideration
7. Target area tactics
   a. SEAD window
   b. Target ID/acquisition
   c. Tactic/backup tactic
   d. Aircraft interval/sequence
   e. Aim points/backup aim points
   f. Threat awareness (SAM, AAA, A/A)
   g. DECM/RWR/expendables
8. Weaponeering/switchology
   a. Target type
   b. Weapon
   c. Attack/delivery mode
   d. Fuze/delay
   e. Functioning delay
   f. Interval
   g. Stick length
   h. Frag pattern
   i. Manual MIL setting
   j. Stations selected
9. Release conditions
   a. Dive angle
   b. Airspeed/Mach
   c. Release/recovery altitude
   d. Heading
   e. Slant range
   f. Time of fall
10. Off-target rendezvous/egress/RTF
11. Hung ordnance/jettison
12. Abort criteria/procedures
13. Safety.

6.1.2.3 Air-to-Air

1. Mission type/objectives/strike integration/friendly assets
2. Threat awareness (A/A, SAM, AAA)
3. ROE/PID criteria
4. GCI/control/bull's-eye

5. Precommit

   a. Position/time/CAP management

   b. Formation/visual lookout

   c. Radar gameplan

   d. Defense in depth

6. Commit

   a. Authority/criteria

   b. Abort/reset

7. Intercept

   a. Geometry/flow

   b. Formation/altitude/airspeed

   c. Communications (cadence/priority)

   d. Radar search responsibilities

   e. Meld/targeting

   f. Sort/lock range/no sort

   g. Drop criteria/factor bandit range

   h. Degrades

   i. Float/strip

   j. Preplanned coordinated maneuvers

   k. Radar warning receiver

   i. Abort/reset

8. Approaching the merge/merge

   a. Missile employment

   b. Fuel package

   c. Crank/expendables

   d. IRCM

   e. Section/division maneuvering

   f. Engage/blowthrough

9. Postmerge/egress

   a. Target area considerations/frag

   b. Flow/new ROE

   c. Radar gameplan

   d. Visual lookout doctrine/commit

   e. Rendezvous

10. Defensive considerations

   a. Communications

   b. Threat/nose position/RWR

   c. Missile/guns defense

   d. E-pole.

6.1.2.4 TARPS

1. Mission type

   a. SSC/mapping/standoff/point target

2. Pod checks — on deck/airborne

3. Operating area/route/TOT

4. Navigation mode/plan — primary/secondary

   a. INS/GPS/visual/DR

   b. Checkpoints

   c. Posttarget IPs

   d. Topography/terrain

5. Target acquisition/ID/placement

6. Sensors

   a. Primary/secondary/tertiary

b. Vg/H settings

c. Troubleshooting

7. Formation/altitude/airspeed

8. Communications

9. Radar plan

10. Threat awareness (SAM, AAA, A/A)

11. DECM/RWR/expendables

12. Egress

a. Target area considerations/frag

b. Rendezvous/RTF

13 . Abort criteria/procedures

14. Safety.

CHAPTER 7

Shore-Based Procedures

7.1 CHECKLISTS

Aircraft checklists are available in two forms, based on the degree of flightcrew familiarization; since the sequence remains the same, the only difference in the forms is the degree of amplification. As the flightcrew becomes more proficient in type, a more abbreviated form is available to promote operational efficiency, and safety is not compromised since in all instances the thoroughness of checks remains the same. The placarded landing checklist on the forward cockpit instrument panel is a fundamental element in this instance. In the interest of procedural standardization, the shore-based and carrier-based procedures are maintained the same, except for the response relative to the checks. The expanded procedures presented in this flight manual describe in detail those items that should be checked on each flight. Adherence to these procedures will provide the flightcrew with a detailed status of weapons system performance incident to flight. However, it is incumbent on the flightcrew to expand the checks as necessary to verify the corrective status of previously reported discrepancies. Reference should be made to the functional checkflight procedures (Chapter 10, paragraph 10.2) for more detailed tests that can be performed on the aircraft and weapons systems if deemed necessary. The flightcrew should be thoroughly familiar with the details of the procedures outlined herein so that the abbreviated checklist forms of the procedures may be safely employed. As the first level of simplification, NAVAIR 01-F14AAD-1B contains a reprint of the normal procedures, with less amplifying information.

7.1.1 Tactical Air Reconnaissance Pod System. **A [T] preceding the text of a procedural step identifies items pertaining only to TARPS aircraft.**

7.2 EXTERIOR INSPECTION

A proper preflight inspection begins with a thorough review of aircraft status and past maintenance history. An understanding of previous discrepancies, corrective action and their impact on the flight can best be gained at this time. The flightcrew should ensure that any and all discrepancies have been properly corrected or deferred prior to accepting the aircraft as ready for flight.

7.2.1 Area Around Aircraft. En route to the aircraft, attention should be directed to the maintenance effort going on in the line area. The flightcrew should ensure that no hazardous situations exist. The entire area should also be generally examined for FOD hazards.

The area around the aircraft that may not be visible from the cockpit should be examined. Particular attention should be paid to support equipment adjacent to the aircraft. It should be determined that the wings and flight controls can be safely moved and that the effect of jet blast during start and taxi will not create a dangerous situation.

7.2.2 Foreign Object Damage and Leak Inspection. Engine intakes and adjacent deck area are of prime concern since the F110-GE-400 is highly susceptible to FOD damage and the engines are capable of picking up objects from the deck. AICS ramps, bleed doors, ECS cooling intakes, exhausts, and afterburner ducts are catchalls for loose objects. They should be closely inspected for security and foreign objects. Inspect all panels for security and loose fasteners. While inspecting the aircraft for FOD, the flightcrew should also be alert for any evidence of oil, hydraulic fluid, or fuel leaks.

7.2.3 Ground Safety Devices and Covers. The following items should be installed:

1. MLG ground safety locks (two)
2. Nose landing gear ground safety pin
3. Tailhook safety pin (ashore)
4. Wheel chocks
5. LAU-7/LAU-138/LAU-92 ground safety pins
6. Sidewinder seeker-head covers (if applicable).

The following items should be removed:

1. Intake, probe, bleed door, and ECS duct covers
2. Water-intrusion tape
3. Launch abort mechanism lock (if the aircraft is to be towed)
4. Tailhook safety pin (shipboard).

7.2.4 Surface Condition. All surfaces should be checked for cracks, distortion, or loose or missing fasteners. All lights and lenses should be checked for cracks and cleanliness.

7.2.5 Security of Panels. All fasteners should be flush and secure on all panels.

7.2.6 Leaks. All surfaces, lines, and actuators should be checked for oil, fuel, and hydraulic leaks. Particular attention should be paid to the underside of the fuselage, engine nacelles, and outer wing panels.

7.2.7 Movable Surfaces. All movable surfaces (flight controls and high-lift devices) should be inspected for position, clearance, and obvious damage.

7.2.8 Inspection Areas. The following exterior inspection is divided into 10 areas. (See Figure 7-1.) Checks peculiar to only one side are designated (L) or (R) for the left or right side. Both the pilot and RIO should preflight the entire aircraft individually.

7.2.8.1 Ⓐ Forward Fuselage

1. Access panel fasteners forward of engine inlets — No Loose or Missing Fasteners.
2. Gun (L) — Safety Pin Installed in Clearing Sector Holdback Assembly, Louvers Clear.
3. Probes — Secure, Openings Clear, AOA Probe Free For Rotation.
4. Nose wheelwell:
   a. Electrical leads — Connected, No Evidence of Overheating.
   b. Hydraulic lines — No Chafing or Leaks.
   c. Doors and linkages — Cotter Pins Installed, No Distortion.
   d. Brake accumulators — 1,900 Psi Minimum.

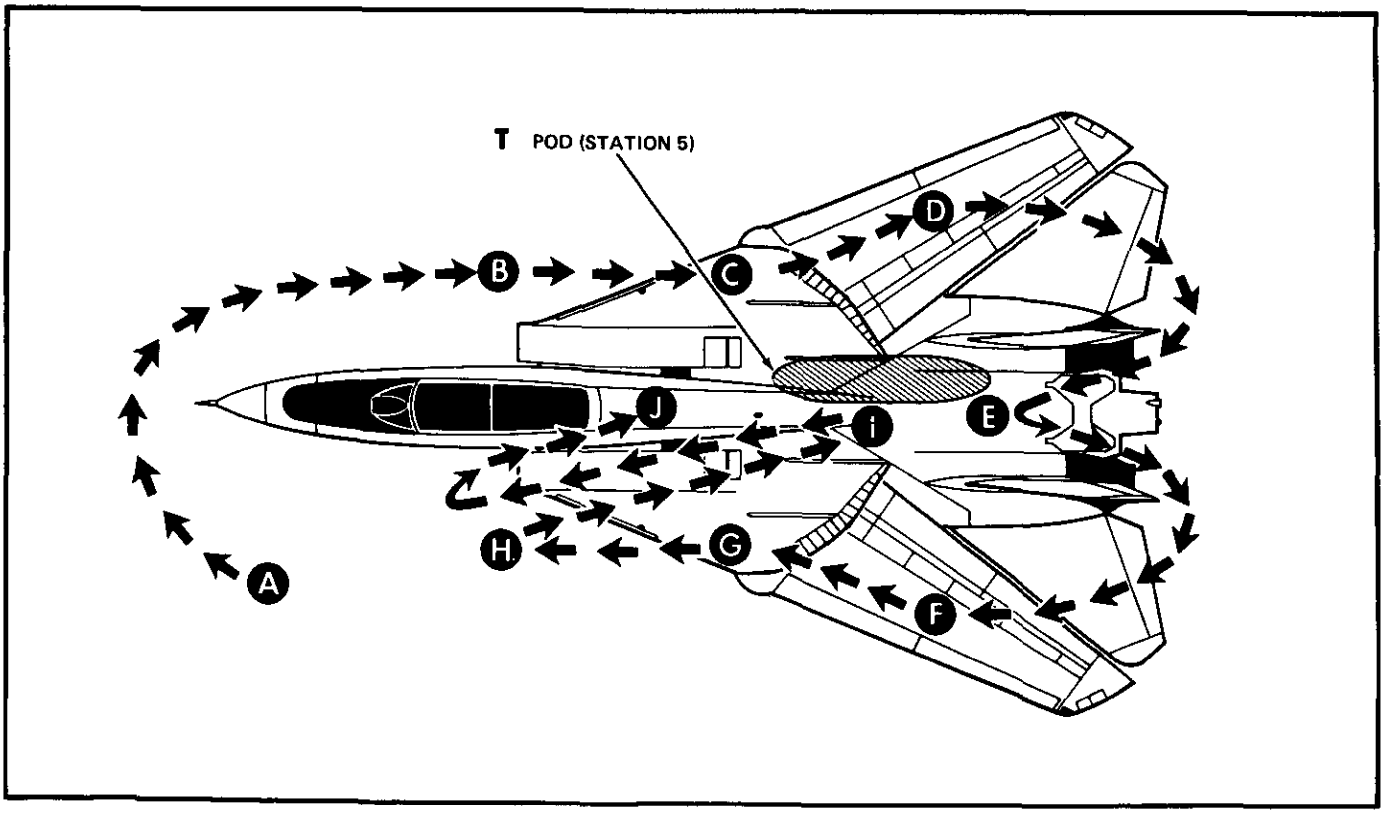


Figure 7-1. Exterior Inspection

e. Canopy air bottle gauge — 1,200 Psi Minimum.

f. Emergency landing gear nitrogen bottle gauge — 3,000 Psi Minimum.

g. Emergency landing gear air release valve — Ensure That Valve Is in Closed Position.

h. Retract actuator — Piston Clean, No Leaks.

i. Flight maintenance indicator — Secure.

j. Antiskid control box BIT flags — Not Tripped.

k. Cabin pressure port screens — Clean.

l. Master arm override — Cover Closed.

5. Nose strut — Piston Clean, Free of Cracks and Scoring, and Uplock Roller Free.

6. Steering actuator — Secure, No Leaks.

7. Launch bar and holdback fitting

a. Abort — Full Up.

b. Roller — Free Rotation.

c. Uplatch and holdback — Free Movement.

8. Nosewheels and tires — Inflation, No Cuts, Bulges, Uneven Wear, or Imbedded Objects.

9. Drag brace — No Leaks, Door Secure.

10. Approach lights — Lenses Clean, No Cracks, Secure.

11. TV camera — Check, Blue Desiccant.

12. Dual chin pod — IRST, TV Cameras (or simulators), and Anticollision Light Secure.

13. Radome — Lock Handle Fastened, Rosemont Probe Straight.

14. OBOGS concentrator vent outlet — No Obstructions.

7.2.8.2 Ⓑ Right Inlet

1. Ramps, metal seals, and rubber seals — Intact, Free of Dirt, Grit, and Cracks.

2. IGV — Blades and Stators Free of Nicks and Cracks. Plane captain to verify that all visible damage has been blended.

3. ECS heat exchanger inlet and fan

a. Fan — Free Rotation.

b. Overspeed pin — Recessed.

c. ECS inlet — Free of FOD, Cables Connected (two).

4. Inlet — Free of Standing Water, Drains Clear.

7.2.8.3 Ⓒ Right Nacelle and Sponson

1. Station 7 and 8 stores

a. Stores — Aligned.

b. Access panels — Secure.

c. Sidewinder missile launcher

(1) LAU-7 Sidewinder coolant doors Latched.

(2) LAU-138 chaff loading and gas bottle safety handle — Stowed.

d. Stores safety pins — Installed.

If external tank/MXU-611 aboard:

e. Ground safety handle — Pulled.

f. Fuel quantity sight gauge — Ball Float Vertical.

g. Sway braces — Tightened Down.

h. Hook latched indicator — White Vertical Line Visible.

i. Inboard and outboard fuel caps — Fastened With Butterfly Latch Secured Facing Aft.

2. Main wheelwell

a. Doors and linkages — Secure.

b. Uplock microrollers — Free.

c. Uplock hooks — Secure.

d. Hydraulic lines — No Chafing or Leaks.

3. Drag brace — Secure, Downlock Safety Pin Forward.

4. Side brace — Seated in Latch.

5. Main struts — Pistons Clean, Free of Cracks or Scoring.

6. Brakes — Pucks Safety-Wired; Wear Indicators Visible (pins at least flush). Lower Torque Arm Swivel; Key and Key Retainer Properly Installed and Safety Wired.

7. Hubcap — Secure, Safety-Wired.

8. Main wheels and tires

   a. Wheels and tires — Inflation, Cuts, Bulges, Uneven Wear, Imbedded Objects (look behind chocks)

9. Gear down microrollers — Contact Made.

10. Engine compartment (if applicable)

    a. Integrated drive generator-transmission fluid — Fluid Visible, Filter (two) Pins Flush.

    b. Engine oil servicing caps — Check.

    c. Bilges — No FOD, Evidence of Overheating, or Leakage.

    d. Fuel, oil, and hydraulic lines — Free of chafing or Leaks.

    e. Bleed air lines — No Heat Discoloration or Damage.

    f. AB fuel pump filter — Pin Flush.

    g. Lube and scavenge bypass filter — Pin Flush.

    h. Oil nozzle filter — Pin Flush.

11. Flight hydraulic reservoir — 1,800 Psi Minimum, Filter Pins Flush.

12. Flight hydraulic system tape gauge — Minimum of Seven on Tape.

Note

Engine must be running for an accurate reading.

13. Hook dashpot pressure gauge — 800 ±10 Psi.

14. Ventral — No Damage, IDG Oil Cooler Intake Clear.

7.2.8.4 Ⓓ Right Glove and Wing

1. Slats, flaps, and cove doors — Surfaces and Hinges Secure.

2. Wing cavity seal — Free of Cuts and Chafing.

3. Formation and position lights — Intact, Lenses Clean.

7.2.8.5 Ⓔ Aft and Under Fuselage

1. Horizontal tails — Leading Edges Free of Damage.

2. Exhaust nozzles and fairings:

   a. Nozzles and fairings — No Cracked or Missing Flaps or Seals.

   b. Fairing cable — Properly Tensioned (pull on cable, fairing flaps should not move).

   c. Bottom surface — No Scrapes or Cracks.

   d. Spray bars and flameholder — Intact.

   e. Turbine blades — No Evidence of Overheating.

3. Fuel vent — No Leakage or FOD.

4. Tailhook

   a. Hook point — Smooth.

   b. Nut and cotter pin — Installed.

   c. Safety pin — Remove if Hook Is Securely Latched Up.

5. Backup flight control module — No Leaks (feel aft of inspection doors), Filter Pins Flush, Close Both Access Doors.

6. Fuel dump — No Leakage From Mast, Free of FOD.

7. Stations 3 through 6 stores

   a. Stores — Aligned.

   b. Access panels — Secure.

   c. Stores safety pins — Installed.

8. Fuel cavity drains — No Leakage.

9. [T] Pod — Check for Security.

10. [T] Protective window covers — Removed.

11. [T] Camera windows — Clean.

12. [T] Camera sensor control — As Briefed.

13. [T] Light meter — Facing Outboard.

14. [T] Lens filter — As Briefed.

7.2.8.6 Ⓕ Left Glove and Wing

1. Slats, flaps, and cove doors — Surfaces and Hinges Secure.

2. Wing cavity seal — Free of Cuts and Chafing.

3. Formation and position lights — Intact, Lenses Clean.

7.2.8.7 Ⓖ Left Nacelle and Sponson

1. Station 1 and 2 racks and stores

   a. Racks and stores — Aligned.

   b. Access panels — Secure.

   c. Sidewinder missile launcher

      (1) LAU-7 Sidewinder coolant doors — Latched.

      (2) LAU-138 chaff loading and gas bottle safety handles — Stowed.

   d. Stores safety pins — Installed.

If external tanks aboard:

   e. Ground safety handle — Pulled.

   f. Fuel quantity sight gauge — Ball Float Vertical.

   g. Sway braces — Tightened Down.

   h. Hook latch indicator — White Vertical Line Visible.

   i. Inboard and outboard fuel caps — Fastened With Butterfly Latch Secured Facing Aft.

2. Main wheelwell

   a. Doors and linkages — Secure.

   b. Uplock microrollers — Free.

   c. Uplock hooks — Secure.

   d. Hydraulic lines — No Chafing.

3. Drag brace — Secure, Down Lock Safety Pin Forward.

4. Side brace — Seated in Latch.

5. Main struts — Pistons Clean, Free of Cracks or Scoring.

6. Brakes— Pucks Safety-Wired; Wear Indicators Visible (pins at least flush). Lower Torque Arm Swivel; Key and Key Retainer Properly Installed and Safety-Wired.

7. Hubcap — Secure, Safety-Wired.

8. Main wheels and tires

   a. Wheels and tires — Inflation, Cuts, Bulges, Uneven Wear, Imbedded Objects (look behind chocks).

   b. Uplock hooks — Secure.

9. Gear-up microrollers — Contact Not Made.

10. Engine compartment (if applicable)

    a. IDG — Fluid Visible (two) Pins Flush.

    b. Engine oil servicing caps — Check.

    c. Bilges — No FOD, Evidence of Overheating, or Leakage.

    d. Fuel, oil, and hydraulic lines — Free of Chafing or Leaks.

    e. Bleed air lines — No Heat Discoloration or Damage.

    f. Afterburner fuel filter — Pin Flush.

    g. Lube and scavenge bypass filter — Pin Flush.

    h. Oil nozzle filter — Pin Flush.

11. Combined hydraulic reservoir — 1,800 Psi Minimum, Filter Pins Flush.

12. Combined hydraulic system tape gauge — Minimum of Seven on Tape.

Note

Engine must be running for an accurate reading.

13. Airstart door — Ground Hydraulic and Electric Covers Tight.

14. Ventral — No Damage, IDG Oil Cooler Intake Clear.

7.2.8.8 Ⓗ Left Inlet

1. Ramps, metal seals, and rubber seals — Intact, Free of Dirt, Grit, and Cracks.

2. IGV — Blades and Stators IGV Free of Nicks and Cracks.

   Plane captain to verify that all visible damage has been blended.

3. Ice detector (L) — Secure.

4. ECS heat exchanger inlet and fan

   a. Fan — Free Rotation.

   b. Overspeed pin — Recessed.

   c. Inlet — Free of FOD, Cables Connected (two).

5. Outboard spoiler module temperature indicator and servicing — No Leaks, Fluid Indicator Rod Protruding.

6. Inlet — Free of Standing Water, Drains Clear.

7.2.8.9 Ⓘ Fuselage Top Deck and Wings

1. Bleed exit doors — Free of FOD, Hardware Intact.

2. ECS heat exchanger exhausts — Free of FOD and Cracks.

3. Antennas — Check.

4. Overwing fairings — No Cracked or Bent Fingers.

5. Eyebrow doors — Intact.

6. Speedbrake — No Distortion or Leaks.

7. Vertical tails and rudders — No Distortion, Lights Intact.

7.2.8.10 Ⓙ Canopy

1. Canopy lanyard — Connected, Yellow Flag Attached at Both Ends.

2. Auxiliary canopy bottle — Cable Taut.

3. Canopy hooks and seal — Secure, Seal Intact.

4. Ejection seat safe-and-arm device safety pins (see Figure 7-2) — Pulled.

5. Auxiliary canopy bottle gauge — 800 psi Minimum.

6. Blade antennas — Intact.

7. Canopy — Clean, Free of Cracks and Deep Scratches.

7.3 EJECTION SEAT INSPECTION

The pilot and RIO shall perform the following checks on their respective ejection seats prior to flight. The ground safety pin in the seat firing handle is the only ground safety device. It must be removed and stowed before flight. Abbreviated preflight checklists for the ejection seat are provided in the pocket checklist and on the ejection seat headbox.

1. SAFE/ARMED handle — SAFE.

2. Manual override handle — Full Down and Locked.

3. Catapult manifold valve — Secure, Hoses Connected.

Check that retaining pin is installed.

4. Top latch mechanism — Latched.

   Check that indicator plunger is flush with end of top latch plunger.

WARNING

If the top latch mechanism is not latched, the seat could rise up the catapult rails during aircraft maneuvers.

5. Parachute withdrawal line — Connected.

   Check that parachute withdrawal line is correctly secured to parachute deployment rocket stirrup.

6. Left pitot head — Stowed.

7. Thermal batteries — Not Expended.

   Check that battery-expended indicator on electronic sequencer is not activated.

8. Left trombone tubes — Connected, Retaining Pin Installed.

9. Leg restraint lines — Secured to Deck, Not Twisted, End Fittings Secured in Seat Bucket Locks.

10. Seat firing initiators — Firing Linkage Connected to Sears.

11. Pyrotechnic quick disconnects — Connected, Red Bands Not Visible.

12. Survival kit — Check.

    a. Oxygen pressure gauge — In the Black.

    b. Emergency oxygen manual actuator — Connected and Stowed.

    c. Emergency oxygen and locator beacon lanyards — Connected to Deck.

13. Oxygen/communications and anti-g lines — Connected to Aircraft Connections.

14. Personnel services disconnect block — Secured to Seat Bucket, Lanyard Attached to Deck.

15. Lapbelts — Secure.

    Pull up on each lapbelt to ensure that lugs are secure in seat bucket locks.

16. Negative-g strap — Secure.

17. Right trombone tubes — Connected, Retaining Pin Installed.

18. Right pitot head — Stowed.

19. Parachute container lid — Secure, Sealed.

    Check environmental seal indicator for correct indication.

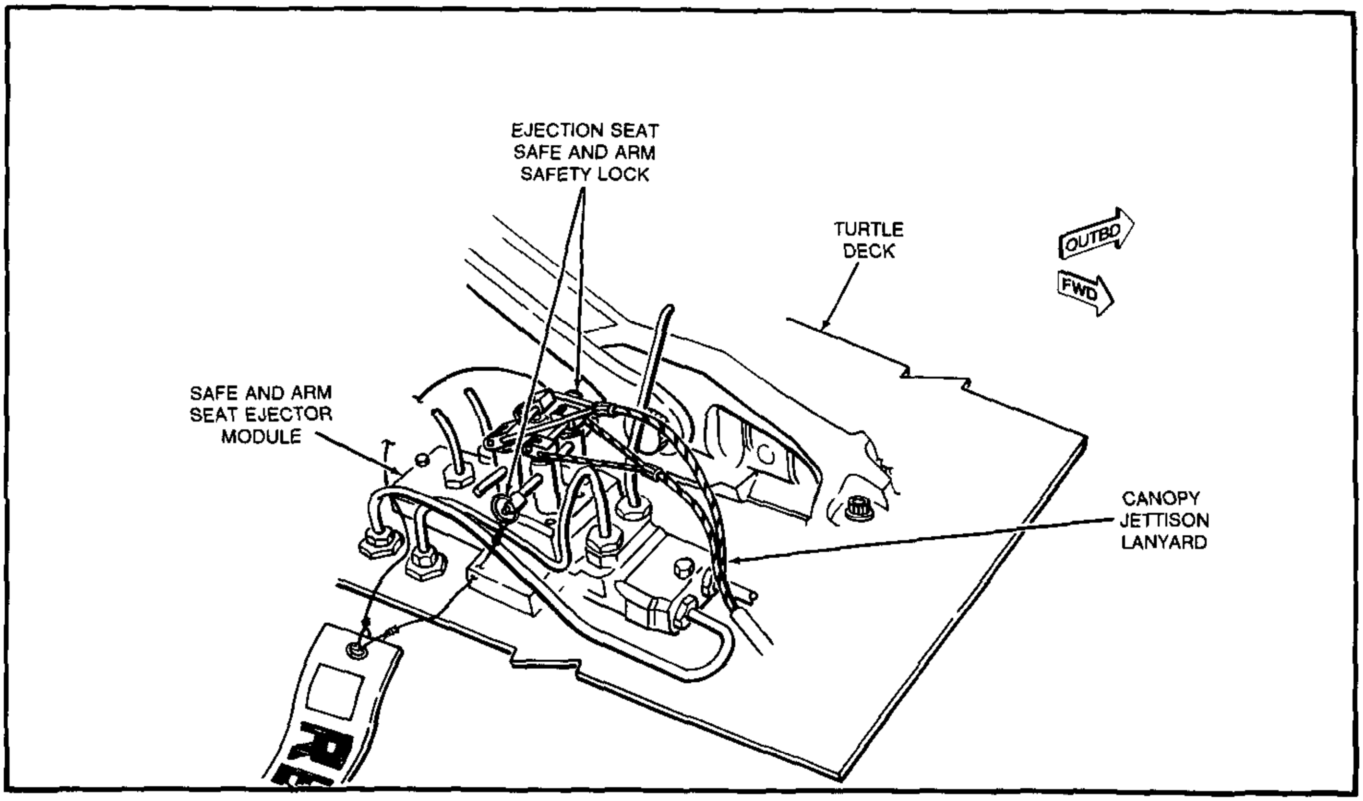


Figure 7-2. Ejection Seat Safe–and–Arm Module

20. Parachute risers — Properly Routed.

    Check that risers are routed down forward face of parachute container and behind retention strap.

21. Ejection seat and canopy pins — Stowed.

7.4 PILOT PROCEDURES

The interior inspection provides a systematic coverage of all cockpit controls to ensure proper setup prior to the application of external power, assuming no external air-conditioning source will be used prior to engine start. These checks correspond to the condition that the plane captain should set up in the cockpit as part of the preflight. Each cockpit setup consists of a sequential sweep of controls on the left console, instrument panel, and right console.

7.4.1 Interior Inspection — Pilot

1. Harnessing — Fasten.

   a. Leg restraint lines and garters — Connect.

      Connect D-rings on leg restraint lines to upper and lower garters, left and right side. Ensure that leg lines are not twisted or looped.

   b. Lapbelt — Connect and Adjust.

      Connect lapbelt straps and adjust snug so as to provide secure lap restraint in flight and seat kit suspension for ground egress or ejection.

   c. Parachute release fittings — Attach to Harness Buckles.

   d. Anti-g and oxygen/communication leads — Attach.

      When connecting the oxygen/communication fitting, avoid twisting the hard hose.

   e. Inertia reel — Check.

      Position shoulder harness lock lever forward to lock position. Check that both shoulder straps lock evenly and securely. Move lever aft to unlock harness.

      Attach composite fitting without causing unnecessary twisting of hard hose.

2. OBOGS master switch — OFF.

3. TONE VOLUME controls — Set.

4. ICS panel

   a. VOL knob — As Desired.

   b. Amplifier — NORM.

   c. Function switch — COLD MIC.

5. Radio VOLUME panel.

   a. JTIDS SEL switch — Set.

   b. VOLUME knobs — As Desired.

6. Tacan mode switch — OFF.

   a. Channel — Set.

   b. VOL knob — Counterclockwise.

7. STAB AUG switches — OFF.

8. U/VHF — OFF.

WARNING

With electrical and/or hydraulic power on the aircraft, wings can move if wing control systems fail.

9. Wing-sweep switch — MAN.

10. Left and right throttles — OFF.

11. Exterior lights master switch — Set.

    Position switch in accordance with standard procedures for day or night and field or carrier operations.

12. FLAP handle — CORRESPONDING.

13. Throttle friction lever — OFF (aft).

14. ASYM LIMITER switch — ON (guard down).

15. L and R ENG mode switches — PRI.

16. BACK UP IGNITION switch — OFF.

17. THROTTLE TEMP switch — NORM.

Note

The F110-GE-400 engine automatically compensates for temperature variations.

18. THROTTLE MODE switch — BOOST.
19. L and R INLET RAMPS switches — AUTO.
20. ANTI SKID SPOILER BK switch — OFF.
21. FUEL panel
    a. WING/EXT TRANS switch — AUTO.
    b. REFUEL PROBE switch — RET.
    c. DUMP switch — OFF.
    d. FEED switch — NORM (guard down).
22. LDG GEAR handle — DN.
23. NOSE STRUT switch — OFF.
24. Parking brake — Pull.
25. Altimeter — Set.

    Set field or carrier elevation as applicable.
26. Radar altimeter — OFF.
27. Standby attitude gyro — Caged.
28. Left and right FUEL SHUT OFF handles — In.
29. MA ARM switch — OFF (guard down).
30. ACM switch — OFF (guard down).
31. Multifunction display mode switches — OFF.

Note

Visually check for security of cockpit equipment, particularly the multifunction displays, HUD, and instrument panel gauges.

32. Clock — Wind and Set.
33. Fuel BINGO — Set.

    Set total fuel remaining value for initial activation of fuel BINGO caution reminder consistent with mission profile to be flown.
34. Circuit breakers — Checked.
35. HYD HAND PUMP — Check.

    Extend handpump handle and stroke to check firmness of pumping action and an indication of pressure buildup on the brake pressure gauge. Stow handpump handle in a convenient position for ready access.
36. HOOK handle — Corresponding.
37. GUN ROUNDS panel — Set.
38. DISPLAYS panel
    a. HUD MODE switch — Set.
    b. HUD DECLUTTER switch — Set.
    c. HUD FORMAT switch — Set.
    d. HUD/VDI ALT switch — BARO.
    e. HUD PWR switch — OFF.
    f. ECM switch — Set.
    g. TCS FOV switch — Set.
39. ELEV LEAD knob — Set.
40. SW COOL switch — Set.
41. L and R generator switches — NORM.

WARNING

Ground engine operation without electrical power supplied by either the generators or external power may cause 20-mm ammunition detonation because of excessive heat in the gun ammunition drum.

42. EMERG generator switch — NORM (guard down).
43. Air-condition controls
    a. TEMP mode select switch — AUTO.
    b. TEMP thumbwheel control — As Desired (5 to 7 midrange).

c. CABIN PRESS switch — NORM.

d. AIR SOURCE — OFF.

44. WSHLD AIR switch — OFF.

45. ANTI-ICE switch — AUTO/OFF.

46. ARA-63 panel

a. CHANNEL selector — Set.

b. POWER switch — OFF.

47. MASTER LIGHT panel controls — As Required.

Set external and interior lighting controls consistent with day or night and field or carrier operating conditions.

48. MASTER TEST switch — OFF.

49. EMERG FLT HYD switch — AUTO (guard down).

50. HYD TRANSFER PUMP switch — SHUTOFF (guard up).

51. CANOPY air diffuser lever — CABIN AIR.

52. VIDEO CONTROL switch — OFF.

53. INBD and OUTBD spoiler switches — NORM (guard down).

54. Storage case — Inspect.

Check adequacy of flight planning documents and storage of loose gear.

7.4.2 Prestart — Pilot

1. External electrical power — ON.

2. If wings are not in OV SW:

a. WING SWEEP DRIVE NO. 1 and WG SWP DR NO. 2/MANUV FLAP cb's — Pull (LD1, LE1).

b. Emergency WING SWEEP handle — Extend and Match Captain Bars With Wing Position Tape.

CAUTION

Wings will move to emergency handle position regardless of wing-sweep cb position.

Note

If wings are in OV SW, do not extend handle.

3. ICS — Check.

4. Landing gear indicator and transition light — Check.

Check gear position indication down and transition light off.

5. MASTER TEST switch — Check.

Coordinate with RIO.

a. LTS.

Check that all warning, caution, and advisory lights illuminate. The brightness of the indexer lights should be set during the test.

b. FIRE DET/EXT.

L and R FIRE lights illuminate to verify continuity of respective system. The GO light will illuminate verifying continuity through the four squib lines, that 28 Vdc is available at the left and right fire switches, and that the fire extinguisher containers are pressurized.

c. INST

Check for the following responses after 5 seconds:

(1) RPM — 96 percent.

(2) EGT — 950 ±10 °C.

Initiates engine overtemperature alarm.

(3) FF — 10,500 Pph.

(4) AOA (units) — 18 ±.5

Reference and indication.

(5) Wing sweep — 45 ±2.5°.

Program, command, and position.

(6) FUEL QTY — 2,000 ±200 Pounds (both cockpits).

(7) Backup oxygen pressure — 1,800 to 2,100 Psi.

(8) L and R FUEL LOW lights — Illuminated (both cockpits).

d. MASTER TEST switch — OFF.

6. Ejection seat SAFE/ARMED handles — ARMED.

Verify seat armed with RIO.

7. CANOPY — Clear RIO To Close.

WARNING

Flightcrews shall ensure that hands and foreign objects are clear of front cockpit handholds and top of ejection seats and canopy sills to prevent personal injury and/or structural damage during canopy opening or closing sequence. Only minimum clearance is afforded when canopy is transitioning fore and aft.

Note

If CLOSE does not close the canopy, depress the grip latch, release and push handle outboard and forward into BOOST. If it is necessary to use BOOST, the handle shall be returned to CLOSE to avoid bleed-off of pneumatic pressure.

8. LAD/CANOPY light — OFF.

Plane captain shall stow boarding ladder and steps.

9. Inform RIO — Ready To Start.

10. Starter air — ON.

CAUTION

The ECS air source shall remain off during engine start until external air is disconnected in order to reduce the possibility of bleed air duct contamination.

7.4.3 Engine Start — Pilot. Prior to engine start, the pilot and plane captain should ascertain that the turnup area is clear of FOD hazards, adequate fire-suppression equipment is readily available, and engine intakes and exhausts are clear. Although the engines cannot be started simultaneously, either can be started first. The following procedure establishes starting the right engine first. Whenever possible the aircraft should be positioned so as to avoid tailwinds, which can increase the probability of hot starts.

WARNING

Coordinate movement of any external surfaces and equipment with the plane captain or director.

CAUTION

- If engine chugs and/or rpm hangup is encountered with one engine turning during normal ground start, monitor EGT for possible hot start. AIR SOURCE pushbutton should be set for the operating engine until rpm stabilizes at idle; then set to BOTH ENG.
- To prevent possible engine overtemperature during crossbleed start attempts, select the operating engine for air source and return to BOTH ENG after rpm stabilizes at idle or above.

1. ENG CRANK switch — L (left engine).

2. ENG CRANK switch — OFF.

3. ENG CRANK SWITCH — R (right engine).

4. ENG CRANK SWITCH — OFF.

5. EMERG FLT HYD switch — Cycle.

a. EMERG FLT HYD switch — LOW.

Check that ON flag is displayed in EMER FLT LOW hydraulic pressure window. Verify control over horizontal tail and rudder control surfaces as viewed on surface position indicator.

b. EMERG FLT HYD switch — HIGH.

Check that ON flag is displayed in EMER FLT HI hydraulic pressure window. Verify control over empennage flight control surfaces and higher surface deflection rate.

c. EMERG FLT HYD switch — AUTO (LOW).

Check that OFF flags are displayed in both EMER FLT HI and LOW hydraulic pressure windows.

CAUTION

Combined and brake accumulators should be charged prior to backup module checks. Checks should be made slowly enough to ensure continuous ON indication in the hydraulic pressure indicator and to prevent damage to the pump or motor.

Note

Ensure combined and flight hydraulic pressures are zero prior to testing emergency flight hydraulic system to allow proper check of 300-psi priority valve.

6. ENG CRANK switch — R (right engine).

Place the crank switch to the R position where the switch is solenoid held until automatically released to the neutral (OFF) position at the starter cutout speed of approximately 49- to 51-percent rpm. Manual deselect of the switch to OFF will interrupt the crank mode at any point in the start cycle. Oil pressure and flight hydraulic pressure rise will become evident at 20-percent rpm.

CAUTION

- If no oil pressure or hydraulic pressure is indicated, start shall be aborted by setting ENG CRANK switch to OFF.
- If the ENG CRANK switch does not automatically return to the OFF position by 50-percent rpm during start, ensure that the ENG CRANK switch is off prior to 60-percent rpm to prevent starter overspeed.
- If the START/VALVE caution light illuminates after the ENG CRANK switch is off, select AIR SOURCE to OFF to prevent starter overspeed.
- When attempting a crossbleed or normal ground start, do not attempt to reengage the ENG CRANK switch if the engine is spooling down and rpm is greater than 46 percent. Between 30- and 46-percent rpm, the ENG CRANK switch may not stay engaged because of normal variations in starter cutout speed.

Note

During cold starts, oil pressure may exceed 65 psi. This pressure limit should not be exceeded for more than 1 minute.

7. Right throttle — IDLE at 20-Percent Rpm.

CAUTION

If an idle crossbleed start is attempted with high-residual engine EGT and/or throttles are advanced from OFF to IDLE prior to 20-percent rpm, higher than normal EGT readings may occur. If the EGT appears to be rising abnormally, increasing the supply engine to 80-percent rpm may yield a normal start temperature.

Note

- Advancing the R throttle from OFF to IDLE automatically actuates the ignition system. An immediate indication of fuel flow (300 to 350 pph) will be exhibited and light-off (EGT rise) should be achieved within 5 to 15 seconds. Peak starting temperatures will be achieved in the 40- to 50-percent rpm range. After a slight hesitation, the EGT will return to normal. Exceeding 890 °C constitutes a hot start. During the initial starting phase, the nozzle should expand to a full-open (100 percent) position.
- If the START VALVE caution light is illuminated after the ENG CRANK switch is off or if the ENG CRANK switch does not automatically return to off, ensure that the ENG crank switch is off by 60-percent rpm and select AIR SOURCE to OFF to prevent starter overspeed.

Note

Loss of electrical power may result in smoke entering the cockpit via the ECS.

8. R GEN light — OFF.

   The right generator should automatically pick up the load on the left and right main ac buses as indicated by the R GEN light going out at approximately 59-percent rpm.

9. R FUEL PRESS light — OFF.

   The fuel-pressure lights should go off by the time the engine achieves idle rpm.

10. Idle engine instrument readings — Check.

    a. RPM — 62 to 78 Percent.

    b. EGT — 350 to 650 °C (nominal).

    c. FF — 950 to 1,400 Pph (nominal).

    d. NOZ position — 100 Percent.

    e. OIL — 25 to 35 Psi (nominal) (15 psi minimum).

    f. FLT HYD PRESS — 3,000 Psi.

11. External power — Disconnect.

WARNING

Ground engine operation without electrical power supplied by either the generators or external power may cause 20-mm ammunition detonation because of excessive heat in the gun ammunition drum.

12. ENG CRANK switch — L (left engine).

    When combined hydraulic pressure reaches 3,000 psi, return switch to neutral (center position).

13. HYD TRANSFER PUMP switch — NORMAL Hydraulic transfer pump will operate from flight side to maintain the combined side between 2,400 to 2,600 psi.

CAUTION

If the transfer pump does not pressurize the combined system within 5 seconds, immediately set HYD TRANSFER PUMP switch to SHUTOFF.

14. HYD TRANSFER PUMP switch — SHUTOFF.

15. Repeat steps 6 through 10 for left engine.

16. Starter air — Disconnect.

17. AIR SOURCE — L ENG, R ENG, then BOTH ENG.

    Verify cockpit airflow in each position.

18. OBOGS master switch — ON.

CAUTION

Ensure ECS service air is available to OBOGS prior to selecting the OBOGS master switch ON.

19. HYD TRANSFER PUMP switch — NORMAL.

20. Ground safety pins — Remove and Stow.

    Plane captain should remove landing gear pins and stow them.

7.4.4 Poststart — Pilot

1. STAB AUG switches — All ON.

2. MASTER TEST switch — EMERG GEN.

   Check that NO GO light illuminates for about 1 second until emergency generator power is connected to essential buses and GO light illuminates. When disconnecting this test, the resultant power interruption causes the standard attitude heading reference system light to illuminate momentarily.

3. VMCU operation — CHECK.

   Following disengagement of the emergency generator, a proper check of the VMCU is indicated by illumination of the PITCH STAB 1 and 2, ROLL STAB 1 and 2, YAW STAB OP and OUT, SPOILERS, HZ TAIL AUTH; RUDDER AUTH, AUTO PILOT, and MACH TRIM lights during the power transient (approximately 1.25 seconds). Once normal power is restored, all lights go out except the RUDDER AUTH light (resettable with the MASTER RESET pushbutton) and the PITCH and ROLL STAB AUG switches will be OFF.

4. Advise RIO that test and check is completed.

5. STAB AUG switches — All On.

6. AFTC — CHECK.

   a. L ENG mode switch — SEC.

      L ENG SEC light illuminates; left NOZ indicator pointer below zero.

   b. L ENG mode switch — PRI.

      L ENG SEC light goes out; NOZ indicator to 100 percent.

   c. R ENG mode switch — SEC.

      R ENG SEC light illuminates; right NOZ indicator pointer below zero.

   d. R ENG mode switch — PRI.

      R ENG SEC light goes out; NOZ indicator pointer to 100 percent.

CAUTION

Selecting secondary (SEC) mode closes exhaust nozzles increasing exhaust nozzle jetwake hazard.

Note

- Performing AFTC check during OBC inhibits AICS ramps from programming. Ramps must be reset before another OBC can be performed.

- Operating engines in secondary mode inhibits the engine monitoring system portion of FEMS until primary mode is reselected.

7. Emergency WING SWEEP handle — OV SW.

   If wings are not in oversweep, move the wings to 68° using WING SWEEP emergency handle in raised position. Then raise handle to full extension and hold until HZ TAIL AUTH caution light goes out and OVER flag appears on wing-sweep indicator. Move handle to full aft OV SW and stow.

8. Wing-sweep switch — AUTO.

9. WING SWEEP DRIVE NO. 1 and WG SW DR NO. 2/MANUV FLAP cb's — IN (LD1, LE1)

10. WING/EXT TRANS switch — OFF.

11. MASTER RESET pushbutton — Depress.

12. OXYGEN SUPPLY valve — ON.

    Turn OXYGEN SUPPLY valve ON, place mask to face and check for normal breathing and regulator and mask operation. Turn OXYGEN SUPPLY valve OFF, check no breathing.

13. COMM/NAV/GEAR/DISPLAYS — ON.

    a. UHF MODE switch — T/R or T/R & G.

    b. Tacan function selector — T/R.

    c. MFDs — ON.

    d. ARA-63 POWER switch — ON.

    e. HUD PWR switch — ON.

    f. Radar altimeter — ON.

    g. VIDEO control switch — ON.

14. Trim — Set 000.

15. Standby gyro — Erect.

16. MASTER RESET pushbutton — Depress.

17. MASTER TEST switch — OBC.

    Coordinate with RIO and plane captain.

WARNING

Increased suction around intakes during inlet ramp programming and the automatic movement of the horizontal stabs presents a FOD hazard and the potential for injury to ground personnel not clear of these areas.

18. Autopilot — Engage.

19. Failure history file — Clear.

20. MFD OBC TEST — Select.

The following systems are automatically exercised during the 1-1/2 minutes required to complete the OBC tests.

a. The AICS self-test turns on hydraulic power and exercises the ramps through full cycle: STOW-EXTND-STOW. During the test, the respective RAMP light illuminates until the ramps return to the fully stowed position and the hydraulics are shut off. A failure is indicated by an INLET light and/or OBC readout.

b. Pitch, roll, yaw stab aug; authority stops; AFCS computers; Mach trim compensator; autopilot, spoiler.

During the course of the test, the STAB AUG lights remain illuminated until the test is satisfactorily completed. All lights should be off at termination of test.

CAUTION

OBC commencement with nose-down trim may result in a force-link disconnect when the stick hits the forward stick stop during the pitch parallel actuator checks.

a. Autothrottle — This test is a computer self-test with output commands inhibited to prevent throttle movement.

21. Speedbrake switch — EXT, then RET. Cycle speedbrake switch to EXT; release and check for partial extension. Select EXT again, checking indicator for transition for full extension. Select RET and check indicator for an indication of full retraction. Check for stabilizer position fluctuation during speedbrake extension and retraction to verify integrated trim operation.

22. REFUEL PROBE switch — All EXT, Then RET.

Cycle the probe to the extend position, noting illumination of the probe transition light with switch-probe position disparity. Check probe nozzle head for condition. Retract probe and again check that transition light goes out when fully retracted and doors closed.

23. WSHLD AIR switch — Cycle.

24. MASTER TEST switch — OFF.

If engaged, verify that autopilot disengages automatically.

25. WING/EXT TRANS switch — OFF.

26. Trim — Checked and Set 000.

CAUTION

Ensure adequate clearance before moving wings.

Note

For CV operations, omit steps 27 through 47.

27. Emergency WING SWEEP handle — 20°.

Move the emergency WING SWEEP handle to 20° (full forward) and engage the spider detent. Stow handle and guard. HZ TAIL AUTH light illuminates coming out of OVSW. Light goes off when OVSW stops removed.

28. MASTER RESET pushbutton — Depress.

The W/S caution legend on the MFD and the WING SWEEP advisory light go out and the AUTO and MAN modes are enabled.

29. External lights — Check (prior to night/IMC flight).

WARNING

During night operations, aircraft with inoperable tail and aft anticollision lights will not be visible from the rear quadrant even under optimum meteorological conditions, thus increasing midair potential.

30. Flaps and slats — DN.

Check for full deflection of the flaps and slats to the down position and automatic activation of the outboard spoiler module. Check for 3° TEU stabilizer position.

31. Flight controls — Cycle.

    Complete full-cycle sweep of longitudinal, lateral, directional, and combined longitudinal-lateral controls while checking for full authority on surface position indicator. Check that all spoilers extend at the same rate with slow lateral stick deflections and extend to full up position.

Observe the following:

a. Pitch control — Horizontal Tail 33° TEU to 7° TED.

b. Lateral control — 24° Total Differential Tail.

c. Directional control — ±30° Rudder.

d. Longitudinal-lateral combined — 35° TEU, 15° TED Horizontal Tail.

Note

A stabilizer vibration may occur when the control system linkage is held in contact with a total tail stop during stick cycling checks. This vibration is acceptable, provided it damps when the control stick is moved to clear the stop in contact. Clearance from the stop can best be verified by movement of the matching stabilizer indicator needle away from its maximum travel position.

32. DLC — Check.

    Verify horizontal tail shift with DLC input.

33. ANTI SKID SPOILER BK switch — SPOILER BK.

34. INBD and OUTBD SPOILER FLR ORIDE switches — ORIDE.

35. MASTER TEST switch — STICK SW.

36. INBD and OUTBD SPOILER FLR ORIDE switches — NORM.

37. MASTER TEST switch — OFF.

38. MASTER RESET — Depress.

39. MASTER TEST switch — STICK SW.

    SPOILER light should illuminate and all spoilers should fail down. Verify that the GO light illuminates with 1-inch lateral stick in each direction.

40. MASTER TEST switch — OFF.

41. MASTER RESET pushbutton — Depress.

42. Spoilers and throttles — Check.

43. ANTI SKID SPOILER BK switch — OFF.

44. INBD and OUTBD SPOILER FLR ORIDE switches — ORIDE.

45. Flaps and slats — UP.

46. Maneuver flaps — DN.

47. Wing-sweep switch — MAN 50°.

CAUTION

If wing-sweep commanded position indicator (captain's bars) does not stop at 50°, immediately select AUTO with wing-sweep switch.

48. Maneuver flaps — Crack Up.

49. Wing-sweep switch — BOMB.

    Check maneuver flap retraction.

50. Emergency WING SWEEP handle — 68°.

51. Emergency WING SWEEP handle — OV SW.

52. Wing-sweep switch — AUTO.

53. MASTER RESET pushbutton — Depress.

Note

CV checklist resumes.

54. ANTI SKID SPOILER BK switch — BOTH.

55. ANTI SKID — BIT.

56. ANTI SKID SPOILER BK switch — OFF.

57. Displays — Check.

58. Tacan TEST button — Depress.

59. ARA-63 — BIT.

60. HUD-VIDEO — BIT.

61. Altimeter — Set.

    Barometric setting and error determined.

62. Compass — CHECK.

    Validate inertial navigation system derived magnetic heading on the displays by cross-checking with the SAHRS derived heading on the BDHI. Cross-checking can also be accomplished by cycling the navigation system between INS and SAHRS.

63. SAHRS attitude reference — Check.

    Check SAHRS attitude reference by boxing, then unboxing SAHRS on the MFD OWN A/C format. HUD attitude should not change.

    Note

    Do not perform this check by boxing SAHRS, then boxing INS. This will manually select INS, preventing an automatic change to SAHRS in the event of INS failure.

64. Flight instruments — Check.

65. Oxygen monitor — Test.

7.4.4.1 Final Checker (Ashore)

1. NOSE STRUT switch — KNEEL; Check Launch Bar DN.

    CAUTION

    Ensure all tiedowns have been removed before selecting KNEEL.

2. Hook — DN; Check RATS Advisory Light On, Then Up.

3. LAUNCH BAR switch — Cycle.

4. NOSE STRUT switch — EXTD.

7.4.4.2 Final Checker Aboard CV

1. Hook — Down On Director Signal; Check RATS Advisory Light On, Then Up.

    CAUTION

    Carrier operations with an inoperative RATS will increase CV wind-over-deck requirements. Failure to notify CV OPS may result in damage to the ship's arresting gear and aircraft tailhook assembly structure. Consult applicable recovery bulletins.

2. Nosewheel steering — Cycle OFF, Then ON.

    WARNING

    Failure to cycle nosewheel steering following hook check will enable nosewheel steering centering to remain engaged and can cause mispositioning of the launch bar during catapult hookup. This may result in launch bar disengaging from shuttle during catapult stroke.

7.4.5 Taxiing. To set the aircraft in motion starting from a static position requires advancing the throttles slightly. While departing the line area, flightcrew should clear the extremities of the aircraft and the wings should remain at 68° or in OV SW to minimize the span clearance. Once in motion, IDLE thrust is normally sufficient to sustain taxi speeds and full nosewheel steering authority may be realized.

7.4.5.1 Taxi Speed. Taxi speed should be maintained at a reasonable rate consistent with traffic, lighting, and surface conditions. Subsequent to flight, while returning to the line at light gross weights, one engine may be shut down to prevent excessive taxi speeds at IDLE thrust.

CAUTION

- Before taxiing aircraft with wings in oversweep and full wing fuel tanks, trim stabilizer to zero to prevent wingtip and stabilizer interference.
- When taxiing across obstacles ensure nosewheel is centered to preclude launch bar from impacting nose wheelwell doors.
- To prevent overheating, do not ride the wheelbrakes.

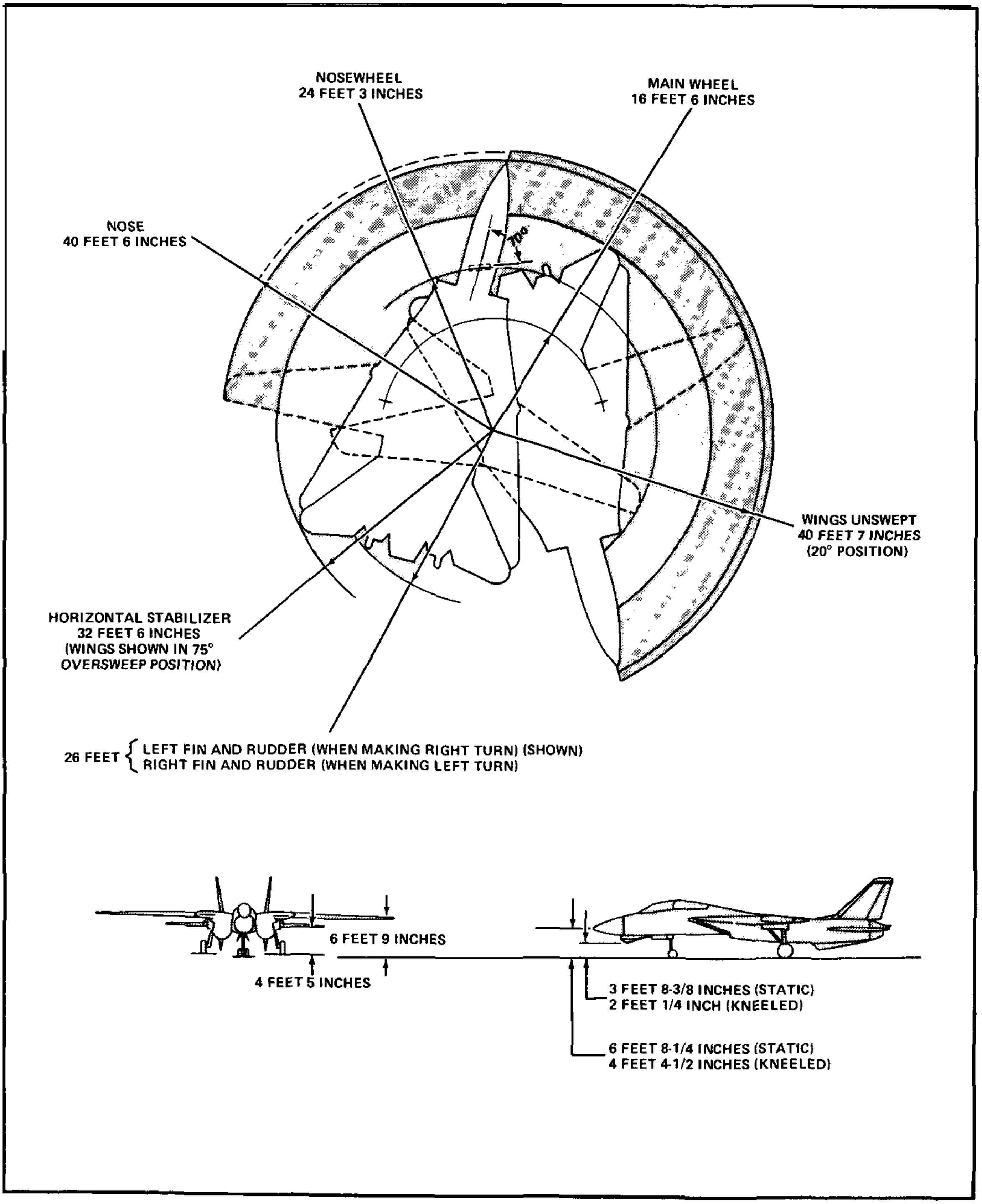


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Figure 7-3. Taxi Turn Radii (Maximum Nosewheel Steering 70°)

Note

When shutting down one engine during taxiing, the right engine is normally shut down so that normal braking is maintained.

7.4.5.2 Taxi Interval. The taxi interval should be sufficient to avoid taxiing in another aircraft's jet wash, which presents additional FOD potential. Although the antiskid system is armed at speeds less than 15 knots, the antiskid system is not operative. The nosewheel steering can remain engaged throughout the taxi phase. Application of wheelbrakes in conjunction with nosewheel steering should be performed symmetrically to minimize nose tire side loads. In minimum radius turns (Figure 7-3) using nosewheel steering, the inboard wheel rolls backward as the axis of rotation is between the main gear. Because of the distance from the cockpit to the main landing gear, the pilot should make allowance for such in turns to prevent turning too soon and cutting corners short.

7.4.5.3 Crew Comfort. Crew comfort during taxi operations is affected by the nose strut air curve characteristics, which maintains the strut in the fully extended (stiff strut) position except during deceleration. Because of the wide stance of the main gear, differential application of wheelbrakes is effective for turning the aircraft without the use of nosewheel steering.

CAUTION

- On-deck engine operations for extended periods can result in an unacceptable buildup in fluid temperatures (hydraulic, engine oil, and IDG oil) by taxiing heat exchanger capacities. Since the left IDG supplies the majority of the electrical power, it is more susceptible to overheating than the right. Tail winds or large power demand, or both, at high ambient air temperatures increase the chances of fluid overtemperature.

- Since the outboard spoiler module is automatically energized with the flap handle down and weight on wheels, it is necessary to restrict the amount of flaps down operation on the deck to prevent module fluid overheating.

7.4.6 Taxi — Pilot

CAUTION

Taxiing with the left engine secured is not authorized. Normal braking and nosewheel steering control will be lost if the hydraulic transfer pump (BIDI) fails while taxiing with the left engine secured.

1. Parking brake — Release.

2. Nosewheel steering — Check.

   NWS ENGA light illuminates upon engagement. Check control and polarity in static position before commencing to taxi.

   Note

   If nosewheel steering is inoperative, the emergency gear extension air release valve may be tripped, which will prevent gear retraction.

3. Brakes — Check.

   Check for proper operation by applying left or right brake individually and observing brake pressure recovery to the fully charged condition.

4. Turn-and-slip indicator — Check.

5. Ordnance — Safe.

   Perform the following functions at prescribed location prior to takeoff in accordance with base operating procedures:

   a. Missile seeker and tuning — Check.

   b. Gun and external stores — Ground Safety Pins Removed and Armed.

7.4.7 Takeoff. The aircraft takeoff checklist should be completed prior to calling for takeoff clearance, and all annunciator lights should be off, except NWS ENGA. Full flaps and slats are optional for all takeoffs regardless of thrust or gross weight conditions. Both flight crewmembers should be operating in HOT MIC during this phase of flight to enhance communications in event of emergency. Upon tower clearance and after visually clearing the approach zone, the pilot should taxi onto the runway (take downwind side if another aircraft to follow) and roll straight ahead to align the nosewheel and to check compass alignment.

Hold in position for takeoff using the toe pedal brakes with nosewheel steering engaged. Perform engine checks at 85- to 90-percent rpm. Select MIL on the roll and monitor engine performance.

WARNING

Takeoffs with the HUD uncaged can produce HUD symbology that is difficult to interpret during turning or asymmetric flight conditions. If takeoff is anticipated following an uncaged landing, selecting the cage/seam switch on the inboard throttle will ensure the HUD returns to the caged format.

Note

- Do not use the parking brake to restrain the aircraft under the high-power conditions since tire skid might result.
- If static engine runup greater than 90-percent rpm is required, runup should be performed one engine at a time.

7.4.7.1 Afterburner Takeoff. AB takeoffs are limited to single-engine, minimum afterburner takeoffs, waveoffs, bolters, or catapult launches. Dual-engine afterburner and single-engine maximum afterburner takeoffs, waveoffs, bolters, or catapult launches are prohibited. Refer to Chapters 4 and 11.

7.4.7.2 Brake Release. After takeoff power checks are completed and at a safe interval behind the preceding aircraft, release the toe pedal brakes. Nosewheel steering should be used for directional control during the initial takeoff roll. Although the rudder becomes effective at 40 to 60 knots, to ensure adequate directional control in the event of an engine failure, nosewheel steering should remain engaged until 100 KCAS. Refer to NAVAIR 01-F14AAP-1.1 for nosewheel steering on and off abort data.

Note

- Takeoffs performed with standing water on the runway may result in unstable engine operation because of water ingestion.
- The nose strut should return to the fully extended position upon brake release; failure to do so will increase the takeoff ground roll. Use of differential braking to control directional alignment should be avoided because of its attendant effect on ground roll distance.

7.4.7.3 Takeoff Roll/Lift-Off. Minimum ground roll takeoff procedures do not differ from the normal procedures. Maintain the control stick at the trimmed condition during the prerotation ground roll phase to minimize aircraft drag. At the precomputed rotation speed (refer to NAVAIR 01-F14AAP-1.1), smoothly pull the control stick aft to position the HUD waterline at a 7° to 10° pitch attitude until safely airborne. With the flaps down, the aircraft seems to balloon from the runway in a near-level nose attitude with a more docile transition to flight than characteristic of swept-wing aircraft.

Note

- The use of excessive back stick on takeoff may cause the tail surfaces to stall, delaying aircraft rotation and extending takeoff distance.
- Although on-deck pitch attitude rotation in excess of 10° provides marginal tail-ground clearance, the aircraft is airborne well before such a phenomenon becomes a limiting factor.

7.4.7.4 After Lift-Off. After lift-off, relax the aft stick force as the aircraft accelerates toward an in-trim condition. Raise the landing gear control handle after ensuring that the aircraft is definitely airborne. Pitching moments associated with gear retraction are negligible and a gear-up indication should be achieved about 15 seconds after initiation.

CAUTION

Illumination of indexer lights is not a positive indication that the main landing gear are clear of the runway. Raising the gear before a positive rate of climb is established will result in blown main tires.

At approximately 180 KCAS (depending on longitudinal acceleration) the FLAP handle can be placed in the UP position. A moderate noseup pitching moment occurs during the flap and slat retraction phase, which takes approximately 8 seconds. Do not attempt to counter a lateral drift because of a crosswind condition. The use of large lateral control deflection should be avoided to keep from breaking out the wing spoilers, which have a negative effect on lift and drag. Differential tail authority within the spoiler deadband (1/2-inch lateral stick deflection) is adequate for maintaining wings-level flight or effecting gradual turns with symmetric thrust. Before reaching the flap (225 KCAS for

10° flaps) and gear (280 KCAS) limit speeds, the pilot should ascertain that all devices are properly configured for higher speed flight. A gradual climbout pitch attitude should be maintained until intercepting the optimum climb speed. A recheck of engine instruments and configuration status should be performed after cleanup during the climbout phase.

7.4.8 Flaps-Up Takeoff. Before the takeoff roll, the procedures for flaps-up takeoff are identical to flaps down, except that the flaps remain retracted and only inboard spoiler brakes are available. During the prerotation ground roll phase, maintain the control stick at the trimmed condition to minimize aircraft drag. At the precomputed rotation speed, smoothly pull the control stick aft to position the HUD waterline at a 7° to 10° pitch attitude until safely airborne.

Do not exceed 10° of pitch attitude until well clear of the runway, as excessive noseup attitudes will cause the vertical fins and tailpipes to contact the runway surface.

CAUTION

Because of increased longitudinal control effectiveness with the flaps retracted, overcontrol of pitch attitude during takeoff is possible. Large or abrupt longitudinal control inputs should be avoided until well clear of the runway.

Transition to flight will occur smoothly as compared to the ballooning effect in flaps-down takeoffs. After main gear lift-off, relax the aft stick force as the aircraft accelerates.

Because of the smooth, flat transition to flight, care should be taken to avoid premature landing gear retraction and resulting blown tires. Raise the landing gear control handle only after ensuring that the aircraft is airborne.

Note

- During flaps-up takeoffs, all flap/wing electromechanical interlocks are removed from the CADC and wing-sweep control box, allowing possible inadvertent wing sweep in the event of a CADC failure.
- Outboard spoilers are inoperative with weight on wheels.

7.4.8.1 Maneuvering Flaps Takeoff. Maneuvering flaps provide improved takeoff performance when compared to the flaps-up configuration and eliminate the pitching moment associated with main flap and slat retraction after takeoff. Slow-speed handling characteristics are superior to the flaps-up configuration. Additionally, possible automatic maneuvering flap/slat extension during rotation/transition to flight can be avoided by extending maneuvering flaps before takeoff.

7.4.9 Formation Takeoff. Formation takeoffs are permitted in the flaps-up/maneuvering flaps-down configurations for section only. However, they shall not be permitted at night, with crosswind component in excess of 10 knots, with standing water on the runway, on runways less than 8,000 feet long and 200 feet wide, or with dissimilar aircraft. All aspects of the takeoff must be briefed by the flight leader. Briefing should include flap setting, power settings, use of nosewheel steering, abort procedures, and signals for power and configuration changes.

7.4.9.1 Military Lead. With the completion of the takeoff checks, the lead aircraft will take position on the downwind side of the runway with the wingman on a normal parade bearing with no wing overlap. Upon signal from the leader, the engines will be advanced to 90-percent power. When ready for flight, the pilots shall exchange a thumbs-up signal. On signal from the leader, brakes are released, MIL is selected, leader then reduces power 2 percent. Directional control is then maintained with nosewheel steering until rudder becomes effective. During takeoff roll, the leader should make only one power correction to enhance the wingman position. If optimum position cannot be obtained, relative position should be maintained until the flight is safely airborne. At the precomputed rotation speed, the leader should rotate the aircraft 7° to 10° noseup on the HUD or MFD and maintain this attitude until the flight is airborne. Turns into the wingman will not be made at altitudes less than 500 feet above ground level.

7.4.9.2 Wingman. The wingman should strive to match the leader's attitude as well as maintain parade bearing with wingtip separation. When both aircraft are safely airborne, the gear is retracted on signal from the leader.

CAUTION

In the event of an aborted takeoff, the aborting aircraft must immediately notify the other aircraft and the tower. The aircraft not aborting should ensure positive wingtip separation is maintained and select full military power to accelerate ahead of the aborting aircraft. This will allow the aborting aircraft to move to the center of the runway and engage the available arresting gear, if required.

CAUTION

It is imperative that the wingman be alert for the overrunning situation and take timely action to preclude this occurrence. Should an overrunning situation develop after becoming airborne, the wingman should immediately increase lateral separation from the leader to maintain wing position. Safe flight of both aircraft must not be jeopardized in an attempt to maintain position.

7.4.10 Takeoff Aborted. See Chapter 13, paragraph 13.1.

7.4.11 Takeoff Checklist. Prior to takeoff, the checklist will be completed by the challenge (RIO) and reply (pilot) method via the ICS on HOT MIC as a double-check of the aircraft configuration status.

For CV operations, steps 1 through 9 may be completed while tied down. For field operations, steps 1 through 15 should be completed in the warmup area.

	RIO CHALLENGE	PILOT REPLAY
1.	"BRAKES"	"CHECK OK, ACCUMULATOR — PRESSURE UP"
2.	"FUEL TOTAL ______ lb."	"NORMAL FEED, AUTO TRANSFER, DUMP OFF, TRANSFER CHECKED (if AUX tanks carried), TOTAL, WINGS EXT (If app.) AFT AND LEFT FORWARD AND RIGHT FEED TANKS FULL BINGO SET ___"
3.	"CANOPY CLOSED, LOCKS ENGAGED, LIGHT OUT, STRIPES ALIGNED, HANDLE IN CLOSE POSITION"	"CLOSED, LOCKS ENGAGED, LIGHT OUT, SEAL INFLATED, HANDLE IN CLOSE POSITION"
4.	"SEAT. . . ARMED, STRAPPED IN EIGHT WAYS COMMAND EJECT" (as briefed)	"ARMED, STRAPPED IN EIGHT WAYS, PILOT/MCO IN WINDOW" (as indicated)
5.	"STAB AUG"	"ALL ON"
6.	"ATLS"	"ON"
7.	"ALL CIRCUIT BREAKERS SET"	"ALL IN"

	RIO CHALLENGE	PILOT RESPONSE
8.	"MASTER TEST SWITCH"	"OFF"
9.	"BI-DIRECTIONAL"	"NORMAL"
10.	"INBD AND OUTBD SPOILER FLR ORIDE SWITCHES"	"ORIDE"
11.	"COMPASS AND STANDBY GYRO"	"ALL HEADINGS MATCH, STANDBY GYRO ERECT"
12.	"OXYGEN"	"OBOGS ON, MONITOR CHECKS GOOD"

CV — APPROACHING

CAT ON DIRECTOR'S SIGNAL

13.	"WINGS (visually checked)"	"20°, AUTO, NO WING-SWEEP CAWs"
14.	"FLAPS AND SLATS" (visually checked)	AS REQUIRED
15.	"SPOILERS AND ANTI-SKID"	"SPOILER MODULE ON, SPOILER BRAKES SELECTED" (field) "SPOILER MODULE ON, SPOILER BRAKES OFF (CV)."
16.	"TRIM"	"0.0.0," (field) AS *REQUIRED* (CV)
17.	"SAHRS ATTITUDE REFERENCE"	"GOOD SAHRS ATTITUDE"
18.	"DISPLAYS"	"SET FOR TAKEOFF, HUD CAGED"
19.	"HARNESS LOCKED"	"LOCKED"
20.	"CONTROLS" (RIO visually check for full spoiler deflection)	"FREE, STICK FULL FORWARD AND AFT, FULL SPOILER DEFLECTION, LEFT AND RIGHT, HYDRAULICS 3,000 PSI"
21.	"ALL WARNING AND CAUTIONS OUT"	"ALL WARNING AND CAUTIONS OUT"

ASHORE — IN TAKEOFF POSITION

22.	"ANTI-SKID/ SPOILER BRAKES"	"BOTH" (if operable)

7.4.12 Ascent Checklist. At level-off or 15,000 feet (whichever occurs first):

1. Cabin pressurization — Check.
2. Fuel transfer — Check.
3. In-flight OBC — Run.
4. Oxygen monitoring system — Test.

WARNING

Subsequent failure of the oxygen monitor system will not be evident to the aircrew resulting in OBOGS output of unknown quality.

Note

Pilot should ensure oxygen monitor test button is released as soon as possible after illumination of the OBOGS caution light to preclude unnecessary depletion of the backup oxygen system.

7.4.13 In-Flight OBC. If desired or required OBC check should be run.

1. OBC disabled on pilot MASTER TEST PANEL — Check.
2. Verify MA ARM — OFF.
3. Multifunction display
   a. Select OBC basic format.
   b. Depress desired test.

      This initiates the in-flight BIT.

7.4.14 Preland and Descent

1. HOOK/HOOK BYPASS — As Desired.
2. Exterior lights — As Desired.
3. Displayed heading/BDHI — Check With MAG Compass.
4. Wing-sweep switch — As Desired.
5. ANTI SKID SPOILER BK switch — BOTH (If operable, CV-OFF).
6. Altimeter — Set.
7. Radar altimeter — ON/BIT Check.
8. Fuel quantity and distribution — Check.
9. Armament — Safe.
10. CANOPY DEFOG/CABIN AIR lever — DEFOG.
11. ANTI-ICE switch — AUTO/OFF.
12. Display mode — TLN.
13. Steering — AWL.
14. ARA-63/ACLS — ON/BIT Check.
15. RADAR WARNING RCVR PWR switch — OFF.
16. ASPJ SYS switch — STBY.
17. CHAFF/FLARE dispenser switch — OFF.
18. RDR switch — STBY OR XMIT (pulse).

WARNING

The RIO should place RDR switch to STBY or XMIT (pulse) on final approach to prevent unnecessary exposure of flight deck personnel to RF radiation hazard.

19. [T] Resolution run — Complete.

Note

Before reconnaissance system shutdown, run film leader to protect target imagery from inadvertent exposure during film download.

20. [T] FRAME switch — OFF.
21. [T] PAN switch — OFF.
22. [T] IRLS switch — OFF.
23. [T] FILM switch — OFF.

CAUTION

Before selecting system switch to OFF, delay 15 seconds for sensor shutdown, IR door to close, and mount to drive to vertical.

24. [T] TARPS control panel SYSTEM switch — OFF.

7.4.15 Pattern Entry. Entry to the field traffic pattern will be at the speed and altitude prescribed by local course rules. Wings shall be repositioned to 20° prior to decelerating through 220 KCAS. When approaching the initial for the break, wings may be positioned manually full aft to facilitate multiplane entry and break deceleration. Break procedures shall comply with squadron, field, and/or CV standard operating guidelines.

7.4.16 Landing

7.4.16.1 Approach. At the abeam position for landing, the aircraft should be at the prescribed altitude, trimmed up to 15 units AOA with the Landing Checklist completed.

Indicated airspeed should be cross-checked with gross weight in wings-level flight to verify AOA accuracy. Direct lift control and the approach power compensator should be engaged as desired and checked for proper operation. The turnoff from the 180° position should be made based on surface wind conditions and interval traffic (type, pattern, touch-and-go or final landing, etc.) so as to allow sufficient straightaway on final prior to touchdown.

The quality of the approach and touchdown is enhanced by starting from on-speed and altitude. The low thrust required in the landing approach leaves little margin for corrections from a high, fast position. Therefore, the pilot must control these parameters precisely from the onset of the approach to touchdown. Inertia and tail movement in conjunction with engine thrust response characteristics dictate the use of small, precise corrections on the glideslope for the most effective control technique. Lateral overcontrol produces large yaw excursions that complicate lineup analysis. All turns should be coordinated with rudder inputs.

The landing should be planned for the downwind side of the runway with traffic behind, or opposite, the nearest traffic on landing rollout, or on the turnoff side of the runway. Pilots should practice flying on the field optical landing aid system whenever possible. Fly the aircraft down to the deck without flaring so as to accurately establish a touchdown point and achieve initial compression of main gear struts to arm the spoiler brakes.

Note

Landing with DLC engaged will reduce the amount of aft stick deflection available. DLC should be deselected when established on landing rollout.

7.4.16.2 Touchdown. To avoid tail-ground clearance problems, pitch attitude should not exceed 15 units AOA. At touchdown, immediately retard throttles to IDLE and confirm spoiler brake deployment. Expeditiously lower the nosegear to the deck and, without allowing the nose to come up, smoothly program the stick full aft.

7.4.16.3 Roll Out. The braking technique to be utilized with or without antiskid selected is essentially the same; a single, smooth application of brakes with constantly increasing pedal pressure. Do not pump the brakes. Directional control during rollout may require some differential braking.

Nosewheel steering may be used during rollout but it must be engaged with the rudder pedals centered to avoid a directional swerve upon engagement. Restrict the use of nosewheel steering during rollout until or unless required for directional control. Under conditions of normal braking (antiskid selected), the antiskid system is passive and has no effect on wheelbrake operation. However, if maximum deceleration is desired, commence braking as the nose is lowered and smoothly apply sufficient pressure to activate the antiskid system. When an impending skid is sensed, antiskid operation will result in a series of short wheelbrake releases and a surging deceleration. Constant pedal pressure should be maintained. Approaching taxi speed (about 15 knots), ease brake pressure and deselect antiskid.

CAUTION

- If brakes are lost, release brake pedals and secure antiskid.
- If antiskid is not deselected before 15 knots, continued hard braking could result in blown tires.
- Ensure feet are off brakes before crossing field arresting gear.

Note

If maximum-effort braking or antiskid is not required, or antiskid is not selected, delaying brake application until the aircraft aerodynamically decelerates below 80 knots greatly reduces the possibility of blown tires and overheated brakes.

Follow the Postlanding Checklist for proper configuration cleanup procedures. Clear the area behind before turning off across the runway. The right engine may be shut down to reduce residual thrust during low-gross-weight taxiing.

7.4.16.4 Touch and Go. For touch-and-go landings, MIL thrust is applied after touchdown while thumbing speedbrakes in manually to configure the aircraft for a go-around. Automatic retraction of speedbrakes occurs upon application of MIL thrust as a safety backup mode of retraction. Control for rotation is greater than experienced on takeoff, although the aircraft has the same basic lift-off characteristics. Fuel required per pass is normally 300 pounds, contingent on traffic pattern.

7.4.16.5 Minimum Descent Rate Landings. Minimum descent rate landings are required for heavy weight and landing gear emergency landings. Aircraft pitch attitude at touchdown is critical.

CAUTION

Do not exceed 10° pitch attitude (on the waterline) and 14 units AOA at touchdown to prevent speedbrake, exhaust nozzle, and/or ventral fin damage.

After touchdown, throttles should be immediately placed at the idle stops. The nosewheel should be lowered to the ground, fully compressing the main landing gear struts. Delaying either action will delay the deployment of ground roll braking spoilers and may increase landing rollout. Additionally, until ground roll braking spoilers are deployed, lateral control remains responsive and pilot-induced lateral oscillation is possible. Aerodynamic braking should not be used as speedbrakes, exhaust nozzle, and/or ventral fin damage may occur.

The Fresnel lens may be used for precise glideslope control until arresting the approach rate of descent. Do not attempt to recenter a high ball in close. The approach should be flown on speed at 15 units AOA. At approximately 30 feet AGL (2 to 3 seconds prior to touchdown), arrest the rate of descent by a slight addition of power. Maintain approach attitude until touchdown. If the Fresnel lens is not available or runway length is critical, fly a shallow approach to touchdown in the first 1,000 feet of runway.

7.4.16.6 Crosswind Landings. If landing is required at crosswind conditions above the limits or on a wet runway with crosswinds approaching the limits, an arrested landing should be made.

Crosswind landing tests with a 20-knot component with all spoilers extended have been completed. With this limit, crosswind landings present no unusual directional control problems with up to a 20-knot component with all spoilers extended. Touchdown should be on speed, firm, and within the first 500 feet. Lateral drift before touchdown must be eliminated by the wings-level crab or wing-down technique (this is especially important on a wet runway). Upon touchdown, lower the nose to the runway to improve the straight tracking characteristics. With a 20-knot component, the upwind wing will raise slightly. However, aerodynamic controls (rudders) will effectively maintain a straight track until approximately 80 KCAS where differential braking may be required. If directional control is marginal, nosewheel steering should be used to maintain control. Nosewheel steering will probably be required during crosswind conditions with a wet runway.

If a landing must be made in crosswind conditions in excess of the limits, do not arm the spoiler brakes for landing and again maintain a wings-level attitude with lateral stick. It must be realized that antiskid will not be available. At some crosswind component, the upwind wing will be raised excessively and, as a result, directional control will be marginal. It is estimated that this will occur with a greater than 25-knot crosswind component.

7.4.16.7 Landing On Wet Runways. If operable, antiskid shall be used on wet runways to minimize the possibility of skidding or blowing tires. Standing water greatly decreases braking effectiveness and may cause total hydroplaning in certain conditions. (Refer to Chapter 18, Extreme Weather Operations.) Intermittent puddles may cause wheels to lock while braking with antiskid not engaged. As the locked wheel leaves the puddle and encounters a good braking surface, it will skid and blow unless brake pressure is released. The following procedures are recommended when landing on a wet runway:

1. Determine field condition before approach (braking action, crosswind component, arresting gear status).

2. If adverse wind and runway conditions exist, make a short-field arrested landing. In the event that the arresting gear is not engaged, execute a waveoff or bolter as appropriate.

3. Consideration should be given to reducing touchdown speed by flying a no-DLC approach. Plan the pattern to be well established on final in a wings-level attitude (crab, if required) on speed. Land on runway centerline, using normal FCLP landing techniques.

4. If a rollout landing is desired, touch down on centerline within the first 500 feet of runway. Landing rollout procedures are the same as in a normal landing. When directional control is clearly established, utilize normal braking. During the high-speed portion of the landing roll, little or no deceleration may be felt. Do not allow the aircraft to deviate from a straight track down the runway. If a skid develops, release the brakes, continue aerodynamic braking, and use rudders or nosewheel steering for directional control. Reapply the brakes cautiously. If the skid continues and adequate runway remains, select power as required and fly away. If conditions do not permit flyaway, use the long field overrun gear if required. If the aircraft is leaving the runway to an unprepared surface, secure both engines.

Note

A blown tire on landing rollout may result in directional control difficulties, particularly at high speeds. Refer to Chapter 15, Landing Emergencies, for blown-tire emergency procedures.

7.4.17 Landing Checklist. The placarded Landing Checklist should be completed in sequence prior to arriving at 180° abeam the touchdown point. All checklist items are essential elements to be checked prior to each landing. With the ICS on HOT MIC, the pilot should call out the accomplishment of each step so that the RIO can doublecheck that all items have been performed.

1. Wing-sweep switch — 20° AUTO.

   Check wings in AUTO sweep control mode and verify at 20°.

2. Wheels — THREE DN.

   Check for wheels-down indication on all three gear, LAUNCH BAR light, and that gear transition light is out. Check that brake accumulator pressure is fully charged.

   During aircraft carrier (CV) qualifications and other operations when the landing gear are not raised after catapult launch, the pilot shall check the LAUNCH BAR advisory light is off prior to each landing.

3. SAS — ON.

4. Flaps — Full DN.

   Check for flap and slat full-down indication and no FLAP light.

5. DLC — Checked.

6. Hook — As Desired.

   Transition light should be out.

7. Harness — Locked.

8. Speedbrakes — EXT (out).

   Check indicator for full speedbrake extension.

9. Brakes — Check.

10. Fuel — Check.

7.4.18 Postlanding — Pilot

1. Speedbrake switch — RET.

2. ANTISKID SPOILER BK switch — OFF.

3. Flaps and slats — UP.

   Move FLAP handle UP and check for complete retraction of main flaps and slats and auxiliary flaps (flaps indicator — 0° and no FLAP caution light). Check automatic deactivation of the outboard spoiler module. As soon as the auxiliary flaps are retracted (8 seconds) the wings will sweep aft if commanded.

4. Wing-sweep switch — BOMB.

CAUTION

Ensure that emergency WING SWEEP handle and wings move to 55°.

5. Emergency WING SWEEP handle — OV SW.

   Raise handle and move aft to 68°. Raise handle to full-up extension and hold. When HZ TAIL AUTH caution light goes out and the OVER flag appears, move emergency WING SWEEP handle full aft (75° sweep position) and stow. Rotate handle guard to stowed position.

6. Ejection seats — SAFE (coordinate with RIO).

   Raise SAFE/ARMED handles to lock seat actuation devices.

7. Avionics — OFF.

   Turn off all avionics (radar altimeter, displays, tacan, ARA-63) except radio.

8. Right throttle — OFF.

   Note

   - Care should be taken when shutting down the right throttle (with the left throttle at IDLE) to prevent inadvertent contact with the left throttle, moving it aft to the cutoff position.
   - Run both engines at idle for 5 minutes before shutdown, especially if they have been run at high power.

9. OBOGS master switch — OFF (alert RIO).

10. OXYGEN SUPPLY valve — OFF.

11. HYD TRANSFER PUMP switch — SHUTOFF.

    Prior to shutoff, check hydraulic transfer pump operation in the combined-flight direction with the HYD PRESS, OIL PRESS, R GEN, and R FUEL PRESS caution lights illuminated.

12. Ordnance — Dearm (field).

    Dearm and safety ordnance in accordance with local operating procedures.

13. Wheels — Chocked.

14. Parking brake — Pull.

    CAUTION

    Do not pull parking brake subsequent to a field landing if the brakes have been used extensively.

15. V/UHF radio MODE switch — OFF.

16. Standby attitude gyro — CAGE.

17. Left throttle (alert RIO) — OFF.

    Alert RIO and upon signal from plane captain, secure left engine. Check emergency generator automatic operation upon shutdown.

18. EMERG generator switch — OFF.

19. Lights — OFF.

    Turn off internal and external light switches.

20. EJECT CMD indicator — Verify Pilot.

21. CANOPY handle — Clear RIO To Open.

22. Flightcrew — Egress.

7.5 RIO PROCEDURES

7.5.1 Interior Inspection — RIO

1. Circuit breakers — Set.

2. Left and right foot pedals — Adjust.

3. Harnessing — Fasten.

   a. Leg restraint lines and garters — Connect.

      Connect D-rings on leg restraint lines to upper and lower garters, left and right sides. Ensure that leg lines are not twisted or looped.

   b. Lapbelt — Connect and Adjust.

      Connect lapbelt straps and adjust snug so as to provide secure lap restraint in flight and seat kit suspension for ground egress or ejection.

   c. Parachute release fittings — Attach to Harness Buckles.

d. Anti-g and oxygen/communication leads — ATTACH.

When connecting the oxygen/communication fitting, avoid twisting the hard hose.

e. Inertia reel — Check.

Position shoulder harness lock lever forward to lock position. Check that both shoulder straps lock evenly and securely. Move lever aft to unlock harness.

4. ANT SEL panel — As Desired.

5. [T] TARPS control panel switches — OFF.

6. ICS panel

a. VOL knob — Set.

b. Amplifier — NORM.

c. Function selector — COLD MIC.

7. SENSOR control panel

a. TCS FOV — WIDE.

b. TCS trim — As Set.

c. MVR source — As Briefed.

d. MVR RECORD — OFF.

8. Tacan mode switch — OFF.

9. JTIDS

a. MODE switch — STBY.

Note

If the primary link system for the mission is JTIDS, ensure the JTIDS MODE switch is in STBY position. STBY provides the backup battery power required to hold the crypto variables and initialization data required for JTIDS missions.

10. KY MODE/TACAN/CMD panel — As Desired.

11. KY-58

a. PLAIN switch — PLAIN.

b. Power switch — OFF.

c. MODE — As Desired.

d. FILL switch — As Set.

12. V/UHF radio MODE switch — OFF.

13. RADAR COOLING switch — OFF.

14. EJECT CMD lever — Set.

Determined by squadron policy.

15. Data storage unit — Secure.

16. ARMAMENT control panel

a. SEL JETT switch — SAFE.

b. MSL PREP switch — OFF.

c. MSL SPD GATE knob — Per SOP.

d. MSL OPT switch — NORM.

e. JETTISON STA SEL switch — OFF.

17. Radio frequency control indicator — As Desired.

18. Standby attitude gyro — Caged, Turn Needle/Ball Centered.

19. Clock — Set and Wind.

20. Sensor hand control panel.

a. RDR switch — OFF.

b. IRST switch — OFF.

c. TCS switch — OFF.

21. Tactical information display — As Desired.

Note

TID NAV MODE and DEST switches are inoperative

22. DD power switch — OFF.

23. MFD 3 power — OFF.

24. ECM switch — OFF.

25. NAV MODE switch — OFF.

26. Data entry unit power — OFF.

27. RADAR WARNING RCVR

    a. PWR switch — OFF.

    b. DISPLAY TYPE switch — As Desired.

28. ASPJ

    a. SYS switch — OFF.

    b. BIT switch — OFF.

    c. TAC switch — NORM.

29. MFA priority switch — NORM.

30. AN/ALE-39 PWR/MODE switch — OFF.

31. Data-link panels

    a. TEST/NORM/AJ switch — NORM.

    b. FREQ selector — Set.

    c. Power switch — OFF.

    d. REPLY switch — NORM.

    e. MODE switch — TAC/JTIDS (as required).

Note

The data-link MODE switch must be set to the required link system (JTIDS or TAC) for appropriate MFD display processing.

    f. ADDRESS — Set.

32. APX-76 — OFF.

33. IFF MASTER knob — OFF.

34. MODE 4 switch — Out.

35. IFF ANT switch — DIV.

36. INTERIOR LIGHTS panel — As Desired.

37. RADAR BEACON switch — OFF.

38. RADAR BEACON MODE switch — As Desired.

39. GND CLG switch — OFF.

40. SYS TEST-SYS PWR ground check panel — Closed.

41. POWER SYS TEST switch — OFF.

7.5.2 Prestart — RIO. The following checks are performed by the RIO after starting air and electrical power are applied prior to starting engines.

CAUTION

- Starting air, which provides full ECS capability, must be connected to the aircraft with electrical power to cool temperature-critical avionics.
- If starting air is not available, a forced-air ground cooling unit and servo air must be connected before turning on avionics equipment.
- If electrical power is not connected with spare starting air, the ECS will drive to full hot.
- To prevent overheating the outboard spoiler module, pull the OUTBD SPOILER PUMP circuit breaker (2B3) anytime external power is connected and the flaps are extended.
- Failure of the COOLING AIR light to illuminate on external electrical power indicates a miswired or failed sensor. The COOLING AIR light will not be available to indicate a subsequent ECS turbine failure.

1. Seat, ICS, and U/VHF foot switches — Adjust.

   Adjust seat height so helmet is beneath the canopy breaker. Adjust ICS and UHF foot pedal fore-aft position for sitting comfort.

2. External power and air — ON.

3. ICS — Check.

   Verify two-way communications between flight crewmembers and adjust volume to a comfortable level.

4. DL, JTIDS, tacan, and U/VHF — Set.

   Set communications/tacan/command control in accordance with mission and flightcrew operating procedures.

5. Fuel quantity — Check.

6. Lights — Check.

   Check for illumination of console and instrument lighting.

7. LTS test — Check.

   Check that all caution and advisory lights and ECM lights illuminate.

   Note

   During pilot INST test, the RIO should observe fuel counter decrease to 2,000 pounds and MASTER CAUTION and FUEL LOW lights illuminate.

8. Ejection seats — ARMED.

   Arm ejection seat by releasing catch and rotating SAFE/ARMED handle down to ARMED.

9. CANOPY handle — CLOSE.

   RIO will normally close canopy. Ensure verbal clearance from pilot. Check that CANOPY light goes out with full forward transition of canopy into the sill locks. Check that SEAT UNARMED light does not illuminate.

   WARNING

   Flightcrews shall ensure that hands and foreign objects are clear of front cockpit handholds, top of ejection seats, and canopy sills to prevent personal injury and/or structural damage during canopy opening or closing sequence. Only minimum clearance is afforded when canopy is transiting fore and aft.

   Note

   If CLOSE does not close the canopy, depress the grip latch and release and push handle outboard and forward into BOOST. If it is necessary to use BOOST, the handle shall be returned to CLOSE to avoid bleed off of pneumatic pressure.

10. Acknowledge — Ready To Start.

7.5.3 Engine Start — RIO.

The RIO must monitor pilot procedures and plane captain signals to ensure maximum safety during the engine start sequence.

7.5.4 Poststart — RIO

1. NAV MODE switch — Align.

2. DD power switch — ON.

   Failure to turn DD power on prior to RDR switch causes a false DD power fault indication in ORT.

3. RDR switch — XMIT.

   Verify that the SENSOR COND advisory light illuminates.

4. RADAR COOLING switch — ON.

   Verify that the SENSOR COND advisory light goes out.

5. MFD 3

   a. Power switch — DAY/NIGHT/AUTO.

   b. BRIGHTNESS and CONTRAST — Set.

6. DEU — On.

7. MSL PREP switch — As Required.

8. TCS switch — ON.

9. Align coordinates — Verify/Update.

10. OXYGEN SUPPLY valve — ON.

    Turn OXYGEN SUPPLY valve ON, place mask to face, and check for normal breathing and regulator and mask operation. Turn OXYGEN SUPPLY valve OFF; ensure oxygen flow has stopped.

11. [T] TARPS control panel SYSTEM switch — RDY.

    Observe DATA/MAN/Vg/H light illuminated.

12. [T] IRLS switch — STBY.

    Observe IR NR light illuminated for cooldown period (maximum of 17 minutes).

13. Tacan mode switch — T/R.

14. IFF MASTER knob — STBY.

    a. Set CODE knob — As Required.

    b. IFF panel — Test.

        (1) MC switch — Out.

        (2) M1, M2, M3 — Test.

        Select NORM and observe that TEST light illuminates.

        (3) MC — Test.

        Observe that TEST light illuminates.

    c. IFF ANT switch — As Desired.

15. JTIDS MODE switch — As Required.

16. Communications — ON/Set.

17. KY-58 — As Required.

18. Standby attitude gyro — Erect.

19. DD — Set.

20. TID controls — Set.

    a. CONTRAST — Set.

    b. BRIGHT control — Set.

    c. CLSN — OFF.

    d. RID/DSBL — OFF.

    e. ALT NUM — ON.

    f. SYM ELEM — ON.

    g. DATA LINK — As Required.

    h. JAM strobe — As Required.

    i. NON ATTK — As Required.

    j. LAUNCH ZONE — As Required.

    k. VEL VECTOR — As Required.

    l. RANGE scale — As Required.

21. Hand control — Set.

22. ASPJ SYS switch — STBY.

23. RADAR WARNING RCVR panel — Set.

    a. Display type switch — NORM.

    b. PWR switch — ON.

    c. TEST switch — SPL.

    d. MODE button — LMT.

24. DATA LINK power — As Required.

25. D/L reply — As Required.

26. AAI control panel — Set.

    a. TEST/CHAL CC switch — Test.

    Check DD display.

27. AN/ALE-39 (per threat) — Set.

    a. BURST switch

    b. BURST INTERVAL

    c. SALVO

    d. SALVO INTERVAL

28. CANOPY DEFOG-CABIN AIR lever — CABIN AIR.

29. Indicator lights — Test.

30. [T] V/H check

    a. Manual V/H thumbwheels set — 360 Knots/ 200 Feet.

    b. V/H switch — Test.

    c. Observe MAN V/H light is out.

    d. V/H switch — MANUAL.

31. [T] Vertical frame check

    a. Manual V/H thumbwheels set — 350 Knots/ 1,800 Feet.

    b. FRAME switch — VERT.

c. FILM switch — RUN.

Observe exposure interval of 1.0 second, frame camera green light illuminated, and check camera frame counter for proper operation.

d. FILM switch — OFF.

e. FRAME switch — VERT.

32. [T] PAN autocycle check

a. PAN switch — CTR.

b. FILM switch — RUN.

Observe exposure interval of 1.0 second, green PAN light illuminated, and check camera frame counter for proper operation.

c. PAN switch — LEFT or RIGHT.

Observe exposure interval of 2.0 seconds, PAN go light illuminated, and check camera frame counter for proper operation.

d. FILM switch — OFF.

CAUTION

Do not run PAN BIT (it may cause film jams).

33. [T] PAN pulse mode check.

a. Manual V/H thumbwheel set — 350 Knots/13,500 Feet.

b. PAN switch — CTR.

c. FILM switch — RUN.

Observe exposure interval of 5.0 seconds, green PAN light illuminated, and check camera frame counter for proper operation.

d. FILM switch — OFF.

e. PAN switch — OFF.

34. [T] IR sensor check.

Note

Before IRLS system check, observe IR NR light out following cooldown and BIT. Observe film counter movement by 1 foot.

a. IRLS switch — WFOV.

b. Manual V/H thumbwheel set — 350 Knots/600 Feet.

c. FILM switch — RUN.

Observe green IRLS light flashing at 5-second interval and check proper film counter operation.

d. FILM switch — OFF.

e. IRLS switch — STBY.

After INS ALIGN COMPLETE computer message or when ready for takeoff:

35. NAV mode switch — INS.

Observe MFD transition from align format.

36. DEST data — Verify.

37. BRG/DIST to destination — Check.

38. OWN A/C groundspeed — Check.

39. MAG VAR — Check.

40. Notify pilot — Ready To Taxi.

7.5.5 Taxi — RIO. The RIO primary responsibility during taxiing is to act as copilot/safety observer. BIT checks may be performed while taxiing, provided that RIO attention is not diverted from copilot/safety observer duties.

1. Record ORT/IBIT and maintenance display results on BER form.

2. OWN A/C groundspeed — Check.

Own-aircraft groundspeed when stopped should be less than 3 knots.

3. [T] OWN A/C altitude — CHECK.

7.5.6 In-Flight Reconnaissance System Check — RIO. En route to target area:

1. [T] FRAME switch — VERT.
2. [T] PAN switch — CTR.
3. [T] IRLS switch — WFOV.
4. [T] FILM switch — RUN.

   Run only long enough to check operation and observe FRAME, PAN, and IRLS green lights illuminated and check frame and foot counters.

5. [T] FILM switch — OFF.
6. [T] IRLS switch — STBY.
7. [T] PAN switch — LEFT or RIGHT.
8. [T] FRAME switch — FWD.

   Note

   Prior to selecting FILM switch to RUN, delay 15 seconds for camera positioning.

9. [T] FILM switch — RUN.

   Run only long enough to check operation and observe FRAME and PAN green lights illuminated and check for proper film counter operation.

10. [T] FILM switch — OFF.
11. [T] FRAME switch — OFF.
12. [T] PAN switch — OFF.

Note

Keep manual V/H thumbwheels matched with actual altitude and airspeed to avert possible degraded imagery if an automatic shift to the manual mode occurs.

7.5.7 TARPS Degraded Mode Procedures

CAUTION

Prior to initiating corrective action on malfunctioning sensors, ensure that other sensors are either in OFF or STBY.

7.5.7.1 Serial Frame Camera Failure

1. [T] FILM switch — Cycle OFF/RUN/OFF.
2. [T] FRAME switch — Cycle OFF/VERT or FWD.
3. [T] FILM switch — RUN.
4. [T] FILM switch — OFF.
5. [T] V/H — MANUAL.
6. [T] Thumbwheels — Set High Vg/H Value.
7. [T] FILM switch — RUN.

If not corrected:

8. [T] FILM switch — OFF.
9. [T] FRAME switch — OFF.

7.5.7.2 Mount Failure

1. [T] FRAME switch — Cycle to Opposite Position.

If not corrected:

2. [T] FRAME switch — OFF.

CAUTION

- Initiate corrective action only one time.
- If mount light does not go off, secure sensor and wait 5 minutes to try again.

7.5.7.3 Panoramic Camera Failure

1. [T] FILM switch — Cycle OFF/RUN.
2. [T] FILM switch — OFF.
3. [T] PAN switch — Cycle OFF/CTR.
4. [T] FILM switch — RUN.

If not corrected:

5. [T] FILM switch — OFF.
6. [T] PAN selector — LEFT or RIGHT.
7. [T] FILM switch — RUN.

If not corrected:

8. [T] FILM switch — OFF.
9. [T] PAN selector — OFF.

CAUTION

Do not initiate BIT.

7.5.7.4 Manual V/H Failure

1. [T] Thumbwheels — 350 Knots/200 Feet.
2. [T] V/H switch — Test.
3. [T] MAN V/H light out — Good Test.
4. [T] MAN V/H light on — Thumbwheel Failure.

7.5.7.5 IRLS Failures

7.5.7.5.1 Cooldown Malfunction (IR NR Light Illuminated)

1. [T] IRLS switch — OFF.
2. [T] IRLS switch — STBY.

   After cooldown is complete, IR NR light will be out (2 minutes) then illuminates for the remainder of BIT (80 seconds). If IR NR light remains on for more than 17 minutes, IR cooling system is malfunctioning; turn the system off.

7.5.7.5.2 Other IR LS Malfunctions (IR LS Light Illuminated)

1. [T] FILM switch — Cycle OFF/RUN/OFF.
2. [T] IRLS switch — OFF.

   If IR LS light remains illuminated, assume IR door malfunction and continue with checklist.

3. [T] IRLS switch — STBY.

   Observe IR NR light illuminated for cooldown period (17 minutes), then out for 120 seconds, then on for remainder of AUTO TEST (80 seconds).

   Note

   Note time IR LS light illuminates during BIT.

4. [T] IRLS switch — NFOV.
5. [T] FILM switch — Cycle RUN/OFF.
6. [T] V/H switch — MAN.
7. Thumbwheels — 350 Knots/350 Feet.
8. [T] FILM switch — RUN.

If corrected:

9. [T] V/H switch — AUTO.

If not corrected:

10. [T] FILM switch — OFF.
11. [T] IRLS switch — OFF.

Note

For actual combat missions, fail indications may constitute abort criteria.

7.5.8 Postlanding — RIO

Note

Before shutdown, run IBIT. Note results on BER card.

1. Ejection seat — SAFE (coordinate with pilot).
2. EJECT CMD lever — PILOT.
3. Harnessing — Unstrap.
4. Radar beacon — OFF.
5. IFF — MODE 4 HOLD, Then OFF.
6. Data link — OFF.
7. ASPJ SYS switch — OFF.
8. INS — VIS FIX.
9. NAV MODE switch — OFF.
10. RECORD switch — OFF.

    Requires at least 20 seconds to allow tape to unthread prior to removal of electrical power.

11. IRST switch — OFF.

12. RDR switch — OFF.

13. DD power switch — OFF.

14. RADAR COOLING switch — OFF.

15. Tacan mode switch — OFF.

16. JTIDS MODE switch — STBY/OFF.

Note

If network operations are anticipated within 24 hours, select STBY; otherwise, select OFF. Do not leave the system in DATA SILENT or NORM for more than 90 seconds without electrical power or the battery will be depleted.

17. Standby attitude gyro — CAGE.

18. OXYGEN supply valve — OFF.

19. V/UHF radio MODE switch — OFF.

20. [T] TARPS control panel switches — OFF.

21. DEU — OFF.

22. MFD — OFF

23. Report — Ready for Shutdown.

After shutdown of both engines:

24. CANOPY handle — OPEN (alert pilot).

25. Flightcrew — Egress.

7.6 HOT REFUELING PROCEDURES

Before commencing ground hot refueling operations, a qualified groundcrew shall inspect the exterior of the aircraft for any discrepancies that might be hazardous to refueling or further flight operations. One groundcrew shall remain in a position on the right side of the aircraft within view of both the pilot and refueling crew. Any hazardous condition requires the immediate termination of refueling operations.

After refueling, the flightcrew should refer to appropriate checklists to configure the aircraft for takeoff, depending on intentions.

1. Fire extinguishing equipment — Available.

2. All emitters — STBY or OFF.

3. Right throttle — OFF.

4. Wheels — Chocked.

5. Parking brake — Pull.

CAUTION

If heavy braking is used during landing or taxiing followed by application of the parking brake, normal brake operation may not be available following release of the parking brake if the brakes are still hot. Check for normal brake operation after releasing the parking brake and before commencing taxiing.

6. REFUEL PROBE switch — FUS EXTD/ALL EXTD (as desired).

7. WING/EXT TRANS switch — As Desired.

Note

- If external tanks or wings accept fuel in FUS EXTD, select ORIDE on WING/EXT TRANS switch.
- If wings or external tanks do not accept fuel in ALL EXTD, select FUS EXTD and turn WING/EXT TRANS switch OFF.

8. REFUEL PROBE switch — RET.

9. WING/EXT TRANS switch — OFF.

7.7 DECK-LAUNCHED INTERCEPT PROCEDURES

Note

These procedures assume that a quick reaction, full-mission-capable launch is essential. Prestart procedures and cockpit configuration may vary in accordance with airwing policy and specific EMCON conditions. All CNI equipment, as applicable, should be placed in ON or STBY, YAW STAB AUG switch should be selected ON, and the HYD TRANSFER PUMP switch should be in NORMAL before application of electrical power. The LTS, INST, EMERG GEN, WG SWP, and STICK SW tests on MASTER TEST panel should be conducted and verified during periodic aircraft turnups. Compliance with the Takeoff Checklist is mandatory to ensure proper aircraft configuration before launch.

7.7.1 Pilot Procedures

1. External electrical power — ON.
2. Seat — ARM.
3. Fire detect — Check.
4. Left engine — IDLE.
5. Right engine — IDLE.
6. Displays — ON.
7. OBC — Select.
8. SW COOL — NORM.
9. OBC — Deselect.
10. Hook operation — Check.
11. Takeoff Checklist.
12. Ordnance crew — Arm.

7.7.2 RIO Procedures

1. NAV MODE switch — CV ALIGN.
2. CAINS/WPT — Select.
3. MFD 3 — ON.
4. Alignment coordinates — Verify/Update.
5. Seat — Arm.
6. RDR switch — XMIT.
7. TCS switch — ON.
8. IRST switch — ON.
9. MSL PREP switch — NORM.
10. [T] TARPS control panel SYSTEM switch — RDY.
11. [T] IRLS switch — STBY.
12. Takeoff Checklist (complete non-OBC functions).

When ALIGN QUALITY ≤2.0:

13. NAV MODE — INS.
14. Ordnance crew — Arm.

Note

- Sparrow tune occurs after CW is enabled and can complete after TX timeout.
- PH attack capability is present after launch and Sparrow tune occurs automatically whenever CW is enabled.

7.8 HOT SWITCH PROCEDURES

Increased potential hazards exist in hot switch operations when an engine is running with canopy open and front seat unoccupied. To minimize this potential hazard, minimum time should be spent in this condition. Pilot switch should be expedited and crew unstrap should be done with canopy closed. Pilot-to-pilot brief should be accomplished with a pilot in the aircraft.

Note

The RIO will vacate the aircraft first. When the RIO is on the ground, flight deck, or hangar deck, the pilot will exit. This is particularly important during shipboard operations.

1. Parking brake — Pull.
2. HYD TRANSFER PUMP switch — NORMAL.
3. RDR switch — OFF.
4. IRST switch — OFF.
5. TCS switch — OFF.
6. RECORD switch — OFF.
7. [T] TARPS control panel SYSTEM switch — OFF.
8. Left throttle — OFF.
9. ASYM LIMITER switch — ON (guard down).
10. ENG MODE SELECT — PRI.
11. THROTTLE MODE switch — MAN.
12. Throttle friction lever— Increase.
13. Ejection seats — SAFE.
14. Flightcrew — Unstrap.

15. Cockpit — Check FOR FOD.

16. CANOPY handle— OPEN.

17. Flightcrews — Switch.

18. Flightcrew — Strap In.

19. Ejection seats — Armed.

20. CANOPY handle — CLOSE.

21. FIRE DET/TEST — TEST.

22. THROTTLE MODE switch — BOOST.

23. Throttle friction lever — As Desired.

24. Left engine — Start.

25. RDR switch — STBY.

26. TCS switch — STBY.

27. IRST switch — STBY.

CAUTION

Ensure TARPS maintenance personnel have loaded sensors and cleared aircraft before initiating power to TARPS pod.

28. [T] TARPS control panel SYSTEM switch — RDY.

Note

The Poststart Checklist shall be completed with respect to aircraft configuration and switch positions prior to taxi.

7.9 FIELD CARRIER LANDING PRACTICE

7.9.1 Preflight Inspection. A normal preflight inspection will be conducted with specific attention directed to tire condition, nosestrut extension, AOA probe conditions, and windshield cleanliness. Check that the hook bypass switch is in FIELD.

7.9.2 Takeoff. The takeoff will be individual.

7.9.3 Radio Procedures and Pattern Entry. A radio check with Paddles is advisable before pattern entry to confirm Charlie time. Approaches to the field for break will be controlled by the tower and then switched to Paddles for FCLP pattern control. At no time will an aircraft remain in the pattern without a UHF receiver. On each succeeding pass, the following voice report will be made at normal meatball acquisition positions:

1. Side number

2. TOMCAT

3. Ball/Clara

4. Fuel state

5. Type of approach, if appropriate (automatic, degraded, etc.).

7.9.4 Pattern. The pattern should be a racetrack with the 180° approximately 1-1/4 miles abeam at 600 feet above field elevation (see Figure 7-4). The length of the groove should be adjusted to give a wings-level descent on the glideslope of 20 to 25 seconds (approximately 3/4 mile). For maximum gross weight at touchdown, refer to Chapter 4, Operating Limitations. The turn to the downwind leg should be commenced after climbing to pattern altitude (600 feet AGL) utilizing 30° angle of bank and 150 KCAS. Turning from the 180° power should be adjusted to maintain optimum angle of attack. A gradual descent may be commenced at this position with a minimum altitude of 450 feet AGL at the 90° position and 350 feet AGL as a minimum until the pilot is receiving glideslope information. At approximately 45°, the meatball appears on the Fresnel lens. Fly a rate of descent such that the ball is centered as the aircraft arrives wings-level in the groove. For manual, automatic, and DLC approach techniques, refer to Carrier-Based Procedures, Chapter 8.

7.9.5 Night FCLP. All provisions that apply to day FCLP also apply to night FCLP, plus the following items:

1. External lights — BRIGHT and STEADY.

2. Hook bypass switch — FIELD.

When comfortably situated in the pattern, instruments should be flown as much as possible up to the 45° position.

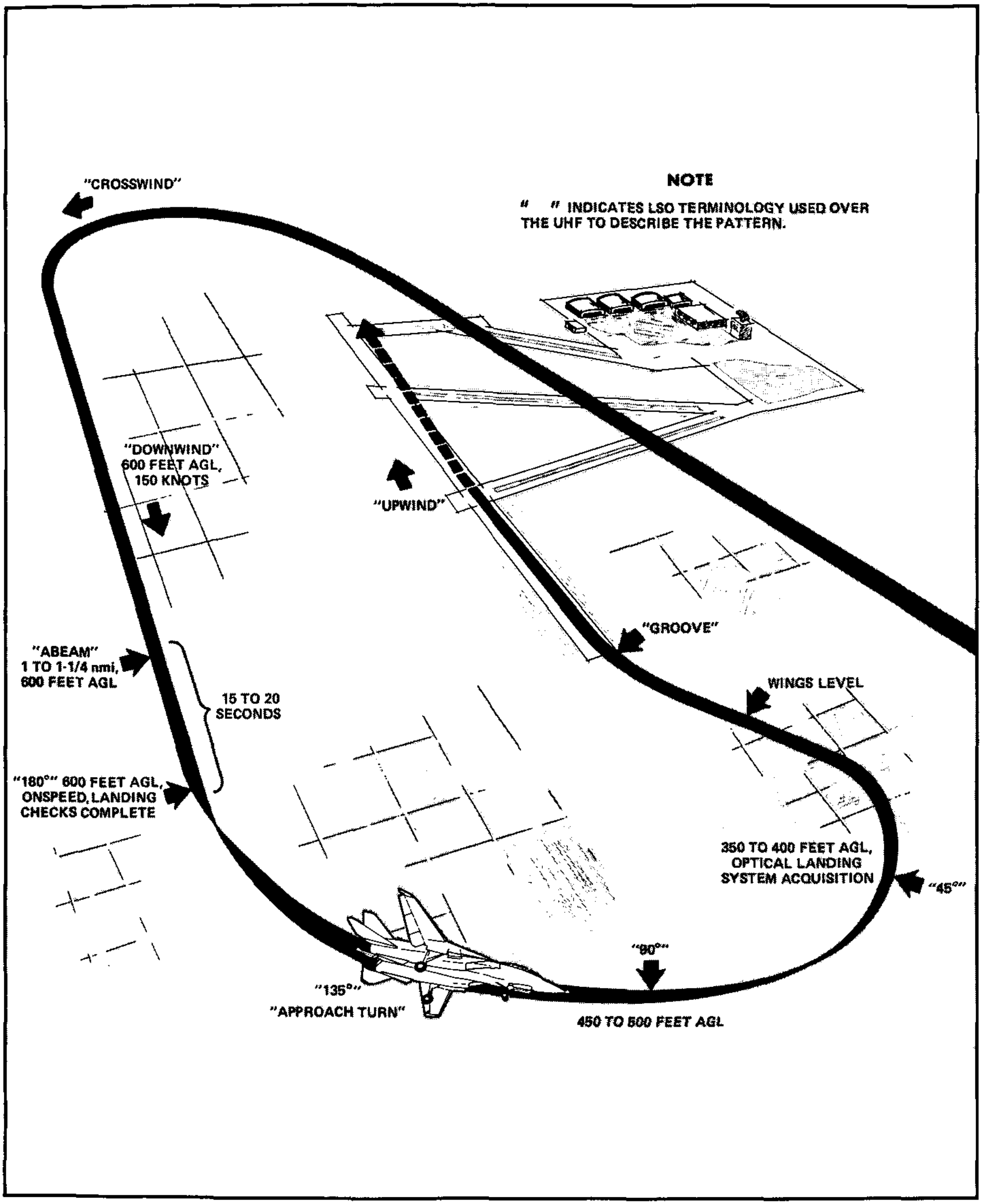

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Figure 7-4. Field Carrier Landing Practice

CHAPTER 8

Carrier-Based Procedures

8.1 CARRIER PREFLIGHT

8.1.1 Launch. Applicable aircraft launching bulletins, the CV and LSO NATOPS Manuals and the pertinent CV air operations manual shall be read by all flight crewmembers prior to carrier qualification. In addition, the predeployment lecture syllabus contained in Chapter I of the CV NATOPS Manual shall be completed.

8.1.2 Briefing. A thorough briefing shall be accomplished by the flight leader prior to launch. This briefing should call particular attention to current BINGO fields, emergency procedures peculiar to carrier operations, operating area NOTAMs, fuel management, and ship NAVAID status. Aircraft configuration, gross weight, expected WOD, and applicable launch trim settings will be verified prior to man-up.

8.1.3 Preflight. Preflight inspection should be accomplished with particular attention given to nosestrut, main landing gear, tires, hook, and underside of the fuselage. Note carefully the actual wing sweep, the lateral spacing between parked aircraft, and the general direction of engine exhaust. Do not preflight the aircraft topside aft of the bleed air doors if spotted with the tail outboard of the safety nets. In the cockpit, particular attention should be given to the flightcrew displays to ensure that the retaining devices have been installed. Ensure that the WING SWEEP handle is secure in the oversweep position when applicable. If the wings are not in oversweep, ensure that the emergency WING SWEEP handle position corresponds with the actual wing position. Leave the emergency WING SWEEP handle guard up, extend the emergency WING SWEEP handle, and pull WING SWEEP DRIVE NO. 1 and WG SW DR NO. 2/MANUV FLAP circuit breakers (LD1, LE1). Crossbleed starts should not be performed unless the area aft of the aircraft is clear. Tiedowns should not be removed and engines should not be started unless the auxiliary brake air pressure gauge indicates a full charge.

8.2 START AND POSTSTART

Shipboard start and poststart procedure abbreviations of the shore-based checklists are as delineated for the poststart-pilot procedures. Certain steps are omitted because aircraft are spotted too close together to allow the wings to be swept forward while tied down. Cranking the left engine prior to starting the right, as outlined in the shore-based procedures will ensure that auxiliary brake pressure is available and will ensure that backup flight control module is full of hydraulic fluid prior to cycling.

8.2.1 Carrier Alignment. Carrier alignment of the INS and SAHRS concurrently or of the INS alone can be accomplished using SINS data or manually entered ship's position, speed, and heading. A stored heading SINS alignment is also available.

8.2.1.1 Concurrent SINS Alignment. For either data-link or deck-edge-cable transmission of SINS data:

1. Ensure SAHRS AC/DC cb's (1A3, 1A5, 1A6, 9I3) are pulled prior to application of electrical power.
2. DATA LINK power switch — ON.
3. DATA LINK MODE switch — CAINS/WPT.
4. Verify parking brake is set.

Note

Application of SAHRS power prior to selecting CV ALIGN will not allow SAHRS to properly align.

5. NAV MODE switch — CV ALIGN.
6. Reset SAHRS cb's.
7. Select OWN A/C MFD format by depressing DATA pushbutton on MFD MENU1 display. The CV SINS DATA format will appear.

8. Verify that SHDG is not boxed. If it is, depress the SHDG pushbutton to unbox it.

9. Monitor the progress of alignment by observing the QUAL and TIME acronyms and the align scale on the MFD OWN A/C format. The SINS (ship) latitude, longitude, and INS north and east velocities can be evaluated on the MFD OWN A/C format. An INS ALIGN COMPLETE message will normally occur in 7 minutes. At this time the align quality should be below 1 nm per hour.

Note

Do not select SAHRS during CV ALIGN to check alignment progress. Wait until INS alignment is complete and INS has been selected on the NAV MODE switch before selecting SAHRS.

10. SAHRS alignment progress may be monitored at this time by selecting the NAV page.

Note

- The SAHRS alignment process will initiate after the INS determines a valid true heading (approximately at INS quality value of 5). SAHRS quality value should reinitiate to approximately 31.2 at that time.
- If power has been applied to the aircraft for an extended period of time prior to INS CV align being initiated, the SAHRS may complete a ground align (NORM) and a SAHRS complete message appears on the MFD. After the INS CV align is initiated, the SAHRS will initiate a concurrent CV align normally, but another SAHRS align complete message may not occur.

11. It is advisable to continue alignment after appearance of the INS ALIGN COMPLETE message if time permits. When ready to take the alignment, the inertial navigation mode may be selected by setting the NAV MODE switch to INS.

Note

Although SINS alignment normally requires no entry of data, if a SINS alignment takes place at any carrier location other than the flight deck, then it is advisable to enter the correct vertical lever arm via the DEU. This is the height in feet of the aircraft INS above the carrier SINS location. This entry can be made only via the DEU by calling up the DEU CV ALIGN page and depressing the VLA option key.

8.2.1.2 Concurrent SINS Stored Heading Carrier Alignment. Perform a reference alignment by following the SINS carrier align procedure in paragraph 8.2.1.1. When the INS ALIGN COMPLETE message appears on the HUD/VDI formats, return the NAV MODE switch to OFF.

1. Repeat steps 1 through 7 of concurrent SINS alignment.

2. Verify that SHDG is boxed on CV SINS DATA MFD format.

3. Repeat steps 9 and 10 of concurrent SINS alignment.

8.2.1.3 Concurrent Manual Carrier Alignment. Manual carrier alignment should be used only when SINS data or the SINS carrier align mode is unavailable. This can be determined by the appearance of the CV MAN DATA format on the MFD with MAN boxed.

1. Repeat step 1 and steps 4 through 8 for concurrent SINS alignment. When the DATA pushbutton on the MFD is depressed, the CV MANUAL DATA format will appear.

2. Enter best knowledge of ship latitude, longitude, speed and heading via the DEU or DD.

Note

- Entry of VLA is never required for manual carrier alignment.
- When using the DEU, data entry is made via the DEU CV ALIGN format, using the LAT, LONG, CSPD, and CHDG option keys and the appropriate quadrant and numerals.
- Data entry using the DD requires selection of the NAV category from the MFK pushtile and the boxing of the OWN A/C acronym prior to entering the carrier latitude and longitude via the DD LAT, LONG, quadrant, and numeral pushtiles. Entry of carrier speed and heading via the DD requires the boxing of the WIND acronym prior to using the DD SPD, HDG, and numeric pushtiles.

3. Repeat steps 9 to 11 for concurrent SINS alignment.

Note

In concurrent manual carrier align, the INS ALIGN COMPLETE computer message may take 15 minutes or longer to appear. The navigation quality at this time may not be better than 3 nm/per hour. Because of the extensive alignment time, it may be necessary to launch prior to the receipt of the INS ALIGN COMPLETE computer message.

8.2.2 SAHRS Standalone Carrier Alignment. The SAHRS standalone CV alignment mode is manually selected from the SAHRS ALIGN MFD format. The SAHRS has no true standalone carrier align mode like the INS. During concurrent INS/SAHRS carrier align modes, the SAHRS depends upon the INS to provide an initial input of true heading. Since this is not available in SAHRS standalone carrier alignment, when the SAHRS CV pushbutton is depressed in SAHRS standalone operation, it is commanded to a DG mode. Once the parking brake is released a DG heading can be entered via the DEU. When the aircraft is airborne, the slaved mode can be selected or if a system velocity source is present, in-flight restart can be selected to bring the SAHRS to a normal operational mode.

8.3 TAXIING

Shipboard taxi operations differ slightly from the field. Taxiing aboard ship requires higher power settings and must be conducted under positive control of a plane director. Any signal from the plane director above the waist is intended for the pilot and any signal below the waist is intended for deck-handling personnel.

8.3.1 Nosewheel Steering. The nosewheel steering system characteristics are excellent and enable extremely tight cornering capability. At full nosewheel steering deflection (70°), the inside mainmount wheel backs down and turn radius will be restricted if the inside brake is locked. For a minimum radius turn, momentarily depress the brake on the inside wheel and then allow the inside wheel to roll freely while controlling the turn rate by braking the outside wheel. For normal turns, symmetric brake applications should be applied to control aircraft forward motion. Forward motion should be initiated before effecting a tight radius turn to reduce power requirements.

8.3.2 Taxi Speed. Taxi speed should be kept under control at all times, especially on wet decks and approaching the catapult area. Be prepared to use the parking brake should normal braking fail. While taxiing, both ejection seats should be armed. The parking brake is an excellent feature that may be used to prevent leg fatigue during taxi delays. However, it should not be used once forward of the jet-blast deflector.

8.4 CATAPULT HOOKUP (DAY)

Set the attitude displays to show level flight at normal strut extension. Proper positioning on the catapult is easily accomplished if the entry is made with only enough power to maintain forward motion and if the plane director signals are followed explicitly.

WARNING

- All functional checks shall be performed before taxiing onto the catapult. Ensure that the Takeoff Checklist is complete and that the proper trim is set for launch before entering the nosetow approach ramp.

- All catapult launches shall be conducted with the HUD in the caged mode. If approaching the catapult after an uncaged HUD landing, cycle the TLN display mode button to ensure the HUD defaults to the caged format.

The catapult director will direct the pilot to approach the catapult track, using nosegear steering and brakes. Upon signal from the plane director and when positioned immediately behind the mount of the lead-in track, kneel the aircraft. If the launch bar is to be lowered from the cockpit, upon signal from the plane director, deflect the nosewheel to lower the launch bar, center the nosewheel, and disengage nosewheel steering. If the launch bar is to be lowered by the deck crew, no pilot action is required. After the hold-back bar has been attached to the aircraft and checked by squadron maintenance personnel, the catapult director will direct the aircraft forward until the hold-back bar is snug against the catapult buffer unit. The aircraft will be stopped in position for shuttle tension up. The attitude displays will show 2° to 3° nosedown with the aircraft in the kneeled position.

WARNING

Nosewheel centering can contribute to launch bar misalignment in the catapult shuttle, which could result in premature launch bar separation during launch. The nosewheel centering latching relay must be deactivated by depressing the nosewheel steering button after the hook check and before entering the catapult. It will also deactivate the nosewheel steering automatic disengagement function; nosewheel steering must be manually disengaged when entering the catapult.

CAUTION

- If the LAUNCH BAR light illuminates immediately upon selecting KNEEL with the NOSE STRUT switch, a malfunction in the system has occurred and the landing gear will not retract following the catapult launch.

- Nosewheel steering is designed to disengage and the NWS ENGA light goes off when deck personnel lower the launch bar on the catapult. The arresting hook must have been cycled on deck and the throttles set at IDLE to enable the system. This feature prevents the pilot from inadvertently damaging the launch bar during control checks after final tensioning.

8.4.1 Catapult Trim Requirements. The following requirements are applicable to clean aircraft or any combination of air-to-air store, external tank, gross weight combinations, and launch cg locations between 7.0-percent and 18.5-percent MAC.

Note

To determine center of gravity for a particular aircraft, refer to NAVAIR 01-1B-4, Handbook of Weight and Balance.

Figure 8-1 lists recommended catapult launch longitudinal trim settings.

Anticipated End Airspeed Above Minimum (Knots)	Longitudinal Trim (degrees) Trailing Edge Up		
	Cg between 7.0% and 11% MAC	Cg between 11% and 16% MAC	Cg between 16% and 18.5% MAC
0 to 9	9	6	3
10 to 20	8	5	2
21 to 50	7	4	0

Figure 8-1. Catapult Launch Trim Requirements

8.4.2 Catapult Launch. Aircraft launch gross weight will be cross-checked and verified by signal with the flight deck personnel prior to kneel. If the aircraft is to be catapulted with a partial fuel load, the pilot should ensure that longitudinal trim settings are adjusted if necessary (Figure 8-2). Upon receipt of the ''tension-up and release brakes" signal, release the brakes, ensure the parking brake is off, and advance the throttles to MIL. Ensure nosewheel steering is disengaged prior to performing control wipeout. When a turnup signal is received from the catapult officer, grip the throttles firmly, check engine instruments, ensure that the caution and advisory panel is clear, and the RIO is ready. When satisfied that the aircraft is functioning properly, salute the catapult officer. Normally, a 3- to 5-second delay will occur before the catapult fires. Optimum launch technique is to maintain a loose grip on the control stick while allowing it to move aft during the catapult stroke.

WARNING

- Failure to allow the control stick to move aft during the catapult stroke will result in degraded pitch rate and excessive sink off bow.

- Catapult launch with a partially filled external tank is not authorized.

Initial catapult firing results in a short-term vertical acceleration of 15g to 20g caused by full compression of the stored-energy nosestrut. Firmly restrain the throttles to prevent their aft travel during the catapult stroke.

At shuttle release, the energy stored in the nosestrut is released, rotating the aircraft up to the initial flyaway attitude of approximately 10° nose up. The pitch trim for launch is designed for hands-off operation. The control stick will, without pilot input, return to the trimmed position shortly after shuttle release. If the trim is set properly, the aircraft should rotate and fly away at the proper attitude without pilot input. During rotation the flightcrew will sense the aircraft characteristics and should be prepared to make control inputs as necessary to ensure a safe flyaway. During low excess endspeed catapult launches (less than 15 knots excess), AOA will spike up to 17 units, then gradually decrease during the flyaway.

8.4.3 Catapult Abort Procedures (Day). If after turnup on the catapult, the pilot determines that the aircraft is down, the pilot gives the no-go signal by shaking his head from side to side. Never raise the hand into view or make any motion that might be construed as a salute. After the catapult officer observes the pilot no-go signal, he will cross his forearms over his head, and then give the standard release tension signal. When the catapult is untensioned, the catapult officer will signal the

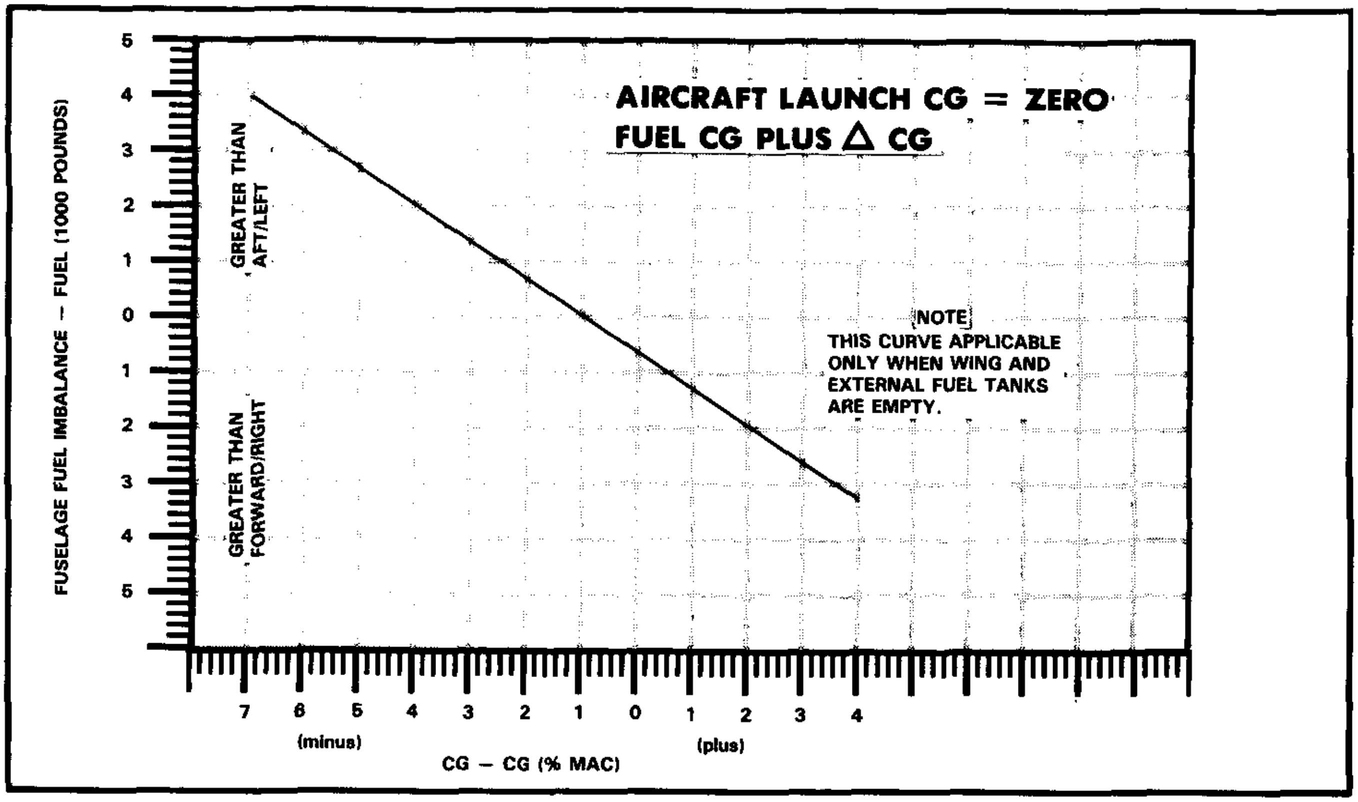

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Figure 8-2. Center-of-Gravity Variation With Fuel Loading

pilot to raise the launch bar. The pilot shall ensure that the throttles are seated in the catapult detent and will raise the launch bar with the LAUNCH BAR ABORT switch.

CAUTION

To avoid damage to the launch bar retract mechanism, do not actuate the LAUNCH BAR ABORT switch with the nosewheel deflected off center.

When the launch bar is clear of the shuttle, the catapult officer will move the shuttle forward of the aircraft launch bar. At this point the aircraft is no longer in danger of being launched. The catapult officer will signal the pilot to lower the launch bar and then step in front of the aircraft and signal the pilot to throttle back.

CAUTION

- If the aircraft is down prior to it being pushed or pulled back for release from the holdback fitting and when directed by the catapult officer, the launch bar shall be raised by the LAUNCH BAR ABORT switch.
- Unkneeling the nosegear while the launch bar is in the catapult track or shuttle will damage the launch bar linkage and bungees. The pilot should unkneel the aircraft only when he is sure that the launch bar is free to rise and upon signal from the catapult officer or taxi director.

If the aircraft is down after the go signal is given, transmit the words "Suspend, Suspend"; however, the flightcrew should be prepared for the catapult stroke and to perform emergency procedures if required.

8.5 LANDING

8.5.1 Carrier Landing Pattern (VFR). The VFR carrier landing pattern (Figure 8-3) shall be in accordance with the CV NATOPS manual. The pattern starts with the level break at 800 feet and 300 to 350 knots. The break interval will be approximately one-half of the desired ramp interval time (15 to 17 seconds normal interval). When established wings level on the downwind leg, descend to and fly the pattern at 600 feet MSL. Engage DLC upon completion of flap extension.

MAXIMUM LANDING GROSS WEIGHT 54,000 POUNDS

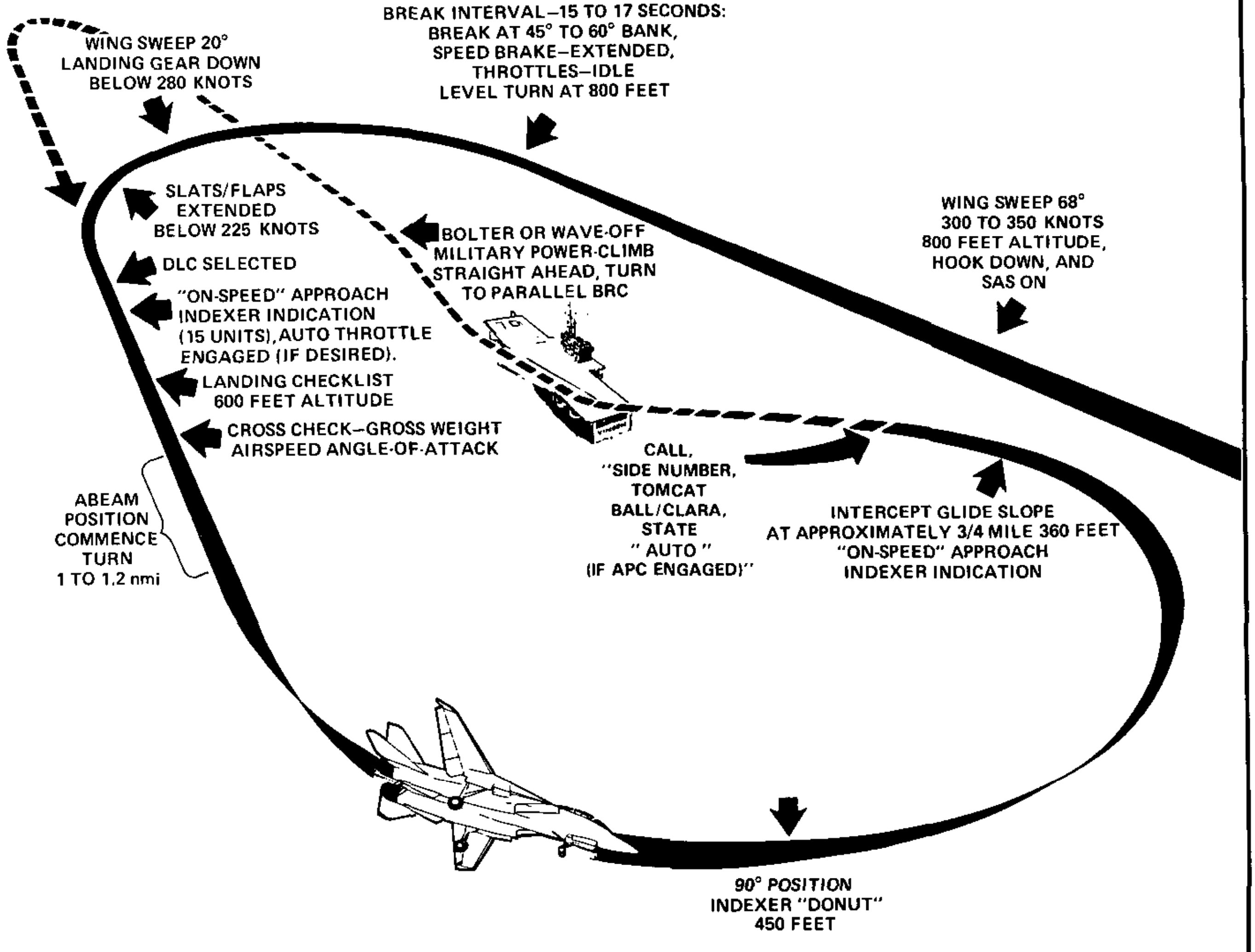

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Figure 8-3. Carrier Landing Pattern

Note

Selection of DLC during the flap extension cycle can generate excessive pitch rates. DLC is to be selected only upon completion of the flap cycle. DLC must be deselected prior to flap retraction to avoid excessive pitch trim change with automatic DLC stowage during the flap retraction cycle.

Slow to 15 units AOA or computed on-speed (whichever is faster) and verify airspeed/AOA correlation, engage APC if desired, check for proper DLC operation, and complete the Landing Checklist prior to reaching the 180° position. The 180° turn is commenced 1 to 1.2 nm abeam the LSO platform to arrive at the 90° position at approximately 450 feet MSL. The nominal bank angle throughout the turn should be 25° to 27°. Glideslope meatball acquisition will occur at approximately 0.6 nm. Do not descend below 300 feet prior to acquiring the ball. On rollout to final, slightly overshoot the ship's wake. Optimum time on glideslope is approximately 15 to 18 seconds.

WARNING

- The LSO and tower must be informed if the landing is to be made in any wing or flap configuration other than 20° wing sweep, flaps and slats down, or RATS inoperative, to ensure wind-over-deck requirements are met.
- Do not attempt shipboard landing with inoperative roll SAS and store asymmetry greater than 170,000 inch-pounds because of lateral pilot-induced oscillation in the approach unless field divert is not possible. (Example: weapon rail at station 6 and AIM-54 missile at station 8 equals 170,000 inch-pounds.)

Note

With the hook down, airspeed in excess of 300 knots may cause the hook transition light to illuminate.

8.5.2 Manual Approach Technique. The rapid engine response characteristics allow the pilot to make timely, small amplitude power changes to make glideslope corrections. Because of the rapid engine response and high-throttle sensitivity, the pilot must avoid overcontrolling power. DLC should be engaged for all approaches. Approaches flown without DLC will degrade flying qualities resulting in significant glideslope and lineup deviations. Pitch compensation for DLC inputs is optimized for approach airspeeds. Activation of DLC at higher airspeeds will result in inducing noticeable changes in pitch attitude. DLC may be employed by vernier or bang-bang control depending on the extent of the correction required. DLC is most effective in correcting for glideslope deviations caused by gusty conditions or ship burble. Caution should be taken not to use DLC to compensate for a major overpowered or underpowered condition.

CAUTION

Caution must be taken to avoid sustained full-down DLC commands for a high condition at the ramp as this will result in excessive sink rates and subsequent hard landings.

Once established on glideslope, keep the scan going, cross-checking meatball, lineup, and AOA. Be alert for a waveoff. With rough seas and pitching decks, some erratic meatball movements may be encountered. If this is the case, average out the ball movements to maintain a smooth and safe rate of descent. To avoid being "cocked up," arrest a "come down in close" with power and up DLC. Attempts to arrest high sink rates with nose attitude alone could result in landing damage to the ventral fins and afterburner. Also, avoid dropping the nose prior to touchdown as this significantly increases the chances of a hook skip bolter. Upon touchdown, add full MIL power, manually retract speedbrakes, and maintain aft stick pressure to minimize chances of a hook skip bolter. Selection of MIL power will automatically disengage DLC and retract the speedbrake.

A good start is imperative to minimizing lineup corrections while on the glideslope and will prevent the tendency to chase lineup. Small, coordinated rudder inputs should be used to reduce the nose yaw that is easily generated by lateral stick inputs.

8.5.3 Approach Power Compensator Technique. Practice is required to develop the proper control habits necessary to use the APC. For the APC to perform satisfactorily, smooth attitude control is essential. Large, abrupt attitude changes result in excessive power changes. APC use is not recommended in gusty conditions. The APC will overcontrol AOA fluctuations resulting in large airspeed and/or glideslope deviations. The APC system was designed to be used with the engines operating in the primary mode and is not recommended with either one or both of the engines in secondary mode.

As the initial turn from the 180° position is made, the aircraft will momentarily indicate up to 2 units slow. The APC will adjust power to correct back to onspeed condition throughout the remainder of the turn. Upon rollout on glideslope, the pilot must override the tendency for the nose to pitch up by maintaining slight forward stick. The aircraft will indicate 1 to 2 units fast, which will slow to onspeed within 5 seconds. The use of DLC in conjunction with small attitude changes to maintain glideslope will minimize AOA deviations and result in optimal APC performance. Timely use of DLC can also be used to more rapidly correct from a fast or slow condition. Close-in corrections are very critical. If a high in-close situation develops, the recommended procedure is to stop the meatball motion and not attempt to recenter it. A low in-close condition is difficult to correct with APC and often results in an over-the-top bolter. It may be necessary to disengage or manually override APC in order to safely recover from a low in-close situation. Throughout the approach, the pilot should keep his hand on the throttles in the event APC disengages inadvertently. A smooth throttle transition from AUTO to BOOST mode can be achieved by depressing the CAGE/SEAM button on the inboard throttle grip.

8.5.4 Waveoff Technique. A waveoff will be initiated immediately upon a signal or voice call from the LSO. MIL power should be used for all dual-engine waveoffs. Maintain the landing attitude until a positive rate of climb is established. Do not over rotate the aircraft in close as this significantly increases the chance of in-flight engagement.

WARNING

Dual engine afterburner takeoffs are prohibited. Inadvertent arrestment or in-flight engagement in dual afterburner would result in catastrophic damage to the aircraft and/or arresting gear.

Normally, waveoffs will be taken straight ahead, especially when close in. When using APC, waveoff technique is the same as for manual approaches except that a force of approximately 8 pounds is required to disengage the throttle torque switches. Disengagement of the APC by overriding the throttle forces results in the throttle MODE switch automatically returning in BOOST and illuminates the AUTO THROT light on the pilot left-hand ladder light assembly. A time delay relay holds the AUTO THROT light on for 10 seconds following APC disengagement.

CAUTION

If a force in excess of 14 pounds is applied to break the throttles out of the automatic mode, the throttle MODE switch will return to BOOST but the throttle mode will revert to manual. The switch must be cycled to MAN and back to BOOST to regain the BOOST mode.

8.5.5 Bolter Technique. The bolter maneuver is effected by selecting MIL and slight aft control stick until the desired flyaway attitude is established.

CAUTION

The use of excessive backstick on a bolter may cause the tail surface to stall, delaying aircraft rotation and causing the aircraft to settle off the angle.

8.5.6 Bingo Fuel. Fuel reserves should be programmed depending on distance of the field from the CV, aircraft configuration, and en route weather. This bingo fuel quantity should be set before takeoff.

8.5.7 Arrested Landing and Exit From the Landing Area. As the aircraft touches down, advance throttles to MIL. Upon completion of landing rollout, reduce power to IDLE. Raise the hook and flaps and select wing-sweep BOMB while allowing the aircraft to roll aft. Apply brakes on signal. Flaps retraction requires approximately 7 seconds. When the flaps are fully retracted the wings will sweep aft. Engage nosewheel steering and taxi forward on the come-ahead signal. If the wings sweep aft to 55°, auxiliary and main flap retraction has been verified and full-aft wing sweep may be selected using the emergency handle. The RIO should monitor wing-sweep position while taxiing. Oversweep should be selected prior to final spot and shutdown. The engines should remain running until the cut signal is given by the plane director. If at any time during this phase of operations a brake failure occurs, pull the parking brake. If the aircraft continues to roll, drop the hook, advise the tower, and signal for chocks to be installed (use nosewheel steering to ensure that the aircraft remains on the deck). Do not unstrap, dearm the ejection seat, or leave the cockpit until tiedowns have been installed.

Note

Aircrew shall inform tower in the event of RATS failure on landing.

8.5.8 Carrier-Controlled Approaches. Should these procedures conflict with the applicable CV Air Operations manual, the latter shall govern. Detailed pilot-controller voice procedures must be established in accordance with each ship's CCA doctrine. Figure 8-4 shows a typical carrier-controlled approach. Mode I, mode IA, and mode II ACLS approaches are described in Chapter 17, Automatic Carrier Landing System. Aircrew should have a thorough understanding of this chapter and the AFCS and APC portions of Chapter 2 prior to attempting a coupled ACLS approach.

8.5.9 Hold Phase. Five minutes before penetration, defogging shall be actuated and maximum comfortable interior temperature will be maintained to prevent possible fogging or icing on the windshield and canopy.

Note

Fuel dump is accomplished by gravity flow and its effectiveness is reduced during the penetration descent. Fuel dump, if required, should be planned accordingly for the level leg.

1. Before descent, check shoulder harness handle locked, set lights as directed by existing weather, and lower arresting hook.

2. Accomplish final changes to radio and IFF upon departing marshal or earlier. After these changes are made, the pilot should make no further changes except under emergency conditions.

3. When commencing penetration, initiate a standard descent: 250 knots, 4,000 fpm, speedbrakes as required.

WARNING

If a gear and/or flaps down penetration is required, ensure that the wings are programmed forward of 22° prior to lowering flaps. If flaps are lowered with wings swept aft of 22°, auxiliary flap extension will be inhibited resulting in rapid nosedown pitching rates.

4. Radar and barometric altimeters shall be cross-checked continuously when below 5,000 feet.

8.5.10 Platform. At 20 miles passing through 5,000 feet, aircraft descent shall be slowed to 2,000 fpm. At this point, a mandatory, unacknowledged voice report will be broadcast by each pilot. The aircraft side number will be given and "platform" will be reported. Continue descent to 1,200 feet.

8.5.11 Ten-Mile DME Fix

1. At 10 miles, report side number and 10-mile gate.

2. Commence transition to landing configuration, unless otherwise directed by CCA, maintaining 1,200 feet.

3. Gear and flaps shall be down by 6 miles.

4. Complete the landing checklist. Check anti-ice, lights, and rain removal, as required.

8.5.12 Six-Mile DME Fix. For a precision approach radar approach, maintain 1,200 feet at approach speed until intercepting the glidepath at 3 to 3.25 miles, unless otherwise directed.

For an air surveillance radar approach, a gradual descent of 600 fpm can be commenced departing the 6-mile DME fix. Maintain 600 feet until the aircraft intercepts the center of the glideslope at 1-1/4 to 1-1/2 miles on a 3.5° slope. Commence a descent of 500 to 700 fpm, using the following checkpoints:

1. 1 mile — 460 feet.

2. 3/4 mile — 360 feet.

3. 1/2 mile — 260 feet.

8.5.13 Meatball Contact. When transitioning to a visual approach, report call, side number, TOMCAT, meatball or Clara (no meatball), fuel state, and type pass. The LSO will acknowledge, and instructions from the final controller will cease. Pilots are cautioned against premature contact reports and transition to visual glideslope during night recoveries when visibility permits sighting the ship beyond 2 to 3 miles. The height and dimension of the entire lens or mirror optical beam at 1-1/4 miles is over 200 feet and the true center cannot be distinguished. This, coupled with the relatively short length of the runway lights, will give the pilot the illusion of being high when, in fact, the aircraft may be well below optimum glideslope. An additional advantage of delaying the meatball report (even though the ball is in sight) is that the final controller will continue lineup instructions that can greatly assist the pilot in establishing satisfactory lineup. Use the vertical velocity indicator to set up a rate of descent of 500 to 700 fpm. The AN/ARA-63 is an excellent aid during the approach and should be used whenever possible.

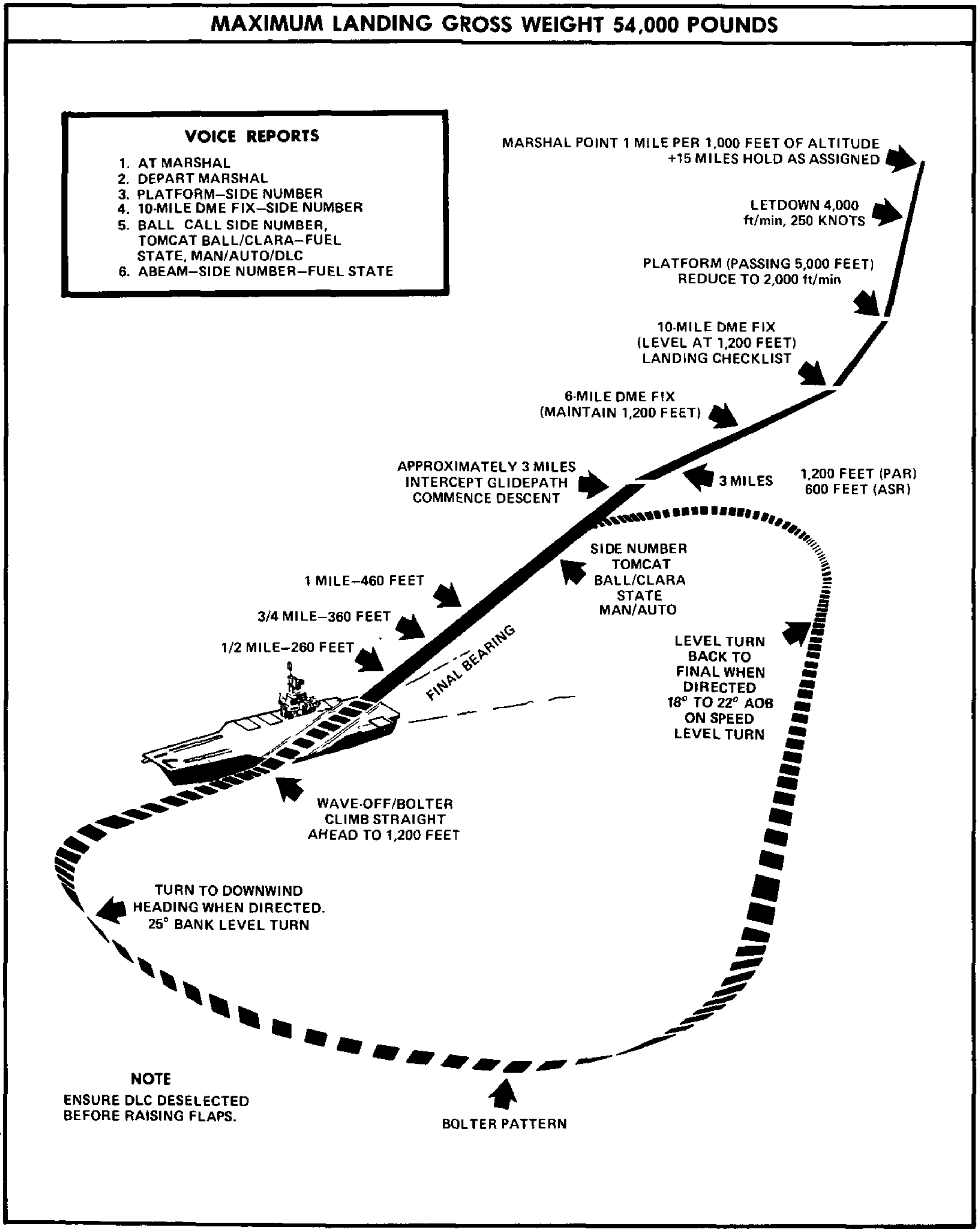


Figure 8-4. Carrier-Controlled Approach (Typical)

8.6 WAVEOFF AND BOLTER

In the event of a waveoff or bolter, climb straight ahead to 1,200 feet and maintain 150 knots. When directed by CCA, initiate a level turn to the downwind leg reporting abeam with fuel state. (If no instructions are received within 2 minutes or 4 miles DME, attempt radio contact; if unable, assume communications failure and initiate the downwind turn to the reciprocal of final bearing reporting abeam with fuel state. If no acknowledgment is received, start a turn at 4 miles or 2 minutes to intercept final bearing.) A 20° bank angle at 150 knots on the upwind turn establishes the aircraft at the desired 2 miles abeam on the downwind leg.

CATCC clears the aircraft to turn inbound to intercept final bearing. A level, on-speed approach turn of 18° to 22° bank angle from the normal downwind position allows the aircraft to properly intercept final bearings at a minimum of 3 miles aft of the ship. Traffic spacing ahead may require that the aircraft continue on downwind leg well past the normal abeam position before being directed to turn to final bearing. No attempt should be made to establish visual contact with the ship when executing a CCA until the final approach turn has been executed.

Note

The radar beacon (AN/APN-154) should be turned off as soon as practicable after landing to avoid causing interference with AN/SPN-42 control of other aircraft in the pattern.

8.7 NIGHT FLYING

Night carrier operations will have a much slower tempo than daylight operations and it is the pilot's responsibility to maintain this tempo. Normal day carrier operations shall be used except as modified below.

8.7.1 Briefing. Before initial night flight operations, all pilots should receive an additional briefing from the following persons:

1. Flight deck officer
2. Catapult officer
3. Arresting gear officer
4. LSO
5. CATCC.

Individual flight briefings will include all applicable items outlined above, with particular emphasis on weather and bingo fuel.

8.7.2 Preflight. In addition to normal cockpit preflight, ensure that external light switches are properly positioned for poststart light check. Install night filters on applicable cockpit displays.

8.7.3 Poststart. Adjust cockpit light to desired brightness. When ready for taxi, indicate with appropriate signal.

8.7.4 Taxi. Night deck-handling operations are of necessity slower than those used during the day. When a doubt arises as to the meaning of a signal from a taxi director, stop.

8.7.5 Catapult Hookup (Night). Procedures for aircraft catapult hookup at night are identical to those used during day operations. However, it is difficult to determine your speed or degree of motion over the deck. The pilot must rely upon, and follow closely, the plane director signals.

8.7.6 Catapult Launch. On turnup signal from the catapult officer, ensure throttles in MIL and check all instruments. When ready for launch, place external light master switch ON (bright and steady). After launch, establish an 8° to 10° pitch attitude, cross-checking instruments to ensure a positive rate of climb. Retract the landing gear. An altitude of 500 feet is considered to be minimum altitude for retraction of flaps. When well established in a climb, switch lights to flashing or as applicable for an instrument climbout. The standby indicator should be used in the event of a primary display(s) malfunction.

WARNING

If wings sweep back inadvertently, close attention should be paid to maintaining positive rates of climb. The loss of lift incurred by premature wing sweep aft can result in significantly decreased rates of climb, with very little change in pitch attitude and trim requirements.

8.7.7 Catapult Abort Procedures (Night). The pilot no-go signal for night launches will be to not turn on the exterior lights, and to transmit on land or launch his aircraft side number, the catapult the aircraft is on, and the words "Suspend, Suspend." After the catapult is untensioned, the catapult officer will signal to raise the launch bar. The pilot shall ensure that the throttles are seated in the catapult detent or throttle friction is full forward before raising the launch bar with the LAUNCH BAR ABORT switch. When the launch bar is clear of the shuttle, the catapult officer will move the shuttle forward of the aircraft launch bar. At this point the aircraft is no longer in danger of being launched. The catapult officer will signal the pilot to lower the launch bar and then step in front of the aircraft and signal the pilot to throttle back.

WARNING

If the aircraft is down after the go signal is given, transmit the words ''Suspend, Suspend''; however, the flightcrew should be prepared for the catapult stroke and to perform emergency procedures if required.

CAUTION

- If the aircraft is down prior to it being pushed or pulled back for release from the holdback fitting and when directed by the catapult launching officer, the launch bar shall be raised by the LAUNCH BAR ABORT switch.

- Unkneeling the nosegear while the launch bar is in the catapult track or shuttle will damage the launch bar linkage and bungees. The pilot should unkneel the aircraft only when sure that the launch bar is free to rise and upon signal from the catapult officer or taxi director.

8.7.8 Arrested Landing and Exit From Landing Area (Night). During approach, all lights shall be on bright and steady. At the end of arrestment rollout, turn off external lights and follow the director's signals while effecting the normal aircraft cleanup procedures.

CHAPTER 9

Special Procedures

9.1 IN-FLIGHT REFUELING PROCEDURES

Note

Before commencing in-flight refueling operations, each flight crewmember shall become familiar with the NATOPS Air Refueling Manual, NAVAIR 00-80T-110, and in-flight refueling system description.

9.1.1 In-Flight Refueling Controls. Regardless of fuel management panel switch positioning, at low fuel states the initial resupply of fuel is discharged into the left- and right-wing box tanks. Thereafter, distribution of the fuel to the forward, aft, wing, and external tanks is controlled by the WING/EXT TRANS switch position. The split refueling system to the left and right engine feed group provides for a relatively balanced center of gravity condition during refueling. Selective refueling of the fuselage or all fuel tanks is provided on the REFUEL PROBE switch with the probe extended. In the FUS/EXTD position, normal fuel transfer and feed is unaltered. This position is used for practice plug-ins, fuselage only refueling, or return flight with a damaged air-refueling probe. The ALL/EXTD shuts off wing and external tank transfer to permit the refueling of all tanks. The REFUELING PROBE switch circuit uses essential dc No. 2 power to control operation of the probe actuator through redundant-extend solenoids and a single-retract solenoid.

9.1.2 In-Flight Refueling Checklist. The in-flight refueling checklist shall be completed before plug-in.

1. RDR switch — STBY.

2. Arming switches — SAFE.

3. DUMP switch — OFF.

4. AIR SOURCE pushbutton — L ENG.

5. REFUEL PROBE switch — As Desired (transition light OFF).

6. Wing sweep switch — MAN/wing-sweep angle — As Desired.

7. Visors — Recommended Down.

WARNING

To prevent fuel fumes from entering the cockpit through the environmental control system (ECS) because of possible fuel spills during in-flight refueling, select AIR SOURCE pushbutton L ENG.

9.1.3 In-Flight Refueling Techniques

Note

The following procedures, as applied to tanker operation, refer to single-drogue tanker only.

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 covers a practical spectrum from the deck to 35,000 feet, 170 to 300 knots, and wing-sweep angles of 20° to 68°. Optimum airspeed and wing-sweep position is 240 knots and approximately 40° wing sweep. This configuration increases aircraft angle of attack enough to lower the receiver's vertical tails below the tanker's jetwash and decreases bow wave effect. SAS-off tanking can most easily be performed at 200 KCAS with 40° of wing sweep.

9.1.3.1 Approach. Once cleared to commence an approach and with refueling checklists completed, assume a position 5 to 10 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 a reference point on the tanker as a primary alignment guide during the approach phase; secondarily, rely on peripheral vision of the drogue and hose and supplementary remarks by the RIO. Increase power to establish an optimum 3- to 5-knot closure rate on the drogue. It must be emphasized that an excessive closure rate will cause a violent hose whip following contact and/or will increase the danger of structural damage to the aircraft; too slow a closure rate results in the pilot fencing with the drogue as it oscillates in close proximity to the aircraft nose. During the final phase of the approach, the drogue has a tendency to move slightly upward and to the right as it passes the nose of the receiver aircraft because of the aircraft-drogue airstream interaction. Small corrections in the approach phase are acceptable. However, if alignment is off in the final phase, it is best to immediately return to the initial approach position and commence another approach, compensating for previous misalignments 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 horizontal stabilizer. Avoid any corrections about the longitudinal axis since they cause probe displacement in both the lateral and vertical reference planes.

9.1.3.2 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. Realization of this situation can be readily ascertained through the RIO. 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 the 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 correctly in line with the drogue, the chance of hooking the hose is diminished as the need for last-minute corrections is minimized. After executing a missed approach, analyze previous misalignment problems and apply positive corrections to preclude a hazardous tendency to blindly stab at the drogue.

9.1.3.3 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. 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. The precise flying imposed on both the tanker and receiver pilots requires a lot of "heads down" time, yet a sharp lookout doctrine must be maintained. This is the receiver RIO's primary responsibility.

9.1.3.4 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 receiver probe will separate from the drogue coupling when the hose reaches full extension.

When clear of the drogue:

1. REFUEL PROBE switch — RET.
2. Probe transition light — Check Out.
3. AIR SOURCE pushbutton — BOTH ENG.
4. Wing-sweep switch — AUTO.

Resume normal flight operations.

9.2 FORMATION FLIGHT

The following formation descriptions are recommended guidelines for F-14 multiplane positioning.

WARNING

Parade formation IFR/VFR and loose cruise flight shall not be performed with the flight lead utilizing autopilot ground-track destination steering because of the midair collision potential associated with inadvertent waypoint steering selection and rapid aircraft AOB changes.

9.2.1 Parade Formation. The basic parade position is either left or right echelon, or a combination of both, as in fingertip three-plane formation. The parade formation is used primarily for multiplane maneuvering at night, in IMC, or during entry into or exit from an airport traffic area.

Wing sweep: 20°
Configuration: Clean or dirty.

1. Line of bearing is determined by placing the upper leading edge of the lead aircraft's intake on the explosive seat warning triangle below the RIO cockpit.

2. Wingtip separation is determined by a position on the bearing line where the leading edges of the lead aircraft's ventral fins are aligned.

3. Stepdown is determined by aligning the lead's opposite engine nacelle just under the near engine nacelle.

This positioning should provide the wingman with approximately 5 feet of wingtip separation and 10 feet of stepdown.

9.2.2 Break Formation. The basic break formation is either left or right echelon, or a combination of both as in a fingertip three-plane formation. This formation is used primarily for multiplane entry into the overhead break pattern.

Wing sweep: 68°
Configuration: Clean.

1. Line of bearing is determined by placing the upper leading edge of the lead aircraft's intake on the explosive seat warning triangle below the RIO cockpit.

2. Wingtip separation is determined by a position on the bearing line where approximately 1 foot of the forward edge of the lead's opposite ventral fin shows in front of the near ventral fin.

3. Stepdown is determined by aligning the lead's opposite engine nacelle just under the near engine nacelle.

This position should provide the wingman with approximately 15 feet of wingtip separation and 10 feet of stepdown.

9.2.3 Diamond Four-Plane Formation. The diamond is the basic four-plane formation used for entry into the overhead break or for aerial fly-bys.

Wing sweep: 68°
Configuration: Clean.

Right and left echelon (dash-2 and dash-3, respectively)

1. Line of bearing is determined by placing the upper leading edge of the lead aircraft's intake on the pilot's helmet.

2. Wingtip separation is determined by a position on the bearing line where the trailing edges of the lead aircraft's ventral fins are aligned. At this position, the trailing edge of the exhaust nozzles should appear in line to the RIO.

3. Stepdown is determined by allowing approximately 6 inches of the lead's opposite engine nacelle to show below the near engine nacelle.

This position should provide the wingman with approximately 12 feet of wingtip separation and 12 feet of stepdown.

Slot (dash-4)

1. Line of bearing is determined by lining up on the lead aircraft's centerline.

2. Approximately 20 feet of nose-to-tail separation can be established by placing the wingman's canopy bow on the lead aircraft's exhaust nozzles.

3. Approximately 25 feet of stepdown should be used. This position may be cross-referenced by placing the upper leading edge of dash-2's or dash-3's intake on the pilot's helmet.

9.2.4 Cruise Formation. Cruise is the basic formation used for multiplane transit to or from an operating area where increased maneuverability is desired.

Wing sweep: 20°
Configuration: Clean.

1. Line of bearing is determined by placing the upper leading edge of the lead aircraft's intake on the RIO's canopy bow.

2. A second line of bearing is determined by placing the lead aircraft's wingtip light on the forward upper UHF antenna.

3. Wingtip separation is determined by allowing approximately 1 foot of the lead's opposite exhaust nozzle to show behind the near exhaust nozzle.

This position should provide the wingman with approximately 64 feet of wingtip separation and 10 feet of nose-to-tail separation.

9.2.5 Aircraft Lighting During Night Formation Flight. The lead aircraft anticollision lights will normally be off during night formation flight in parade. However, the possibility exists that the wing aircraft can inadvertently stray into a position aft of the normal bearing where only a single white tail light on lead is visible. In this position, serious misjudgment of separation and closure rate can occur. To prevent this, lead aircraft anticollision lights should be on when the wing aircraft is not in normal parade and mission requirements permit.

9.3 BANNER TOWING

9.3.1 Ground Procedures. The following procedures are provided for guidance. Local course rules may dictate modification of these steps:

1. When tower clearance onto the duty runway has been received, tow aircraft taxis to position as directed by tow hookup crew. Tow pilot holds this position until released by tow hookup crew. Escort pilot maintains position on taxiway at approach end of runway.
2. When signaled to do so by tow hookup crew, tow pilot proceeds to taxi down runway.
3. Upon receipt of visual taxi signal from tow hookup crew to slow down, escort pilot relays this signal to tow pilot via UHF radio.
4. Upon receipt of visual taxi signal from tow hookup crew to stop, escort pilot relays this signal to tow pilot via UHF radio.
5. Upon receipt of signal from tow hookup crew that tow hookup is complete, escort pilot requests tow pilot to take up slack.
6. Tow pilot proceeds to taxi down the runway.
7. When banner moves forward onto runway, escort pilot transmits, "Tow aircraft hold, good banner," and taxis onto runway abeam banner for takeoff.
8. When ready, tow pilot transmits, "Tower, Lizard 616 for banner takeoff, escort to follow banner."
9. After banner becomes airborne, escort pilot commences takeoff roll.

9.3.2 Shipboard Procedures. The following procedures are provided for guidance. Local rules may dictate modification of these steps:

1. When clearance has been received, tow aircraft taxis to the catapult shuttle in use as directed by flight deck personnel. Tow pilot holds this position until released by catapult director.
2. When signaled to do so, banner crew lays banner on flight deck 45 feet starboard of waist catapult centerline and 10 feet aft of unit horizontal stabilator, with banner bar perpendicular to the catapult centerline.
3. Banner crew sequentially positions nylon towline bundle lengthwise and parallel to catapult track in position in front of banner. Nylon towline, with prepared end facing banner buckle, is attached to banner using swivel and connecting link. Steel cable leader (75 feet of 3/16-inch diameter) is attached to forward end of nylon towline bundle using connecting link.
4. Banner crew then unrolls leader forward, down angle deck and parallel to catapult track to prevent entanglement and kinks. The forward end of leader is brought back and laid on deck near the aircraft's right main landing gear. Forward end of leader has Mk 8 Mod 0 target release ring attached to it.
5. Upon clearance from catapult officer, banner crewmember crawls underneath aircraft with leader in hand just aft of right ventral fin. He then attaches Mk 8 Mod 0 target release ring to banner tow adapter. Upon appropriate signals from the flight deck director, the pilot lowers hook to assure proper detachment of target release ring and then raises the hook. The banner crewmember will then reattach target release ring.
6. After hookup, the banner crewmember exits from beneath aircraft at same place he entered. He then walks toward island and gives thumbs up signal to catapult officer. The banner, towline, and leader are now ready for launch.

9.3.3 Flight Procedures. Flight tests have demonstrated no significant degradation of aircraft performance and handling characteristics when towing a banner.

CAUTION

Angle of bank should be limited to 30° or less to preclude contact between the tow cable and afterburner nozzle.

Note

Depending on the airspeed of the tow aircraft, the banner will normally hang 200 to 400 feet below the tow aircraft's altitude.

Refer to Chapter 4 for banner towing restrictions.

9.3.3.1 Takeoff. Normal takeoff procedures, including rotation speeds and techniques, are suitable for takeoff with the banner.

CAUTION

- Takeoff ground roll with banner can be estimated by adding a factor of 10 percent to basic aircraft takeoff performance. If aircraft lift-off will not occur prior to crossing the long-field arresting gear, the gear must be removed to preclude the banner being torn off.
- If the crosswind component is in excess of 10 knots, the takeoff roll should be made on the upwind side of the runway to prevent the banner from striking the runway lights on the downwind side of the runway.

Note

Adequate clearance exists to prevent contact between the tow cable and speedbrakes during ground operation. If takeoff is aborted, basic emergency procedures are applicable. The tow cable will be released when the tailhook is lowered.

After lift-off, continue rotation to 15° (maximum of 20°), while raising the landing gear. Do not exceed 17 units AOA. Climb out at 180 to 200 KIAS until the flaps are up, then continue climb at 200 to 220 KIAS.

Note

- Avoid use of afterburner to prevent damage to tow cable.
- Tow airspeeds in excess of 220 KIAS will result in excessive banner fraying.

For shipboard operations, after lift-off, rotate to 15° (20° maximum) not to exceed 17 units AOA while raising the gear and flaps. Prior clearance must be received from the tower for an unrestricted climb. Maintain heading until the banner is well clear of ship. Climb out at 180 to 200 KIAS until flaps are up, then continue to climb out at 200 to 220 KIAS.

Note

The maximum aircraft gross weight for a shipboard banner launch is 67,000 pounds.

9.3.3.2 Cruise/Pattern. No special pilot techniques are required when towing a banner. En route cruising speeds of 180 to 220 KIAS will provide adequate energy for mild maneuvering while minimizing banner fray. If a low-pattern airspeed is desired, extend flaps/slats if necessary to maintain AOA at or below 12 units. The tow aircraft must call all turns to allow the chase aircraft to position itself on the outside of the turn.

If the banner is shot off or falls off in flight, the remaining cable should be dropped in the gunnery area or in a confirmed clear area. After the cable is released, a chase aircraft should join to verify that the cable has been dropped.

WARNING

Without the banner, any remaining cable will flail unpredictably. The chase should approach the tow aircraft from abeam, avoiding a cone-shaped area defined by the tow's 4- to 8-o'clock positions.

9.3.3.3 Descent. Airspeeds of 160 to 220 KIAS should be used for descent. Flaps and slats may be utilized to increase the rate of descent as desired.

CAUTION

Speedbrakes should not be used while towing since limited clearance exists between the cable and speedbrakes during extension and retraction in flight.

9.3.3.4 Banner Drop. The tow aircraft should extend its flaps and reduce airspeed (140 to 160 KIAS, 12 units AOA maximum) for the drop. The banner should be dropped in wings-level flight at a minimum aircraft altitude of 1,000 feet AGL. The chase aircraft should ensure adequate clearance exists between the banner and ground obstacles during approach to the drop zone and provide calls to assist in lineup. Release is normally called by the tower when the banner is over the center of the drop zone. Release is accomplished by lowering the tailhook. In most cases, the banner will hit down range of the release point. However, high-wind conditions may require the tow aircraft to adjust the release point to avoid downwind travel of the banner. Following banner release, the tailhook should be raised.

9.3.3.5 Shipboard Banner Drop. The tow aircraft should extend its flaps and reduce airspeed (140 to 160 KIAS, 12 units AOA maximum) for the drop. The banner should be dropped in a clear area in wings-level flight at a minimum altitude of 1,000 feet MSL. If a clear area is not available, the banner should be dropped approximately 1 nm abeam the port side of the carrier. Release is called by the air officer when the banner is over the drop zone. Banner release is accomplished by lowering the tailhook.

CAUTION

When the tailhook is lowered for banner release, ensure that the balance ball is centered or slightly right (left yaw). If any right yaw is present, tow cable/tailhook entanglement is possible.

9.3.3.6 Banner Release Failure. If the arresting hook fails to extend, the banner cannot be released. In this case, the following procedure is recommended:

1. In gunnery range (or other cleared area) descend to low altitude, extend flaps, slow to 140 to 160 KIAS, 12 units AOA maximum and descend to 100 to 200 feet AGL. This will drag banner off on ground (or water). Have escort pilot confirm that banner breaks off on ground collision, and determine length of remaining tow cable.

WARNING

The escort pilot must remain well clear of the remaining cable. The last 25 percent of the remaining cable will flail unpredictably.

2. If 100 feet or greater remaining tow cable length is confirmed by escort pilot, plan to touch down 1,000 to 1,500 feet long, runway length permitting.

CAUTION

Every effort must be made by the tow pilot not to drag the remaining tow cable across lines, fences, or other obstacles because of property damage that will result.

Note

The long touchdown should be carefully planned because long-field arrestment is impossible.

9.4 FUEL MANAGEMENT SYSTEM OPERATIONAL CHECK

The following fuel management system operational check can be used by flightcrews to perform a check of the fuel transfer system, including FUEL FEED switch, WING/EXT TRANS switch, sump tank interconnect valve, fuselage motive flow isolation valves, low-level thermistors, and box-beam vent valves. In addition, the procedure tests for proper functioning of the automatic electrical controls in the fuel feed system. The final four procedures (steps 5 through 8) can best be performed in a shore-based environment where minimum fuel on deck requirements are not as restrictive.

PROCEDURES	COMMENTS
Initial conditions: FWD/R & AFT/L — 3,000 pounds (approximately) L & R FEED — 1,500 to 1,750 pounds (full) L/R WINGS — Empty (0 to 200 pounds) TOTAL — 6,000 pounds (approximately)	Ensure 4,500 pounds on tapes for operation of FEED switch.
1. WING/EXT TRANS switch — OFF.	1. Switch should not move until automatic interconnect occurs. Verifies proper automatic electrical operation.
2. FUEL FEED switch — FWD/R Monitor 500-pound split, AFT/L high.	2. Verifies sump tank interconnect valve open via manual operation and aft fuselage motive flow valve shut off.
3. FUEL FEED switch — AFT/L Monitor 500-pound split, FWD/R high.	3. Same as step 2 except forward fuselage motive flow valve shut off.
4. FUEL FEED switch — NORM Verify FWD/R high split remains constant.	4. Verifies system returns to isolated mode with no leaks.
5. Monitor WING/EXT TRANS switch returns to AUTO. AFT/L — 1,700 ±200 pounds, or FWD/R — 2,100 ±200 pounds.	5. Verifies cell No. 2 or 5 low-level thermistor's proper operation to trigger automatic interconnect function.
6. Monitor tapes/feeds for system balancing. **Note** Balancing normally begins 6 to 9 minutes after WING/EXT TRANS switch returns to AUTO.	6. Verifies sump tank interconnect valve opens via automatic operation and L/R box-beam vent valves open. Verifies proper operation of FWD/AFT motive systems.
7. After landing, run both engines until R and L FUEL LOW lights illuminate. Verify: R FUEL LOW at L FEED — 1,000 ±200 pounds, L FUEL LOW at R FEED — 1,000 ±200 pounds.	7. Verifies proper operation of cell Nos. 2 and 5, and left box-beam and right box-beam low-level thermistors.
8. Shut down right engine and pull R FUEL SHUTOFF handle. Continue to run left engine to verify continued R FEED quantity decrease. Then shut down left engine.	8. Verifies sump tank interconnect valve remains open via left side motive flow pressure. This verifies proper operation of motive flow isolation valve.

CHAPTER 10

Functional Checkflight Procedures

10.1 FUNCTIONAL CHECKFLIGHTS

Functional checkflights will be performed when directed by, and in accordance with, OPNAVINST 4790.2 series and the directions of NAVAIRSYSCOM type commanders, or other appropriate authority. Functional checkflight requirements and applicable minimums are described below. Functional checkflight checklists are promulgated separately.

10.2 CHECKFLIGHT PROCEDURES

To complete the required checks in the most efficient and logical order, a flight profile has been established for each checkflight condition and identified by the letter corresponding to the purpose for which the checkflight is being flown (A, B, or C, as shown in Figure 10-1). The applicable letter identifying the profile prefixes each check in the Functional Checkflight Checklist, NAVAIR 01-F14AAD-1F. The postmaintenance checkflight procedures are specific, supplementary checks to be performed in conjunction with NATOPS normal procedures (Chapter 7). Checkflight personnel will familiarize themselves with these requirements before each flight. Thorough professional checkflights are a vital part of the squadron maintenance effort. Checkcrews perform a valuable service to the maintenance department by carrying out this function. The quality of service provided by checkcrews reflects directly in the quality of maintenance and, reciprocally, enhancement of flight operations. To avoid degradation of this valuable service, always adopt the attitude that thoroughness, professionalism, and safety are primary considerations for all checkflights. A daily inspection is required before each checkflight.

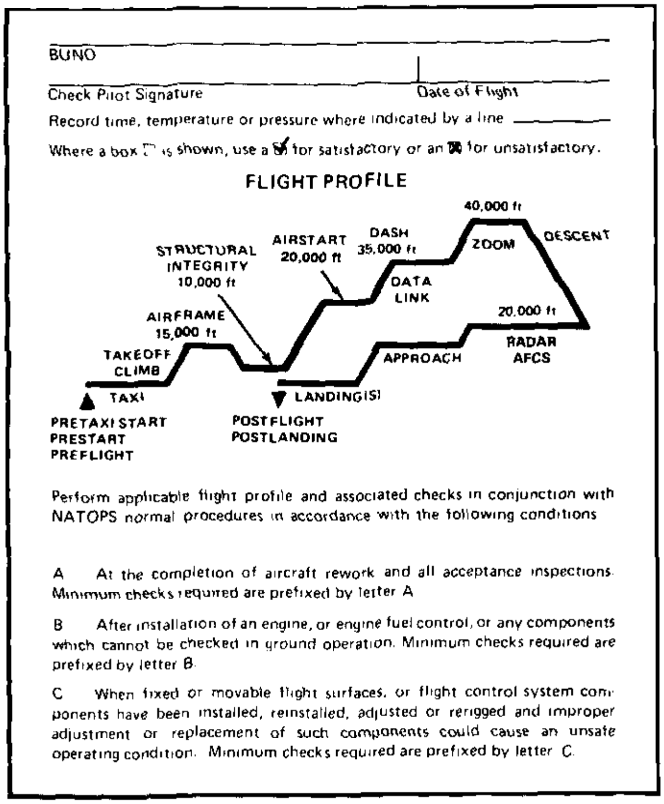


Figure 10-1. Flight Profile

Note

Shipboard constraints can preclude completion of some items on the applicable flight profile checklist.

PROFILE

10.3 FUNCTIONAL CHECKFLIGHT PROCEDURES (PILOT)

10.3.1 Prestart

ABC

1. Fuel quantity and distribution. Check for proper fuel quantities in each system. Left tape 6,200 pounds maximum, right tape 6,600 pounds maximum, wings approximately 2,000 pounds each, and the external tanks approximately 1,800 pounds. Check total.

	Left	Right
FEED		
FUS		
WING		
EXT		
TOTAL		

A

2. ICS.

   a. Normal.

   b. Backup.

   c. Emergency.

A

3. Refuel probe.

   a. Extend (with handpump).

   b. Retract (with handpump).

A

4. OXYGEN SUPPLY valve — ON.

A

5. Backup oxygen — Check.

   Turn OXYGEN system master switch to BACKUP, then OFF. Place mask to face and check for normal breathing, regulator, and mask operation. Check no breathing after approximately 30 seconds.

A

6. Seat adjustment — Check.

A

7. Canopy rigging.

   a. Both cockpit handles same position during operation.

   b. BOOST not required to close.

PROFILE

10.3.2 Start

ABC 8. ENG CRANK switch — L (left engine).

Observe auxiliary brake pressure rise. Observe combined hydraulic system pressure rise.

ABC 9. ENG CRANK switch — OFF.

ABC 10. ENG CRANK switch — R (right engine).

ABC 11. ENG CRANK switch — OFF.

Note

Plane captain will bleed FLT and COMB HYD systems during steps 8 and 10.

ABC 12. EMERG FLT HYD switch — Cycle.

a. EMERG FLT HYD switch — LOW.

Check that ON flag is displayed in EMER FLT LOW hydraulic pressure window. Verify control over horizontal tail and rudder control surfaces as viewed on surface position indicator.

b. EMERG FLT HYD switch — HIGH.

Check that ON flag is displayed in EMER FLT HI hydraulic pressure window. Verify control over empennage flight control surfaces and higher surface deflection rate.

c. EMERG FLT HYD switch — AUTO (LOW).

Check that OFF flags are displayed in both EMER FLT HI and LOW hydraulic pressure windows.

CAUTION

Combined and brake accumulators should be charged prior to backup module checks. Checks should be made slowly enough to ensure continuous-on indication in the hydraulic pressure indicator.

ABC 13. BACK UP IGNITION — ON.

Note

With weight on wheels and BACK UP IGNITION switch ON, main high-energy ignition is off.

ABC 14. ENG CRANK switch — R (Right engine).

Place the crank switch to R where the switch is solenoid held until automatically released to the neutral (OFF) position at the starter cutout speed of 55-percent rpm. Manual deselect of the switch to OFF will interrupt the crank mode at any point in the start cycle. Oil pressure and flight hydraulic pressure rise will become evident at 20-percent rpm.

PROFILE

Note

When using wells system air for engine start, manual deselection of starter crank switch may be required.

ABC

15. Right throttle — IDLE (20-percent rpm)

CAUTION

If an idle crossbleed start is attempted with high residual EGT (after hot start) and/or throttle is advanced from OFF to IDLE prior to 20-percent rpm, higher than normal EGT readings may occur. If the EGT appears to be rising abnormally, increasing the supply engine to 80-percent RPM may yield a normal start temperature.

Note

- Advancing the right throttle from OFF to IDLE automatically actuates the ignition system. An immediate indication of fuel flow (300 to 350 pph) will be exhibited and light-off (EGT rise) should be achieved within 5 to 15 seconds. Peak starting temperatures will be achieved in the 40- to 50-percent rpm range. After a slight hesitation, the EGT will return to normal. Exceeding 890 °C constitutes a hot start. During the initial starting phase, the nozzle should expand to a full-open (100 percent) position.

- If the engine has been shut down within the past 60 minutes, monitor it closely for a hot/hung start. If the start is aborted because of a hot start (EGT above 890 °C), *motor the engine until the EGT is less than 250 °C.*

- Loss of electrical power may result in smoke entering the cockpit via the ECS.

ABC

16. Right engine instrument readings.

    a. RPM — 62 to 78 Percent.

    b. EGT — 350 to 650 °C (nominal).

    c. FF — 950 to 1,400 Pph (nominal).

    d. NOZ position — 100-Percent Open.

    e. OIL — 25 to 35 Psi (nominal) (15 psi minimum).

    f. FLT HYD - 3,000 Psi.

PROFILE	
ABC	17. External power — Disconnect. Removal of ground electrical power causes the right generator to supply power to the right and left main electrical buses.
A	18. Tailhook — EMERG DOWN.
ABC	19. ENG CRANK switch — L (left engine). When combined hydraulic pressure reaches 3,000 psi, return switch to neutral (center) position.
ABC	20. HYD TRANSFER PUMP switch — NORMAL. Hydraulic transfer pump will operate from flight side to maintain the combined side between 2,400 to 2,600 psi. **CAUTION** If the transfer pump does not pressurize the combined system within 5 seconds, immediately set HYD TRANSFER PUMP switch to SHUTOFF.
ABC	21. ENG CRANK switch — OFF and Check BI-DI.
ABC	22. HYD TRANSFER PUMP switch — SHUT OFF.
ABC	23. Repeat steps 14, 15, and 16 for left engine.
ABC	24. BACK UP IGNITION switch — OFF.
ABC	25. Starter air — Disconnect.
ABC	26. AIR SOURCE — L ENG, R ENG, then BOTH ENG. Verify cockpit airflow in three positions.
ABC	27. Right throttle — OFF Then Immediately to IDLE. Observe rpm decrease then rise to idle rpm. **Note** Failure of the engine to relight above 59 percent indicates a failure of the N_2 deceleration auto-relight logic.
ABC	28. Left throttle — OFF Then Immediately to IDLE. Observe rpm decrease then rise to idle rpm. **Note** Failure of the engine to relight above 59 percent indicates a failure of the N_2 deceleration auto-relight logic.

PROFILE	
ABC	29. HYD TRANSFER PUMP switch — NORMAL.
A	30. Restore normal tailhook and raise.
ABC	31. Idle engine instrument readings.

	Left	Right	Nominal
NOZ position (%)			100% open
OIL (PSI)			25 to 35 (15 minimum)
RPM (%)			62 to 78%
EGT (°C)			350 to 650
FF (PPH)			950 to 1,400

ABC

32. OBOGS master switch — ON.

CAUTION

Ensure ECS service air is available to OBOGS prior to selecting the OBOGS master switch ON.

10.3.3 Poststart

ABC

33. EMERG GEN/VMCU operation — Check.

Voltage drop obtained when emergency generator is turned off will activate VMCU. This will result in instantaneous illumination of the following lights for 1 to 2 seconds:

a. PITCH STAB 1 and 2

b. ROLL STAB 1 and 2

c. YAW STAB OP and OUT

d. HZ TAIL AUTH

e. RUDDER AUTH

f. SPOILERS

g. AUTO PILOT

h. MACH TRIM.

When normal voltage is regained, VMCU is deactivated; all lights will go out except RUDDER AUTH.

PROFILE	
ABC	34. AFTC — Check.
ABC	35. MASTER TEST switch — WG SWP.

34. AFTC — Check.

a. L ENG select switch — SEC.

L ENG SEC light illuminates; left NOZ position indicator pointer below zero.

b. L ENG select switch — PRI.

L ENG SEC light goes out, NOZ position indicator to 100 percent.

c. R ENG select switch — SEC.

R ENG SEC light illuminates; right NOZ position indicator pointer below zero.

d. R ENG select switch — PRI.

R ENG SEC light goes out; NOZ position indicator pointer to 100-percent.

CAUTION

Selecting secondary (SEC) mode closes exhaust nozzles, increasing exhaust nozzle jet wake hazard.

Note

- Performing AFTC check during OBC inhibits AICS ramps from programming. Ramps must be reset before another OBC can be performed.

- NOZ position indication is lost in SEC mode.

35. MASTER TEST switch — WG SWP.

Wing-sweep mode switch must be in AUTO.

Wing-sweep program index moves from 20° to 44° and back to 20°. The following lights illuminate at start of test and are out at test completion (approximately 25 seconds): WING SWEEP, FLAP, and REDUCE SPEED.

Note

- During the wing-sweep preflight test, both altimeters may fluctuate momentarily.

- The WING SWEEP advisory light illuminates 3 seconds after the test starts, then goes out and illuminates again 8 seconds into the test.

- The WING SWEEP advisory light goes out at the end of the test. The RUDDER AUTH, HZ TAIL AUTH, and MACH TRIM lights illuminate for the entire test and remain illuminated at the end of the test.

PROFILE

A

36. UHF/VHF/JTIDS/ICS.

    Check complete operation of pilot COMM switch — UHF 1, UHF 2, JTIDS, ICS.

AB

37. OBC (autopilot ENGAGE).

    Prior to running OBC, clear FHF.

    a. After ramps are extended — Select Ramps to STOW.

    b. Verify RAMP lights go off and INLET lights illuminate.

    c. When OBC is complete:

        (1) Reset both AICS and check that INLET RAMPS are in AUTO.

        (2) Reinitiate complete normal OBC.

        (3) Upon completion, record OBC, MCF and FHF.

ABC

38. Speedbrake switch.

    a. EXT-RET.

    b. Verify stabilizers shift 2° TED (clean) or 3° TED (AIM-54 rails) on extension and opposite on retraction (ITS).

ABC

39. ECS.

    a. AIR SOURCE pushbuttons should be pressed: L ENG, R ENG, OFF, then back to BOTH ENG. There will be slight reduction in flow with single-engine air source selected. There should be no excessive interruptions in airflow when source changes are made.

    b. Cockpit temperature control (TEMP mode selector switch) should be checked in both MAN and AUTO modes to ensure proper temperature control.

ABC

40. Flaps down.

    a. Verify stabilizer shifts 3° TEU (ITS).

ABC

41. Flight controls — TRIM.

    a. Trim — Full Nose Down (9° TED).

    b. Stick full aft — Check for Free Movement.

    c. Trim — Full Nose Up (greater than 18° TEU) (17 to 19 seconds).

    d. Stick full forward — Check for Free Movement.

    e. Yaw trim — 7° Left to 7° Right (12 to 14 seconds).

    f. Trim — Full Left (check 6° differential tail split).

PROFILE

g. Stick full left — Check Power Approach Spoiler Gearing and Uniform Spoiler Extension.

h. Trim — Full Right (16 to 18 seconds); Check 6° Differential Tail Split.

i. Stick — Full Right; Check Power Approach Spoiler Gearing and Uniform Spoiler Extension.

ABC

42. Flight controls — Cycle.

Observe following:

a. Longitudinal — 33° TEU to 7° TED Horizontal Tail (33° to 10° without ITS).

b. Lateral — 24° Total Differential Tail.

c. Depress autopilot emergency disengage paddle — 14° Total Differential Tail.

d. Directional — 30° Rudder.

e. Longitudinal — Lateral Combined, 35° TEU to 15° TED.

f. Spoilers — 55°.

ABC

43. Spoiler checks.

a. DLC — Check.

(1) Engage DLC. Verify stabilizer shifts 2-3/4° TED. Inboard spoilers extend to 17-1/2°.

(2) Full up DLC. Verify stabilizer returns to trim. Inboard spoilers go to -4-1/2°.

(3) Full down DLC. Verify stabilizer remains 2-3/4° below trimmed position and inboard spoilers extend to 55°.

(4) Stick 2 inches left (check spoiler gearing).

(a) Left wing outboard +30°.

(b) Left wing inboard +55°.

(c) Right wing both -4-1/2°.

(5) Stick right 2 inches (check spoiler gearing).

(a) Right wing outboard +30°.

(b) Right wing inboard +55°.

(c) Left wing both -4-1/2°.

PROFILE

Note

If either right SPOILER position indicator shows one position higher than actual spoiler position (that is, DN vice drooped and extended vice DN), a spoiler zero-degree switch has failed. Spoiler symmetry protection circuitry is inoperative and spoiler ground-roll braking in flight is possible.

b. SPOILER BK — Select.

c. SPOILER FLR ORIDE operation.

(1) INBD and OUTBD SPOILER FLR ORIDE switches — ORIDE.

(2) MASTER TEST switch — STICK SW.

(3) Verify all spoilers remain extended (55°).

(4) INBD and OUTBD SPOILER FLR ORIDE switches — NORM.

Verify INBD and OUTBD spoilers fail down and SPOILER light illuminates.

CAUTION

With SPOILER FLR ORIDE switches in ORIDE, spoiler symmetry protection circuitry is disabled. Ensure that switches are in NORM.

(5) Verify spoilers down.

(6) MASTER TEST switch — OFF.

(7) MASTER RESET — Depress.

d. MASTER TEST switch — STICK SW.

(1) Verify GO light illuminates with 1-inch lateral stick inputs left and right.

(2) MASTER TEST switch — OFF.

(3) MASTER RESET — Depress.

Verify SPOILER light goes out and all spoilers extend to 55°.

e. SPOILER BK/THROTTLE interlocks — Check.

A 44. Displays — CHECK.

A 45. Tacan — BIT.

A 46. ARA-63 — BIT.

Check HUD, VDI, and standby gyro needles.

PROFILE	
A	47. Gunsight — Verify (manual mode).
	a. Select A/A.
	b. Select GUN.
	c. Select manual mode via CAGE/SEAM switch.
	d. Dial in 34 mils. Verify the manual reticle is positioned over the HUD heading tick.
AB	48. Autopilot emergency disengage.
	a. Paddle switch — Hold Depressed.
	b. Verify throttles in manual mode.
A	49. OXYGEN Monitor — TEST.

The TEST button must be held for up to 1 minute to vent oxygen from the monitor oxygen sensor. Once the monitor senses insufficient oxygen concentration, the cockpit caution lights will be illuminated and oxygen supply source shifted to BOS. Release the TEST button as soon as the OBOGS light is illuminated. Verify OBOGS light is extinguished within 20 seconds.

WARNING

The monitor will fail without any indication to the aircrew. For this reason, it is essential that the pilot test the monitor function prior to launch and prior to ascending above 10,000 feet MSL. If the aircrew suspects the onset of hypoxia at any time, immediately select BACKUP. The monitor may be tested once the aircraft has descended to a maximum cabin altitude of 10,000 feet by reselecting ON on the OBOGS master switch.

Note

The monitor can take up to 2 minutes to warm up, depending on the ambient temperature. The OBOGS light will not be illuminated during the warmup period.

10.3.4 Taxi

ABC	50. Turn needle/slip indicator — Check.

10.3.5 Engine Runup

AB	51. Engine runup — Check.

PROFILE

CAUTION

On board ship, use of MRT and MIN AB is restricted to a maximum of 30 seconds to prevent damage to the holdback bar and the JBD.

	Left	Right	Limits
NOZ position (%) AT MIL			closed nominal 3 to 10
OIL (PSI)			25 to 65
RPM (%)			95 to 104 nominal (107.7 maximum)
EGT (°C)			935°
FF (PPH)			9,000 to 12,000

a. Verify hook is stowed and RATS light is out.

b. Right engine mode — SEC.

c. Right throttle — MIL.

Note acceleration time (less than 10 seconds).

d. Right engine mode — PRI.

Record engine parameters.

e. Hook — DOWN.

Verify RATS light and 3- to 6-percent rpm decay.

f. Right throttle — MIN AB.

Verify rpm increases 3 to 7 percent.

g. THROTTLE MODE switch — MAN.

h. Right throttle — IDLE.

i. THROTTLE MODE switch — BOOST.

j. Hook — UP.

Verify hook is stowed and, RATS light is out.

k. Repeat steps b through j with left engine.

PROFILE

10.3.6 Takeoff and Climb

A 52. Landing gear — Retract (9 to 15 seconds nominal).

A 53. Barometer and radar altimeters — Check Below 5,000 Feet.

AB 54. AFTC — Check.

Note

- SEC mode transfer while in minimum AB may result in pop stalls. Nonemergency manual selection of SEC mode airborne should be performed in basic engine with the power set above 85-percent RPM.
- If the fan speed limiter circuit has failed, engine rollback may occur with the selection of SEC mode. In the event of engine rollback, PRI mode must be reselected above 59-percent rpm or flameout will occur and an airstart will not be possible.

a. L ENG mode switch — SEC.

b. Left throttle — Check Basic Engine Power Response.

c. L ENG mode switch — PRI.

d. R ENG mode switch — SEC.

e. Right throttle — Check Basic Engine Power Response.

f. R ENG mode switch — PRI.

g. Cycle AICS cb's at a constant subsonic Mach.

10.3.7 10,000-Foot Check

AB 55. OXYGEN monitor — TEST.

The TEST button must be held for up to 1 minute to vent oxygen from the monitor oxygen sensor. Once the monitor senses insufficient oxygen concentration, the cockpit caution lights will be illuminated and oxygen supply source shifted to BOS. Release the TEST button as soon as the OBOGS light is illuminated. Verify OBOGS light extinguished within 20 seconds.

WARNING

The monitor will fail without any indication to the aircrew. For this reason, it is essential that the pilot test the monitor function prior to launch and prior to ascending above 10,000 feet MSL. If the aircrew suspects the onset of hypoxia at any time, immediately select BACKUP. The monitor may be tested once the aircraft has descended to a maximum cabin altitude of 10,000 feet by reselecting ON on the OBOGS master switch.

PROFILE	
ABC	56. Fuel transfer — Check.
AB	57. ECS check (250 knots).

CAUTION

In CV environment, ensure external tanks are empty prior to ECS checks.

ECS check should be performed at altitude above 8,000 feet so cabin pressurization can be checked, but low enough to prevent large cockpit pressure changes when cockpit air is secured.

a. Cabin altitude approximately 8,000 feet.

b. Air distribution — CANOPY DEFOG-CABIN AIR.

c. Radar power switch — STBY (coordinate with RIO).

d. AIR SOURCE pushbutton — OFF.

Cockpit pressurization will quickly bleed off with cabin pressure altimeter moving upward toward aircraft altitude.

CAUTION

Oxygen breathing time on BACKUP is limited.

Note

- When ECS service air to the OBOGS concentrator is shut off, the aircrew has approximately 30 seconds before depleting residual OBOGS pressure and mask collapse.

- Restoration of service air (selecting RAM) will return OBOGS to operation.

e. CABIN PRESS switch — DUMP.

Cockpit will completely depressurize.

f. RAM AIR switch — INCR (35 to 50 seconds).

As ram air door opens (up to 50 seconds to open fully), there will be an increase in cockpit airflow.

g. AIR SOURCE pushbutton — RAM.

With RAM selected, 400° manifold is repressurized, which maintains canopy seal, airbags, and antenna waveguides pressurization. As canopy seal reinflates, cockpit pressurization available from ram air will be much more apparent.

PROFILE

h. CABIN PRESS switch — NORM.

i. AIR SOURCE pushbutton — BOTH ENG.

j. Radar power switch — XMIT (Coordinate with RIO).

ABC

58. MFD OBC TEST — Select.

10.3.8 15,000-Foot Checks

AC

59. Stabilize at 300 knots.

a. Full stick roll — SAS OFF-ON.

Note full extension of down-wing spoilers. SAS-on roll acceleration will be slightly higher because of increased horizontal tail authority.

b. Pitch pulse — SAS OFF-ON.

At slow speeds, pitch SAS OFF is hardly noticeable. Lack of pitch SAS becomes more apparent as speed increases.

c. Rudder pulse left and right — SAS OFF-ON.

Yaw excursions should cease immediately upon engagement of YAW STAB.

AC

60. Wing-sweep and maneuver devices (check at 0.5 Mach).

a. Maneuver devices — EXTD.

b. Wing-sweep switch — AFT (check that wings stop at 50°).

c. Maneuver flaps partial up with thumbwheel. Ensure that devices retract.

d. Wing-sweep switch — BOMB.

(1) Verify maneuver devices automatically retract and then wings sweep to 55°.

e. Wing-sweep switch — MAN FULL AFT.

f. Wing-sweep switch — AUTO.

g. Emergency WING SWEEP handle — Cycle 22°, -68°, -22°.

(1) Verify spider detent engaged, emergency WING SWEEP caution off..

(2) MASTER RESET pushbutton — Depress.

Check WING SWEEP advisory light off.

h. Maneuver devices — EXTD.

i. Accelerate to greater than 0.79 Mach and check maneuver devices automatically retracted (maneuver devices start automatic retraction at 0.68 ±0.02 Mach).

PROFILE

j. Decelerate to less than 0.68 Mach and check maneuver devices remain retracted.

k. Wing-sweep switch — AUTO.

ABC 61. ASYM LIMITER switch — Check (airspeed 300 knots).

a. Throttles — MIL or Less.

b. ASYM LIMITER switch — OFF.

c. Left throttle — MAX AB.

Observe full AB available.

d. ASYM LIMITER switch — ON.

Observe reduction to min AB (12 percent).

e. Repeat steps a through d for right engine.

ABC 62. High AOA AUTO MAN devices.

a. Roll SAS — OFF and ALPHA COMP cb (RB1) In.

b. Throttles — IDLE.

c. Slowly increase aircraft AOA and allow aircraft to stabilize; maneuver devices extend at 10.5 units AOA.

Note

The maneuver device AOA signal from the nose alpha probe to CADC has a faster response rate than the signal from the left-side fuselage probe to AOA indicator, causing a low reading (error) on the indicator. This error is directly proportional to the aircraft AOA maneuver rate. Therefore, to determine when maneuver device extension occurs, perform the high-AOA maneuver device check by slowly increasing aircraft AOA and allowing aircraft to stabilize.

d. Maneuver devices retract at 8 units AOA.

e. ALPHA COMP cb — Out.

ABC 63. Approaches to stalls and approach configuration check (approximately 15,000 feet).

a. Clean stall.

(1) Stabilize in level flight at 15 units AOA.

(2) Ensure maneuver devices retracted.

(3) Slowly decelerate to buffet onset. Note AOA (light airframe buffet at 12 to 13 units, increasing to moderate intensity at 15 units AOA).

PROFILE

(4) Continue deceleration to 28 units AOA. Note any abrupt or significant rolloff tendencies.

b. Clean stall with maneuvering devices extended.

(1) Stabilize in level flight at 15 units AOA.

(2) Extend maneuvering devices.

(3) Slowly decelerate to buffet onset. Note AOA (light airframe buffet at 13 to 14 units AOA).

(4) Continue deceleration to 28 units AOA. Note any abrupt or significant rolloff tendencies.

(5) When AOA is below 15 units, retract maneuvering devices.

c. Approach configuration check.

(1) Perform landing checklist (roll SAS ON, ALPHA COMP cb out).

(2) DLC — Engage.

Check for excessive lateral trim requirements.

(3) AUTO THROTTLE.

(a) Response to longitudinal stick.

(b) Response to turn entry, steady rollout.

(c) Response in HOT/NORM/COLD.

(d) AUTO THROT light.

1. Manual override.

2. CAGE/SEAM button.

d. Dirty stall.

Slowly decelerate to level flight to 20 units AOA. Note any abrupt or significant rolloff tendencies.

e. Attempt speedbrake extension at MIL power.

f. ALPHA COMP cb — In.

ABC

64. Structural integrity check (0.9 Mach at 10,000 feet).

a. High-speed dash — MIL THRUST.

b. High-g turn.

PROFILE

c. Anti-g valve operation.

d. HUD g — Check.

10.3.9 Airstarts (20,000 Feet)

AB 65. Radar power switch — STBY (coordinate with RIO).

AB 66. Spooldown airstart.

a. Stabilize at 300 knots.

b. Right throttle — OFF Then IDLE at 60-percent rpm.

Note

Subidle stall can be cleared by cycling the throttle to OFF and immediately returning it to IDLE.

c. Stabilize at 300 knots.

d. Left throttle — OFF Then IDLE at 60-percent rpm.

AB 67. Radar power switch — XMIT (coordinate with RIO).

10.3.10 Climb to 35,000 Feet

AB 68. Fuel management.

	Left	Right
FEED		
FUS		
WING		
EXT		
TOTAL		

AB 69. ECS check.

a. Automatic cabin temperature control.

b. Manual cabin temperature control.

c. Cabin altitude schedule (approximately 14,000 feet at 35,000 feet).

AB 70. Afterburner light-off — Check (check at 210 knots).

a. ASYM LIMITER switch — OFF.

PROFILE

b. Throttles — MAX AB.

Verify AB light-off within 10 seconds.

c. Throttles — Less Than MIL.

d. ASYM LIMITER switch — ON.

AB

71. Engine instruments (engine MIL power at 0.9 Mach).

	Left	Right	Limits
OIL (PSI)			25 to 65
RPM (%)			107.7 maximum
EGT (°C)			935°

10.3.11 High-Speed Dash (35,000 Feet)

AB

72. Idle lockup — Check.

a. Jam throttles — MAX AB (accelerate to 1.2 Mach).

b. Both throttles to MIL until nozzles close, then IDLE above 1.1 Mach and verify less than 2-percent rpm decay.

CAUTION

Monitor rpm decay while retarding throttles to IDLE to ensure proper idle lockup operation. Discontinue idle lockup check if rpm decays more than 2 percent above 1.1 Mach. Place throttles to MIL and decelerate.

c. Jam throttles — MAX AB (accelerate to 1.5 Mach).

d. Engine instruments — Monitor.

	Left	Right	Limits
NOZ position (%)			50 to 60 (open)
OIL (PSI)			25 to 65
RPM (%)			107.7 maximum
EGT (°C)			935°

e. Mach trim compensation — Check.

PROFILE

f. Wing-sweep program — Check.

g. Compare pitot-static instruments at 1.5 Mach.

	Pilot Stby	RIO Stby	Calibrated
Altitude			
Airspeed			

10.3.12 Zoom (40,000 Feet)

AB 73. Pitch up to FL 400.

AB 74. Cabin pressurization and ECS — Check (approximately 17,000 feet at 40,000 feet).

10.3.13 20,000-Foot Checks

A 75. AFCS check.

a. Attitude hold.

(1) Autopilot — Engage; Verify No Transient.

(2) Check for smooth operation in CSS.

b. Heading hold.

(1) Heading hold — Engage.

(2) Left and right pedal sideslip — Check Return to Reference Heading.

(3) CSS left or right to 5° roll — Aircraft Should Return to 0° Angle of Bank.

c. Altitude hold.

(1) ALT hold — Select (verify A/P REF advisory illuminates).

(2) A/P REF — NWS pushbutton — Depress (verify A/P REF advisory goes off).

(3) Check for altitude control.

(a) ±30 feet in level flight.

(b) ±60 feet in 30° angle of bank.

d. Ground track hold (DEST steering not selected).

(1) GT hold — Select (verify A/P REF advisory on).

(2) A/P REF — NWS pushbutton — Depress (verify A/P REF advisory goes out).

PROFILE

(3) Verify A/P establishes crab into wind to hold selected track.

(4) Autopilot emergency disengage paddle switch — Depress.

(5) PITCH and ROLL STAB AUG switches — ON.

ABC

76. Negative alpha/FOD check (20,000 feet, 300 knots).

a. Throttles — MIL.

b. Roll inverted in wings-level attitude and set — 1.0g.

WARNING

Negative-g maneuvering at high gross weight should be avoided because of possiblility of aircraft departure.

c. Check for normal engine operation and FOD or loose gear.

A

77. Air-to-air check.

a. Weapon selector switch — LR.

b. Test target — Select.

c. Attack steering — LAR-V_c.

d. Collision steering.

e. Attack steering — LAR-V_c.

(1) MR.

(2) SR.

f. Target intercept.

(1) VSL high.

(2) VSL low.

(3) MRL.

(4) PLM.

(5) PAL.

(6) Select gun.

(7) Observe proper HUD display.

PROFILE	
	g. Gun sight — Check.
	(1) RTGS/MANUAL.
	(2) MMGS.
A	78. Air-to-ground check.
	a. Select A/G.
A	79. Fuel dump check.
	a. Speedbrake switch — EXT.
	b. DUMP switch — DUMP.
	(Observe no fuel dump).
	c. Speedbrake switch — RET (observe fuel dump).
	d. DUMP switch — OFF.
A	80. Fuel system check (total fuel less than 8,000 pounds).
	a. WING/EXT TRANS switch — OFF.
	b. FUEL FEED switch — FWD/R Monitor 500-Pound Split, AFT/L High.
	c. FUEL FEED switch — AFT/L Monitor 500-Pound Split, FWD/R HIGH.
	d. FUEL FEED switch — NORM.
	Verify FWD/R high split remains constant.
	10.3.14 Approach
ABC	81. Landing Checklist complete.
ABC	82. ACLS/ARA-63 — Check.
ABC	83. Airspeed and AOA (15 units AOA) — Check.
	a. AOA, INDEXER, HUD.
	(1) Gross weight ________ pounds.
	(2) Airspeed _____ knots (124 knots ±4 knots at 44,000-pound gross weight. Add 3 knots per 2,000 pounds over 44,000-pound gross weight).

PROFILE

10.3.15 Touchdown

ABC 84. Verify exhaust nozzle less than 26 percent.

a. Three to seven seconds after touchdown, nozzles 100 percent.

ABC 85. Walkaround inspection — Complete.

10.4 FUNCTIONAL CHECKFLIGHT PROCEDURES (RIO)

10.4.1 Prestart

A 1. ICS.

a. Normal.

b. Backup.

c. Emergency.

ABC 2. IND LT — TEST.

A 3. Seat adjustment — Check.

A 4. Canopy rigging.

a. Both cockpit handles same position during operation.

b. BOOST not required to close.

ABC 5. NAV MODE switch — ALIGN.

a. After displays are on, verify and/or enter alignment coordinates.

10.4.2 Poststart

A 6. Multifunction display.

a. Verify navigation display.

A 7. ALR-67 — BIT.

A 8. Altimeter — Set and Check; Record Error __________.

When the local barometric pressure is set, all altimeters should agree within 75 feet at field elevation.

10.4.3 Taxi

A 9. BDHI — Cross-Check Heading With VDI/HUD.

PROFILE

A

10. NSV — Check (at takeoff end of runway).

Groundspeed	Time

10.4.4 Takeoff and Climb

AB

11. Engine runup — Check at MIL.

	Left	Right	Limits
NOZ position (%)			nominal 3 to 10
OIL (PSI)			25 to 65
RPM (%)			95 to 104 nominal (107.7 maximum)
EGT (°C)			935°
FF (PPH)			9,000 to 12,000

A

12. Airspeed — Check (200 knots).

Pilot Standby	RIO Standby	HUD
________ KIAS	________ KIAS	________ KCAS

A

13. Altimeter — Check.

INS/SAHRS	ALTIMETER

A

14. Tacan and NSV position — Cross-Check.

A

15. INS navigation and radar mapping check.

   a. Radar map — Check All Range Scales.

10.4.5 15,000-Foot Checks

ABC

16. Structural integrity check.

   a. Anti-g valve operation.

   b. Set radar power switch to STBY before pilot ECS check.

PROFILE

10.4.6 20,000-Foot Checks

AB

17. Radar power switch — XMIT (airstarts complete).

10.4.7 Climb to 35,000 Feet

AB

18. Engine instruments — Record.

	Left	Right	Limits
OIL (PSI)			25 to 65
RPM (%)			107.7 maximum
EGT (°C)			935°

A

19. D/L — Check.

A

20. Select assigned frequency and ADDRESS.

A

21. Receive D/L messages.
    a. Steering symbols.
    b. TID target data.
    c. Data-link messages.

10.4.8 High-Speed Dash (35,000 Feet)

A

22. Engine instruments — Record.

	Left	Right	Limits
NOZ position (%)			50 to 60 (open)
OIL (PSI)			25 to 65
RPM (%)			107.7 maximum
EGT (°C)			935°

10.4.9 Descent

A

23. Air-to-air check
    a. Radar modes
        (1) PULSE.
        (2) PD SRCH.

PROFILE

(3) RWS.

(4) TWS AUTO.

(5) TWS MAN.

(6) HRWS.

b. MLC switch — OUT-AUTO-IN (PD SRCH).

c. Navigation.

(1) Tacan fix — Record (do not initiate update).

Δ Latitude	Δ Longitude

(2) Radar fix — Record (do not initiate update).

Δ Latitude	Δ Longitude

(3) Visual fix — Record (do not initiate update).

Δ Latitude	Δ Longitude

d. Weapon systems checks against suitable airborne targets.

(1) Intercept targets, check operation in PD SRCH, RWS, and TWS MAN.

(a) Observe transition to PULSE STT.

(b) Return to PULSE SRCH.

(c) Close to visual range and verify DD display.

(2) VSL mode — HI-LO LOCK-ON.

(3) MRL mode — Check LOCK-ON.

e. IFF — Check Modes 1, 2, 3, and 3C.

PROFILE	
A	24. Air-to-ground check.
	a. Select A/G.
	b. Select CTGT mode.
	(1) Verify symbology.
	(2) 30° dive 12,000-foot roll-in.
	(3) Designate target.
	(4) Verify solution.
	(5) Maneuver-designator remains on target.
	(6) Complete 30° dive.
	c. Select CCIP mode.
	(1) Verify symbology.
	(2) 30° dive 12,000-foot roll-in.
	(3) Fly impact point over target.
	(4) Complete 30° dive.
	d. Air-to-ground GUN sight.
	(1) Select GUN.
	(2) Dive angle greater than 15°.
	(3) Check symbology.
	e. Exit A/G.
ABC	25. Perform radar IBIT and record results.
A	26. NSV — SAHRS.
	a. Pilot check HUD and VDI display and maneuver aircraft.
	b. Radar antenna scan — Check.
	10.4.10 Approach
A	27. Airspeed
	a. Compare with pilot airspeed at 15 units AOA; record error _______ knots.

PROFILE

10.4.11 Landing

ABC

28. Radar – PS, or power switch — STBY.

10.4.12 In Chocks

ABC

29. INS/SAHRS and visual — Check and Update in Chocks.

   a. Record closeout error.

	Δ Latitude	Δ Longitude	Δ Time	Groundspeed
INS				
SAHRS				

   b. Initiate fix enable.

   c. Observe aircraft symbol shift on TID.

ABC

30. Call up maintenance current failures.

   Record

10.4.13 Postflight

ABC

31. Walkaround inspection — Complete.

PART IV

Flight Characteristics

Chapter 11 — Flight Characteristics

CHAPTER 11

Flight Characteristics

11.1 PRIMARY FLIGHT CONTROLS

Primary flight controls are devices that change the flightpath of the aircraft. They consist of the differential horizontal stabilizer for pitch and roll control, the spoilers for supplementary roll control, and the rudders for directional control. A stability augmentation system is provided for the three axes of aircraft motion.

11.1.1 Pitch Control. The horizontal tail is effective from under 100 knots to over Mach 2. Its effectiveness gives the aircraft several capabilities not enjoyed by other fighters, including low takeoff rotation speeds and the ability to reach or exceed limit load factor over much of the subsonic and supersonic envelope; it is also an excellent drag device below 100 knots on landing rollout. The major disadvantages of the large horizontal stabilizer authority are that the pilot can generate high enough pitch rates (particularly in the nosedown direction) to cause coupling under certain conditions, and that a pitch attitude sufficient to scrape tailpipes and ventral fins can be attained on landing rollout or takeoff rotation.

11.1.2 Roll Control. Differential deflection of the horizontal tail surfaces provides primary roll control throughout the flight envelope and is the only roll control when the wings are swept beyond 62° (disabling the spoilers).

Spoilers are very effective at low to medium AOA for roll control, and reduce the aft fuselage torsional loads induced by the differential tail. The spoilers are also the primary mechanism for direct lift control and spoiler braking.

11.1.3 Directional (Yaw) Control. Twin rudders furnish directional control. Through strong dihedral effect (roll because of sideslip), good roll control is also available from rudder inputs at medium and high AOA. Rudder power is sufficient to provide adequate control under all asymmetric store loading conditions.

11.1.4 Stability Augmentation. Pitch SAS increases damping of the longitudinal, short-period dynamic response, but the aircraft can be operated safely throughout the flight envelope without it.

Roll SAS increases roll acceleration during the initial lateral stick input. The SAS reduces differential tail deflection to limit maximum roll rate to less than 180° per second to reduce aft fuselage loads and to prevent roll coupling in the transonic speed range. An undesirable byproduct of the roll-rate limiting is an oscillatory roll rate perceived as a nonlinear roll response encountered in full lateral stick deflection rolls at medium subsonic speeds and higher. Because roll SAS provides structural protection, flight above 0.93 Mach is prohibited without roll SAS with wing-mounted AIM-54 (loadings 3B5, 3B6, 3C5, 3C6). Should tactical considerations necessitate violating this restriction, restrict rolls to less than full lateral stick deflection and to not more than 180° of bank angle change at one time. This minimizes the possibility of aircraft damage. Initial roll acceleration is slower without roll SAS; however, high AOA handling qualities are improved (see paragraph 11.6).

With regard to controllability, yaw SAS is the most critical of the stability augmentation functions. Directional dynamic response (yaw oscillations or dutch roll) is poorly damped without it. In regions of reduced directional stability above 24 units AOA or when supersonic, the SAS dampens yaw rates that might otherwise cause loss of control, or structural damage. Below 0.93 Mach, with yaw SAS OFF, normal maneuvering can be accomplished if extra care is taken to control yaw and sideslip excursions with rudder (maintain coordinated flight).

11.2 SECONDARY FLIGHT CONTROLS

Secondary flight controls affect the flightpath of the aircraft although they have other primary purposes, such as increasing lift or drag. Secondary flight controls of the aircraft include main, auxiliary, and maneuver flaps, leading edge slats, speedbrakes, DLC, and the variable sweep wing.

11.2.1 Maneuver Flaps and Slats. Maneuver flaps and slats provide increased turn performance (increased turn rate/decreased turn radius) when extended. Additionally, the extension of the maneuver slats decreases departure susceptibility by increasing positive dihedral effect (roll because of sideslip). The longitudinal trim change upon extension and retraction of the devices is slight (2 to 4 pounds aft on extension, approximately 2 pounds forward on retraction).

11.2.2 Landing Flaps, Slats, and DLC. Trim changes during extension and retraction of flaps/slats are significant. During extension of flaps/slats at 200 knots, an initial push force of approximately 5 pounds is required followed by a pull force of up to 15 pounds. Engagement of DLC at approach speeds causes essentially no trim change. Forces during retraction of the flaps/slats are generally opposite and of approximately the same magnitude. The force required during retraction of flaps/slats may be less objectionable than those during extension, as the flaps are generally raised at a slower airspeed and, therefore, require less opposing force.

Note

Retracting the flaps with DLC engaged may require up to 30 pounds push force to maintain pitch attitude when the DLC automatically disengages as the flaps pass 25°.

11.2.3 Speedbrakes. The speedbrakes provide some deceleration capability throughout the flight envelope. However, the most effective means to slow the aircraft is to reduce thrust while applying g, since the speedbrakes are marginally effective at moderate to low speeds. Extension and retraction of the speedbrakes results in a pitch trim change that varies with flight conditions. In general, this change is not objectionable except at higher airspeeds where the rapidity of the change (1.5 seconds for full extension) may prevent fine (±3 mil) gunsight tracking and possibly lead to a minor case of pilot-induced oscillation.

11.3 GENERAL FLIGHT CHARACTERISTICS

11.3.1 Static Longitudinal Stability. Static longitudinal stability indicates the direction of longitudinal stick force required with changing airspeed from a trim condition. At slow speeds where the wings are not sweeping, static longitudinal stability is slightly positive (forward stick is required for increasing speeds, aft stick is required for decreasing speeds). At speeds where the wings are automatically sweeping aft, static stability becomes neutral to slightly negative.

In the transonic region, from Mach 0.8 to 1.5, static longitudinal stability is essentially neutral. There is, however, *a minor reversal in the stick force gradient* (forward stick force may have to be relaxed to maintain level flight when accelerating) at approximately Mach 0.95. Above Mach 1.5, the stick force gradient becomes neutral. Since the engine line of thrust is below the aircraft cg, reducing power causes a slight nosedown pitch; power addition causes a noseup pitch.

11.3.2 Dynamic Longitudinal Response Characteristics. The initial response of the aircraft to a longitudinal stick input is greatly dependent on the dynamic longitudinal response or "short period" characteristics. Dynamic longitudinal response to pilot inputs is somewhat sluggish in cruise and approach configurations when compared to most other modern day fighters. In cruise configuration this may not be evident until high gain, close coupled tasks, such as fine gunsight tracking, are attempted. Here, the pilot's tendency is to overdrive the aircraft with the control stick resulting in a slight porpoising of the nose. This can be avoided by applying a longitudinal stick input and waiting for a nose response before applying a further correction.

In approach configurations, the sluggish nose response will be most noticeable during approaches without DLC, as more nose movement must accompany the larger power adjustments required to maintain onspeed AOA when flying the ball.

11.3.3 Maneuvering Stick Force. Maneuvering stick force, or stick force per g of the aircraft, is predictable throughout most of the flight envelope. That is, an increase in force commands a corresponding increase in g (approximately 4 pounds per g). The stick force per g generally changes very little with altitude, airspeed, loading, or cg position.

Stick displacements required during maneuvering are relatively large and may be uncomfortable to some pilots. While the stick forces are not especially high, the stick must be placed relatively close to the pilot's torso to attain a given g. This gives the pilot less leverage with his arm and is more tiring, especially at lower airspeeds and higher AOA, where stick force per g can be as high as 10 pounds per g.

11.3.4 Roll Performance. The roll performance (maximum roll rate attainable) is generally satisfactory, particularly at high airspeeds. At lower speeds, however, the high-aspect ratio and roll inertia of the aircraft restrict its time to roll to considerably less than that of smaller, more nimble tactical aircraft (A-4, F-16). The sluggish maximum roll rate at low airspeeds and high AOA are definite tactical limitations.

Large aft stick inputs applied with lateral stick during supersonic rolling maneuvers result in increased adverse sideslip and should be avoided. High Mach number, high-altitude rolling maneuvers may result in oscillatory sideslip and roll ratcheting during aggressive maneuvering with roll SAS off. Depending on the phasing of these dynamics, centering lateral stick may be insufficient to stop the rolling motion and opposite lateral stick may be required in order to terminate roll.

11.3.5 Roll Response. The roll response to control inputs is good with three exceptions. First, at high airspeeds, the roll-rate limiting feature of the roll SAS causes marked variations in roll acceleration during the initial lateral stick input, which results in a roll-rate oscillation. Natural pilot compensation for this characteristic may lead to a lateral pilot induced oscillation during maximum roll-rate maneuvers at high airspeeds. Additionally, at high airspeeds, roll response to small inputs is overly sensitive, primarily because of low breakout forces and a nonlinearity caused by an abrupt increase in roll rate when the stick is displaced laterally just enough to break out the spoilers. This can result in bank angle overshoots during maneuvering flight. Lastly, at high angles of attack, at all airspeeds, the cumulative effect of several phenomena results in a lateral control reversal in which the aircraft rolls in a direction opposite to the lateral control input. This characteristic is further amplified in paragraph 11.6.6, Lateral Control Reversal.

11.3.6 Dutch Roll. Although large lateral stick inputs can excite the dutch roll mode of the aircraft in cruise configuration, the most severe degradation in flying qualities from the dutch roll is in approach configuration. During an approach, the dutch roll is characterized by a wallowing, snakey motion of the nose that severely degrades lineup control. The period on this motion is quite long, and has the unfortunate result that the pilot perceives a heading error when referenced to centerline, when in fact the flightpath is correct. More consistent lineup control can be gained by coordinating lateral stick inputs with rudder.

11.3.7 Trim Characteristics. The trim rate in pitch is slow. During acceleration runs in MAX power at low altitude, trim may have to be run nearly continuously to maintain longitudinal stick force at or near zero. Lateral control authority and roll rates at slow speeds will be reduced by almost one-half with full stick deflection in the direction of full lateral trim because of decreased spoiler deflection (see spoiler gearing curves in Chapter 2). Therefore, when maximum lateral control authority is required, such as during an asymmetric flap condition, trim in the direction of stick displacement should be avoided. Runaway trim in any axis is controllable. During field landings, the aircraft can be recovered safely with runaway trim; however, carrier approaches with full runaway pitch trim may be difficult.

Trimming the aircraft to level flight can be broken down into two areas. At airspeeds slower than those using automatic wing-sweep programming, the aircraft is relatively easy to trim to level flight because it has positive longitudinal static stability. At airspeeds where the wings automatically move with a change in airspeeds, it becomes very difficult to achieve a hands-off trim. Because of the change in aircraft pitching moment caused by movement of the wings, the nose tends to pitch further down with each increase in speed or further up with each decrease in speed.

Changes in thrust settings normally require a trim change, particularly in the approach configurations. A reduction in power causes a slight nosedown pitch.

11.4 ASYMMETRIC THRUST FLIGHT CHARACTERISTICS IN COMBAT AND CRUISE CONFIGURATION

11.4.1 General. With one engine inoperative, flight characteristics are considerably affected by the thrust asymmetry generated by the operating engine. The distance of the engines from the aircraft centerline produces flight control requirements and flying qualities not present in centerline thrust aircraft. Flight control requirements are a function of the thrust setting on the operating engine. The thrust required to maintain flight, and therefore the magnitude of the thrust asymmetry, is a function of the following.

11.4.1.1 Gross Weight. Heavier gross weights require higher thrust settings to maintain level flight and, therefore, larger control deflections to counter the greater asymmetric thrust.

11.4.1.2 Configuration. Aircraft configuration varies the amount of thrust required at a particular flight condition. At cruise configuration airspeeds, control requirements will be significantly reduced compared to landing configurations, which will require significantly higher thrust settings and in turn larger control forces to maintain desired flightpath.

11.4.1.3 Airspeed. At maximum endurance airspeeds, minimum thrust is required to maintain level flight; therefore, the smallest asymmetric moment is produced. Higher or lower airspeeds will require higher power settings and, therefore, increased control forces. At airspeeds above maximum endurance, the greater asymmetry will be offset largely by the additional control power available. Minimum control speed is reached at the point when maximum rudder deflection is no longer sufficient to maintain directional control.

11.4.1.4 Altitude. Net thrust is strongly dependent on altitude. For a constant throttle setting, the asymmetric thrust is considerably higher at sea level than at higher altitudes. The F110 produces considerably more thrust than the TF-30 powered F-14A. At maximum afterburner, the F110's thrust at 10,000 feet is equivalent to that of the TF-30 at sea level.

11.4.1.5 Bank Angle. Bank angle increases induced drag and, therefore, requires higher thrust settings to maintain level flight. The higher thrust setting demands increased rudder deflection in a turn compared to that required in level flight at the same airspeed. Turn direction, into or away from the failed engine, significantly affects rudder requirements. In straight-line flight, some amount of rudder deflection will be required to offset the yawing moment from asymmetric thrust at zero bank angle. Five degree bank angle into the good engine will introduce a side force component countering the thrust asymmetry and thereby reducing the rudder requirement.

11.4.1.6 Asymmetric Thrust Limiting System. With operative ATLS, the magnitude of any asymmetric thrust in MAX power will be reduced, thereby reducing the control requirements to maintain the flight condition or reducing time to recover if a departure has occurred. ATLS should be engaged from startup to shutdown. ATLS can be turned off if required for tactical considerations such as a single-engine ACM bugout.

11.5 ENGINE STALLS AND FLAMEOUT

The F110 engines demonstrate exceptional operability throughout the flight envelope. No "hung stalls" (similar to the classic TF-30 stall) have been observed in flight tests. Self-clearing "pop" stalls, which may produce an audible "bang," may occur above 35,000 feet when below 100 knots in MAX power and usually occur in conjunction with an AB blowout. To date these stalls have resulted in no engine damage, are self-clearing in approximately 1 second, and have required no pilot action for engine recovery. However, throttles should be reduced to idle when subsonic (MIL when over 1.1 Mach) to minimize the possibility of engine damage during all engine stalls. A supersonic stall may cause inlet buzz resulting in a rough, bumpy ride (+2.5 to -1g at 6 cycles per second). Inlet buzz should subside when decelerating below 1.2 Mach. When supersonic, any wing drop tendencies should be controlled with lateral stick alone.

11.5.1 Medium and High-Subsonic Airspeed. Above approximately 100 knots, sufficient controllability exists to control a maximum AB/stalled engine thrust asymmetry with operative ATLS. Aircraft response to an engine failure is generally mild and is characterized by slow buildup in yaw rate followed by slowly increasing rolloff in the same direction as yaw. This response is insidious since the aircrew will only notice the roll as it masks the yaw rate. Rudder is the primary control to offset yawing moment from asymmetric thrust. Higher airspeeds provide more rudder effectiveness and increase pilot ability to control yaw caused by asymmetric thrust.

WARNING

> The use of lateral stick to offset the uncommanded roll caused by yaw from asymmetric thrust at high AOA will generate adverse yaw and aggravate the yaw caused by asymmetric thrust. The result may be a yawing, rolling departure.

Yaw rate increase after an engine stall or failure may be completely masked by roll if the pilot does not recognize that the engine malfunction has occurred and that aircraft motion is the result of that malfunction. Therefore, when any uncommanded rolloff or yaw rate occurs during maneuvering flight with maximum thrust, the pilot should reduce AOA, reduce thrust, counter with rudder, and avoid the use of lateral stick alone.

11.5.2 Low Subsonic Airspeed. As aircraft speed approaches zero, flight control effectiveness also approaches zero and maximum thrust asymmetry could generate a rapid yaw rate buildup if corrective action is not taken. If thrust asymmetry is encountered, the pilot should immediately retard both throttles smoothly to IDLE, while maintaining neutral control.

These actions should prevent yaw rate buildup and allow the aircraft nose to fall through and regain flying speed. After throttles are reduced, the pilot should lock his harness in anticipation of a possible departure.

WARNING

> Loss of thrust on one engine while maneuvering at low airspeed must be dealt with immediately since flight control effectiveness may be insufficient to counter the yaw rate generated by asymmetric thrust.

If both engines are stalled after retarding throttles to IDLE, at least one engine must be secured immediately to prevent turbine damage and provide maximum potential for an airstart. If possible, secure the engine that did not stall initially (the second engine to stall). The cause of the first engine stall may not be known at this point; however, it is possible that the second stall may have been induced during the throttle transient to IDLE. Leaving one engine in hung stall minimizes the likelihood of total loss of hydraulic and electrical power (emergency generator). See Chapter 14 for a detailed discussion of compressor stall and airstart emergency procedures.

11.6 HIGH ANGLE OF ATTACK FLIGHT CHARACTERISTICS

Several characteristics of the F-14 affect its behavior in high AOA flight. Among these are directional stability, dihedral effect, stores loading, the stability augmentation system, and maneuver flaps/slats.

11.6.1 Directional Stability. Directional stability is the tendency of the aircraft to return to trimmed, zero sideslip when disturbed. At low AOA, the aircraft exhibits positive directional stability and, if sideslip is generated by a control input or turbulence, the aircraft will return to the trimmed, zero-sideslip condition.

As AOA increases, directional stability begins to drop and, for a clean aircraft, becomes negative at approximately 20 to 22 units AOA. At high AOA with negative directional stability, the aircraft becomes more difficult to fly because the pilot must maintain the zero-sideslip condition with rudder inputs.

11.6.2 Dihedral Effect. Dihedral effect is the tendency of the aircraft to roll in reaction to sideslip being generated. The F-14 exhibits positive dihedral effect throughout the positive-AOA envelope (tending to roll away from sideslip) but negative dihedral effect at negative AOA. This tendency is borne out by the aircraft response from a rudder input. When right rudder is applied from a straight-and-level flight condition, the aircraft sees sideslip from the left and so rolls to the right or away from the sideslip. Positive dihedral effect is a stabilizing influence in the area of reduced directional stability (high-AOA flight).

11.6.3 Stores. As external stores are added to the aircraft, the high-AOA flying qualities degrade because of a decrease in directional stability. Flight tests have shown that no one store is significant by itself. Rather, each store causes a small decrease in directional stability that accumulates as additional stores are loaded. In addition to degrading directional stability, external stores increase aircraft basic weight. As aircraft weight is increased, more AOA is required to produce the same normal acceleration or g. As AOA increases above 12 to 14 units AOA, directional stability decreases. Therefore, external stores may have a twofold effect on directional stability. Flight test has shown store loadings up to and including 3C3 (four AIM-54s, two AIM-7s, two AIM-9s, and two tanks) can be safely flown to the limits of the basic aircraft with roll SAS off as long as the cruise configuration maneuvering limits presented in Chapter 4 are complied with. No significant change in flying qualities occurs because of aft cg location.

CAUTION

Maneuvering with significant external store loadings should be approached with caution if the pilot is used to maneuvering the clean or nearly clean aircraft, since the high-AOA flying qualities will be degraded from the clean aircraft.

11.6.4 Stability Augmentation System. The effect of the SAS on aircraft high-AOA flight characteristics ranges from minor to very significant. With the pitch SAS off, the nose will be slightly more sensitive during close controlled tasks such as gunsight tracking. During large amplitude maneuvers, slightly higher AOA may be reached. In general, pitch SAS on or off will not significantly influence departure characteristics or recovery and no limitations concerning its use are necessary. Turning the yaw SAS off significantly decreases the departure resistance of the aircraft. High-AOA maneuvering should not be conducted with the yaw SAS off. All discussion on high-AOA flight characteristics in this section assumes that the yaw SAS is engaged and operating. Roll SAS has the opposite effect. With the roll SAS on, maximum differential tail authority commanded by lateral stick (±12°) is nearly doubled from that commanded with roll SAS off (±7°). Additionally, engagement of roll SAS enables the roll rate feedback circuitry, which will attempt to arrest aircraft roll commanded with no lateral stick inputs (as when rolling the aircraft with rudders only at high AOA) with differential tail opposite the roll. This inadvertent cross control alone can cause departures from controlled flight. High-AOA maneuvering shall not be conducted with the roll SAS on. Unless otherwise stated, the following discussion assumes the roll SAS is off.

11.6.5 Maneuvering Flaps and Slats. Maneuver flaps and slats extension delays buffet onset below 0.7 Mach, reduces the intensity of the buffet, reduces the effects of adverse yaw at high AOA through increased positive dihedral effect (roll caused by sideslip), and increases the sustained g available. Above 0.7 Mach, buffet onset occurs prior to the maneuver flap/slat extension threshold, but once the maneuver flaps/slats are fully extended, buffet is reduced. Maneuver flaps/slats will not extend above 0.85 Mach because of the wing-sweep interlocks. Although maneuver flaps/slats increase the severity of the wing rock between 20 and 28 units AOA, overall departure resistance of the aircraft is greatly improved (Figure 11-1, sheets 1 and 2). This wing rock may be damped with rudders, but greater difficulty may be encountered with maneuver flaps and slats extended, particularly at low airspeeds. If this occurs, the wing rock may be damped by neutralizing the lateral and the directional controls and momentarily reducing AOA to below 20 units. Since maneuver flaps and slat extension and retraction is fully automatic, no changes in high-AOA flying techniques are required. Maneuver flaps/slats should be utilized in the automatic mode from takeoff to landing.

CAUTION

Maneuvering with inoperative maneuvering flaps/slats should be approached with caution if the pilot is used to maneuvering the aircraft with automatic flaps/slats, since the high-AOA flying qualities will be degraded from the automatic flap/slat aircraft. If maneuvering flaps/slats are inoperative, maintain coordinated flight with lateral inputs and rudder.

11.6.6 Lateral Control Reversal. Since roll control is provided by wing mounted spoilers and differential stabilators, the aircraft exhibits proverse yaw throughout the flight envelope (yaw in the direction of the lateral stick input). At high AOAs, several other aerodynamic and physical properties overpower the proverse yaw and will yaw and roll the aircraft opposite the commanded input. The primary contributor to this roll reversal is the negative directional stability at high AOAs (above 18 units at 0.9 Mach, and above 21 units at 0.15 Mach). The sequence of events causing this roll reversal is as follows (for the sake of example consider a left stick input): 1) The aircraft initially rolls in the direction commanded (left); 2) as the aircraft starts to roll left, airstream's direction relative to the aircraft changes from the vertical plane (plane of symmetry) into left sideslip (the definition of kinematic coupling); 3) because of the negative directional stability, the aircraft reacts to the left sideslip by diverging in yaw to the right, further increasing the left sideslip; 4) because of strong dihedral effect, the aircraft responds to the left sideslip and right yaw rate by reversing the roll to a right roll. The net effect in the eyes of the pilot is that at high angles of attack, the aircraft responds to lateral control inputs by feinting in the desired direction and then rolling and yawing opposite to the direction commanded. For this reason, generous use of the rudders is recommended at high AOAs in order to roll the aircraft. Roll SAS on during high-AOA maneuvering will aggravate the aircraft's tendency for lateral control reversal and will result in cross-control inputs during rudder-only rolls.

11.6.7 Miscellaneous. Speedbrake position has no effect on high-AOA flight characteristics. Wing-sweep angles aft of the AUTO schedule reduce buffet intensity, but departure resistance is reduced and more altitude is required for dive pullout when recovering after a departure. Therefore, the AUTO sweep schedule is best for high-AOA maneuvering.

11.6.8 Stall Characteristics. The 1g level stall (maneuver flaps/slats retracted) is characterized by the onset of light airframe buffet at 12 to 13 units AOA. This increases to moderate intensity at 15 units AOA with essentially no change in intensity at AOA as high as 60°. Buffet is not a satisfactory cue to determine airspeed or AOA during high-AOA maneuvering. The reduction in directional stability is apparent at 20 to 28 units AOA and even small control inputs will produce mild wing rock (+10° to 15°). Above 25 units AOA, lateral stick deflection causes roll opposite stick deflection. The stick should be centered laterally above 25 units AOA, and the rudder used to maintain balanced flight. Rudders are effective at controlling yaw and bank angle at all AOAs. Large rudder or lateral stick inputs produce an increase in AOA as sideslip increases. If the deceleration is continued to full aft-stick deflection, AOA is equivalent to approximately 45° to 55°. The cockpit AOA indicator pegs at 30 units AOA, which is equivalent to approximately 25° true AOA. Pitch attitude at stall is between 10° to 20° above the horizon with no external stores and 10° to 15° below the horizon with maximum external load. Some longitudinal porpoising may occur at full aft stick.

Maneuver flaps and slats delay buffet onset to 13 to 14 units AOA and reduce the magnitude of buffet in high-AOA flight. Wing rock, commencing at 20 to 28 units AOA, is more severe (up to +25° AOB) and more difficult to damp with maneuver slats extended because of the increased dihedral effect.

The clean stall is defined as the application of full aft stick combined with rates of descent up to 9,000 fpm. As much as 5,000 feet is required for recovery from the fully developed stall.

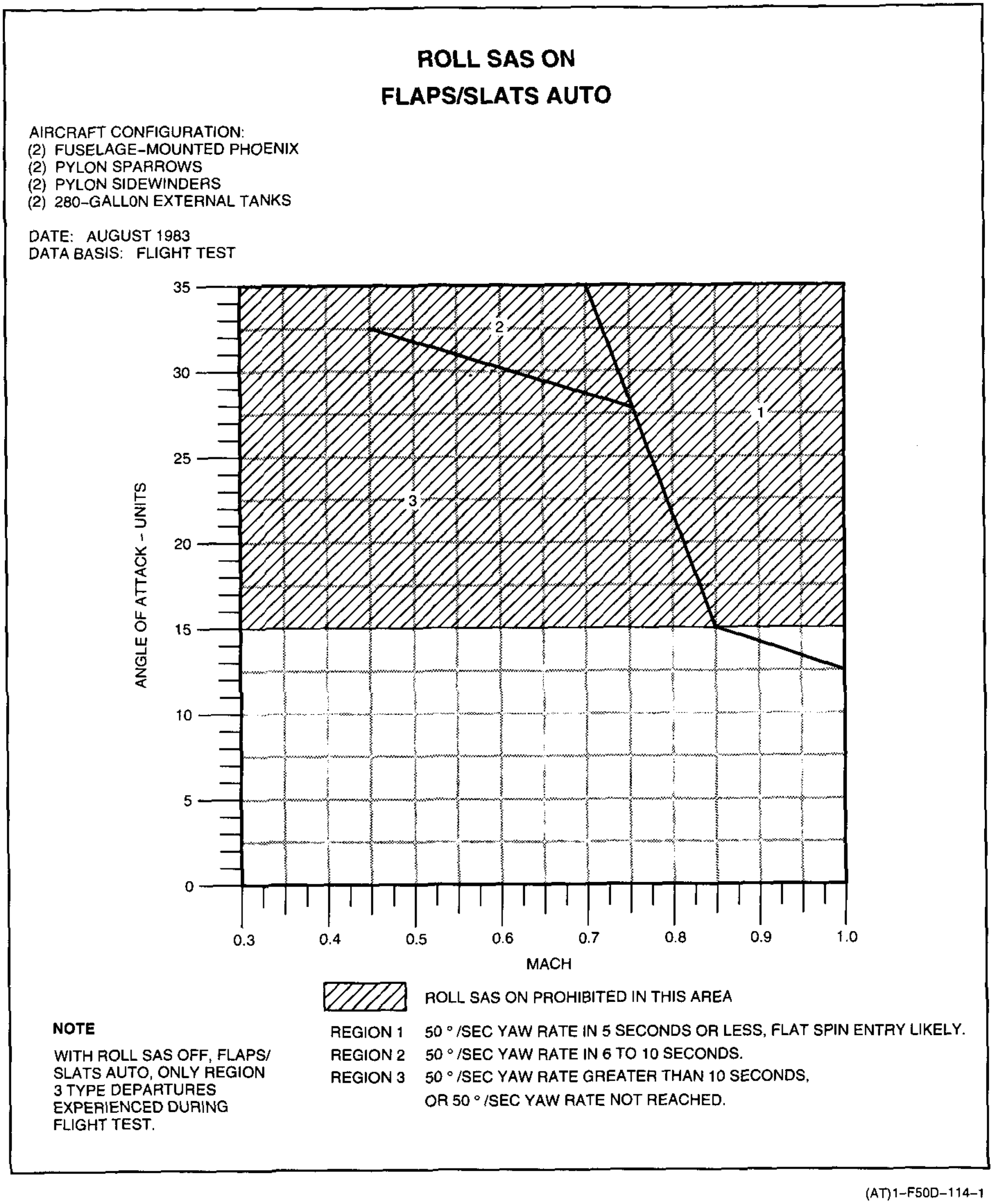
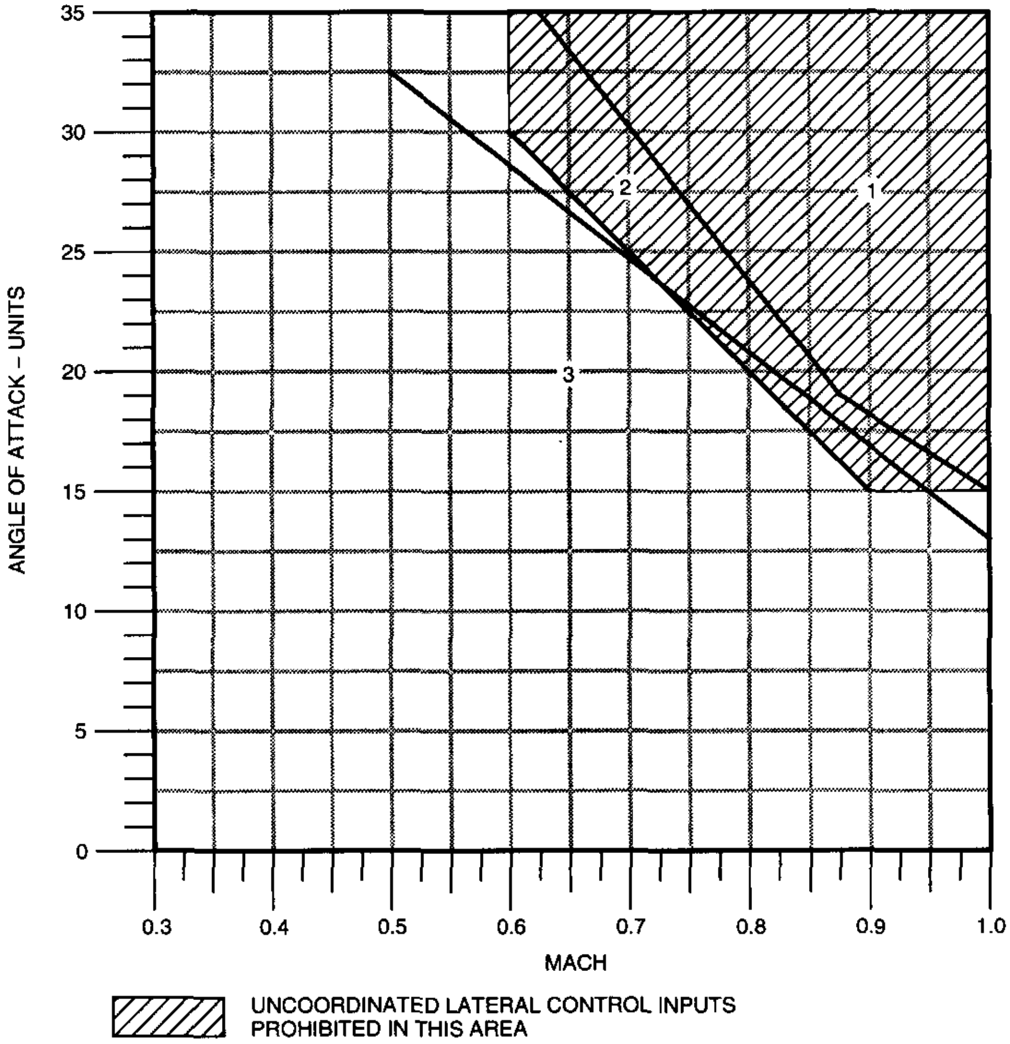


Figure 11-1. Lateral-Control-Induced Departure Areas (Sheet 1 of 2)

ROLL SAS OFF
FLAPS/SLATS RETRACTED

AIRCRAFT CONFIGURATION:
(2) FUSELAGE-MOUNTED PHOENIX
(2) PYLON SPARROWS
(2) PYLON SIDEWINDERS
(2) 280-GALLON EXTERNAL TANKS

DATE: AUGUST 1983
DATA BASIS: FLIGHT TEST



REGION 1 50 °/SEC YAW RATE IN 5 SECONDS OR LESS, FLAT SPIN ENTRY LIKELY.
REGION 2 50 °/SEC YAW RATE IN 6 TO 10 SECONDS.
REGION 3 50 °/SEC YAW RATE GREATER THAN 10 SECONDS, OR 50 °/SEC YAW RATE NOT REACHED.

(AT)1-F50D-114-2L

Figure 11-1. Lateral-Control-Induced Departure Areas (Sheet 2 of 2)

11.6.9 Vertical Stalls. If the aircraft is allowed to decelerate to zero airspeed in a vertical or near vertical attitude, it will slide backwards momentarily, then pitch over (usually backwards) to a near vertical dive. Aircraft motions during the initial fall will be predominantly inertial with random pitching and yawing as the aircraft accelerates. After the initial nosedown pitch, the aircraft may pass through the vertical to near level flight attitude, yaw in one direction, and then return to a vertical dive attitude. This may occur more than once. This tendency is more pronounced at aft wing sweeps, but can usually be controlled with longitudinal control inputs. Some recoveries may be accompanied by large random yawing and/or rolling motions that will generally dampen without pilot action as the aircraft accelerates. The controls should be released when airspeed decreases below 100 knots in the vertical stall to prevent inadvertent inputs that may lengthen recovery time. Control inputs should not be applied until the aircraft is nose down and accelerating. Rudder and lateral stick are also effective in damping oscillations once the aircraft is nose low and accelerating. The aircraft is very responsive to longitudinal stick inputs at all AOA at speeds above 100 knots.

Refer to paragraph 11.5.2, Low-Subsonic Airspeed for procedures to follow in the event of an engine stall. Refer to Chapter 14 for vertical stall recovery procedures.

During flight tests, vertical stalls in maximum afterburner power sometimes resulted in afterburner blowouts on one or both engines possibly followed by pop stalls that may or may not be audible to the pilot. All the stalls were self clearing with no tendency for EGT to rise out of limits. As the aircraft recovered and airspeed increased, the afterburner relit if the throttle remained in the afterburner detent. When practicing vertical stalls, basic engine power settings are recommended to avoid inducing engine afterburner transients that have an unknown effect on engine life. Maximum engine stall margin for the F110 is obtained at IDLE power.

11.7 DEPARTURE FROM CONTROLLED FLIGHT

11.7.1 General. Although the F-14 is an honest aircraft with moderate departure resistance, departures can be induced by large or sustained control inputs that generally feel unnatural to the pilot. Since the aircraft has an essentially unrecoverable flat-spin mode, yaw rate must be controlled before it can build and the aircraft transitions to the flat-spin mode. In general, departures are characterized by increasing yaw rate with oscillations in roll and yaw. Yaw rate is masked by the roll rate and is not evident to the pilot until approximately 90° per second yaw rate (2 "eyeball-out" g) is reached.

In an upright departure at approximately 50° per second yaw rate or less, if full forward stick is applied to reduce AOA, the aircraft will generally recover. At over 50° per second yaw rate, lateral/directional control inputs (rudder opposite yaw, lateral stick into yaw) are required to recover the aircraft. If these inputs are not made, the yaw rate will continue to build and the aircraft may enter the flat spin. The time to reach 50° per second yaw rate after control input or engine failure is very critical. If 50° per second yaw rate is reached in 5 seconds or less, the pilot may not have enough time to neutralize, analyze, and apply recovery controls before the aircraft enters a flat spin depending on type and severity of departure, altitude and AOA at entry, and aircraft configuration. The time to reach 50° per second yaw rate for various aircraft configurations as a result of lateral stick, rudder, or cross-control inputs is presented in Figures 11-1 through 11-3. Generally, the most severe departures are induced through the differential tail, which is commanded by lateral stick and/or roll SAS inputs. Rudder inputs, asymmetric thrust, and inertia coupling can cause or contribute to the severity of departures.

11.7.1.1 Mach and AOA Effects. As Mach number increases, flight-control-induced departure susceptibility and severity increases. Generally, as AOA increases, the severity of the departure increases. For example, a lateral stick input at 0.9 Mach, 30 units AOA, will produce a more violent departure than the same input at 0.9 Mach, 20 units AOA. The one exception is rudder-induced departures. As AOA is increased to about 30° (over 30 units AOA), rudder effectiveness decreases as the rudder is washed out and rudder-induced departures become less severe.

11.7.1.2 Maneuver Flaps/Slats. Extended maneuver flaps and slats significantly decrease departure susceptibility and severity through increased dihedral effect, as can be seen by comparing Figure 11-1, sheets 1 and 2.

11.7.1.3 External Stores. As external stores are added, departure susceptibility and severity increase. No one store is significant in and of itself. Rather, each store causes a small degradation in flying qualities that accumulates as additional stores are added. In general, fuselage-mounted stores have less effect than pylon- or nacelle-mounted stores.

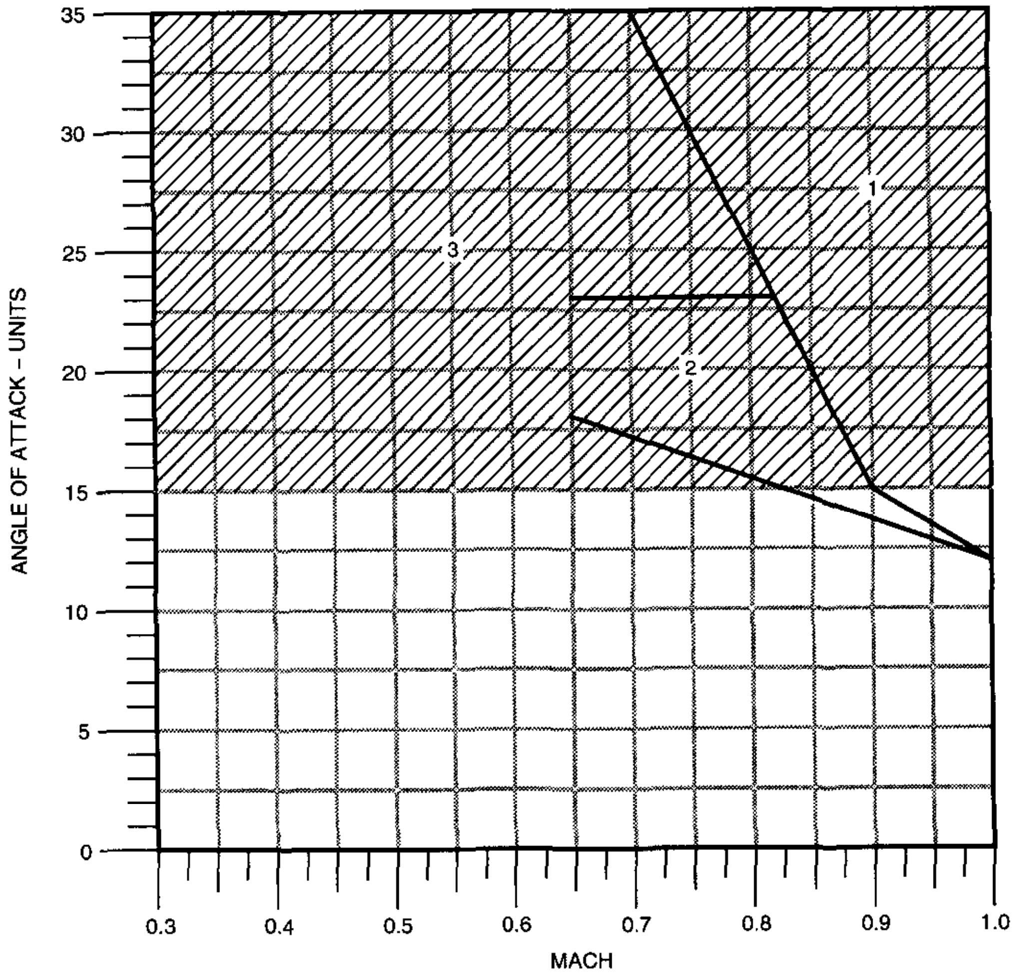
11.7.2 Lateral-Stick-Induced Departures. Uncoordinated lateral stick inputs with roll SAS off and maneuver flaps and slats extended generally produce benign departures that are easily recoverable. However, when maneuver slats are retracted or roll SAS is on, departures can be violent.

ROLL SAS ON

FLAPS/SLATS AUTO OR RETRACTED

AIRCRAFT CONFIGURATION:
(2) FUSELAGE-MOUNTED PHOENIX
(2) PYLON SPARROWS
(2) PYLON SIDEWINDERS
(2) 280-GALLON EXTERNAL TANKS

DATE: AUGUST 1983
DATA BASIS: FLIGHT TEST



ROLL SAS ON PROHIBITED

REGION 1 50 ° /SEC YAW RATE IN 5 SECONDS OR LESS, FLAT SPIN ENTRY LIKELY.
REGION 2 50 ° /SEC YAW RATE IN 6 TO 10 SECONDS.
REGION 3 50 ° /SEC YAW RATE IN 11 SECONDS OR MORE, OR 50 ° /SEC YAW RATE NOT REACHED.

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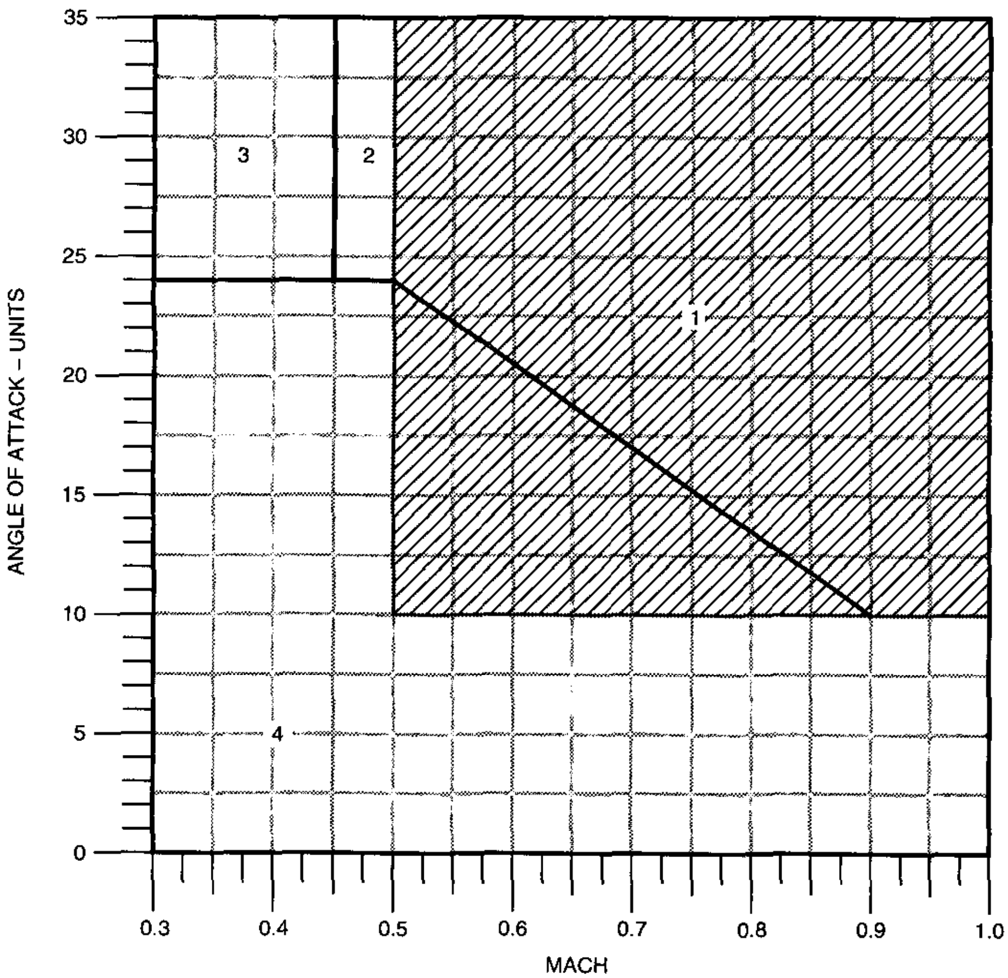
Figure 11-2. Rudder-Induced Departure Areas

ROLL SAS OFF
FLAPS/SLATS AUTO OR RETRACTED

AIRCRAFT CONFIGURATION:
(2) FUSELAGE-MOUNTED PHOENIX
(2) PYLON SPARROWS
(2) PYLON SIDEWINDERS
(2) 280-GALLON EXTERNAL TANKS

DATE: AUGUST 1983
DATA BASIS: FLIGHT TEST



CROSS CONTROL INPUTS PROHIBITED IN THIS AREA

REGION 1	50 ° /SEC YAW RATE IN 5 SECONDS OR LESS, FLAT SPIN ENTRY LIKELY.
REGION 2	50 ° /SEC YAW RATE IN 6 TO 10 SECONDS.
REGION 3	50 ° /SEC YAW RATE IN 11 SECONDS OR MORE, OR 50 ° /SEC YAW RATE NOT REACHED.
REGION 4	NOT TESTED

(AT)1-F50D-116-0

Figure 11-3. Cross-Control-Induced Departure Areas

Flight test of uncoordinated lateral-stick-induced departures have produced yaw rates as high as 70° per second in 3 seconds with roll SAS on and flaps/slats AUTO. In the high-Mach, high-AOA area, flat spin entry could occur very abruptly and quickly (Figure 11-1, sheet 1). Abrupt, violent departures in this area can be eliminated or reduced to a low peak yaw rate with more easily recoverable departures by coordinating lateral stick inputs with rudder in the same direction.

WARNING

Subsonic maneuvering with roll SAS on shall not be conducted above 15 units AOA.

When maneuver flaps/slats are retracted and roll SAS engaged, departure resistance is severely degraded and high yaw rates can be attained very quickly. In the high-Mach, high-AOA area, flat spin entry can occur very abruptly and rapidly. In flight tests, 72° per second was reached in as little as 2.0 seconds with lateral g in the cockpit over 1.5g. The rapidity with which the aircraft departs can be very disorienting and could possibly delay recovery.

WARNING

When automatic maneuvering flaps/slats are not operating, uncoordinated lateral control inputs shall not be used in the area indicated in Figure 11-1, sheet 2.

Even with maneuvering flaps/slats in AUTO, the flaps/slats will be retracted above 0.85 Mach. Lateral stick inputs occurring above 0.85 Mach produce violent departures in Figure 11-1, sheet 2, but not in Figure 11-1, sheet 1, because, as the aircraft decelerates below 0.85 Mach, the maneuver flaps/slats extend.

Note

Lateral stick inputs should be avoided when maneuvering at high AOA except when cross-controlling at low Mach or coordinating with rudder at high Mach.

11.7.3 Rudder-Induced Departures. Rudder inputs with the roll SAS off produced abrupt, high-yaw rate accelerations but generally did not exceed 50° per second yaw rate in 10 seconds of control application in flight test because, as the AOA increases, the rudder washes out and the yawing moment decreases. Rudder inputs with the roll SAS on can cause very violent departures because the roll SAS commands differential tail opposite the rudder input to arrest roll rate even if the stick is centered. In the high-Mach, high-AOA area, flat spin entry could occur very abruptly and quickly if the aircraft is departed with roll SAS on (Figure 11-2).

WARNING

Subsonic maneuvering with the roll SAS on shall not be conducted above 15 units AOA.

Unintentional lateral control inputs can change these characteristics drastically. During high-Mach rudder inputs, cockpit lateral acceleration is such as to favor unintentional lateral stick inputs. In flight test, as little as 1/2-inch lateral stick (roll SAS off) opposite a full rudder input combined to produce a 50° per second yaw rate in 3 seconds. To avoid unintentional cross-controls, small coordinated lateral stick should be used when maneuvering with rudder at high Mach (above approximately 0.7 Mach). There is no significant difference in departure characteristics between the maneuver flap and slat extended and retracted configurations for rudder inputs.

11.7.4 Cross-Control-Induced Departures. Sustained cross-controls produce jerky, ratcheting roll and yaw rates and unpredictable aircraft motion. Generally, as Mach number is increased, fewer ratchets will occur prior to the steady yaw rate increase. Above 0.5 Mach, the aircraft motion is very violent and unpredictable, and no ratcheting motion may occur prior to a high yaw acceleration (Figure 11-3). Below 0.5 Mach, if the roll SAS is off, cross-controls can be safely used. The pilot must realize, however, that a cross-control maneuver is an intentional departure of the aircraft that produces 30° to 40° per second yaw rate in this low-Mach regime. An engine stall or failure during such a maneuver may aggravate the departure and must be reacted to immediately to recover the aircraft.

WARNING

Cross-control inputs shall not be used above 0.5 Mach when above 10 units AOA. Cross-controls at supersonic speeds shall not be used.

11.7.5 Asymmetric-Thrust-Induced Departures. Asymmetric-thrust-induced departures are similar to those induced by the flight controls. At high altitude (greater than 20,000 feet), asymmetric thrust results in a mild departure characterized by mild roll and yaw rates into the dead engine if the airspeed is above 100 knots. The yaw rate is usually masked by the roll rate. If no pilot action is taken, the aircraft usually stabilizes at some moderate yaw rate from which recovery is easily accomplished. On occasion, the yaw rate will continue to increase slowly, taking 20 seconds or more to reach 50° per second. At lower altitudes (15,000 feet) yaw rate may reach 50° per second in 10 seconds because of increased trust asymmetry. Departures induced by asymmetric thrust alone below 100 knots or when airspeed drops below 100 knots in the departure are characterized by mild roll and a smooth gradual increase in yaw rate that will attain values well over 50° per second.

The pilot's natural tendency is to oppose uncommanded roll with lateral stick, but this aggravates the departure, particularly if roll SAS is on. During maneuvering flight, uncommanded roll should be countered by rudder and a reduction in AOA. See additional discussions on asymmetric thrust flight characteristics in this section.

Note

Departure characteristics because of asymmetric thrust while in afterburner are comparable to an F-14A/TF-30 aircraft if ATLS is utilized and operative. Without ATLS operating, a maximum afterburner/stalled engine condition at high AOA will result in a more dynamic departure than the F-14A/TF-30 aircraft.

11.7.6 Accelerated Departures. Accelerated departures are initially characterized by a rapid increase in lateral acceleration but may become violently oscillatory about all three axes. Tests have shown aircraft rates in excess of 120° per second in roll and 70° per second in yaw. Pitch rates oscillate up to +30° per second and lateral acceleration oscillates up to +0.8g. These oscillations may cause pilot disorientation, and proper recovery controls may not be obvious. If this occurs, the proper response would be to neutralize rudders and lateral stick, apply forward longitudinal stick, and lock the shoulder harness. Recovery indications should become apparent within two turns.

11.7.7 Coupling. Coupling occurs when motions in more than one axis interact. The F-14, like all high-performance aircraft capable of producing high-rate, multiple-axis motion, is susceptible to coupling. High-rate, multiple-axis motions, particularly at high AOA, can produce violent coupled departures. During flight test, a guns defense/collision avoidance maneuver using full rudder followed by full coordinated lateral and aft stick produced violent coupled departures with up to 66° per second yaw rate in less than 2 seconds. Yaw rates of this magnitude require prompt positive recovery inputs by the pilot. External stores contribute to the severity of the departure by decreasing directional stability and increasing inertia.

WARNING

Avoid high-rate, multiple-axis motion because of possible violent departures.

11.7.8 Departure Recovery. Before recovery controls are applied, the crew must analyze flight conditions to determine the departure mode entered. The turn needle indicates only the direction of yaw and not magnitude of yaw rate, since it pegs at 4° per second yaw rate. An upright departure is indicated by AOA pegged at 30 units; an inverted departure by AOA of 0 units. Generally, increasing airspeed is indicative of a recovery in progress, as is aircraft reaction to pilot control inputs.

11.7.9 Upright Departure Recovery. Recovery from upright departures is positive and generally rapid. The high control power that allows the pilot to depart the aircraft also enables him to recover when the controls are properly applied and sufficient altitude is available for recovery.

Successful upright departure recovery depends on recognition of the departure from controlled flight, application of appropriate recovery control inputs, and subsequent recognition of when the aircraft has recovered. Departure from controlled flight is usually characterized by an uncommanded roll/yaw or an abrupt nose slice or pitch. Common examples of these motions are lateral control reversal at high AOA, or uncommanded roll and yaw resulting from asymmetric thrust. When appropriate recovery controls are applied and maintained as discussed in detail below, recovery from an upright departure will be indicated by decreasing yaw rate, decreasing AOA, and increasing airspeed. The decrease in AOA and increase in airspeed during recovery will be evident to the pilot by the aircraft response to control inputs. The aircraft may stop rolling because of sideslip and begin to roll because of differential tail commanded by the pilot for recovery from higher yaw rate departures. A nose drop and associated unload may occur, and the roll rate may increase under these conditions.

Note

The most important action of any upright departure recovery is reducing the AOA. This is enhanced by timely application of forward stick and countering the yawing motion of the aircraft.

If the AOA is pegged at 30 units or increasing rapidly, smoothly apply forward stick as required to reduce AOA. Full forward stick may be required. In an upright departure where less than 50° per second yaw rate is observed, if full forward stick is applied to reduce AOA, throttles retarded to idle, and rudder is applied opposite the yaw direction, the aircraft will generally recover, as shown in Figure 11-4. Cockpit indications of yaw direction are the pilot's turn needle and the spin arrow displays on the TID and MFD (Figure 11-5). Refer to paragraph 11.7.9.1 for a detailed discussion of spin arrow displays. An additional noninstrument indication of yaw direction is the roll direction. In an upright departure, the aircraft yaw rate is the same direction as the roll rate. Typically, roll rate is much more evident to the pilot than yaw rate. The turn needle and TID spin arrow may be backed up by referencing the roll direction.

Reducing thrust asymmetry during recovery by retarding the throttles to IDLE removes any possible thrust asymmetry, places the engines in the region of greatest stall margin, and reduces time to recover. Maintaining a thrust asymmetry, particularly with the good engine in MAX A/B, will delay recovery at high altitudes and may prevent recovery at lower altitudes since flight controls may not be powerful enough to overcome asymmetric thrust. Asymmetric thrust has its greatest effect upon upright departure recovery at low airspeed, where flight controls are not as effective, and low altitude, where asymmetric engine thrust is the largest.

If application of forward stick to reduce AOA and rudder opposite turn needle/yaw does not result in positive recovery indications, it is likely that 50° per second yaw rate has been exceeded and that lateral stick is required for recovery. In this case, optimum recovery controls are full rudder opposite the yaw rate/turn needle, full lateral stick into the yaw rate/turn needle, with as much forward stick as possible while maintaining full lateral stick. These controls will recover the aircraft out to a yaw rate of approximately 100° per second (Figure 11-4). Yaw rates of 100° per second or more can be identified by sustained eyeball-out g. During recovery from departures where yaw rates of 50° to 100° per second are experienced, the aircraft may stop rolling because of sideslip and begin to roll because of differential tail commanded by the pilot for recovery. A nose drop and an associated unload may occur. These are indications of a positive recovery in process.

Once recovery indications from a low yaw-rate departure (less than 50° per second) are verified, the forward longitudinal stick should be relaxed to maintain 17 units AOA, which will minimize altitude loss for recovery and avoid negative g as airspeed builds. Rudders should be neutralized as rotation stops. As recovery from higher yaw-rate departures is indicated, the lateral stick that was held into the turn direction should be neutralized, and the forward longitudinal stick should be relaxed to minimize altitude loss for recovery and avoid negative g as airspeed builds. The aircraft is very responsive to longitudinal stick inputs at all AOA at speeds above 100 knots. Pullout should be accomplished at 17 units AOA. Lateral stick and rudder may be used to counter any remaining roll and yaw oscillations.

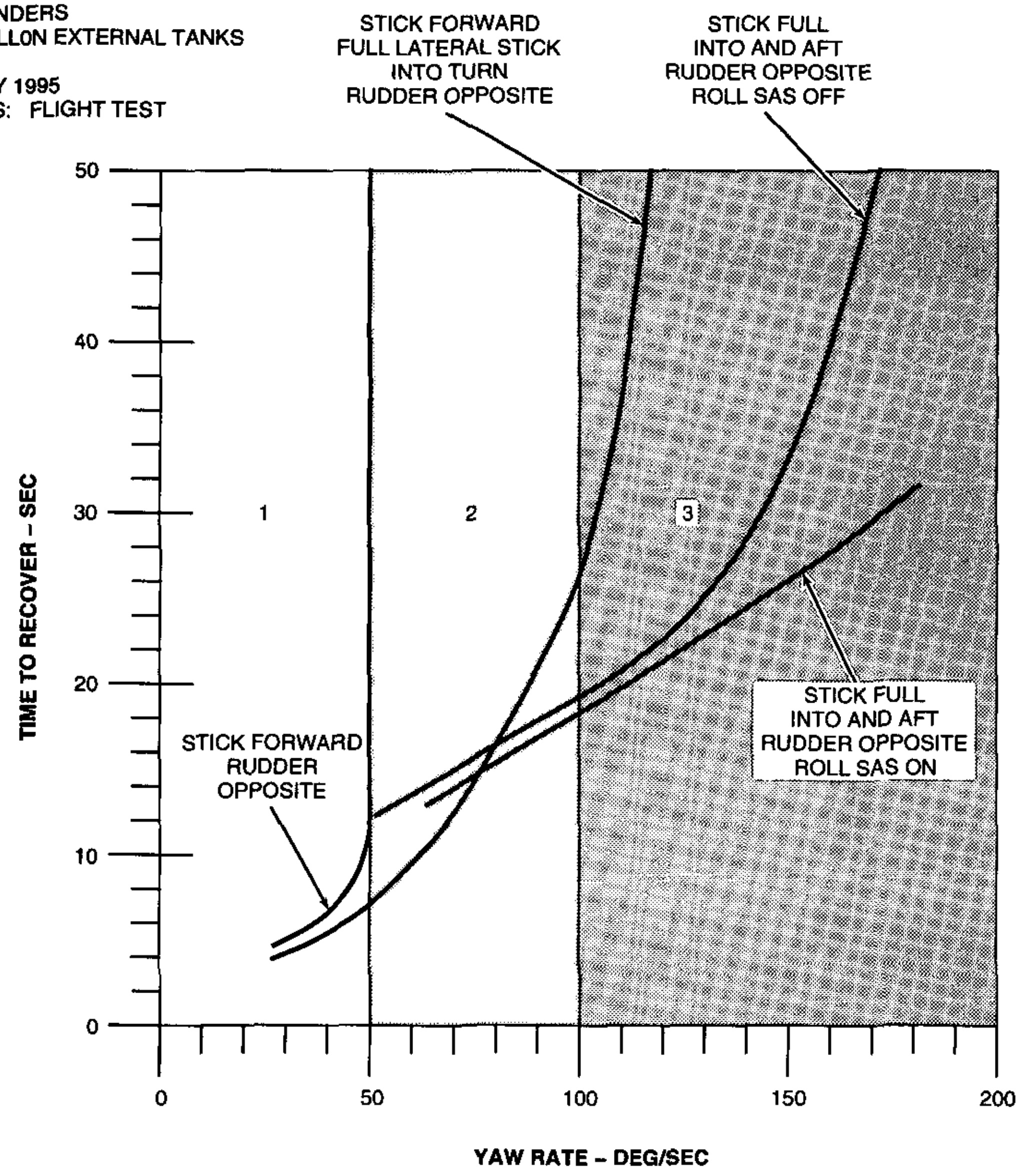
Centrifuge tests indicate the pilot begins to sense eyeball-out g at about 2g, which occurs at approximately 90° to 100° per second yaw rate. If sustained eyeball-out g is sensed, it is likely that 100° per second yaw rate has been exceeded and optimum recovery controls are full rudder opposite the yaw rate/turn needle, full lateral stick into the turn needle, as much aft stick as possible (while maintaining full lateral stick) and roll SAS ON. Roll SAS ON provides the pilot with the greatest possibility for recovery if the yaw rate exceeds approximately 150° per second. Refer to Chapter 14 for upright departure/flat spin emergency procedures. Recovery controls should be applied and maintained until recovery is indicated, ejection altitude is reached, or increasing eyeball-out g threatens aircrew incapacitation.

As yaw rate decreases during recovery from very high yaw-rate departures (above 100° per second, or where sustained eyeball-out g is sensed), the aft stick and full lateral stick recovery controls result in somewhat different recovery characteristics. If these recovery controls are maintained below a yaw rate of approximately 100° per second, large AOA oscillations may be experienced as well as oscillations in roll and pitch. The overall recovery may feel very rough and oscillatory. If these recovery controls are maintained below approximately 80° per second, recovery will be delayed and the potential for yaw rate reversal and progressive departure in the opposite direction is greatly increased. For this reason, the control stick which was maintained aft into the turn should be moved forward and into the turn when sustained eyeball-out g is no longer sensed. Further recovery can then be accomplished as previously described.

F-14 DEPARTURE RECOVERIES

AIRCRAFT CONFIGURATION:
(2) FUSELAGE-MOUNTED PHOENIX
(2) PYLON SPARROWS
(2) SIDEWINDERS
(2) 280-GALLON EXTERNAL TANKS

DATE: MAY 1995
DATA BASIS: FLIGHT TEST



REGION 1	STICK - FORWARD/NEUTRAL LATERAL RUDDER - OPPOSITE TURN NEEDLE/YAW
REGION 2	NO RECOVERY: STICK - INTO TURN NEEDLE/YAW
REGION 3	SUSTAINED EYEBALL OUT G SENSED: STICK FULL INTO AND AFT, RUDDER OPPOSITE REQUIRED FOR RECOVERY

(AT)0-F50D-501-0

Figure 11-4. F-14 Departure Recovery Diagram

WARNING

Maintaining aft and lateral stick recovery controls below approximately 100° per second yaw rate can result in large AOA excursions and oscillations in roll and pitch, which may complicate recognition of recovery from an upright departure and delay recovery. Maintaining these controls below approximately 80° per second will delay recovery and increase the potential for yaw-rate reversal and progressive departure in the opposite direction.

11.7.9.1 Spin Arrow Displays. At yaw rates greater than 30° per second, the spin arrow displays (Figure 11-5) have priority and override all other display formats on the MFD1 and the TID. MFD2 and MFD3 display the VDI format. When a yaw rate exceeding 30° per second is detected, the current format on these displays is overridden by the spin indicator format. In this format, the spin arrow points in the direction of the spin. Above the spin arrow in the MFD format, vertical tape displays provide airspeed, altitude, and AOA indications. If required, an indication of left or right engine stall is provided. A moving caret shows yaw rate from 30° to 180° per second. If the yaw rate exceeds 180° per second, the caret is pegged.

Note

- If MFD1 is not operating, the spin indicator format is displayed on MFD2.
- If INS and SAHRS failures occur while the spin arrow format is displayed, the pointer on the yaw-rate scale is removed from the MFD, the spin arrow is frozen, and an "X" is superimposed over the spin arrow. The airspeed, AOA, and altimeter scales are not obscured (Figure 11-6).

At yaw rates over 30° per second, the TID display is blanked and the spin arrow appears pointed in the direction of yaw. If the yaw rate exceeds 90° per second, the spin arrow will flash at a 4-times-per-second rate. A fixed scale from 30° to 110° per second increasing in the direction of yaw in increments of 20 will be displayed below the spin arrow. A diamond will be positioned above the numbers to indicate the existing yaw rate. For yaw rates in excess of 110° per second, the diamond will travel past 110 and be positioned over a + sign.

Note

- The primary reference for the spin arrow, the INS, is valid for yaw rates up to 300° per second; the backup reference, the SAHRS, is valid for the same yaw rates.
- If INS and SAHRS failures occur while the spin arrow format is displayed, the pointer on the yaw rate scale is removed from the TID and a breakaway X is superimposed over the spin arrow display (Figure 11-6).

11.7.10 Flat Spin. The only true upright, fully developed spin in the F-14 is the flat spin. It is recognized by the flat aircraft attitude (approximately 10° nose down with no pitch or roll oscillations), steadily increasing yaw rate, and high-longitudinal acceleration (eyeball-out g). It may develop within two to three turns following a departure if yaw is allowed to accelerate without rapid, positive steps to effect recovery. High yaw-rate departures are usually induced by aerodynamic controls and possibly aggravated by a thrust asymmetry. The aircraft may first enter an erect oscillatory spiral as airspeed rapidly decreases. Frequent hesitations in yaw and roll may occur as yaw rate increases. The turn needle and the spin arrow are the only valid indications of yaw and spin direction as they always indicate turn direction correctly, whether erect or inverted. AOA will peg at 30 units, and airspeed will oscillate between 0 and 100 knots. The aircraft may also depart by entering a coupled roll where yaw rate may build up without being noticed, to the point that when roll stops, yaw rate is sufficient to sustain a flat spin. A large sustained thrust asymmetry, at low airspeed (particularly at low altitude), may also produce sufficient yaw rate to drive the aircraft into a flat spin if proper recovery controls are not used. In all instances, recovery should be accomplished by prompt application of departure recovery procedures to reduce AOA and control yaw rate.

Regardless of the method of entry, once the flat spin has developed, the flat aircraft attitude (10° nose down), steadily increasing yaw rate, and buildup of longitudinal-g forces not accompanied by roll and/or pitch rates will be apparent to the flightcrew. AOA will be pegged at 30 units, yaw rate will be fast (as high as 180° per second) and altitude loss will be approximately 700 feet per turn. Longitudinal acceleration (eyeball-out g) at the pilot's station will be 5.5 to 6.5g and at the RIO's station, 3.5 to 4.5g. Time between aircraft departure and flightcrew recognition of a fully developed flat spin depends upon the nature of the entry (accelerated departure, low-speed stalled engine, etc.). The time between recognition of a flat spin and buildup of incapacitating longitudinal-g forces is dependent

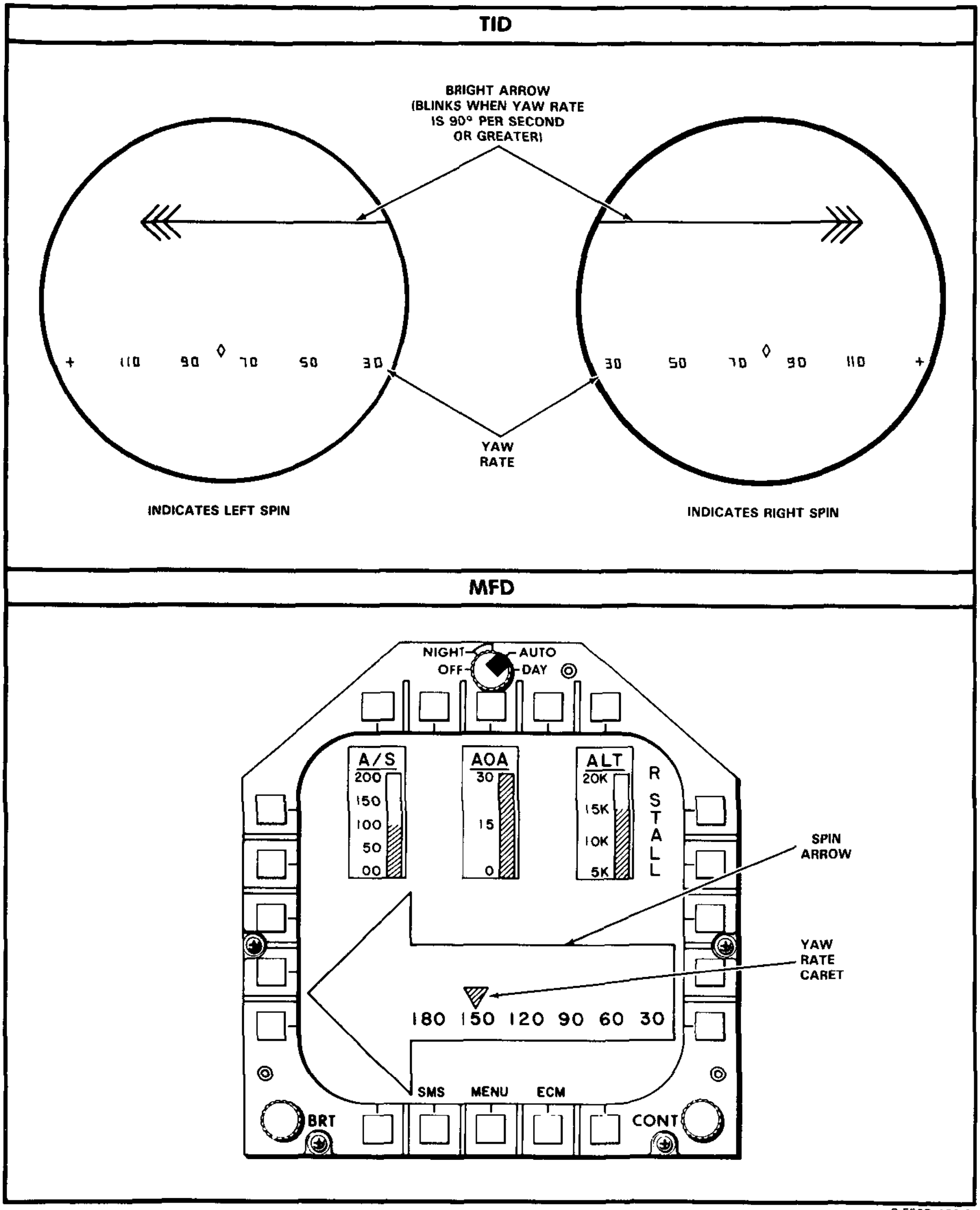


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Figure 11-5. Spin Arrow Displays

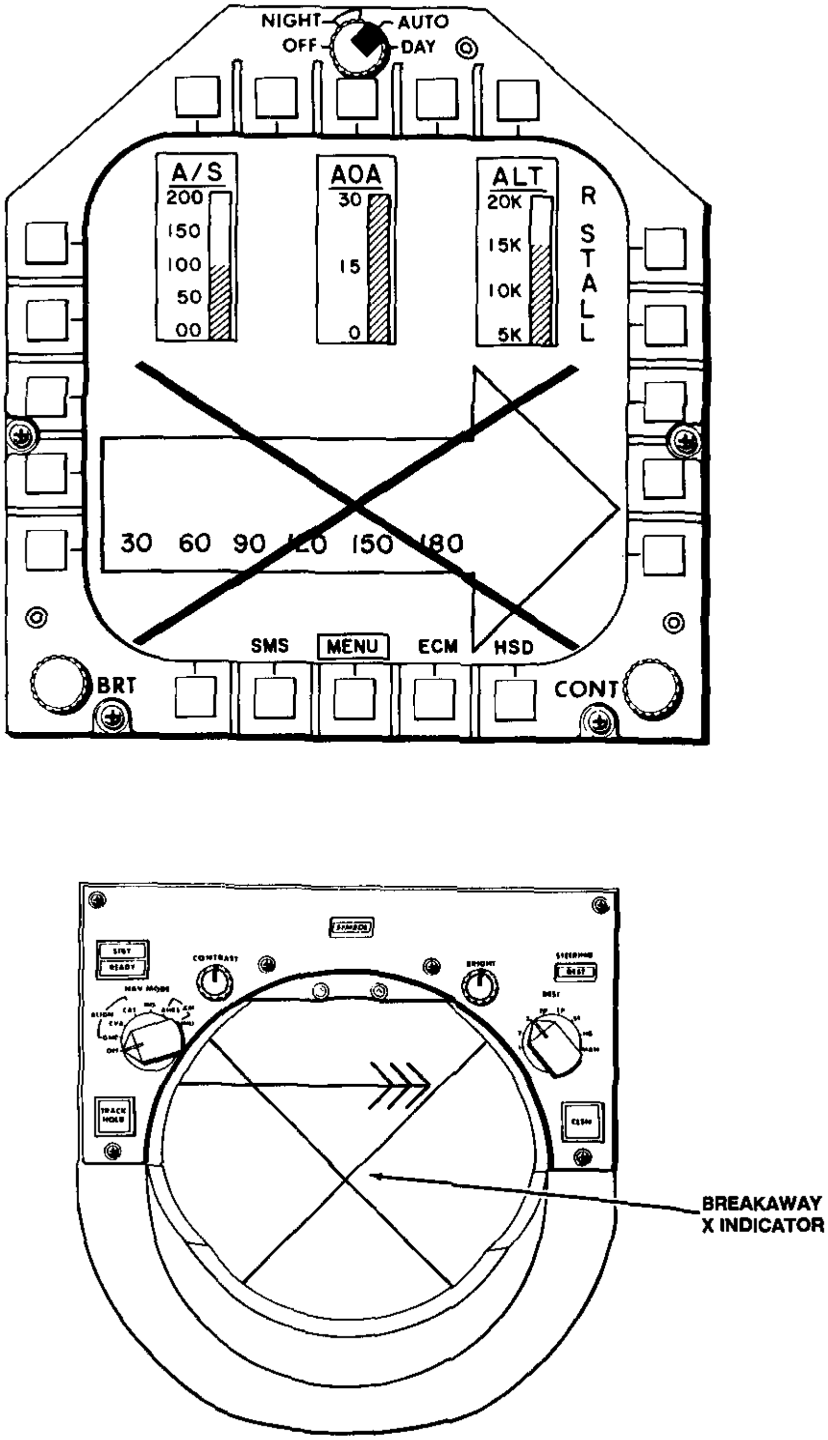

Figure 11-6. MFD-1/TID Right Spin Display (INS and SAHRS Failed)

upon aircraft loading, thrust asymmetry, flight control position during spin entry, locked or unlocked harness, tightness of the lap restraints, and flightcrew physical condition and stature. Test data indicate that following recognition of a flat spin, the pilot may be able to maintain antispin controls for 15 to 20 seconds (approximately 7 to 10 turns) but may severely jeopardize his ability to eject because of the incapacitation that occurs as the g forces build. Consistent successful F-14 flat-spin recovery procedures have not been demonstrated; therefore, once the aircraft is confirmed to be in a flat spin, the flightcrew should eject. This decision should not be delayed once the flat spin is recognized.

It is important to understand that longitudinal g forces can be present in accelerated departures from controlled flight and ejection initiated solely because of longitudinal g forces is premature. To preclude premature ejection from a recoverable aircraft, verify that the aircraft is not rolling or oscillating in pitch or is not in a coupled departure. If any of these characteristics are evident, then a flat spin has not developed and departure recovery procedures should be continued.

11.7.11 Negative AOA Departures. During flight test, a negative AOA departure mode has been experienced. Cross-control inputs in the low to medium Mach (less than 0.6 Mach) and low to medium AOA (AOA less than 25 units) area resulted in rapid transition to negative AOA with up to 2.5 negative g. The motion was very disorienting, uncomfortable, and confusing. Neutralizing controls would produce a recovery from this departure; use of aft stick would speed recovery.

CAUTION

Use of cross-control in the low to medium Mach (less than 0.6) and low to medium AOA (AOA less than 25 units) may result in negative-g departures.

11.7.12 Inverted Stall/Departure. As in normal stall approaches, there is no clearly defined inverted stall. A moderate rate application of full forward stick in inverted flight results in a negative AOA of about -30°.

CAUTION

Dynamic forward stick inputs of moderate rate may exceed the negative-g limit of -2.4g. Indicated AOA will show zero beyond about -5° true AOA.

Dihedral effect is negative at negative AOA. Therefore, a right rudder input produces right yaw, but left roll. This feels natural to the pilot in inverted flight, and enables raising a wing with opposite rudder when inverted. At negative AOA, oil pressure will indicate zero and illuminate the OIL PRESS caution light and MASTER CAUTION light.

WARNING

Zero- or negative-g flight in excess of 10 seconds in afterburner or 20 seconds in military power or less depletes fuel feed tanks (cells 3 or 4), causing flameout of both engines.

Recovery from an inverted stall is performed by applying full aft stick, while neutralizing lateral stick, to return to positive-g flight. Recovery from negative-g conditions will usually occur immediately. Return to level flight can then be performed from the resultant nosedown attitude by rolling erect with rudder and/or lateral stick and pulling out at 17 units AOA.

Excessive negative-g maneuvering can also exceed the aircraft lift limit and cause departure. Aircraft motion following departure will be very erratic and disorienting; any induced yaw rate can result in upright or inverted spin entry. Aircraft at high gross weights with external tanks and stores require a relatively minor negative load to induce this type of departure.

WARNING

Negative-g maneuvering at high gross weights should be avoided because of a high probability of departure.

11.7.13 Inverted Spin. An inverted spin may be encountered if the aircraft unloads while there is a yaw rate present. In flight tests, the inverted spin has been caused by holding full forward stick while inverted, applying full rudder, and holding this combination through 360° of roll. Pro spin controls need not be held to maintain the aircraft in a spin. The inverted spin is primarily identified from cockpit instruments by less than zero g and an AOA of zero units. Since the inverted spin is quite disorienting, spin direction must be determined by observing the turn needle deflection and spin arrow. Altitude loss during the inverted spin is 800 to 1,800 feet per turn and time per turn is 3 to 6 seconds. Nose attitude in the inverted spin is approximately 25° below the horizon. Warning of possible inverted spin usually occurs sufficiently in advance for the aircrew to take corrective action. Warning is usually very noticeable in the form of a nosedown pitch (negative g) with a yawing and possible rolling motion that is quite uncomfortable to the aircrew. In the fully developed inverted spin, rudder opposite yaw/turn needle is the strongest antispin control. Aft stick is a strong antispin control during the incipient spin phase and a weak antispin control in the inverted spin. In the absence of asymmetric thrust, the antispin control inputs will recover a fully developed inverted spin within one turn. Lateral stick opposite yaw is an antispin control, however, it is not included in the recovery procedures because opposite rudder recovers the aircraft so effectively. If opposite rudder and lateral stick were used, the recovery would occur very rapidly and a postrecovery departure in the direction of stick and rudder would be highly probable. Refer to Chapter 14 for inverted departure/spin emergency procedures.

11.8 TAKEOFF AND LANDING CONFIGURATION FLIGHT CHARACTERISTICS

11.8.1 Normal Stalls. During deceleration in a level, 1g stall approach, light buffet starts at about 19 units AOA. Buffet does not significantly change thereafter as the AOA is increased and provides no usable stall warning. A reduction in stick force is felt between 24 and 28 units AOA. At 25 units AOA, divergent wing rock and yaw excursions define the stall. Sideslip angle may reach 25°, and bank angle 90° within 6 seconds if the AOA is not lowered. Above 24 units AOA, lateral stick inputs produce considerable adverse yaw. Large sideslip angles, whether produced by rudder or lateral stick, are accompanied by a nose rise, which may require forward stick application to prevent the AOA from increasing to 28 units. Extending the speedbrakes slightly aggravates the stick force lightening at 24 units AOA but improves directional stability significantly, reducing the wing rock and yaw tendency at 25 units AOA. Stall approaches should not be continued beyond the first indication of wing rock. When wing rock occurs, the nose should be lowered and no attempt should be made to counter the wing rock with lateral stick or rudder. Stalls with the landing gear extended and flaps up are similar to those with flaps extended. Buffet starts at 16 to 18 units AOA and wing rock at 26 units AOA. Figure 11-7 shows stall speeds for standard day temperature at sea level with slats/flaps extended and gear down.

11.8.2 Stall Recovery. Stall recovery is easily accomplished by relaxing aft stick force and easing the stick forward, if necessary, to decrease AOA to less than 16 units. Maintain 15 to 16 units AOA and stabilized military or afterburner thrust during recovery to level flight. Recovery to level flight requires about 1,000 feet of altitude.

WARNING

Avoid high-rate, multiple-axis motion because of possible violent departures and engine stalls.

CAUTION

Use of cross-control in the low to medium Mach (less than 0.6) and low to medium AOA (AOA less than 25 units) may result in negative-g departures.

11.8.3 Asymmetric Thrust Flight Characteristics

11.8.3.1 Takeoff Configuration. Afterburner takeoffs are prohibited specifically because of controllability concerns in the event of an engine failure during takeoff. An engine failure during a MIL power takeoff with the F110 engine will produce essentially the same characteristics as a TF-30 powered aircraft with a MAX A/B-idle thrust asymmetry (MCBs open). The high-compression ratio of the compressor section will result in very rapid spooldown during an engine failure and rotor lock can be anticipated within several seconds of the engine failure. An engine failure in the takeoff configuration produces rapid nose movement in the direction of the failed engine. The pilot's first impression is usually that the aircraft will depart the runway. Even if the aircraft's heading swerve is corrected, the aircraft may continue to skid sideways across the runway. The wing on the side of the failed engine may rise 10° to 15°. This is noticeable to the pilot, but easily corrected with lateral stick. If the airspeed is high enough to allow correction of the heading swerve, all lateral drift can be stopped.

Aircraft controllability during asymmetric thrust takeoff emergencies is influenced by rudder position, thrust asymmetry, airspeed, nosewheel steering, and pilot reaction time, with pilot reaction time being the most critical factor. During the takeoff roll, rudder control power increases as the airspeed increases, thus improving the pilot's ability to control an asymmetric thrust condition. Below minimum control groundspeed (V_{MCG}), insufficient rudder control power will be available (nosewheel steering OFF), and large lateral runway deviations will be experienced if the takeoff is continued. The lower the airspeed at which the asymmetry

F-14A + /D

AIRCRAFT CONFIGURATION
ALL DRAG INDEXES
WING SWEEP Λ_{LE} = 20°
FLAPS/SLATS EXTENDED: GEAR DOWN

ENGINES:
(2) F110-GE-400

DATE: JANUARY 1990
DATA BASIS: ESTIMATED

REMARKS
ICAO STANDARD DAY

FUEL GRADE: JP-5 (JP-4, JP-8)
FUEL DENSITY: 6.8 (6.5, 6.7) 1b/gal

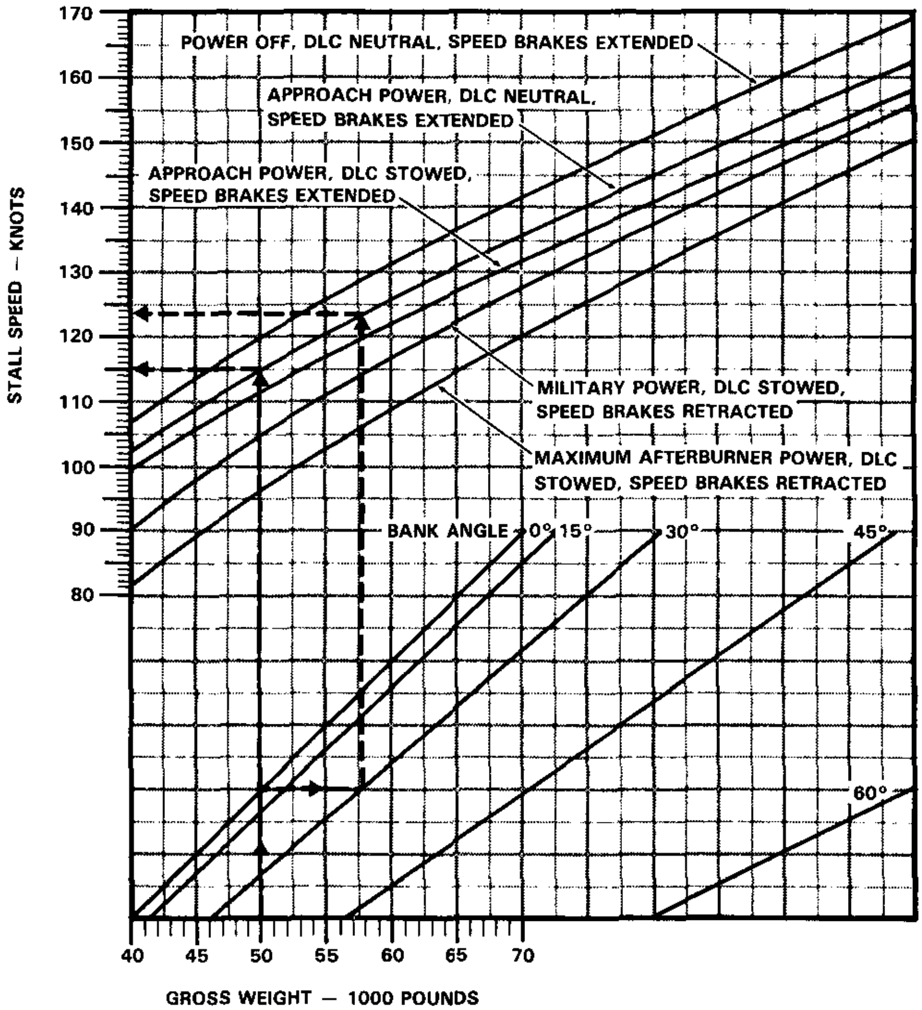

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Figure 11-7. Stall Speeds for Wing Rock at 25 Units AOA

THRUST ASYMMETRY	FLAP POSITION	VMCG SPEEDS MAXIMUM 50 FT LATERAL DEVIATION
Military - IDLE	Extended	132 to 138 knots
Military - IDLE	Retracted	135 to 140 knots

Figure 11-8. Minimum Control Speed, Ground (VMCG)

occurs, the larger the lateral deviation. Longer pilot reaction times result in dramatically larger lateral deviations. V_{MCG} speeds (takeoff continued) for the F-14B/D are presented in Figure 11-8. Even if the takeoff is aborted, significant runway lateral deviations may occur before the aircraft is brought back under control.

Use of the nosewheel steering up to 100 knots will reduce the amounts of deviation during the abort. For example, if the engine fails at 90 knots, the lateral deviation will be 10 to 15 feet with nosewheel steering engaged, and approximately 50 feet with nosewheel steering disengaged.

If the single-engine failure occurs during or after lift-off or catapult launch, the aircraft is controllable if proper aircrew techniques are employed. Airborne rudder effectiveness is presented in Figure 11-9. Rudder is the primary control for countering yaw because of asymmetric thrust since lateral stick inputs alone will induce adverse yaw in an already critical flight regime. At the first indication of an engine failure, the pilot should not hesitate to apply up to full rudder to counter roll and yaw. Above 100 knots, rudder effectiveness without nosewheel steering is sufficient to control this deviation adequately. In addition, use of nosewheel steering is undesirable above 100 knots because of a directional pilot induced oscillation tendency.

WARNING

Failure to limit pitch attitude will place the aircraft in a regime of reduced directional stability, rudder control, and rate of climb. The aircraft may be uncontrollable at AOA above 20 units. Smooth rotation to 10° pitch attitude (approximately 14 units AOA) will provide good initial flyaway attitude, ensure single-engine acceleration, and generate adequate rate of climb. See Chapter 13 for single-engine takeoff emergency procedures, and NAVAIR 01-F14AAP-1.1 for single-engine performance data.

11.8.3.2 Landing Configuration — General. Asymmetric thrust flight in the landing configuration must be approached with caution. Gross weight should be reduced prior to landing in order to improve waveoff performance. Rudder trim, augmented as necessary by additional rudder pedal deflection, should be used to counter thrust asymmetry.

Speedbrakes should remain retracted during actual single-engine approaches. A straight-in approach should be flown. Avoid turns into the dead engine. Steep angle of bank turns into the dead engine reduce climb performance and may result in rudder requirements exceeding available control deflection causing loss of control. The pilot may have to reduce the thrust on the operating engine to regain control, which may not be feasible at low altitude. By performing turns away from the failed engine, both thrust and rudder requirements will be reduced. Any maneuvering required prior to final approach should be accomplished using a maximum of 20° angle of bank in turns away from the failed engine.

Note

The role of the RIO is critical in this regime. He should closely monitor airspeed, bank angle, and AOA throughout the approach.

Refer to Chapter 15 for single-engine landing emergency procedures and NAVAIR 01-F14AAP-1.1 for single-engine performance data. For additional discussion of landing configurations and techniques, see paragraphs 11.8.3.3 and 11.8.3.4. For additional discussion of asymmetric thrust flight characteristics, see paragraph 11.8.3.

11.8.3.3 Landing Configuration — Engine in Primary. DLC will not be available with the left engine secured. With the left engine operating in primary mode and 3,000 psi combined hydraulic pressure, DLC should be engaged when established on final approach. Any maneuver required prior to rolling out on final approach should be accomplished using 12 units AOA or less. Once established on final approach, fly 15 units or faster (DLC engaged) or 14 units or faster (no DLC) to provide additional control power.

Note

While shipboard recoveries mandate the use of the minimum recommended approach airspeed because of aircraft and arresting gear structural limitations, field recoveries benefit from slightly faster airspeeds because of the increased control power and reduced apparent thrust asymmetry.

SEA LEVEL — STANDARD DAY

AIRCRAFT CONFIGURATION:
FLAPS UP OR DOWN
ALL GROSS WEIGHTS

DATE: JANUARY 1990
DATA BASIS: ESTIMATED

REMARKS
ENGINE(S): (2) F110-GE-400
LOCKED ROTOR: N_1 = ZERO RPM; N_2 = ZERO RPM

FUEL: JP-5 (JP-8, JP-4)
FUEL DENSITY: 6.8 (6.7, 6.5) lb/gal

STATIC MINIMUM CONTROL AIRSPEED — VMC STATIC

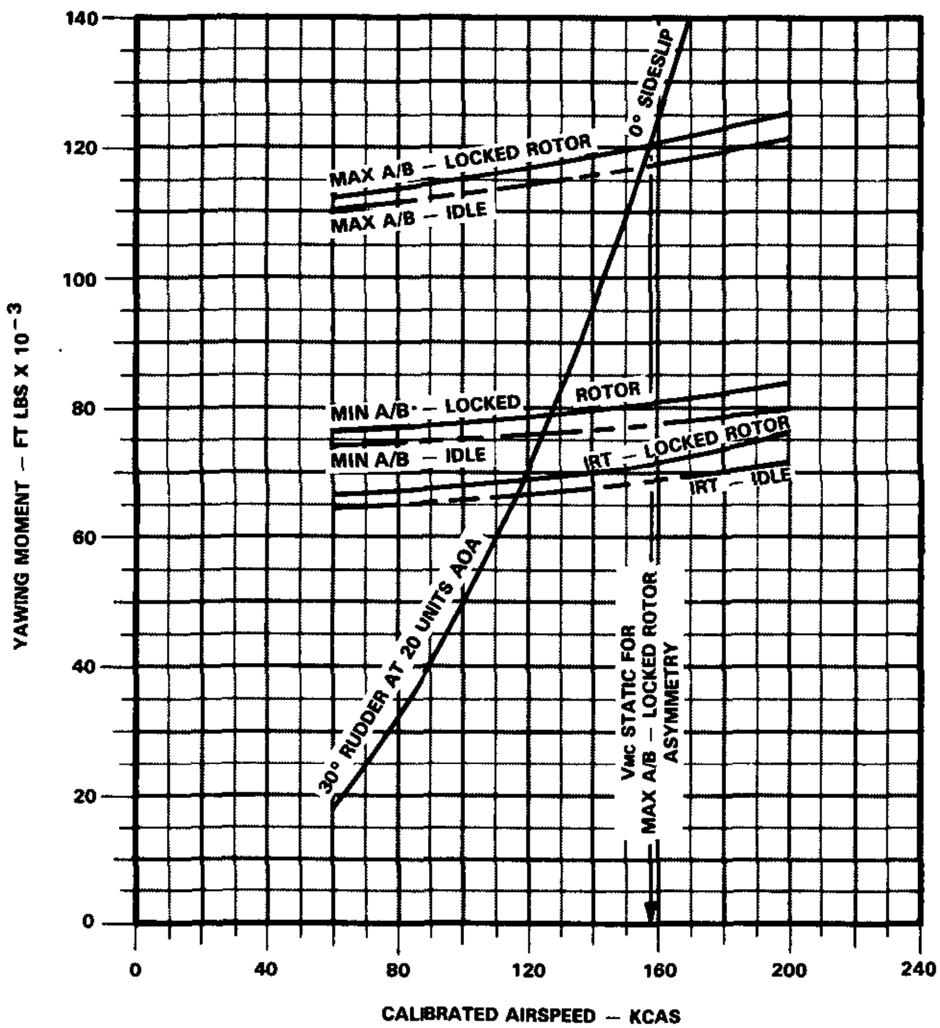

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Figure 11-9. Rudder Effectiveness

Airspeed control for a 14-unit approach is difficult, therefore, there may be a tendency to overcontrol power. An effective technique is to have the RIO provide airspeed calls (i.e., "2 knots slow/fast") to the pilot during final approach. With DLC engaged, minimize use of the throttle in close and use DLC for fine glideslope corrections. Decreasing the amount of throttle activity will limit excitation of the dutch roll. RATS will engage on touchdown, but does not significantly affect CV bolter performance. MIN A/B (ATLS on) may be used if required. During a bolter, apply rudder simultaneously with power addition to maintain centerline. Adequate directional control power exists to prevent drift on bolter.

Military thrust waveoff performance in primary mode is good, averaging 30 to 40 feet of altitude loss from a nominal 600-fpm sink rate. Waveoff performance from high sink rates is improved using MIN A/B (ATLS on). Altitude loss is minimized by maintaining approach AOA (slight, gradual pitch rotation required).

Note

Altitude loss during a single-engine waveoff is minimized by maintaining approach AOA until a positive rate of climb is established. Avoid overrotating in close as this will increase the chance of an in-flight engagement. MIN A/B (ATLS on) may improve waveoff performance from high sink rates.

Sufficient rudder control power exists to maintain control of the aircraft during MIL and MIN A/B single-engine waveoffs, provided AOA is not allowed to increase above 18 units. Simultaneously add rudder (approximately two-thirds to three-fourths deflection) with power to counter the asymmetric thrust and track centerline. If a yaw rate develops into the failed engine, immediately apply full opposite rudder to arrest the yaw rate and then reduce rudder as required to track centerline. Rudder may be supplemented by small lateral stick inputs. The use of MAX A/B offers little or no improvements in single-engine waveoff performance **and is prohibited.** The aircraft is extremely difficult to control in MAX A/B and large bank angles into the operating engine are required to maintain centerline. Late or inadequate control inputs during a MAX A/B waveoff can result in large lateral flightpath deviations. If unable to control yaw rate during A/B waveoff (possible ATLS failure), immediately reduce power to MIL.

11.8.3.4 Landing Configuration — Engine in Secondary. Approaches in single-engine SEC mode are considered extremely hazardous. Thrust response in secondary mode is nonlinear and very sluggish. At military power, thrust in secondary mode can vary from as little as 65 percent to as much as 116 percent of primary mode thrust at MIL power. Although the majority of engines produce greater than 90 percent of primary mode thrust (at MIL power), the possibility exists that in the full flap configuration, a low-thrust engine will not provide enough thrust for level flight. Engine acceleration times can also vary and can be as much as three times longer than in primary mode. Aircraft should recover ashore. Shipboard landings should only be attempted as a last resort and only if performance is adequate. See Chapter 15 for performance check and specific emergency procedures.

DLC should not be engaged for any single-engine SEC mode approaches. Any maneuver required prior to rolling out on final approach should be accomplished using 10 units AOA or less. Once established on final approach, fly 13 units or faster to improve waveoff capability and provide additional control power.

Note

While shipboard recoveries mandate the use of the recommended approach AOA because of aircraft and arresting gear structural limitations, field recoveries benefit from slightly faster airspeeds because of the increased control power and reduced apparent thrust asymmetry.

Airspeed control for a 13-unit approach is difficult, therefore, there may be a tendency to overcontrol power. An effective technique is to have the RIO provide airspeed calls (i.e., "2 knots fast") to the pilot during final approach. Extreme care should be used when working off a high and/or fast condition as any large power reduction could result in a situation requiring military power for correction. Use small throttle movements and small attitude adjustments for glideslope corrections. Avoid nosedown attitude changes just prior to touchdown as this will minimize the chance of a hook skip bolter. In the event of a bolter, rotate to a 10° pitch attitude, not to exceed 14 units AOA. During a bolter, apply rudder simultaneously with power addition to maintain centerline. Adequate directional control power exists to prevent drift on bolter.

Waveoff performance in secondary mode may be poor and high sink rates must be avoided. The poor engine acceleration in SEC mode makes engine rpm at waveoff initiation a major factor in waveoff performance. Grossly underpowered conditions must be avoided. During single-engine waveoffs in secondary mode, rotate the aircraft slightly to capture/maintain 14 to 15 units AOA as this will help to break the rate of descent.

WARNING

Single-engine waveoff performance with operating engine in SEC mode will be severely degraded. Extreme care should be used to avoid an underpowered, high rate-of-descent situation.

11.8.4 Degraded Approach Configuration. Refer to Chapter 15 for degraded approach emergency procedures.

11.8.4.1 No Flaps, No Slats, and Wings at 20°. If a no-flap, no-slat landing is anticipated, a straight-in approach should be performed because of the narrow margin afforded between 15 units AOA and the onset of airframe buffet. The approach is flown at 15 units AOA. Airframe buffet will occur at 16 to 17 units AOA with wing drop (5° to 10°) and/or an increase in sink rate occurring at 16.5 to 17.5 units AOA. Spoiler effectiveness is slightly degraded because of the absence of the aerodynamic slot formed when the flaps are extended. Precise airspeed control is essential for a no-flap/no-slat approach. Fast or high/fast approaches result if timely throttle adjustments are not made throughout the approach. The pilot must wave off approaches that result in large throttle reductions (to near idle) in close.

CAUTION

Nose attitude control is more sensitive during a no-flap approach, and care must be exercised not to overcontrol nose corrections in close. Cocked-up, high-sink landing can result in damage to ventral fins and/or afterburners.

11.8.5 Outboard Spoiler Module Failure. When the wings are forward of 62°, loss of outboard spoilers results in a decrease in roll authority and in lateral control effectiveness. Such loss causes no significant degradation in approach handling characteristics and is generally only apparent when large bank angle changes are commanded, such as during roll into and out of the approach turn. If the outboard spoiler module fails when the flaps and slats are down, the spoilers may float up and lock at some position above neutral. This may be accompanied by trim changes in all three axes, which can be trimmed out. Approach speed will increase slightly if a spoiler float occurs. If the failure occurs when the flaps are up, spoiler float is minimized.

WARNING

In the event of outboard spoiler module failure, do not engage DLC or ACLS.

11.8.6 SAS Off. Approach characteristics are not significantly degraded with partial or total SAS failure. The aircraft is slightly more sensitive to longitudinal control inputs if pitch SAS is lost. Lateral-directional response to turbulence increases if yaw SAS is lost. Roll SAS failure results in slightly increased roll sensitivity.

Note

Pitch SAS loss may result in loss of outboard spoilers. Roll SAS loss may result in loss of inboard spoilers.

11.8.7 Aft Wing-Sweep Landings. The aircraft may be safely landed with the wings as far aft as 40° (CV) and 68° (field). If the wings fail to respond to command, the emergency wing-sweep handle should be used to match the captain bars (commanded position) with the wing-sweep position tape. Matching the captain bars with the position tape ensures the commanded position is the same as the actual position, removing hydraulic pressure from the wing-sweep motors (hydraulic pressure will still remain present at the wing-sweep control servo valve/four-way valve). This reduces the likelihood of hydraulic failure or asymmetric wing sweep because of the failure of the crossover shaft. Optimum AOA for shipboard aft wing-sweep approaches is 15 units. AOA may be increased up to 17 units maximum for field landings to minimize approach airspeed for normal field landings or remain within published arresting gear limitations for short-field arrested landings. At wing-sweep angles of ≥ 51°, each 1-unit increase in approach AOA reduces approach airspeed by approximately 5 knots. Airspeeds for various configurations are shown in Figure 11-10.

With the wings frozen forward of 50°, the main flaps/slats should be used. A normal 15-unit approach should be used in this configuration and approach speeds will remain within field arresting gear limitations. If main flaps/slats are not available, maneuvering flaps should be used. Extension of the main flaps/slats only will result in a flap light with the wings aft of 20°.

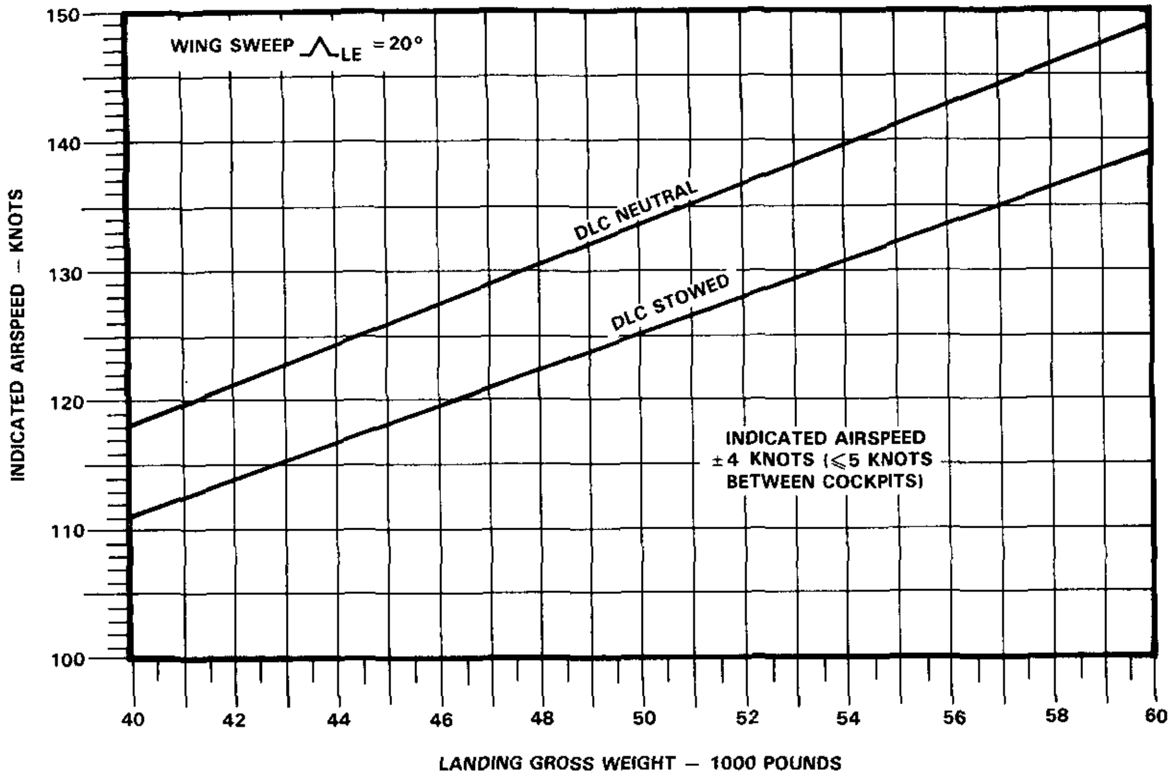
WARNING

If maneuvering flaps are used, ensure that the maneuver flap thumbwheel is not actuated during the approach.

AIRCRAFT CONFIGURATION:
ALL DRAG INDEXES

DATE: SEPTEMBER 1994
DATA BASE: FLIGHT TEST

FUEL GRADE: JP-5 (JP-4, JP-8)
FUEL DENSITY: 6.8 (6.5, 6.7) lb/gal



EMERGENCY OPERATION (Wing Sweep ≤50°)
AIRSPEED CORRECTION TO BE ADDED TO
DLC STOWED APPROACH SPEED

WING SWEEP (DEGREES)	AUX FLAPS RETRACTED (KIAS)	ALL FLAPS/SLATS RETRACTED (KIAS)	SLATS RETRACTED MANEUVER FLAPS EXTENDED (KIAS)
20	6	27	22
25	14	33	28
30	20	38	33
35	25	44	39
40	30	49	44

EMERGENCY OPERATION (Wing Sweep >50°)
AIRSPEED CORRECTION TO BE ADDED TO
DLC STOWED APPROACH SPEED

AUX FLAPS (DEGREES)	15 UNITS AOA (KIAS)	17 UNITS AOA (KIAS)
51	55	45
60	58	48
68	60	50

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Figure 11-10. Landing Approach Airspeed (15 Units AOA)

Note

Main flaps/slats extension with the wings aft of 20° will result in a large nosedown pitch transient.

DLC should not be engaged as it increases final approach speeds. APC gains are not optimized for wing sweeps other than 20° and, therefore, APC should not be used. Reducing gross weight will reduce approach speed by about 3.5 knots for each 2,000-pound reduction in gross weight at the 68° wing-sweep position. Pilot over-the-nose visibility is adequate at both 15 and 17 units AOA. The RIO will lose sight of the ball because of the higher pitch attitude at 16 to 17 units AOA on the standard 3.25° field glideslope.

Flying characteristics in aft wing-sweep configurations are dependent on wing-sweep angle and AOA. As wing-sweep angle increases, trimmed stick position moves aft. At 68° sweep, roll performance is sluggish but adequate at up to 17 units AOA with roll SAS engaged. At up to 62° wing sweep, differential tail is augmented with spoiler for roll control. The aircraft exhibits a very strong dihedral effect with the wings swept aft, so rudder may be used to augment roll performance if desired. Crosswind landings have not been evaluated at or near the aircraft crosswind limit, but a crabbed approach is recommended vice the wingdown, top-rudder technique. Ensure that the fuselage is aligned with the runway prior to touchdown.

Although pitch control is adequate, maintaining trim airspeed is increasingly difficult with increasing sweep angle because of low stick force cues for airspeed deviations. This necessitates close monitoring of airspeed by the aircrew since the approach indexers are unusable above 16 units AOA. As wing sweep progresses further aft, stall becomes less clearly defined. There is no strong aircraft buffet when AOA is increased beyond 17 units. Aircraft waveoff performance is adequate at both 15 and 17 units AOA. During single-engine operation, up to maximum power may be required to arrest aircraft rate of descent during a waveoff. Single-engine approaches with aft wing sweep have not been tested and rudder control power may be limited in this condition. Fuel permitting, aircraft handling and stall characteristics as well as waveoff performance should be evaluated at altitude prior to commencing an aft wing-sweep approach.

If using an approach AOA greater than 15 units, nozzle clearance at touchdown is reduced. Additionally, the high rate of descent (approximately 1,000 fpm on a 3.25° glideslope) and high touchdown speed place high stress on the main landing gear tires. The recommended technique for field landings is to maintain a maximum of 17 units AOA while attempting to minimize the rate of descent just prior to touchdown. Do not attempt to flare the landing and do not aerobrake.

WARNING

Nozzle clearance is reduced at elevated approach AOA. Ensure that a maximum of 17 units AOA is maintained at touchdown.

Aft wing-sweep touch-and-go performance has not been flight tested; however, rotation speeds approaching or possibly exceeding tire limitations should be expected. Nose tire limitations, runway remaining, status of long-field arresting gear, and tire pressurization must all be factored into a decision to go around following a hook skip. If committed to landing following a hook skip with operative hydraulics, consideration should also be given to securing the starboard engine in order to reduce residual thrust.

Engagement speeds listed in the emergency field arrestment guide are groundspeeds. Headwind may be subtracted from final approach airspeed, tailwinds must be added, and compensation must be made for field elevation (add approximately 10 knots to arresting gear limit for a field elevation of 4,000 feet).

11.9 ASYMMETRIC WING SWEEP

11.9.1 Wing-Sweep Design Limitations. An understanding of the wing-sweep design limitations is necessary to cope successfully with an in-flight asymmetric wing condition to avoid the possibility of structural damage and to minimize the possibility of loss of aircraft control. The following discussion is therefore offered.

The wing-sweep feedback position and interlock functions for the auxiliary flaps, main flaps/slats, and spoiler cutout are controlled by the left wing-sweep actuator. Cockpit wing-sweep position indication is controlled by the right wing-sweep actuator.

The existence of wing-sweep position feedback on the left wing only can have a definite impact during a jammed wing-sweep actuator/failed synchronizing shaft condition. A jammed right wing-sweep actuator will result in normal left wing operation because wing-sweep commands are nulled out by the left wing-sweep actuator position. A jammed left wing-sweep actuator in an intermediate position, in conjunction with a wing-sweep command, will result in a constant command to the right wing-sweep actuator that cannot be nulled, since the right wing has no position feedback. In this case, the right wing will travel to the overtravel stop (19° or 69°) in the direction of the last command. The right wing can be positioned in either the 19° or 69° position only, but not in any intermediate position since there is no way to null out the command. A condition similar to a jammed wing-sweep actuator occurs when one hydraulic system has failed in conjunction with a synchronizing shaft failure.

A temporary actuator jam on one side while the wings are sweeping, in conjunction with a broken synchronizing shaft, will result in resumption of operation with asymmetrical wing positions. Symmetrical wing position, within 1°, can be achieved again by commanding the wings full forward or full aft (20° or 68°). The direction to command the wing is dependent on whether the right wing is forward or aft of the left position. The right wing position is displayed by the wing position tape on the cockpit wing-sweep indicator. If, for example, the right wing is forward of the left wing, the wings should be commanded full forward to 20°. The right wing will drive to the 19° overtravel stop and remain there until the left wing reaches 20°, nulls the command, and hydraulic power is shut off. If the right wing is aft of the left wing, the wings could be commanded full aft to 68°. The right wing will drive to the 69° overtravel stop and remain there until the left wing reaches 68°, nulls the command, and hydraulic power is shut off.

Normal symmetrical wing-sweep operation, within 1°, should follow. Some jeopardy exists during aft command operation since spoiler control will be lost when the left wing obtains 62°.

Note

A mechanical jam in the wing-sweep system may prevent the wings from being resynchronized. This may be because of the failed synchronizing shaft jamming an actuator.

The auxiliary flaps/main flap interlocks are controlled by the left wing-sweep actuator. This means that during asymmetric wing conditions, it is possible to satisfy the interlock requirements with the left wing and damage aircraft structure with the off-schedule right wing. For example, if the left wing is at 20° and the R/H wing is at 35°, the 21° interlock in the auxiliary flap system is satisfied by the left wing. Lowering the flaps without inhibiting auxiliary flaps will drive the auxiliary flaps through the fuselage in the vicinity of the flight hydraulic system. Pulling the AUX FLAP/FLAP CONTR circuit breaker (8G3) will remove electrical power to the auxiliary flaps and prevent auxiliary flap deployment.

Note

Extending the main flaps with the auxiliary flaps inhibited will result in a large nosedown trim change.

The wing-sweep control drive servo is powered through WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) circuit breakers. Pulling these circuit breakers inhibits all electrical command paths to the wing-sweep control valve. Manual commands to the valve are available through the emergency WING SWEEP handle. Pulling the WG SWP DR NO. 2/MANUV FLAP (LE1) circuit breaker removes power from the maneuver devices and inhibits automatic retraction of the maneuver devices with landing gear handle extension. The maneuver devices should be commanded up prior to pulling the WG SWP DR NO. 2/MANUV FLAP circuit breaker. It may also be necessary to utilize emergency up on the flap handle to achieve full flap and slat retraction.

11.9.2 Asymmetric Wing-Sweep Flight Characteristics. Asymmetric wing-sweep failures will be manifested as a wing heaviness accompanied by a WING SWEEP advisory light, indicating a failure of the primary wing-sweep channel. A subsequent failure of the backup wing-sweep channel will illuminate the WING SWEEP warning light.

Flight tests have shown that the aircraft may be safely landed with asymmetric wing sweep as long as spoiler control is retained following the wing-sweep failure.

The aircraft is not controllable for landing with a wing asymmetry such as the left wing aft of the spoiler cutout angle (62°) and the right wing forward at 20°. The maximum asymmetry demonstrated for landing was 20°/60°, although tests of 20°/68° at altitude indicate that this configuration is landable if spoilers are operational (that is, the left wing is at 20° and the right wing is at 68°). The high approach speeds coupled with reduced lateral control authority obtained with asymmetric sweep become limiting factors for aircraft carrier (CV) operations. If at all possible, the flightcrew should attempt to divert for a field landing. In-flight refueling was not evaluated during flight tests. Cruise configuration flying qualities in the normal refueling airspeed range (approximately 250 knots) were qualitatively assessed to be suitable for the task. The effects of asymmetric sweep are diminished as airspeed increases (decreasing angle of attack), so that using a higher than normal tanking speed may decrease pilot workload. Lateral and directional trim should be utilized to decrease lateral stick force during refueling and cruise flight.

Note

The use of lateral trim to reduce stick force during approach and landing should be avoided, however, because it reduces the amount of spoiler available for roll control.

Asymmetric wing sweep is primarily a lateral control problem, increasing in severity as angle of attack increases and as flap deflection increases. The aircraft will roll toward the aft wing and yaw toward the forward wing. For example, right wing forward of left wing causes left-wing-down roll and nose-right yaw. The resultant sideslip angle is favorable from a controllability standpoint and should be removed with rudder only if it is uncomfortable to the pilot. Rudder trim into the forward wing may be utilized, if desired, to increase sideslip angle and generate a restoring rolling moment via dihedral effect (right rudder trim for right wing forward of left, and vice versa). Lateral stick force will be accordingly reduced.

Main flaps should be utilized to decrease approach airspeed for asymmetric sweep landings if both wings are forward of 50° sweep. During flight tests, a flap setting of 20° to 25° was found to provide the best flying qualities in comparison to the other flap settings tested (0°, 10°, 35°). Safe landings may be performed, however, with all the flap configurations evaluated. In the flaps-up configuration, undesirable prestall buffet is experienced at 16 to 16.5 units AOA for all wing asymmetries.

Stall-induced buffet is not experienced in flaps-down configurations because the leading edge slat delays wing stall. Airframe buffet may occur, however, because of the turbulent airflow that passes through the auxiliary flap hole that impinges on the horizontal tails. This buffet increases with increasing flap deflection and is significantly worse with 35° flaps as compared to 10° or 20°. In addition to increased buffet levels, the 35° flap configuration is prone to lateral PIO during high-gain tasks such as close-in lineup corrections. This is primarily because of the increased spoiler effectiveness obtained with power approach spoiler gearing. The PIO tendency is eliminated by selecting flaps 25° or less, which causes a switch to cruise spoiler gearing.

All asymmetric wing configurations require precise monitoring of AOA during lateral maneuvering because of the existence of significant pitch-roll coupling. This is especially critical with flaps up. In general, the aircraft tends to increase angle of attack when rolling toward the forward wing and decrease angle of attack when rolling toward the aft wing. In order to provide adequate maneuvering margin below the stall buffet region, recommended approach AOA is 14 units for all flap-up, asymmetric wing configurations up to 40° differential split (Figure 11-11). A landing with the maximum possible asymmetry of 20°/68° (48° differential split) was not attempted during flight tests, but evaluation of this configuration at altitude indicates that 13 to 14 units AOA will provide adequate control for approach and landing as long as spoilers are available (left wing at 20°, right wing at 68°). Recommended approach AOA is 15 units for all flap-down, asymmetric wing configurations (Figure 11-11).

If the left wing is positioned aft of the spoiler cutout sweep angle (62°) the spoilers are inoperative and lateral control is limited to differential tail only. Flight tests indicate that the maximum controllable asymmetry at 14 units AOA in this configuration is a 15° differential split. The preferable action in this case is to attempt to move the left wing forward of the spoiler cutout angle to regain spoiler control. If this is not possible, an attempt should be made to command the right wing as far aft as possible in order to minimize the wing asymmetry, and then perform a slow flight check at altitude to determine the minimum control speed. The pilot must then determine if the configuration provides a reasonable approach airspeed.

Sideslip-induced pitot static system errors may be experienced with all asymmetric wing-sweep configurations. Accurate airspeed/AOA indications may be obtained by bringing the aircraft to a zero-sideslip condition. A wingman may provide an airspeed check prior to landing.

11.10 DUAL HYDRAULIC FAILURES BACKUP FLIGHT CONTROL MODULE FLIGHT CHARACTERISTICS

11.10.1 General. Several factors work in concert to affect the handling qualities of the F-14 when operating with a dual-hydraulic failure. The first is the total loss of the SAS in all three axes. Since the bare airframe is lightly damped in both pitch and yaw, gusts and small control inputs result in uncommanded responses or oscillations. The pilot's general impression is that the aircraft is sloppier in all axes and precise control is more difficult. The pilot does have some control over these characteristics as they are very dependent on configuration and airspeed.

The second factor is the capabilities of the remaining flight control system. The inboard spoilers, speedbrakes, and auxiliary flaps are inoperative, and the inboard spoilers and speedbrakes can be expected to float. The degree of spoiler float will be a function of airspeed, AOA, sideslip, flap setting, and the mechanical condition of individual spoiler actuators. During flight test, changes in float are very slow and do not generate any

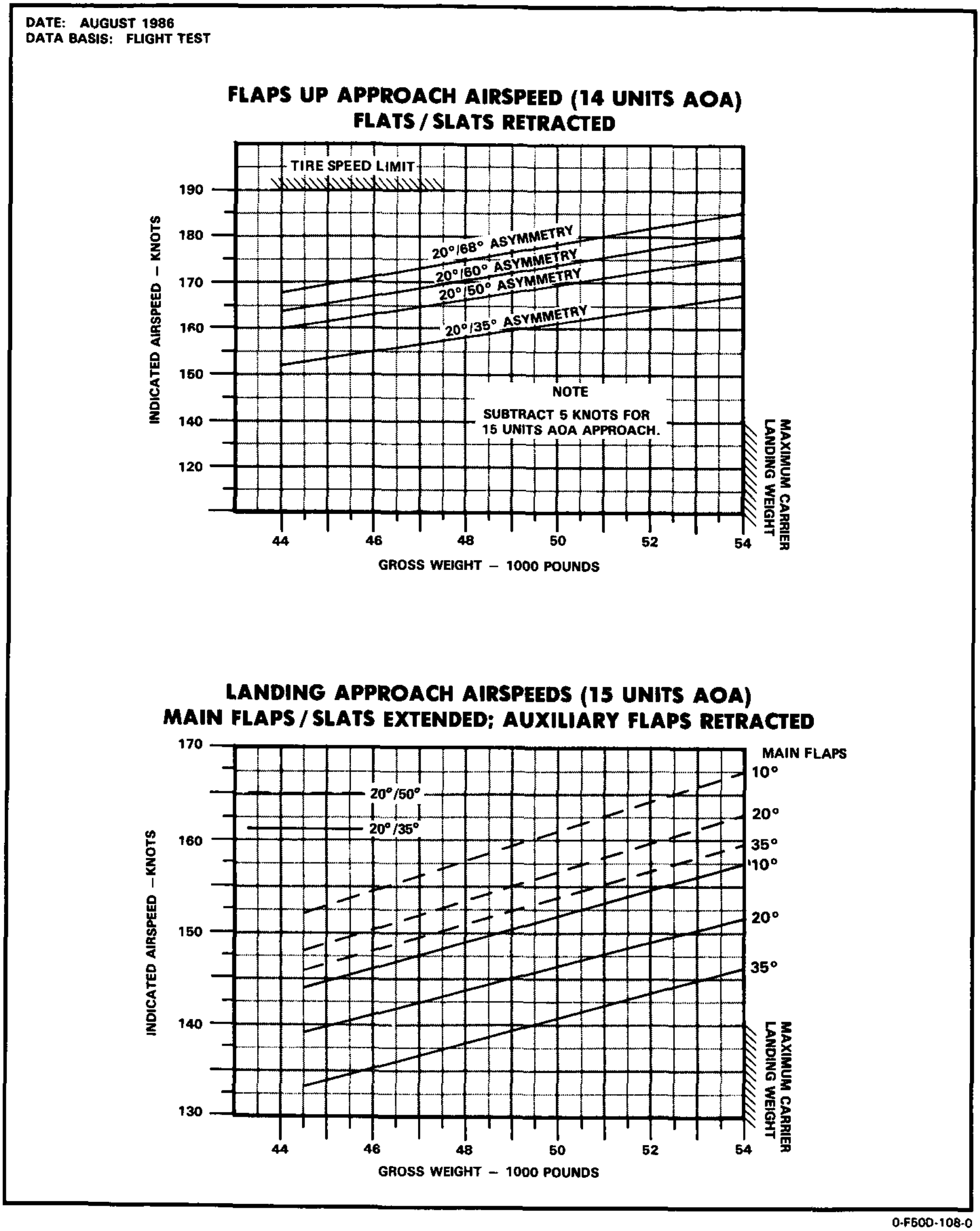

Figure 11-11. Asymmetric Wing-Sweep Landing Approach

abrupt rolling moments but do impose significant lateral trim changes. Outboard spoilers remain fully functional because of the independent nature of the outboard spoiler module, which also serves to power the main flaps and slats via the flap handle or the maneuver flap thumbwheel. Lastly, only the rudders and horizontal stabilizers are powered by the BFCM. Because of the low output of the BFCM, the stabilizers are dramatically reduced in their ability to respond to pilot commands. The stabilizers are rate limited to 10° per second in HIGH and 5° per second in LOW as opposed to a normal rate of 36° per second. This can be a severe limitation to the pilot's ability to control the aircraft, depending on the abruptness of the pilot commands.

Each of these factors influences the handling qualities in different regions of the flight envelope. Handling qualities at speeds in excess of 200 KCAS are primarily constrained by the absence of pitch SAS and the limitations of the BFCM. At approach speeds, the handling qualities are primarily affected by floating spoilers and the loss of yaw SAS, although rate limiting of the stabilizer can occur.

11.10.1.1 Rate Limiting. The pilot will observe rate limiting both in the feel of the control stick and in the response of the aircraft. In the F-14 flight control system, the stick is mechanically connected to the stabilizer. With normal hydraulics, there is virtually no time delay between the pilot's command and the stabilizer moving in response to the command. With the BFCM providing significantly less hydraulic flow, at a substantially reduced pressure, the stabilizer moves so slowly that it is possible for rapid pilot inputs to exceed the stabilizer maximum deflection rate. When this happens, the pilot will feel an abrupt increase in stick force until the stabilizer catches up to the pilot's command. If the pilot feels an abrupt increase in stick forces, the stabilizer is operating on its rate limit. This can be observed during the prestart BFCM checks and is most severe in LOW.

The pilot's perception of the aircraft response is likewise affected by rate limiting because of slower response of the stabilizer to deflection commands. If slow control inputs are made, the delay is insignificant, aircraft response appears normal, and control is unaffected. If control inputs are abrupt, however, with many reversals in direction (such as might be required to tank, land, or fly close formation), the pilot and the stabilizer can be out of phase with one another, and a divergent PIO will develop that results in loss of control. This occurs in pitch caused by larger deflections available, but may be aggravated by large lateral or directional flight control inputs that further reduce the flow available to command the stabilizer and, therefore, increase the susceptibility to rate limiting in pitch. LOW mode is extremely limited in its ability to accommodate rapid control inputs, while the HIGH mode can accommodate moderate pilot control inputs.

The abrupt degradation that occurs with rate limiting makes the handling qualities hazardous. The handling qualities of the aircraft while operating with the BFCM in HIGH are generally good for moderate gain tasks, and it is virtually transparent to the pilot that the flight control system is degraded. However, when operating near the rate limit of the system, very small increases in pilot gain will result in an abrupt and dramatic loss of control and the task being performed must be aborted (i.e., the aircraft cannot be controlled adequately to continue the task). Uncontrollable pitch attitude oscillations of +10° can develop in less than 3 seconds. Regaining control is simply a matter of loosely releasing the stick, permitting the oscillations to dampen, and then smoothly reapplying control to restore the aircraft to the desired flight condition. In summary, if the system is not rate limited, the handling qualities are good; if the system is rate limited, the aircraft rapidly becomes uncontrollable.

11.10.1.2 Task Performance. There are four variables that the aircrew can control to maximize the probability of successfully completing mission tasks. Selection of an appropriate motor speed is the first controllable variable. Tightly controlled tasks such as landing, close formation, and in-flight refueling require the control rates available with HIGH mode. Judicious selection of airspeed can also influence successful task performance. With SAS OFF, the sensitivity of the aircraft increases significantly with airspeed. The slower the airspeed, the slower the response. For tightly controlled tasks, the flight control system must be capable of responding faster than the natural dynamic character of the aircraft, or the pilot must accept undesirable overshoots and oscillations. The flight control system capabilities with the BFCM in either LOW or HIGH are very restricted. Part of the solution is to slow down the aircraft and its response as much as is practicable to give the flight control system the best chance of keeping ahead of the aircraft. The third variable is configuration, some of which are more suited to specific tasks. Lastly, pilot technique may limit the ability of the aircraft to perform some tasks. The slower and smoother the input, the less likely rate limiting will be encountered. Flight tests performing each of the following tasks have revealed the mixture of the above variables whereby successful recovery of the aircraft can best be ensured.

11.10.2 Low Mode Cruise and Formation. Cruise handling qualities in LOW mode are degraded but satisfactory. Roll response is very sluggish and some overshoots can be expected when trying to establish a bank angle. In pitch, any abrupt pitch input at 250 KCAS or faster will result in multiple oscillations when trying to precisely set a pitch attitude. Flying very loose formation is fairly easy, provided tight control is not attempted. Any attempt to finely control vertical elevation relative to a lead aircraft (≤ 2 feet) will result in rate limiting the stabilizer and loss of control. Control can be reestablished by relaxing the grip on the stick, allowing the oscillations to dampen, and then smoothly reapplying control. Slower airspeeds (200 KCAS) provide for more predictable control as discussed in paragraph 11.10.1. Do not attempt IMC formation, close night formation, in-flight refueling, or landing while in LOW mode. LOW mode control is satisfactory for the performance of configuration changes such as lowering gear and flaps.

WARNING

> A pitch PIO will develop if any tight longitudinal control is attempted. Control can easily be regained by relaxing the grip on the stick, allowing any oscillations to dampen, and then smoothly reapplying longitudinal stick to reestablish the desired flight condition. Do not attempt IMC formation or close night formation while in LOW mode.

Note

> Airspeeds less than 250 KCAS while operating in LOW mode will reduce the susceptibility to rate limiting.

11.10.3 High Mode Cruise and Formation.

Up and away flying qualities in HIGH mode are generally excellent, with the only noticeable degradation being a slight sluggishness in roll response. Cruise and formation tasks are very easy, provided that very tight tolerances are not attempted (< ±1 foot). Higher speeds (> 250 KCAS) will increase the probability of rate limiting during parade formation. Close IMC or night formation is possible but not advisable because the divergent PIO occurs very abruptly with no warning. The F-14 with the hydraulic failure should lead any formation flight except as required for in-flight refueling.

11.10.4 In-Flight Refueling. In-flight refueling can be safely performed but is very dependent on flight condition, configuration, and pilot technique. The best success can be expected at 180 KCAS with maneuvering flaps and a smooth technique. There are two reasons for the strong influence of airspeed. First of all, tanking is easier to perform at slower speeds because the aircraft is much less sensitive, the bow wave is considerably reduced, and the probe position can be more predictably and smoothly controlled, reducing the necessity for aggressive plays to seat the probe. Secondly, the BFCM has an easier job keeping up with aircraft dynamics, decreasing the likelihood of rate limiting. Any attempt to tank faster than 200 KCAS will result in loss of control. Tanking handling qualities are unaffected by landing gear position and are improved with aft wing sweeps in the event that the wings are trapped aft. Flaps should be selected to 10° with the maneuver flap thumbwheel, which still functions normally with outboard spoiler module power. Lastly, the influence of technique is that the rate limiting is caused by abrupt control inputs and counter corrections. The 2 seconds surrounding contact are the critical phase since the controls can be three times more active than during the approach or stabilized refueling.

While spotting the basket is common throughout the F-14 community, it is the surest way to place excessive demands on the flight control system during the second or two prior to contact and provoke a loss of control. The best way to avoid abrupt inputs is for the pilot to resist spotting the basket and instead rely on the RIO's directive commentary. Since the stabilized refueling is easy and requires only moderate flight control activity, the airspeed can safely be increased to 200 KCAS once engaged if additional airspeed is required to obtain proper store operation (as might be required with ram-powered buddy stores such as the D-704 or D-301). While not flight tested, a very low gain technique must be used at the minimum airspeed attainable by the tanker if the only resource is a large body tanker such as the KC-10, for which 180 KCAS might be impossible. The pilot must respond to any undesired motion by loosely releasing the stick and allowing the aircraft to dampen itself.

WARNING

> - Any abrupt control input to effect engagement can rate limit the stabilizers and result in loss of control. To avoid rate limiting, the pilot should resist spotting the basket and instead rely on RIO commentary to perform engagement.
> - If any undesirable motions or oscillations occur during or after engagement, the pilot must immediately release the stick and permit the motions to dampen before resuming active control.

WARNING

Do not attempt in-flight refueling from wing-mounted stores of large-body tankers (VC-10 Canberra) where nose-to-tail overlap is present. The basket does trail adequately aft of the tail for KC-130 and airwing assets.

Note

If the air refueling store does not adequately transfer fuel at 180 KCAS once engaged, the airspeed can safely be increased to 200 KCAS to improve the transfer rate.

11.10.5 Landing. Landing handling qualities are primarily affected by the loss of SAS, inboard spoilers, speedbrakes, auxiliary flaps, and DLC, rather than limitations of the BFCM itself. Longitudinal control is generally good provided no large abrupt pitch changes are attempted. Lateral control is degraded by virtue of the inoperative SAS and inboard spoilers. Spoiler float and its impact on lateral control is considerably aggravated by slower airspeeds and increased flap deflections. Consequently, field landings should be performed with the maneuver flaps down, and the MANUV FLAP/WG SWP DR NO. 2 circuit breaker pulled to lock them down (LE1). Airspeed control is degraded because of the dramatically decreased drag and low approach power setting. Any airspeed from 15 units to 180 KCAS should be considered acceptable with the wings at 20°; waveoff performance is dramatically improved if some additional speed is carried. Fifteen units should be used if the wings are trapped significantly aft. Speeds in excess of 180 KCAS on final should otherwise be avoided because of the increased susceptibility to rate limiting. Lateral control is degraded but satisfactory, and a straight-in approach to an arrested landing should be performed. The very low drag, runway length, long field gear, and length of time while operating on the BFCM must all be considered in choosing a game plan for handling bolters. The nose must smoothly be rotated to the flyaway attitude if a go-around is elected. Flaps can be selected to full once on deck to obtain the additional drag from the outboard flap panels and ground roll braking from the outboard spoilers.

WARNING

- Aggressive nose movement in close or on bolter can rate limit the stabilizer resulting in low altitude loss of control. Do not use APCS. Glideslope is satisfactorily controlled with appropriate use of power and smooth pitch inputs, allowing airspeed to vary within the recommended range. Smoothly rotate nose to flyaway attitude on bolter.
- Carrier landings with a dual-hydraulic failure are very hazardous and should not be attempted because of the abrupt and unpredictable nature of rate limiting. Control would most probably be lost between the in-close and at-the-ramp positions when the pilot or LSOs could not avert a catastrophic flight deck mishap.

CAUTION

Waveoff performance from low power settings is very poor. Carrying extra speed during approach will improve waveoff performance by permitting smooth rotation to 15 units AOA to break the rate of descent while engines are spooling up.

11.10.6 BFCM Thermal Durability. The thermal behavior of the BFCM and its isolated hydraulic loop determine the durability of the system. With the motor operating in LOW, the temperature of the motor and the fluid will stabilize and the motor can run indefinitely. In HIGH, however, the motor can heat up within 8 minutes to temperatures at which it might fail. The motor should be selected to HIGH only after the aircraft is on final with intent to land, unless tanking is required. The motor should be selected to LOW once safely airborne following waveoff, missed approach, or bolter, and then HIGH reselected on final. The elapsed time on HIGH must be closely monitored if in-flight refueling is required. Once disengaged, LOW must be immediately selected.

WARNING

Operations of more than 8 minutes total in HIGH may fail the BFCM motor. Extended LOW operation (> 30 minutes) after in-flight refueling will permit several additional minutes of use for subsequent landing.

11.11 FLIGHT CHARACTERISTICS WITH AFT CG LOCATIONS

11.11.1 Store Effects on Cg Location. The normal NATOPS cg limits are expressed relative to a reference condition known as zero fuel gross weight (ZFGW). This condition known as zero fuel gross weight (ZFGW). This configuration is defined as wings at 20°, gear and flaps down, zero fuel on board. Adding fuel or raising the gear and/or flaps will move the cg position forward from the ZFGW position. The limit for ZFGW cg locations with tunnel-mounted stores is 17.0-percent MAC. On a typical fleet aircraft, one Mk 84 2,000-pound bomb placed on station 4 or 5 results in a ZFGW cg aft of 17.0-percent MAC, possibly as far aft as 18.5- to 19-percent MAC. Two aft hung Mk 84s can produce a ZFGW cg of up to 22-percent MAC. Aft wing sweep can be used to move the neutral point of the F-14 aft and restore normal static longitudinal stability margin and normal flying qualities even with extremely aft cg locations. In-flight actual cg location varies as fuel is burned but remains relatively constant at its most forward position between 5,000 to 10,000 pounds. Below 5,000 pounds, the cg moves aft toward the ZFGW position. Wing-mounted AIM-7/9s move the ZFGW cg location slightly forward, while external tanks have no effect on the cg location.

11.11.2 Wing-Sweep Effects on Stability. Static stability of an aircraft is determined by the difference in location of the neutral point, where the lift component can be assumed to act, and the cg position. A positive static margin exists as long as the neutral point remains aft of the cg location. As the wings of the F-14 sweep aft, the cg location also moves slightly aft but the greatest change is in the neutral point position that moves further aft as well. Aft wing sweep can be used in conjunction with an aft-cg position to restore the normal margin between the neutral point and the cg, producing the same level of stability and normal flying qualities.

11.11.3 Cruise and Combat Flight Characteristics With Aft Cg. Flying qualities at aft cg locations up to 22-percent MAC with gear and flaps up are only slightly degraded. This degradation will probably not be apparent to the pilot. No change in flying qualities is noted during dive recoveries between 400 and 500 KCAS. Stick force per g remains relatively nominal even with 4,000 pounds of aft hung bombs. No degradation to any aspect of flying qualities is noted above 300 KCAS as the wings remain sufficiently aft on the normal wing-sweep schedule to produce a positive static margin for even the most aft cg locations. At 20° of wing sweep, 250 KCAS, and a ZFGW cg of 18.6 percent, the aircraft exhibits some reduction in static stability and is slightly more responsive to pitch inputs, although this increase in responsiveness may not be significant enough to be noticed during normal flight operations. Wing-mounted stores or external tanks have no adverse effects on aft cg flying qualities.

11.11.4 Takeoff and Landing Configuration Flight Characteristics with Aft Cg. With the gear and flaps lowered and 20° of wing sweep with a ZFGW cg location of 18-percent MAC or greater, the static margin is greatly reduced from normal and can be negative for the extremely aft cg locations produced by 4,000 pounds of bombs on the aft weapon stations. The aircraft is extremely susceptible to pilot-induced oscillations during closely controlled tasks such as close formation or flying the ball. Loss of control is likely. With a wing sweep of 26° for ZFGW cg locations up to 18.6-percent MAC, normal static margin is restored and normal flying qualities are regained. For ZFGW cg location greater than 18.6-percent MAC, 30° of wing sweep is sufficient for normal handling qualities to be regained.

Wing-mounted stores and external tanks reduce lateral-directional stability in the takeoff and landing configuration slightly, although the difference in flying qualities is not significant and may not be noticeable. Once established in the optimum wing-sweep configuration appropriate for the amount of ordnance hung on the aft stations, normal approach techniques can be used. However, a straight-in approach should be flown as power requirements in a turn with aft wing sweep are significantly different than normal and could produce a severely underpowered approach. No abnormalities in aircraft response or performance are apparent during landing approaches at 15 units, even with 4,000 pounds of aft hung ordnance. APC is not optimized for aft wing-sweep landings and should not be used. DLC should not be used as it adds 8 knots to recovery WOD requirements and has improper pitch trim response at aft wing sweep. Expect on-speed airspeed for 25° of wing sweep to increase 6 knots over the normal DLC on 20° of wing-sweep approach speed, and 12 knots increase if wings are at 30°. For CV arrestments, the appropriate recovery bulletin should be consulted.

Ashore, a field arrestment is recommended with spoiler brakes dearmed because of the large noseup pitch occurring at spoiler deployment. If a field arrestment is not possible, expect to use full forward stick to counter the noseup pitching moment and to maintain forward stick until below 80 KCAS with a resultant longer rollout.

PART V

Emergency Procedures

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INTRODUCTION

Part V consists of Chapter 12, Ground Emergencies; Chapter 13, Takeoff Emergencies; Chapter 14, In-Flight Emergencies; Chapter 15, Landing Emergencies; and Chapter 16, Ejection. These chapters cover the recommended procedures for coping with emergencies and malfunctions that may be encountered during aircraft operations. Knowledge of the aircraft systems and emergency procedures must be reviewed on a regular basis to ensure that the flightcrew will take the correct course of action under adverse conditions.

Each emergency presents a different problem that requires positive, specific, remedial action in accordance with recommended procedures and good airmanship. Judgment, precision, and teamwork are essential during emergencies. The flightcrew must weigh all the factors of a given situation and then take appropriate action. As soon as possible, the pilot should notify the RIO, flight leader, flight, and ground station in as much detail as possible of the existing emergency and of the intended action. When an emergency occurs, three basic rules are established that apply to airborne emergencies. They should be thoroughly understood by all flightcrew.

1. Maintain aircraft control.
2. Analyze the situation and take proper action.
3. Land as the situation dictates.
    a. Land as soon as possible — Land at the first site at which a safe landing can be made.
    b. Land as soon as practicable — Extended flight is not recommended. The landing site and duration of flight is at the discretion of the pilot in command.

Note

- The ground, takeoff, in-flight, and landing emergency procedures are sequenced as outlined in the Emergency Procedures Table of Contents.
- Decision factors ("if" statements) are provided as a guide in selecting certain procedures.

Critical Procedures (Boldface Procedures)

Procedures marked with asterisks (*) are considered critical and are referred to as "boldface" procedures. The boldface procedures in this part are provided as a study reference and are not intended to be used as an alternate to the amplified procedures contained in Chapters 12, 13, 14, 15, and 16 or the abbreviated procedures contained in NAVAIR 01-F14AAD-1B. Flight crewmembers should be able to accomplish boldface procedures without reference to the NFM or PCL.

Warning, Caution, Advisory Lights/Displays

The warning, caution, advisory lights/displays are listed together with the cause and corrective action.

EMERGENCY PROCEDURES

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BOLDFACE PROCEDURES

ENGINE FIRE ON THE DECK

*1. Both FUEL SHUT OFF handles . . . . . Pull

*2. Both throttles . . . . OFF

UNCOMMANDED ENGINE ACCELERATION ON DECK

*1. Paddle switch . . . . . Depress and Hold

*2. Throttle(s) . . . . As Desired

*3. ENG MODE SELECT . . . . SEC

*4 THROTTLE MODE switch . . . . MAN

BRAKE FAILURE AT TAXI SPEED

*1. ANTI SKID SPOILER BK switch . . . . SPOILER BK or OFF

ABORTED TAKEOFF

*1. Throttles . . . . IDLE

*2. Speedbrakes . . . . EXT

*3. Stick . . . . AFT

*4. Hook . . . . . . DN (1,000 feet before wire)

*5. Brakes . . . . As Required

*6. Right engine . . . . OFF (if required)

SINGLE-ENGINE FAILURE FIELD/CATAPULT LAUNCH/WAVEOFF

*1. Set 10° pitch attitude on the waterline (14 units AOA maximum).

*2. Rudder . . . . Opposite Roll/Yaw . . . . Supplemented by Lateral Stick

*3. Both throttles . . . . As Required for Positive Rate of Climb

*4. Landing gear . . . . UP

*5. Jettison . . . . If Required

BLOWN TIRE DURING TAKEOFF; TAKEOFF ABORTED OR AFTER LANDING TOUCHDOWN

*1. Nosewheel steering . . . . Engaged

*2. ANTI SKID SPOILER BK switch . . . . SPOILER BK

BLOWN TIRE DURING TAKEOFF; TAKEOFF CONTINUED OR AFTER LANDING GO-AROUND

*1. Throttles . . . . As Required

*2. Landing gear and flaps . . . Leave as Set for Takeoff

FIRE LIGHT AND/OR FIRE IN FLIGHT

*1. Throttle (affected engine) . . . . IDLE

*2. AIR SOURCE pushbutton . . . . OFF

*3. OBOGS master switch . . . . . . BACKUP

If light goes off (and no other secondary indications):

*4. MASTER TEST switch . . . FIRE DET TEST

If light remains illuminated, FIRE DET test fails, or other secondary indications:

*5. FUEL SHUT OFF handle (affected engine) . . . . Pull

*6. Throttle (affected engine) . . . . OFF

*7 Climb and decelerate.

*8. Fire extinguisher pushbutton . . . Depress

COMPRESSOR STALL

*1. Unload aircraft (0.5g to 1.0 g).

If greater than 1.1 Mach:

*2. Both throttles . . . . MIL

When 1.1 Mach or less:

*3. Both throttles . . . . Smoothly to IDLE

If EGT above 935 °C and/or engine response abnormal:

*4. Throttle (stalled engine) . . . . OFF

ENGINE FLAMEOUT

*1. Throttle . . . . IDLE or Above (affected engine)

*2. BACK UP IGNITION switch . . . . ON

If hung start or no start:

*3. Throttle . . . . Cycle OFF, Then IDLE (affected engine)

If still hung or no start:

*4. ENG MODE SELECT . . . . SEC

If one engine is operable, perform a crossbleed airstart.

If both engines flamed out/inoperative or crossbleed not possible:

*5. Airspeed . . . . 450 Knots (altitude permitting)

RAMPS LIGHT/INLET LIGHT

*1. Avoid abrupt throttle movements.

*2. Decelerate to below 1.2 TMN.

*3. Affected INLET RAMPS switch . . . STOW

ELECTRICAL FIRE

*1. L and R generators . . . . OFF

If uncommanded SAS or spoiler inputs present:

*2. ROLL and PITCH CMPTR AC cb's . . Pull (LA1, LB1)

*3. YAW SAS switch . . . . OFF

ECS LEAKS/ELIMINATION OF SMOKE AND FUMES

*1. AIR SOURCE pushbutton . . . . OFF

*2. OBOGS master switch . . . . BACKUP

*3. If smoke or fumes present:

a. AltitudeBelow 35,000 Feet

b. CABIN PRESS switchDUMP

*4. RAM AIR switch . . . . OPEN

LAD/CANOPY LIGHT WITH RIO'S CANOPY LIGHT/CANOPY LOSS

*1. Canopy . . . . BOOST CLOSE (canopy remaining)

*2. EJECT CMD lever . . . . PILOT

UNCOMMANDED ROLL AND/OR YAW

*1. If flap transition:
FLAP handle . . . . Previous Position

*2. Rudder and stick . . . . Opposite Roll/Yaw

*3. AOA . . . . Below 12 Units

*4. Downwing engine . . . . . . MAX THRUST (If required)

UPRIGHT DEPARTURE/FLAT SPIN

*1. Stick . . . . Forward/Neutral Lateral, Harness-Lock

*2. Throttles . . . . Both IDLE

*3. Rudder . . . . Opposite Turn Needle/Yaw

If no recovery:

*4. Stick . . . . Into Turn Needle

If yaw rate is steady/increasing, spin arrow flashing, or eyeball-out g is sensed:

*5. Roll SAS — On; Stick — Full Into Turn Needle and Aft.

If recovery indicated:

*6. Controls . . . . NEUTRALIZE

*7. Recover at 17 units AOA, thrust as required.

If flat spin verified by flat attitude, increasing Yaw rate, increasing eyeball-out g, and lack of pitch and roll rates:

*8. Canopy . . . . Jettison

*9. EJECT . . . . (RIO Command Eject)

INVERTED DEPARTURE/SPIN

*1. Stick . . . . Full Aft/Neutral Lateral, Harness — Lock

*2. Throttles . . . . Both IDLE

*3. Rudder . . . . Opposite Turn Needle/Yaw

If recovery indicated:

*4. Controls . . . . Neutralize

*5. Recover at 17 units AOA, thrust as required.

If spinning below 10,000 feet AGL:

*6. EJECT . . . . (RIO Command Eject)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS

WARNING — *WARNING LIGHT AND/OR DISPLAY LEGEND (HUD, HUD/MFD, MFD) DISPLAY LEGEND — CAUTION

ADVISORY

LIGHT/LEGEND	CAUSE	ACTION
AAA	AAA tracking radar detected.	As briefed.
ACLS/AP	ACLS or autopilot disengagement.	Take control for manual landing approach.
AAI ZERO (MFD)	Improper IFF interrogator operation.	As briefed.
AI	Airborne interceptor tracking detected.	As briefed.
L A/ICE R A/ICE (MFD)	Designated engine anti-ice is on or anti-ice valve has failed opposite commanded position.	If INLET ICE light on, perform appropriate procedure. If INLET ICE light off, inlet ice may be on though not commanded. Report to maintenance.
A/P REF (MFD)	Selected A/P reference is not engaged.	Depress autopilot reference pushbutton to engage A/P reference mode.
FWD ASPJ AFT ASPJ (MFD)	Improper ALQ-165 position.	As briefed.
ASPJ HOT (MFD)	ALQ-165 self-protection jammer overheated.	Secure ALQ-165.
L AUG R AUG (MFD)	AB is not available and opposite engine is limited to MIN AB if ATLS is on.	No immediate action required; assess operational impact.
AUTO PILOT	Autopilot or reference failure.	1. MASTER RESET pushbutton — Depress. *If light remains illuminated:* 2. PITCH AND ROLL COMPTR AC cb's (LB1, LA1) — Cycle.
AUTO THROT	Autothrottle has been disengaged.	1. Assume manual/boost control. 2. Satisfy APC interlocks. 3. Reengage APC AUTO.

Warning, Caution, Advisory Lights/Displays (Sheet 1 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
AUX FIRE EXT (MFD)	Low-extinguisher agent pressure.	Report to maintenance.
BINGO	Totalizer less than preset value.	Pilot option.
BLEED DUCT	Bleed duct overheat condition or ECS regulating failure.	*1. AIR SOURCE — OFF. *2. OBOGS — BACKUP. *3. If smoke or fumes present: a. Altitude Below 35,000 feet. b. CABIN PRESS — DUMP. *4. RAM AIR — OPEN. 5. Airspeed — <300 Knots/0.8 Mach. 6. Nonessential electrical — Secure. 7. CANOPY DEFOG/CABIN AIR lever CANOPY DEFOG. *8. Land as soon as possible. *If electrical fire:* 9. Follow electrical fire procedures.
BRAKES	Operating in auxiliary brake mode, antiskid failure, or parking brake set.	1. Turn antiskid off. 2. Cautious brake application. 3. Release emergency brake.
B/U OXY LOW	Backup oxygen less than 200 psi.	**B/U OXY LOW light (both cockpits):** 1. BACKUP OXY PRESS — Check. *If BACKUP OXY PRESS < 200 PSI:* 2. Cabin alt — Less than 10,000 Feet. 3. Oxygen supply — OFF. 4. Oxygen masks — Release One Side. *Before landing:* 5. Oxygen masks and supply — ON. 6. Emergency oxygen — Activate. *If BACKUP OXY PRESS > 200 psi:* 2. BACKUP OXY PRESS — Monitor. **B/U OXY LOW light (pilot only):** 1. BOS CONTR/B/U OXY LOW cb — Check In (7A4). 2. BACKUP OXY PRESS — Check. **B/U OXY LOW Light (RIO Only):** 2. BACKUP OXY PRESS — Check.

Warning, Caution, Advisory Lights/Displays (Sheet 2 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
CABIN PRESS	Cabin pressure failure.	1. Oxygen mask — ON. *If below 15,000 feet:* 2. CABIN PRESS — Cycle.
CADC	CADC failure.	1. MASTER RESET — Depress. 2. CADC cb's (LA2, LB2, LC2, LD2) — Cycle. 3. MASTER RESET — Depress. *If light still remains illuminated:* 4. Remain below 1.5 Mach.
CANOPY	Canopy not locked.	*1. Canopy — BOOST CLOSE (canopy remaining). *2. EJECT CMD — PILOT. 3. Airspeed and altitude — Below 200 Knots/15,000 Feet. 4. Seats and visors — DOWN. 5. If canopy has departed aircraft, perform controllability check. 6. Land as soon as possible.
C & D HOT	Controls and displays hot.	1. Select cabin air. 2. WCS switch OFF.
CIU (MFD)	Improper operation of converter-interface unit.	Expect loss of CIU inputs/outputs.
CIU HOT (MFD)	Converter-interface unit overheated.	Pull cb's 3E7, 4E1, 4E2.
CLSN (HUD)	RIO has collision steering selected.	Pilot option.

Warning, Caution, Advisory Lights/Displays (Sheet 3 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
COOLING AIR (IN FLIGHT)	Indication of possible bleed duct failure forward of the pressure primary heat exchanger and 400 °F modulating valve.	1. AIR SOURCE — OFF. 2. OBOGS — BACKUP. *If associated with any other direct or indirect indication of ECS malfunction:* 3. Perform ECS Leak/Elimination of Smoke and Fumes Procedure. *If not associated with any other direct or indirect indication of ECS malfunction and operational requirements dictate temporary reselection of ram to regain lost service systems:* 3. AIR SOURCE — RAM. 4. RAM AIR door — FULLY OPEN. 5. AIR SOURCE — OFF. 6. Land as soon as practicable.
COOLING AIR (ON DECK)	Inadequate cooling.	1. AIR SOURCE — Check L ENG, R ENG, or BOTH ENG. 2. Throttles — Advance Without Closing Nozzles. 3. CANOPY DEFOG/CABIN AIR lever — CANOPY DEFOG. 4. ECS — MAN/FULL HOT (CONT). *If light goes out:* 5. Throttles — IDLE. 6. ECS — As Desired. *If light remains illuminated:* 7. Secure systems.
CW	Continuous-wave emitter detected.	As briefed.
DEU HOT (MFD)	Data entry unit overheated.	Expect loss of DEU.
DP1 HOT DP2 HOT (MFD)	Display processor overheated.	Pull cb's 1G2, 1G4, 1G6, 3F4, 4F3, 4F6.
DSS HOT (MFD)	Data storage set overheated.	Expect loss of DSS.
EMERG JETT PUSHBUTTON/ ACK LIGHT	When depressed with weight off wheels, activates emergency stores jettison signal to the SMS and illuminates light for 5 seconds. Jettison function is disabled with weight on wheels.	None.

Warning, Caution, Advisory Lights/Displays (Sheet 4 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
ENG FIRE EXT (MFD)	Low-extinguisher agent pressure.	Report to maintenance.
L ENG SEC R ENG SEC	Engine mode control in secondary.	*If engine transfers to sec mode:* 1. Throttle — Less Than MIL. 2. ENG MODE SELECT — Cycle. *If PRI mode restored:* 3. Maintain constant subsonic airspeed in level flight. 4. Affected L or R AICS cb — Cycle. *If engine remains in SEC:* 3. ENG MODE SELECT — SEC. 4. Avoid abrupt throttle movements. 5. Land as soon as practicable.
L FIRE R FIRE * (HUD/MFD)	Fire/overheat condition in engine nacelle.	*If HUD/MFD message:* Message is a repeat of a discrete from the fire detect system. If FIRE warning light is off and FIRE DET TEST checks 4.0, then assume message was incorrect and keep engine on line. *If FIRE warning light and message:* *1. Throttle (affected engine) — IDLE. *2. AIR SOURCE — OFF. *3. OBOGS — BACKUP. *If light goes OFF and no secondary indications:* *4. MASTER TEST — FIRE DET TEST. *If light remains illuminated, FIRE DET TEST fails, or other secondary indications:* *5. FUEL SHUT OFF — Pull. *6. Throttle — OFF. *7. Climb and decelerate. *8. Fire extinguisher — Depress. *9. Refer to Single-Engine Cruise Operations. 10. Land as soon as possible. 11. If fire persists — Eject.

Warning, Caution, Advisory Lights/Displays (Sheet 5 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS

LIGHT/LEGEND	CAUSE	ACTION
FLAP	Flap position disparity with commanded position or flap/slat asymmetry.	1. Airspeed — Below 225 Knots. 2. FLAP handle — Ensure Full Up. 3. MASTER RESET — Depress. 4. While holding MASTER RESET pushbutton depressed, maneuver flap thumbwheel — Full Forward. 5. Check FLAP light out. *If after landing/takeoff flap transition, or reillumination after above procedures:* 1. MASTER RESET — Depress. 2. If light still illuminated, check FLAP handle and indicator position, then proceed with appropriate steps below. *Flap handle up and flaps not fully retracted:* 1. Flap handle — EMER UP. *Flap handle up and flaps indicating full up:* 1. Flaps — Cycle. *Flap handle down and flaps not fully extended:* 1. Wing sweep — Ensure at 20°. *Flap handle down and flaps down:* 1. Wing sweep — Ensure at 20°. 2. MASTER RESET — Depress. *Flap and slat asymmetry:* Refer to Chapter 14.
L FLMOUT R FLMOUT (MFD)	Engine flameout.	Check engine gauges. *If invalid, report anomaly to maintenance:* *If valid, perform the following:* *1. Throttle — IDLE or Above. *2. BACKUP IGNITION switch — ON. *If hung start or no start:* *3. Throttle — Cycle OFF, Then IDLE.

Warning, Caution, Advisory Lights/Displays (Sheet 6 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
L FLMOUT R FLMOUT (MFD)	Engine flameout.	*If still hung or no start:* *4. ENG MODE SELECT — SEC. *If one engine is operable, perform a crossbleed airstart.* *If both engines flamed out/inoperative or crossbleed not possible:* *5. Airspeed — 450 Knots. 6. OBOGS — BACKUP. *When start complete:* 7. BACKUP IGNITION — OFF. 8. ENG MODE SELECT — PRI. 9. OBOGS — ON. *When primary mode restored:* 10. Maintain constant subsonic Mach in level flight. 11. Affected AICS cb — Cycle.
L FUEL LOW R FUEL LOW	Usable fuel in L and AFT or R and FWD fuselage tanks 1,000 pounds.	1. DUMP switch — OFF. 2. Fuel distribution — Check. *If wing and/or external fuel remaining:* 3. WING/EXT TRANS — ORIDE. 4. Land as soon as practicable.
L FUEL PRESS R FUEL PRESS	*Sump tank boost pump discharge less* than 9 psi.	1. Both throttles — MIL Power or Less. 2. Restore aircraft to 1.0g flight. *If both lights remain on:* 3. Increase positive g's to > 1.0g. 4. Descend below 25,000 feet. 5. Maintain cruise power settings or less. 6. Land as soon as possible. *If one light remains on:* 3. No afterburner above 15,000 feet. 4. Fuel distribution — Monitor. 5. Land as soon as practicable.
L GEN R GEN	Generator failure and/or disconected from its ac bus.	1. Generator — OFF/RESET, Then NORM. *If generator does not reset:* 2. Generator — TEST.
HOT TRIG	Firing logic met. Pilot's trigger will fire weapon when squeezed.	Pilot option.
HYD PRESS	Combined or flight pump discharge pressure 2,100 psi or less.	Refer to Chapter 14 for appropriate procedure.

Warning, Caution, Advisory Lights/Displays (Sheet 7 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS

LIGHT/LEGEND	CAUSE	ACTION
HZ TAIL AUTH	CADC failure or failure of actuators to follow schedule.	1. MASTER RESET — Depress. *If light remains illuminated:* 2. ROLL STAB AUG — OFF. 3. Above 400 knots, restrict lateral control to one-quarter throw. 4. ROLL STAB AUG — ON for Landing. 5. Do not select OV SW after landing.
IFF	Mode 4 interrogation received; no reply generated.	As briefed.
IFF ZERO (MFD)	Improper IFF transponder operation.	As briefed.
L IGV SD R IGV SD (MFD)	Inlet guide vanes off schedule.	AICS fail operation mode in use. Stall margin may be very slightly reduced but still remains satisfactory and greater than that in SEC mode. High-power thrust may be reduced.
IMU (MFD)	Improper operation of inertial measurement unit.	Secondary navigation mode is in use.
INS (MFD)	Improper operation of inertial navigation system.	Secondary navigation mode is in use.
INTEG TRIM	Power loss or discrepancy between input signal and position	MASTER RESET.
R INLET L INLET	Computer malfunction or ramp mispositioning.	*1. Avoid abrupt throttle movements. *2. Decelerate below 1.2 TMN. *3. Affected INLET RAMPS — STOW. *If RAMPS light remains illuminated:* 4. Throttle — 80 percent or Less. 5. Affected AICS cb — Pull. 6. Affected INLET RAMPS — AUTO. 7. Land as soon as practicable. *If INLET light only illuminated, attempt AICS program reset:* 4. Decelerate below 0.5 TMN. 5. Affected AICS cb — Cycle. *If INLET light goes off:* 6. Affected INLET RAMPS — AUTO. *If INLET LIGHT remains illuminated:* 6. Affected AICS cb — Pull. 7. Affected INLET RAMPS — AUTO. 8. Remain below 1.2 TMN.

Warning, Caution, Advisory Lights/Displays (Sheet 8 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
INLET ICE	Icing condition exists in inlet or ENG/PROBE ANTI-ICE switch is on.	1. Select ORIDE/ON. *When clear of icing conditions:* 2. ANTI-ICE — AUTO/OFF.
IPF	JTIDS is failed, a momentary glitch, or 20-percent duty cycle has been exceeded.	Select IPF RESET on JTIDS control panel.
IRSTS HOT (MFD)	Infrared search and track system overheated.	Secure system.
JTID HOT (MFD)	Possible loss of cooling air or a high JTIDS transmit duty cycle.	Secure system.
LAD/ CANOPY	With RIO CANOPY light, canopy unlocked.	*1. Canopy — BOOST CLOSE. *2. EJECT CMD — PILOT. 3. Airspeed and altitude — Below 200 Knots/15,000 Feet. 4. Seats and visors — DOWN. 5. If canopy has departed aircraft, perform controllability check. 6. Land as soon as possible.
LAD/ CANOPY	Without RIO CANOPY light, ladder not stowed.	1. Airspeed minimum. 2. Obtain in-flight visual check if possible. 3. Land as soon as practicable.
LAUNCH BAR (Ground)	Launch bar unlocked, engines less than MIL thrust.	As appropriate.
LAUNCH BAR (Flight)	Launch bar not locked in up position or cocked nosegear.	1. Landing gear — Leave Down. 2. Obtain visual inspection. *If nosegear cocked, refer to Landing Gear Malfunction guide.* *If launch bar down or visual inspection not available:* 3. Request removal of arresting cables for field landing. 4. Request removal of crossdeck pendants 1 and 4 for CV landing.
L LO THR R LO THR (MFD)	Designated engine may be producing less than expected thrust.	If associated with RATS check, monitor engine gauges and FEMS engine data for normal rpm, FF, and temperatures. If no anomalies, message is false alarm triggered by the hook. If not associated with a RATS check, record FEMS data and abort.

Warning, Caution, Advisory Lights/Displays (Sheet 9 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
LOCK	Radar locked on target.	Pilot option.
L MACH # R MACH # (MFD)	Mach number signal to designated engine has failed.	In flight — Remain below 1.1 TNM. Small throttle reductions below MIL at high Mach can result in engine stall. On deck — Assess operational impact of speed restriction for mission.
MACH TRIM (MFD)	Failure of Mach trim actuator to follow program.	1. MASTER RESET. 2. Retrim manually.
MASTER CAUTION	Actuated by any caution light on caution panel.	Push to reset after discrete MSG noted.
MC1 MC2 (MFD)	Improper operation of mission computer.	Backup operation selected automatically.
MC1 HOT MC2 HOT (MFD)	Mission computer overheated.	Backup operation selected automatically.
L N1 OSP R N1 OSP (MFD)	Engine fan rpm exceeds 106 percent.	1. Throttle — IDLE. Check rpm gauge for N_2 and FEMS engine data on MFD for N_1 to determine validity of overspeed message. *If overspeed continues:* 2. ENG MODE SELECT — SEC. *If overspeed condition persists:* 3. Throttle — OFF. 4. Refer to Single-Engine Cruise Operations. 5. Land as soon as practicable.
L N2 OSP R N2 OSP (MFD)	Engine core rpm exceeds 107.7 percent.	1. Throttle — IDLE. Check rpm gauge for N_2 and FEMS engine data on MFD for N_1 to determine validity of overspeed message. *If overspeed continues:* 2. ENG MODE SELECT — SEC. *If* overspeed *condition persists:* 3. Throttle — OFF. 4. Refer to Single-Engine Cruise Operations. 5. Land as soon as practicable.

Warning, Caution, Advisory Lights/Displays (Sheet 10 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
NWS ENGAGE	Nosewheel steering is engaged.	Disengage when appropriate.
L OIL HOT R OIL HOT	Engine oil temperature limits exceeded or high scavenge oil temperature.	*On deck:* 1. Throttle — OFF. *In flight:* 1. Oil pressure — Check. 2. Throttle — 85-percent rpm. 3. If after 1 minute, light still illuminated — Throttle OFF. 4. Land as soon as practicable. 5. Refer to Single-Engine Cruise Operations. 6. Relight engine for landing if necessary.
L/R OIL LO (MFD)	Designated engine oil level is approximately 2 quarts low Postflight, engine at idle.	Alert ground personnel; servicing required.
OIL PRESS	L or R oil press <11 psi.	1. Throttle (affected engine) — IDLE. *If oil pressure below 15 psi, above 65 psi, or engine vibration:* *If shutdown feasible:* 2. Throttle (affected engine) — OFF. 3. Refer to Single-Engine Cruise Operation (Chapter 14). *If shutdown not feasible:* 2. RPM — Set Minimum Rpm. 3. Avoid high-g or large throttle movements. 4. Land as soon as practicable.
OBOGS	Low percent oxygen.	1. BACKUP OXY PRESS — Check.
PITCH STAB 1 PITCH STAB 2	Channel 1 or 2 inoperative.	*If single pitch or roll stab light:* 1. MASTER RESET — Depress. 2. If light remains illuminated — No Limitations. *If both pitch or roll stab lights:* 1. Airspeed — Reduce to Stab Limits. 2. Pitch — Not Restricted. 3. Roll — 1.6 TMN. 4. Wait 10 seconds for self-test. 5. PITCH CMPTR AC cb or ROLL CMPTR AC cb — Cycle (LA1 or LB1). 6. Recheck lights.

Warning, Caution, Advisory Lights/Displays (Sheet 11 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
L RAMPS R RAMPS	Computer/mechanical malfunction or ramp mispositioning.	Refer to INLET light.
RATS	RATS operation enabled.	1. Tailhook — DOWN. *If conditions permit:* 2. ANTI ICE CONTR HOOK CONT/ WSHLD/AIR cb — Pull (8C2).
RCV	ALG-165 is receiving threat identification signal.	As briefed.
RDC SPEED (HUD/MFD)	Flaps fail down, airspeed 225 knots; total temperature 388 °F, 2.4 M	1. Reduce speed. 2. Check FLAP handle. 3. MASTER RESET.
RDP FAN	Radar data processor fan failure.	Expect overheat.
RDR ENABLED	Radar operation on ground is possible.	Radar POWER switch to STBY (as applicable).
RDR HOT (MFD)	Radar system overheated.	Select STBY.
READ MFD	Warning or caution message(s) being displayed on MFD.	As appropriate to displayed message(s).
ROLL STAB 1 ROLL STAB 2	Channel 1 or 2 inoperative.	*If single pitch or roll stab light:* 1. MASTER RESET — Depress. 2. If light remains illuminated — No Limitations. *If both pitch or roll stab lights:* 1. Airspeed — Reduce to Stab Limits. 2. Pitch — Not Restricted. 3. Roll — 1.6 TMN. 4. Wait 10 seconds for self-test. 5. PITCH CMPTR AC cb or ROLL CMPTR AC cb — Cycle (LA1 or LB1). 6. Recheck lights.

Warning, Caution, Advisory Lights/Displays (Sheet 12 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUTION**	**ACTION**
RUDDER AUTH	CADC failure or failure of actuator to follow schedule.	1. MASTER RESET — Depress (10 seconds). 2. If light remains illuminated — Above 250 Knots, Restrict Rudder Inputs to < 10°.
RWR (MFD)	Improper ALR-67 radar warning receiver operation.	As briefed.
RWR HOT	ALR-67 overheated.	Secure ALR-67.
SAHRS	SAHRS not available.	Avoid IFR flight if INS is degraded.
SAM	Steady — Tracking radar detected. Flashing — Missile launch detected.	As briefed.
SDU ALARM (MFD)	Improper operation of KY-58.	As briefed.
SENSOR COND	Overheat or pump loss in radar coolant loop.	1. RADAR COOLING — OFF. 2. RDR — OFF. 3. APG-71 PUMP PH A, B, C cb — Pull. *If other conditions exist that may indicate an ECS malfunction, either directly or indirectly, perform ECS leak/elimination of smoke and fumes procedures:* 4. Land as soon as practicable.
SHOOT	Target meets LAR requirements.	As briefed.
SMS HOT (MFD)	Store management system overheated.	
SPOILERS	Symmetric spoiler detctor has locked down spoilers.	*If associated with abnormal roll and/or yaw:* 1. Counter roll with at least 1 inch of lateral stick. 2. Visually check spoiler position/ operation. Refer to Chapter 14.

Warning, Caution, Advisory Lights/Displays (Sheet 13 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
START VALVE	Starter solenoid air valve open after engine start.	1. Ensure ENG CRANK — OFF. 2. AIR SOURCE — OFF. *If on deck:* 3. Throttle — OFF. *If airborne:* 3. ENG START cb — Pull (RF1). 4. OBOGS — BACKUP.
L STALL R STALL * (HUD/MFD)	Engine stall and/or overtemperature.	*1. Unload aircraft (0.5g to 1.0g). *If greater than 1.1 Mach:* *2. Both throttles — MIL. When 1.1 Mach or less: *3. Both throttles — Smoothly to IDLE. Check EGT and FEMS engine data for TBT to determine validity of stall message. *If EGT above 935 °C and/or engine response abnormal:* *4. Throttle (stalled engine) — OFF. *If EGT normal and/or airstart successful:* 5. Perform engine operability check.
L TBT OT R TBT OT (MFD)	Turbine blade overtemperature.	1. Throttle — IDLE. Check EGT gauge and FEMS engine data on MFD for TBT to determine validity of overtemperature message. *If still overtemperature:* 2. Throttle — OFF.
TRANS/RECT	Lack of dc output from either or both T/R.	1. Generator — OFF/RESET, Then NORM. 2. If both lights remain illuminated, select EMERG GEN on MASTER TEST panel. 3. Land as soon as practicable.
WHEELS	Landing gear not down with flaps down and either throttle ≤ 85 percent.	Lower gear.

Warning, Caution, Advisory Lights/Displays (Sheet 14 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	**CAUSE**	**ACTION**
W/S (MFD)	Failure of both wing-sweep channels or spider detent disengaged.	*Advisory light only, no loss of normal control:* 1. MASTER RESET — Depress. *WING SWEEP light and W/S legend, no automatic or manual control:* 1. Airspeed — Decelerate to 0.9 or Less. 2. Check spider detent engaged. 3. MASTER RESET — Depress. *If WING SWEEP light and W/S caution legend illuminate again:* 4. WING SWEEP DRIVE NO.1 and WG SWP DR NO.2 MANUV FLAP cb — Pull. 5. Emergency WING SWEEP handle — Comply With Schedule. Refer to Chapter 14.
WING SWEEP	Failure of one wing-sweep channel.	Advisory light only: 1. MASTER RESET — Depress.
WSHLD HOT	Center windshield temperature 300 °F.	1. WSHLD AIR — OFF. *If light remains illuminated:* 2. AIR SOURCE — OFF. 3. OBOGS — BACKUP. 4. RAM AIR — OPEN. 5. Reduce airspeed < 300 knots or 0.8 Mach. 6. Land as soon as practicable.
YAW STAB OP	First failure in yaw SAS.	1. MASTER RESET — Depress. 2. If light remains illuminated — Stay Below 1.0 TMN.
YAW STAB OUT	Second failure in yaw SAS.	1. YAW STAB — OFF. 2. MASTER RESET — Depress. *If light remains illuminated:* 3. Decelerate below 1.0 TMN. 4. YAW SAS PWR cb's — Cycle. 5. If light remains illuminated, remain below 1.0 TMN. *If light out:* 6. Reset YAW STAB switch.

Warning, Caution, Advisory Lights/Displays (Sheet 15 of 15)

CHAPTER 12

Ground Emergencies

12.1 ON-DECK EMERGENCIES

12.1.1 Engine Fire on the Deck

PILOT

*1. Both FUEL SHUT OFF handles — Pull.

*2. Both throttles — OFF.

3. If conditions permit — Windmill Engine.

4. BACK UP IGNITION switch — Check OFF.

CAUTION

Excessive windmilling of engine with oil system failure may increase combustion/smoking (blue/white) and result in greater difficulty extinguishing, causing further damage to engine.

If FIRE light and/or other secondary indications:

5. Fire extinguisher pushbutton (affected engine) — Depress.

6. Egress.

RIO

1. Notify ground and/or tower.

2. Egress.

12.1.2 Abnormal Start

1. Throttle (affected engine) — OFF.

2. BACK UP IGNITION switch — Check OFF.

Note

- If hot start on deck, windmill engine until EGT is below 250 °C before attempting restart.

- If wet start, continue cranking until tailpipe is clear of fuel.

12.1.3 START VALVE Light After Engine Start

1. Ensure ENG CRANK switch — OFF.

2. AIR SOURCE pushbutton — OFF.

3. Throttle (affected engine) — OFF.

CAUTION

- If the starter valve does not close during engine acceleration to idle rpm, continued airflow through the air turbine starter could result in catastrophic failure of the starter turbine.

- If the START VALVE caution light illuminates after the ENG CRANK switch is off, or if the ENG CRANK switch does not automatically return to the off position, ensure that the ENG CRANK switch is off by 60-percent rpm and select AIR SOURCE to OFF to preclude starter overspeed.

12.1.4 Uncommanded Engine Acceleration on Deck. Uncommanded engine acceleration may or may not be associated with throttle movement. Uncommanded throttle(s) are characterized by increased or decreased throttle settings caused by failures of the throttle control system.

Uncommanded engine acceleration without throttle movement is a result of an AFTC or MEC failure normally associated with one engine. Selection of either L or R ENG select switch to SEC may restore throttle authority.

*1. Paddle switch — Depress and Hold.

*2. Throttle(s) — As Desired.

*3. ENG MODE SELECT — SEC.

Note

In SEC mode, nozzle is commanded fully closed.

*4. THROTTLE MODE switch — MAN.

If Engine(s) still uncommanded and aircraft is not in catapult tension:

5. Throttle(s) — OFF.

6. FUEL SHUT OFF handle(s) — Pull.

Note

- Approximately 50 pounds of force must be applied to the throttles to override the boost system to ensure disengagement of APC BIT self-test.
- The quickest and most reliable method to secure uncommanded throttles is to revert the throttle system to the manual mode and secure the throttle(s). Since manual is, by design, a backup mode, the throttle rigging may not be the same as the boost mode. It may take a hard snapping motion to position the throttle into OFF. If throttle(s) are misrigged in manual mode, the OFF position may not secure fuel flow to the engine.
- Both throttles cannot be secured simultaneously; however, reverting to manual mode will allow both throttles to be repositioned to IDLE simultaneously.

12.1.5 Ground Egress Without Parachute and Survival Kit. Methods and routes of ground egress will vary with the situation. In all cases, kneeling the aircraft (conditions permitting) via the nose strut switch will facilitate a safer exit for the aircrew. If sufficient time does not exist for ground personnel to deploy the boarding ladder, aircrew should egress to the rear of the aircraft, over the horizontal stabilizers or wings, or directly to the deck from the cockpit if the tail is over water. In the case of fire, the location and intensity of the fire will dictate the safest escape route. If electing to egress directly from the cockpit, aircrew should grasp the canopy rail with both hands, hang to full body extension, and drop to the ground. A parachute-landing fall maneuver may be required to minimize risk of injury. Spacing of pitot static probes along both sides of the forward fuselage will allow for an unobstructed egress.

WARNING

- Standing and jumping from the cockpit or attempting to slide down the nose of the aircraft during ground egress can result in severe injury.
- If the ENG/PROBE ANTI-ICE switch is in the ORIDE position, touching the pitot probes with bare skin will cause burns.

1. Kneel aircraft (if possible).

2. Canopy — OPEN or JETTISON

3. Parking brake — Pull.

4. Ejection seat — SAFE.
(Safe by raising the SAFE/ARMED handle)

5. All fittings (Restraint fittings and oxygen hose) — Release.

Note

To retain survival kit, do not release lapbelt restraint fittings.

12.1.6 Emergency Entrance. See Figure 12-1 for procedures for entering the cockpit for emergency rescue.

12.1.7 Weight-On-Off Wheels Switch Malfunction. There are WOW switches on the left and right main gear that interact with many aircraft subsystems to provide safety interlocks. The interlocks prevent operation of various components or systems on deck or in flight, as appropriate.

CAUTION

Failure of the left or right WOW switches to the in-flight mode can cause loss of engine ejector air to the IDGs and hydraulic heat exchangers causing thermal disconnect and/or heat damage to the generators and aircraft hydraulic systems.

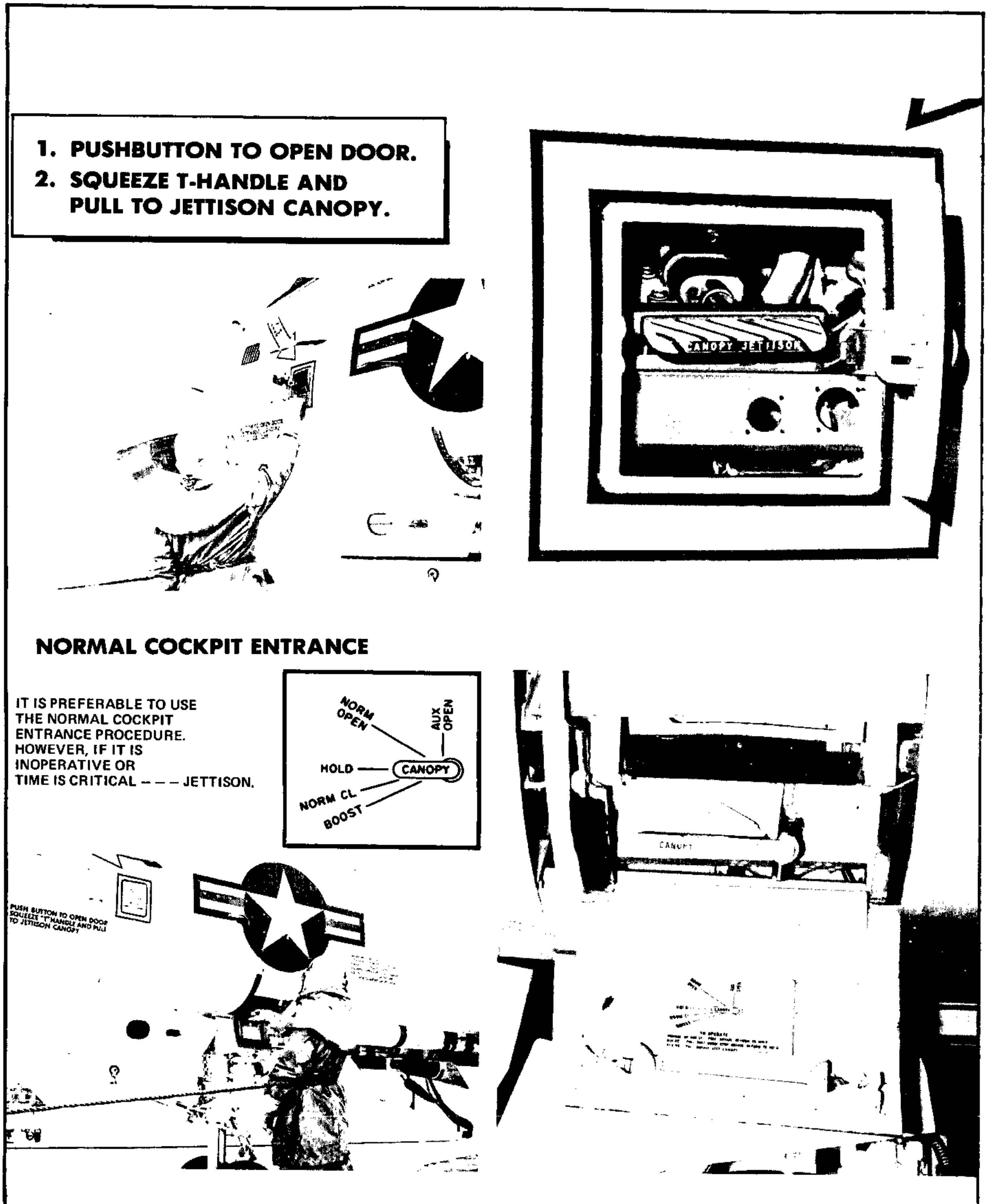

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Figure 12-1. Emergency Entrance

12.1.7.1 Failure Of Weight On-Off Wheels to In-flight Mode

INDICATIONS:

1. WOW acronym displayed.
2. Approach indexers illuminated.
3. Nozzles may be partially closed at idle rpm.
4. Nosewheel steering inoperative.
5. Launch bar light illuminated (if nosegear turned >10°).
6. Ground-roll braking inoperative.
7. Wing-sweep MASTER TEST disabled.
8. Oversweep disabled.
9. Outboard spoiler module on with FLAP handle UP (wings less than 62°).
10. Aircraft will not kneel.

If two or more of the preceding anomalies are detected, the following action should be taken:

PILOT

1. Clear runway (if applicable).
2. Generators — OFF.
3. Throttles — OFF (after downlocks are in place).

CAUTION

Failure of the left or right WOW switches to the in-flight mode can cause loss of engine ejector air to the IDGs and hydraulic heat exchangers causing thermal disconnect and/or heat damage to the generators and aircraft hydraulic systems.

RIO

1. RDR switch — OFF.

WARNING

With failure of the WOW switch to the in-flight mode, the following functions are enabled:

a. Radar can scan and radiate.

b. ALQ-165 can transmit.

c. Probe heaters will be on in AUTO.

d. ALQ-167 can radiate (TARPS).

e. BOL chaff can dispense.

12.1.8 Binding/Jammed Flight Controls On Deck

1. Hold light pressure against binding/restriction to facilitate maintenance troubleshooting procedures.

CAUTION

Do not attempt to free controls by force, as further damage to flight control system may result.

2. Abort mission.

12.1.9 Brake Failure at Taxi Speed

*1. ANTISKID SPOILER BK switch — SPOILER BK or OFF.

2*. NWS — Verify Engaged

3.* Parking brake — PULL (if required) (applying parking brake will lock both main wheels.)

WARNING

Complete loss of hydraulic fluid through the wheelbrake hydraulic lines will render the parking brake ineffective.

If brakes still inoperative:

4. Hook — DN.

CAUTION

After lowering the hook, NWS will automatically center and will remain centered until NWS is cycled.

5. Lights — ON.

6. Notify ground and/or tower.

7. Both throttles — OFF (If required).

If collision imminent, DO NOT delay step 7.

WARNING

During shipboard operations, aircrew should not delay ejection decision if aircraft departure from flight deck is imminent.

CHAPTER 13

Takeoff Emergencies

13.1 ABORTED TAKEOFF

Emergencies during takeoff are extremely critical and require fast analysis and quick decision by the pilot. The decision to abort should not be delayed just because emergency arresting gear is available at the end of the runway. Whether to abort or continue the takeoff depends on the length of runway remaining, refusal speed, best single-engine climb speed, and the arresting gear available. Failure of either engine, a fire warning light, or a blown tire during takeoff dictates an immediate abort if enough runway is available. The ejection seats will provide safe escape at ground level and low airspeeds. Therefore, if a safe aborted takeoff cannot be performed and takeoff is impossible, eject.

In an aborted takeoff, aerodynamic ground-roll braking is assisted by simultaneous deflection of all spoilers (flaps down) or inboard spoilers only (flaps up) to 55° when both throttles are retarded to IDLE.

Note

Moving flap handle down activates outboard spoilers to assist in aerodynamic ground-roll braking.

When securing the starboard engine, use caution to prevent inadvertent shutdown of both engines. If both engines are shut down, hydraulic pressure is lost, along with antiskid, nosewheel steering, spoiler braking, and normal braking. Full aft stick is used to augment aerodynamic braking. Care should be taken while positioning the stick aft to avoid any nose rotation. The aircraft's tendency to rotate is accentuated with the flaps up because of increased longitudinal control effectiveness, and aft stick must be applied at a slower rate to avoid rotation.

WARNING

Maximum braking effort in aborts initiated near rotation speed at takeoff gross weights may result in blown tires even with antiskid engaged.

CAUTION

Rolling over an arresting wire with brake pressure applied may result in blown tires.

If arresting gear is available, use it to avoid rolling off the runway. Always inform the control tower of your intention to abort the takeoff and engage the arresting gear, so that aircraft landing behind you can be waved off. Lower the hook in sufficient time for it to fully extend (normally 1,000 feet before engagement). Use nosewheel steering to maintain directional control and aim for the center of the runway. At night, use the taxi light to see the arresting gear. If off center just before engaging the arresting gear, do not turn the aircraft but continue straight ahead, parallel to the centerline.

If aborting with a blown nosewheel tire, it is likely that either or both engines have FOD. In the event of any blown tire during an aborted takeoff, the flaps should not be moved until they can be inspected for FOD.

Aircraft control following loss of an engine during the takeoff roll is a function of thrust setting and airspeed. In most cases, an aborted takeoff will be required. Refer to paragraph 11.8 for additional discussion of takeoff configuration, asymmetric thrust flight characteristics.

13.1.1 Aborted Takeoff Checklist

*1. Throttles — IDLE.

*2. Speedbrakes — EXT.

*3. Stick — AFT.

Note

The stick should be positioned fully aft at a rate that will not cause any nose rotation.

*4. Hook — DN (1,000 feet before wire)

*5. Brakes — As Required.

*5. Brakes — As Required.

*6. Right engine — OFF (if required).

Note

If performing no flap/maneuvering flap takeoff, lowering the flap handle slightly during an abort will deploy all spoilers for ground-roll braking if SPOILER BRAKE or BOTH is selected, assisting in decelerating the aircraft.

13.2 SINGLE-ENGINE FAILURE FIELD/ CATAPULT LAUNCH/WAVEOFF

Initial aircraft controllability is highly dependent on timely and proper rudder usage. Rudder is the primary control for countering yaw caused by asymmetric thrust since lateral stick inputs alone will induce adverse yaw in an already critical flight regime. Compounding the situation, visual cues for ascertaining yaw excursions may be absent at night. While roll caused by yaw will always be apparent, yaw excursions during night/IFR conditions may be first indicated by the turn and slip indicator and heading indicator if in near wings-level flight. The pilot should be prepared to apply up to and including full rudder at the first indication of an engine failure. Do not rotate aircraft below 130 knots in any configuration. Refer to NAVAIR 01-F14AAP-1.1, Chapter 26 for higher rotation speeds. Additional areas for consideration are discussed below.

13.2.1 Angle-of-Attack/Endspeed Consideration. Failure to limit AOA will place the aircraft in a regime to reduce directional stability, rudder control, and rate of climb. The aircraft may be uncontrollable at AOA above 20 units. Smoothly rotating to 10° pitch attitude on the waterline and approximately 14 units indicated AOA provides the best compromise between controllability, good initial flyaway attitude, and adequate single-engine performance. For compromise, normal 15-knot excess endspeed catapult launches (mandatory from catapult No. 4 and highly recommended from catapult No. 3) will place the aircraft in the approximate 14-unit AOA regime. Zero excess endspeed launches on hot days, where single- engine performance is marginal, will place the aircraft in the approximate 18- unit AOA regime and will require the pilot to precisely fly the aircraft away from the water, avoiding sudden pitch control inputs.

13.2.2 Rate of Climb Consideration. Rate of climb may be increased by selecting afterburner with ASYM LIMITER switch in ON. Only minimum AB is available. The most adverse drag condition is with the wings level on a constant heading, but techniques used by traditional multiengine aircraft (such as raising the dead engine with 5° angle of bank) are applicable for the F-14. Airspeed and angle of bank control will also greatly affect rate of climb (refer to NAVAIR 01-F14AAP-1.1 for all of these effects).

Under normal circumstances, 180 knots is used as the flaps up speed. However, if during a single-engine takeoff the aircraft has achieved a safe flying speed and a positive rate of climb but has difficulty achieving flap speed, moving the flaps up in increments prior to 180 knots will enhance acceleration and climb capabilities.

13.2.3 Stores Jettison Considerations. If an acceptable rate of climb cannot be maintained or deceleration cannot be countered by thrust alone, jettison should be selected. The benefits of an instantly lighter aircraft and lower drag configuration always produce positive effects on performance. Separation characteristics of the external tanks in this configuration, however, have never been verified by flight tests and consequently may result in stores-to-aircraft collision with unknown consequences. The use of ACM jettison, which will selectively bypass nonselected stores, could be utilized but does not offer the same gross weight reduction and requires the additional interlocks of gear handle plus ACM guard up.

13.2.4 Aircrew Coordination. Each launch must be made with the aircrew prepared for the worst case. Even when mentally prepared to handle this emergency, the F-14 crew faces a difficult task in executing a safe flyaway. Of paramount importance is a knowledgeable understanding by both pilot and RIO of what to expect when confronted with an engine failure during launch. Both must have already determined during a preflight briefing the points to be considered, that is, controllability, AOA/pitch attitude, engine, rate of climb, and jettison considerations. The pilot will probably be the only one to know if an engine fails during launch. The RIO will probably be the only one in a position to successfully initiate ejection prior to departing the ejection envelope.

13.2.5 Single-Engine Failure Field/Catapult Launch/Waveoff

*1. Set 10° pitch attitude on the waterline (14 units AOA maximum).

*2. Rudder — Opposite Roll/Yaw Supplemented By Lateral Stick

*3. Both throttles — As Required for Positive Rate of Climb

*4. Landing gear — UP.

*5. Jettison — If Required.

6. If banner tow, hook — DOWN.

7. If unable to control aircraft — Eject.

8. Establish 10-unit AOA climb.

9. Climb to safe altitude.

10. Flaps — UP.

11. Refer to Single-Engine Cruise Operations, Chapter 14.

13.3 BLOWN TIRE DURING TAKEOFF

If a tire blows during the takeoff roll and an abort is impossible, do not raise the landing gear or flaps. Leave the landing gear down to avoid fouling the blown tire in the wheelwell. Leave the flaps down; they may be damaged by pieces of ruptured tire. Also, climbing with the gear and flaps down is an optimum flight attitude for emergency fuel dumping.

13.3.1 Blown Tire During Takeoff; Takeoff Aborted or After Landing Touchdown

*1. Nosewheel steering — Engaged.

*2. ANTI SKID SPOILER BK switch — SPOILER BK.

CAUTION

- Do not delay engaging nosewheel steering in order to center rudder pedals.
- Aircraft should have ground locks installed and engines secured before moving aircraft.

Note

Antiskid will sense a constant release on a dragging blown tire.

13.3.2 Blown Tire During Takeoff; Takeoff Continued or After Landing Go-Around

*1. Throttles — As Required.

*2. Landing gear and flaps — Leave As Set for Takeoff.

CAUTION

Blown tire(s) can cause engine FOD and/or structural damage.

3. HYD ISOL switch — FLT.

Note

This will require bending the cam on the gear handle in order to move the HYD ISOL switch to FLT.

4. Refer to BLOWN TIRE LANDING procedures paragraph 15.5.

CHAPTER 14

In-Flight Emergencies

14.1 COMMUNICATIONS FAILURE

1. Check mikes and earphone plugs.

2. Check oxygen mask connections and oxygen hose disconnect.

3. RIO check console connector adjacent to shoulder harness control lever. Pilot check console connector aft of g valve.

4. Increase ICS volume and attempt B/U and EMERG positions.

5. Attempt intercommunications with VHF/UHF transceiver.

6. If cockpit altitude is safe, oxygen mask can be removed so that when helmet earmuff is held open, verbal communications can be maintained.

14.1.1 Flightcrew Attention Signals. When no other method of communicating exists, the following signals should be used:

1. Pilot will attract RIO by rocking of wings.

2. RIO will attract pilot by shouting ".... #,@,&,!"

3. Acknowledgment will be thumbs-up, high on left-hand side of cockpit, and future communications will be conducted by visual hand signals using HEFOE code.

14.1.2 COMM-NAV Emergency Procedures

14.1.2.1 Lost (Without Navigation Aids or Radio Receiver)

1. Pilot select running lights on FLASH.

2. RIO squawk mode 3 Code 7600.

3. Attempt home base location by radar mapping or DR to best known position. Attempt marshal pattern location by APX-76 interrogation.

4. Drop four bundles of chaff at 2-mile intervals, then complete series of four standard left-hand 360° turns at 20-second intervals.

5. If no chaff, fly minimum of two triangular patterns to left with 1-minute legs.

6. Repeat patterns at 20-minute intervals.

7. Conserve fuel throughout and facilitate radar pickup by maintaining highest feasible altitude consistent with situation.

8. Be alert for aircraft attempting to join.

9. After joining, communicate with appropriate hand or light signals.

14.1.2.2 Lost (Without Navigation Aids But With Radio Receiver)

1. Same as without radio, but make turns to right.

14.1.2.3 No Radio (With Navigation Aids)

1. Proceed to alternate marshal.

2. Energize ID function at least once each minute.

3. Commence penetration or letdown at EAC. If not given EAC, commence approach at estimated time of arrival.

4. Be alert for aircraft vectored to join.

14.2 PITOT-STATIC SYSTEM FAILURES

If the altimeter and Mach airspeed indicators are erroneous, pitot pressure, static pressure, and total temperature inputs to the central air data computer may also be inaccurate. Placing the ANTI-ICE switch in ORIDE/ON or AUTO/OFF may restore operation if the malfunction was caused by icing.

Note

- Pitot-static system failures because of icing may input an erroneous Mach number to the AICS programmer, which will result in the ramps being in the wrong position for the actual Mach number (engine stall may result). If this erroneous Mach number is outside 0.3 to 0.9 band, the AICS anti-ice positioning feature will be overridden.

- With known or suspected pitot-static malfunctions, do not exceed 0.9 TMN.

If it is apparent that icing is not the problem, use the AOA indicator in place of airspeed for flight conditions as shown in Figure 14-1. Descend to an altitude below 23,000 feet. When cabin altitude stabilizes at 8,000 feet, aircraft altitude will be approximately 23,000 feet. Below 23,000 feet, aircraft altitude can be determined by dumping cabin pressure and using the cabin altitude indicator above 5,000 feet. Below 5,000 feet, use the radar altimeter.

Reduce airspeed and set wing sweep to 20° using the emergency wing-sweep mode. The landing should be without the autothrottle engaged. If the mission computer computations are affected, the RIO can manually enter estimated wind direction and velocity through the computer address panel or the DEU.

14.3 EMERGENCY JETTISON

All stores including external fuel tanks (stations 2 and 7), but excluding Sidewinder missiles (AIM-9), are jettisoned in a fixed interval between sequenced stations to avoid store-to-aircraft collision. See Figure 14-2 for external stores jettison table.

WARNING

- With landing flaps and slats down, do not fire Sidewinder missiles.

- If jettisoned during takeoff emergency, external fuel tanks may collide with the aircraft because of their unstable characteristics.

1. EMERG STORES JETT pushbutton — Depress.

FLIGHT CONDITION		ANGLE-OF-ATTACK UNITS
CATAPULT (15 KNOTS EXCESS)		
Transition From Catapult	MRT	14.0
	AB	13.0
MILITARY POWER CLIMB		
All Drag Index	Sea Level	6.0
	Combat Ceiling	9.5
MAXIMUM POWER CLIMB		
All Drag Indexes	Sea Level	5.0
	Combat Ceiling	8.0
CRUISE AT ALTITUDES BELOW 20,000 FEET (All Gross Weights)		
Drag Index = 8		8.0
Drag Index = 100		9.0
CRUISE AT OPTIMUM ALTITUDE		
All Drag Index		8.0
MAXIMUM ENDURANCE		
All Drag Indexes, All Altitudes		10.0
IDLE DESCENT		
250 KCAS		9.0
Maximum Range		10.0
GEAR AND FLAPS EXTENSION		
Safe Gear Extension (Flaps UP) at 280 KIAS		6.5
Safe Flap Extension (Gear DN) at 225 KIAS		9.0
APPROACH		
CCA/GCA Pattern; 220 KCAS; Gear UP; Flaps UP; 54,000 pounds.		9.0
Final ON SPEED Approach (Gear DN): Two Engines (All Flap Configurations)		15.0
Single Engine/PRI:		
FULL FLAP, DLC ENGAGED		15.0
FULL FLAP, DLC STOWED		14.0
NO FLAP		14.0
Single Engine/SEC:		
FULL FLAP (CV ONLY)		13.0
NO FLAP (FIELD ONLY)		15.0

DRAG INDEX	CONFIGURATION
8	(4) AIM−7
100	(6) AIM−54
	(2) 267−gallon external tanks

Figure 14-1. Airspeed Indicator Failure

JETTISON MODE	TYPE OF STORES					REMARKS
	EXTERNAL TANKS	PHOENIX	SPARROW	SIDE-WINDER	AIR TO GROUND	
EMERGENCY (PILOT)	✓	✓	✓	—	✓	(*) VERIFY ON DURING LTS CHECK PRESTART - PILOT ①
ACM (PILOT)	✓	✓	✓	—	✓	(*) SEQUENCE JETTISON SELECTED STATIONS ② ④ ⑤
SELECTIVE (RIO)	✓	✓	✓	—	✓	② ③ ⑤

NOTE

- FUZING SAFED IN ALL JETTISON MODES. (DOES NOT PRECLUDE INADVERTENT ARMING OF MECHANICAL FUZES.)
- SIDEWINDER CANNOT BE JETTISONED.

INTERLOCKS

1. WEIGHT OFF WHEELS (EITHER RIGHT OR LEFT MAIN GEAR)
2. LANDING GEAR HANDLE UP
3. MASTER ARM SWITCH ON
4. ACM COVER UP
5. STATION SELECT

(*) JETTISON SEQUENCE

STATIONS 1B, 8B, 2, 7, -4D, -5D, -4A, -5A, -4C, -5C, 4B, -5B, -3D, -6D, -3A, -6A, -3C, -6C, -3B, -6B

NOTE

- THE TIME INTERVAL BETWEEN STATIONS INDICATED BY (-) IS 100 MS.
- SUBSTATIONS A, B, C, AND D OF RAIL ARE NUMBERED CLOCKWISE, LOOKING DOWN AT RAIL WITH A THE LEFT REAR STATION ON EACH RAIL.
- STATIONS 1B, 8B, 2, AND 7 ARE JETTISONED SIMULTANEOUSLY.

Figure 14-2. External Stores Jettison

Note

- The EMERG STORE JETT function is disabled with weight on wheels.
- The EMERG STORES JETT and ACK lights illuminate when emergency jettison is activated.
- A weight-off-wheels signal from the left or right main wheel is sufficient to enable emergency jettison.
- A complete emergency store jettison sequence can take 1.7 seconds.

If step 1 fails, proceed with ACM jettison.

ACM jettison will release all stores selected except Sidewinder missiles.

1. LDG GEAR handle — UP.
2. DEU STA SEL — As Required.
3. ACM guard — UP (cover up).
4. ACM JETT — Depress and Hold (at least 2 seconds).

Note

- ACM jettison follows the same sequence as emergency jettisoning but requires individual selection of stations to be released. Station not selected is skipped.
- When jettisoning bombs from stations 3, 4, 5, and 6, the interval between sequenced stations is automatically designated at 100 milliseconds to avoid store-to-store and store-to-aircraft collision.

14.4 FIRE LIGHT AND/OR FIRE IN FLIGHT

Fire may be accompanied by other indications such as explosion, vibration, smoke, or fumes in the cockpit, trailing smoke, or abnormal engine instrument indications.

A fire in flight precipitated by a failure in the engine can be catastrophic in an extremely short period of time. The shrapnel generated by the engine can rupture fuel and/or hydraulic lines, resulting in a raging fire. The sequence of events for the failure could include all or some of the following:

1. A low-amplitude vibration and noise.
2. Intermittent bursts of white sparks in the vicinity of the aft edge of the overwing fairing.
3. Sparks turning to flames.
4. Continuous yellow sparks in an area of increasing size.
5. Flames and/or smoke spreading forward to wing pivot point and encompassing the area of the overwing fairing.
6. Flames, smoke, and/or heat crossing the centerline of aircraft and exiting in the other overwing fairing area.

These indications may or may not be accompanied by a FIRE light and a HUD/MFD legend. This midship passage of heat and flames could be through the area containing the flight control system control rods, which run fore and aft through the back of the aircraft. Heat and flames progressing through this area would impinge on the longitudinal and lateral control rods causing possible distortion or failure. Loss of aircraft may follow. The flightcrew faced with this type of fire in flight must react immediately.

Note

If the FIRE warning light is off and a HUD/MFD legend is displayed, verify FIRE DET TEST checks 4.0. Assume message was incorrect and keep engine on line. The legend is a repeat of a discrete from the fire detection system.

*1. Throttle (affected engine) — IDLE.

*2. AIR SOURCE pushbutton — OFF.

*3. OBOGS master switch — BACKUP.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-80 for oxygen breathing time remaining.

Note

When ECS service air to the OBOGS concentrator is shut off, the aircrew has approximately 30 seconds before depleting residual OBOGS pressure and mask collapse.

Note

Restoration of service air (selecting RAM) will return OBOGS to operation.

If light goes off (and no other secondary indications):

Note

Fire detection test is not available on the emergency generator.

*4. MASTER TEST switch — FIRE DET TEST

If light remains illuminated, FIRE DET test fails, or other secondary indications:

*5. FUEL SHUT OFF handle (affected engine) — Pull.

*6. Throttle (affected engine) — OFF.

*7. Climb and decelerate.

*8. Fire extinguisher pushbutton — Depress.

Note

Ensure BACK UP IGNITION switch is OFF.

9. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.

10. Land as soon as possible.

11. If fire persists — Eject.

14.5 ENGINE EMERGENCIES

14.5.1 Compressor Stall. A compressor stall is an aerodynamic disruption of the airflow through the compressor. Compressor stalls may occur at any altitude/airspeed combination, including supersonic, and can be identified by any one or a combination of the following indications.

Note

The loss of Mach number signal from the CADC results in the loss of both airflow limiting and idle lockup functions of the AFTC. This may result in pop stalls at supersonic speeds (on a cold day) at high power and inlet buzz, resulting in pop stalls at idle power.

a. Loud bangs or vibrations

b. Rapid yaw or nose slice

c. Increasing EGT

d. Rpm rollback and/or thrust loss

e. Lack of throttle response

f. Inlet buzz (supersonic only)

g. Fireball emanating from the exhaust and/or intake.

*1. Unload aircraft (0.5g to 1.0g).

If greater than 1.1 Mach:

*2. Both throttles — MIL

When 1.1 Mach or less:

*3. Both throttles — Smoothly to IDLE.

Note

If above 1.1 Mach, monitor minimum rpm to ensure proper functioning of idle lockup to avoid inducing a stall.

If EGT is above 935 °C and/or engine response is abnormal:

*4. Throttle (stalled engine) — OFF.

If EGT normal and/or airstart successful:

5. Perform engine operability check.

Note

After any stall, throttle movement should be minimized until engine operability checks are performed. Engines should be exercised at 10,000 feet in cruise and then at approach speeds, one at a time, to ensure stall-free performance is available for landing. If engine performance is abnormal, set power as necessary and avoid further throttle movement. Land as soon as practical.

Flight test operations have not produced any fully developed engine stalls. Pop stalls have been observed and were self-clearing with no adverse operational impact. Engine ground testing has shown that a hard stall (characterized by loud bang) can result in substantial damage to the IGV system. The damage resulted in complete detachment of the IGV from the external linkage. There was no FOD.

When the IGV linkage breaks, the IGVs assume a fixed aerodynamic trailing position. This position is near normal for MIL or AB power settings, but is too far open at lower throttle positions. This reduces fan stall margin with the greatest reduction halfway between IDLE and MIL. Airborne, a hard stall may result in similar damage and will likely have been the result of an AICS malfunction and/or fuels/engine control system failure. If a stall occurs during AB operation, the asymmetric thrust limiting circuit should reduce the good engine to minimum AB. Asymmetric thrust may produce adverse flying qualities under low airspeed and/or high AOA conditions.

WARNING

Do not delay securing an overtemped engine. Undue delay will greatly increase the likelihood of severe turbine damage and decrease the chance for a successful airstart. If both engines are overtemped, one engine must be secured immediately to provide maximum potential for a successful airstart.

Note

Airspeed and altitude will determine whether both engines can be safely shut down (with dual compressor stalls), or whether one should be secured and relit prior to shutting down the other. If airspeed is insufficient to provide windmill rpm for hydraulic pressure, one engine should be left in hung stall.

There is a threefold danger present when one engine has experienced a compressor stall. The most serious danger manifests itself at slow airspeeds and high power settings, where the sudden thrust asymmetry (a stalled engine yields negligible thrust) will induce or aggravate a departure and may produce sufficient yaw rate to cause a flat spin if proper recovery controls are not used.

The other two dangers from a compressor stall are that the stalled engine may suffer overtemperature damage and that the good engine might also stall. Although the emergency procedures are designed to address all three dangers, the pilot must understand that aircraft controllability takes priority over engine considerations and involves both throttle position and flight controls. Reference to the engine instruments will probably be required to determine the stalled engine. If the aircraft has departed controlled flight, this should not be attempted until the pilot has ensured that thrust asymmetry has been minimized and that yaw rate and AOA are under control. The rationale for each individual step in the emergency procedure is as follows:

Step 1: Unload the aircraft (0.5g to 1.0g) — Unloading the aircraft reduces the likelihood of a departure, while providing a more normal engine inlet airflow. It is not intended that the pilot push full forward stick or induce negative g, but merely that any g load on the aircraft be reduced to as near 1.0g as possible. In the nose-high, slow-airspeed case, the pilot may temporarily lose control effectiveness. This should not be cause for alarm and the pilot should be able to expeditiously establish a wings-level, nose-low attitude as long as step 2 is followed immediately.

Step 2: If speed is 1.1 Mach or greater, both throttles — MIL. Setting the throttles to MIL will both help reduce the asymmetric thrust developed during the stall and potentially help the engine recover from the stall. It is not recommended to retard the throttle to below MIL until the aircraft is below 1.1 Mach. The engine may automatically switch to SEC mode, and a throttle setting below MIL may result in inlet buzz (idle speed lockup is lost in SEC mode) compounding the stall problem and potentially inducing a stall in the operating engine.

Step 3: Throttle(s) — If speed is 1.1 Mach or less, retard smoothly to IDLE. During a departure, retarding both throttles to IDLE will help recover the aircraft by minimizing the asymmetric thrust. In the case of a violent slicing departure involving asymmetric thrust, reduction of throttles to IDLE is the most critical step and must be done immediately. If control of the aircraft is not in question, there is no need to retard the throttle on the operating engine. Retarding only the stalled engine throttle reduces the remote probability of inducing a dual-engine stall. In addition, thrust from the operating engine may be required during low-altitude emergencies. Minimizing asymmetric thrust at high AOA and low airspeed shall be accomplished whenever possible. Obviously, there are situations (landing pattern, catapult launch, low altitude, and airspeed) where idle power is unacceptable, and emergency procedures must be tempered by pilot judgment.

Step 4: Stalled engine, throttle off — When an engine stalls, the combustor flame does not extinguish. Airflow through the engine and cooling flow to the turbine blades are severely reduced, and the turbine blades may suffer overtemperature damage. Securing the stalled engine to OFF extinguishes the combustor flame, thereby reducing the turbine blade temperature.

14.5.1.1 Supersonic Airspeed. Supersonic compressor stalls will produce inlet buzz. This results in a rough, bumpy ride (+2.5g to -1g at six cycles per second). The proper technique to recover from a supersonic compressor stall is to smoothly retard throttles to MIL, keep feet on the deck, and control any wing-drop tendencies with lateral stick.

14.5.1.2 Dual Compressor Stall

WARNING

- During recovery from a dual-engine compressor stall (with both engine-driven generators having dropped offline), flight control inputs may temporarily reduce the combined hydraulic system pressure. If combined hydraulic system pressure drops to between 2,000 and 1,100 psi, the emergency generator will automatically shift to the 1-kVA mode and power only the essential No. 1 buses. If the combined hydraulic pressure continues to fall, the essential No. 1 buses will drop offline, resulting in a total electrical failure.
- Complete loss of electrical power will result in loss of ICS, OBOGS, backup oxygen (below 10,000 feet MSL), engine instruments, spin direction indicators (spin arrow and turn needle), and displays.
- If combined hydraulic system pressure recovers, the emergency generator should automatically reestablish 1-kVA power to the essential No. 1 buses. The emergency generator switch must be cycled through OFF/RESET to NORM to regain the 5-kVA mode to the essential No. 2 buses.
- Engine instruments are powered by the essential No. 1 bus but may not be automatically restored with the 1-kVA mode. It may be necessary to cycle the emergency generator switch through OFF/RESET to NORM to regain lost engine instruments.

If both engines are stalled after retarding throttles to IDLE, at least one engine must be immediately secured to prevent turbine damage and provide maximum potential for an airstart. If possible, secure the engine that did not initiate the event (the second engine to stall). The cause of the first engine stall may not be known at this point; however, it is possible that the second stall may have been induced during the throttle transient to IDLE. Leaving one engine in hung stall minimizes the likelihood of total loss of hydraulic and electrical power (emergency generator).

WARNING

Leaving one engine in hung stall may catastrophically damage the turbine. It is, therefore, imperative that the pilot expeditiously secure and relight one engine to prevent turbine damage. Attention should be given to the remaining stalled engine as soon as possible.

14.5.2 Airstarts. The most likely reasons to perform an airstart are that the engine has shut down because of control system failure, hardware failure, fuel feed failure, FOD, or engine stall. The augmenter fan temperature control contains diagnostic logic to identify primary (PRI) engine mode failures and automatically transfers to secondary (SEC) mode when required. If the shutdown was not pilot commanded, the engine may switch to SEC mode automatically. The first airstart attempt should be made in the engine mode selected by the AFTC (either PRI or SEC). If an initial PRI mode airstart is unsuccessful, the ENG MODE SELECT switch should be in SEC for any subsequent airstart attempts.

If an engine flames out, the automatic relight feature will attempt to restart the engine immediately; however, if rpm is decaying below the throttle-commanded level, spooldown airstart procedures should be initiated immediately. If engine flames out because of an automatic shutdown caused by an overspeed greater than 110 percent, there will be no automatic relight. To regain fuel flow, the throttle must be cycled to OFF then to IDLE.

Note

An overspeed condition in excess of 110 percent will result in momentary loss of rpm indication until N_2 rpm falls below 110 ±.5 percent. EGT and FF indicators will continue to function normally.

There are three airstart phases: spooldown, crossbleed, and windmill. Spooldown is the first phase and provides the best opportunity for a rapid start. Windmill is the last phase and is available only in very high-energy conditions.

Spooldown airstarts should be initiated immediately when it is apparent that an engine has lost thrust and that rpm will decay below the throttle-commanded level.

High rpm, high airspeed, and low altitude increase the likelihood of a successful spooldown start. See Figure 14-3. The best conditions for both PRI and SEC mode spooldown starts are below 30,000 feet, above 300 knots, and with rpm greater than 30 percent. Spooldown airstarts that light-off with rpm as low as 30 percent can take up to 90 seconds to accelerate to idle and 20 seconds when initiated at 50 percent or greater.

When initiating a spooldown airstart to clear a stall, cycle the throttle OFF then to IDLE with the engine in either PRI or SEC mode. EGT and rpm indications should rapidly decrease when the throttle is OFF confirming throttle position. If OFF is selected to clear an engine stall, the throttle should remain in OFF for a few seconds until the stall clears. Typically, airstarts are characterized by a rapid light-off and initial EGT rise with a slow initial increase in rpm. In the low-rpm range, it may take up to 10 seconds to observe an apparent increase in rpm. The rpm display should be flashing if the rpm is increasing.

Hung starts are characterized by the rpm stagnating below idle. The current engine indicating system (EIG) will stop flashing if the next higher segment is not reached within 10 seconds. A low-range (less than 45 percent) hung start can be overcome with the assistance of crossbleed air. A midrange hung start at subidle rpm (50 to 60 percent) can be corrected by cycling the throttle OFF then to IDLE. Above 45 percent, the starter will not engage. At the completion of the start sequence the engine corresponds to actual throttle position.

14.5.2.1 Dual-Engine Airstart (Or Airstart of One Engine With the Other Engine Secured). Dual-engine redundancy and automatic relight makes this situation extremely unlikely. Dual engine windmill airstart procedures after unsuccessful automatic and manual spooldown airstart attempts should be considered tertiary and performed with serious consideration given to airspeed altitude and safe ejection limitations. Flight test data indicate nominal windmill airstart airspeed requirements to be in the vicinity of 450 knots. Depending on airspeed and altitude available at windmill aircraft profile commencement, a dive angle of up to 45° may be required to achieve nominal airstart airspeeds.

WARNING

Dive angle should not exceed 45°. At 7,500 feet AGL and less than 450 knots, commence a smooth, 2g pull converting airspeed to altitude and eject when less than 350 knots.

Once established at 450 knots, approximately 20° nose down is required to maintain constant airspeed. While attempting airstarts, flight control authority is critical. As rpm decreases, sufficient hydraulic pressure for smooth flight control inputs should be available with one engine windmilling above 18 percent or two engines windmilling above 11 percent. At 450 knots, 15° dive, a 2g pullup should be initiated at 2,000 feet. Once the windmill airstart is considered to be unsuccessful, the aircraft shall be decelerated to less than 350 knots and ejection performed before controllability is lost.

CAUTION

- When advancing both throttles from OFF, cycle the right throttle first to a position above IDLE, to avoid the throttle quadrant locking pin feature.
- Main generators drop off at 55-percent rpm. The emergency generator will drop off at 11- to 12-percent rpm. Engine ignition will not be available below 10 percent.
- Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-81 for oxygen breathing time remaining.

Note

- When ECS service air to the OBOGS concentrator is shut off, the aircrew has approximately 30 seconds before residual OBOGS pressure and mask collapse.
- Airstart can be performed on both engines simultaneously.

14.5.2.2 Engine Flameout

*1. Throttle — IDLE or Above (affected engine).

*2. BACK UP IGNITION switch — ON.

Note

Spooldown airstarts can take up to 90 seconds to reach idle rpm if light-off occurs at low rpm, low airspeed, and high altitude.

If hung start or no start:

*3. Throttle (affected engine) — Cycle OFF, Then IDLE.

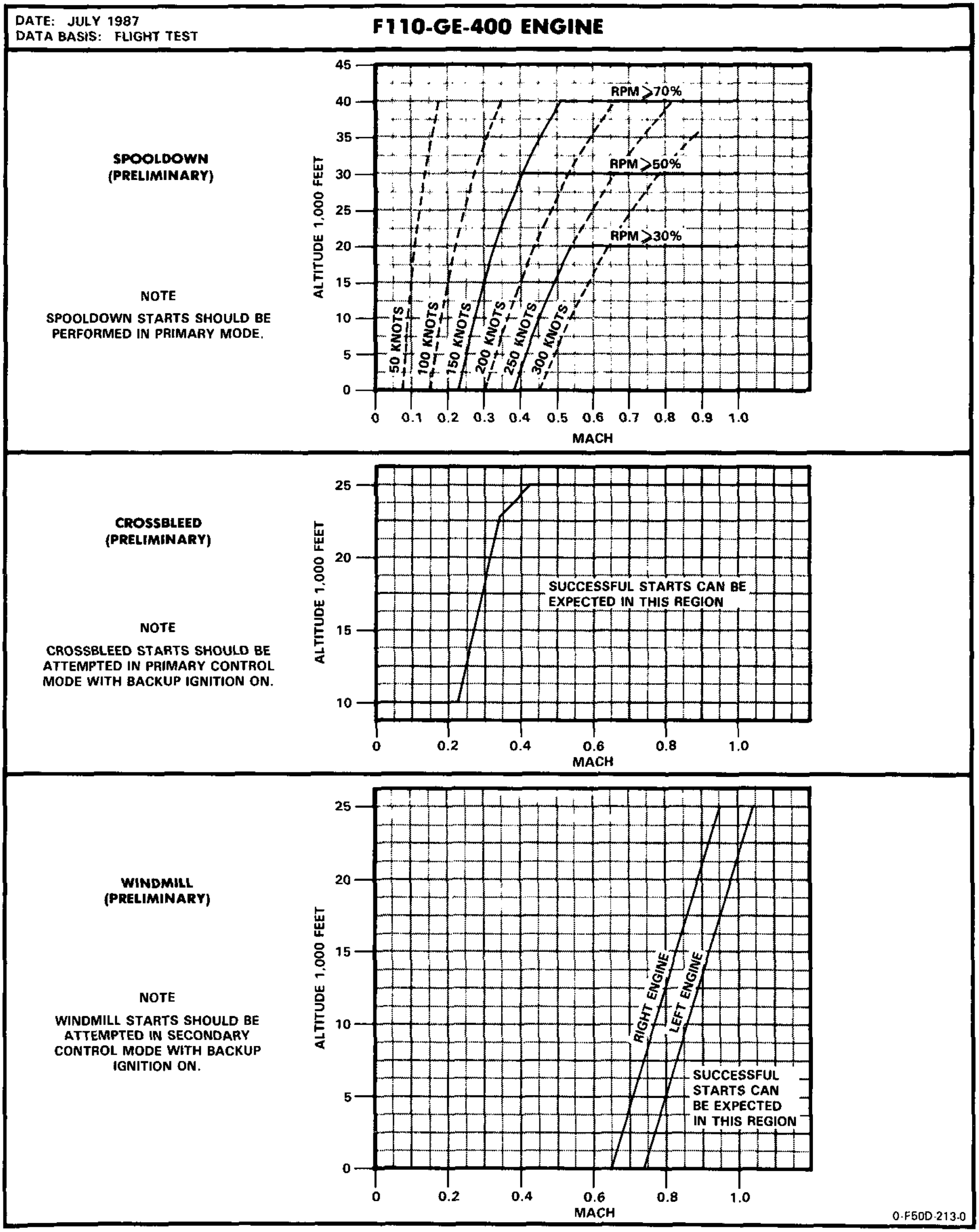


Figure 14-3. Airstart Envelope

If still hung or no start:

*4. ENG MODE SELECT — SEC.

If one engine is operable, perform a crossbleed airstart, paragraph 14.5.2.3.

If both engines flamed out/inoperative or crossbleed not possible:

WARNING

- A dual-engine compressor stall may result in a total electrical failure, rendering the ICS, OBOGS, backup oxygen (below 10,000 feet MSL), engine instruments, spin direction indicators (spin arrow and turn needle), and displays inoperative.
- If sufficient hydraulic pressure restores the 1-kVA mode of the emergency generator, it may be necessary to cycle the emergency generator switch through OFF/RESET to NORM to regain lost engine instruments.
- Ejection above 350 knots is hazardous; the decision to exceed 350 knots rests with the aircrew.
- Sufficient hydraulic pressure for smooth flight control inputs should be available with one engine windmilling at 18-percent rpm or two engines at 11 percent.
- Dive angles should not exceed 45°. At 7,500 feet AGL minimum, commence a smooth 2g pullup to a 20° dive, maximum. At 2,000 feet AGL minimum, pull up to level flight. If the airstart is unsuccessful, convert airspeed to altitude and eject at 350 knots or less before controllability is lost.

*5. Airspeed — 450 Knots (altitude permitting).

6. OBOGS master switch — BACKUP.

When start is completed:

7. BACK UP IGNITION switch — OFF.

8. ENG MODE SELECT — PRI.

9. OBOGS master switch — ON.

CAUTION

Ensure ECS service air is available to OBOGS prior to selecting the OBOGS master switch ON.

When primary mode is restored:

10. Maintain constant subsonic Mach in level flight.

11. Affected L or R AICS cb — Cycle (LF1, left or LG1, right).

WARNING

If WING SWEEP advisory light is illuminated, cycling L AICS circuit breaker (LF1) may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) cb's are pulled.

14.5.2.3 Crossbleed Airstart

1. Throttle (bad engine) — OFF.
2. FUEL SHUT OFF handle — Check In.
3. Throttle (good engine) — 80-Percent Rpm (minimum).
4. BACK UP IGNITION switch — ON.
5. ENG MODE SELECT — PRI.
6. ENG CRANK switch (bad engine) — ON.
7. Throttle (bad engine) — IDLE Immediately.

Note

Quickest light-offs are achieved with throttle to IDLE at less than 10-percent rpm.

If hung start:

8. Throttle (bad engine) — OFF Then IDLE.

If still hung:

9. ENG MODE SELECT — SEC.

When start is completed:

10. BACK UP IGNITION switch — OFF.

11. ENG MODE SELECT — PRI.

When primary mode is restored:

12. Maintain constant subsonic Mach in level flight.

13. Affected L or R AICS cb — Cycle (LF1, left or LG1, right).

WARNING

If WING SWEEP advisory light is illuminated, cycling L AICS circuit breaker (LF1) may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) cb's are pulled.

14.5.3 Single-Engine Flight Characteristics. Single-engine flight characteristics are dependent on gross weight, configuration, angle of attack, wing sweep, and maneuvering requirements. In the cruise configuration, with one engine operating at military/high power settings, rudder deflection and/or trim is required to prevent yaw toward the failed engine. However, single-engine performance capabilities can be significantly restricted by adverse flying qualities in approach power configuration, particularly at high gross weights in turning flight because of the effects of thrust asymmetry at normal approach speed. This degrades with turns into the failed engine such that rudder requirements to maintain level flight can exceed available rudder control. Flight in this configuration should be planned to avoid turns into the failed engine with bank angles limited to 20° maximum and AOA limited to 12 units. The aircraft design is such that no one system (flight control, pneumatic, electrical, etc.) depends on a specific engine. Therefore, loss of an engine does not result in loss of any complete system as long as the HYD TRANSFER PUMP is operative. Refer to NAVAIR 01-F14AAP-1.1 for single-engine performance data.

14.5.3.1 Single-Engine Failure During Flight. It is uncommon to encounter compressor stalls that require immediate engine shutdown. Occasionally, mechanical failure of F110 engine components results in engine failure. These failures may be obvious as when accompanied by severe engine vibration or may be subtle as indicated by a lack of engine response to throttle changes. Turbine failure for example, may appear only as an apparent loss of thrust and/or the inability to obtain a successful airstart. For confirmed mechanical failures, the engine should be secured and the FUEL SHUT OFF handle pulled.

WARNING

If an engine fails or a mechanical malfunction has been determined, the respective FUEL SHUT OFF handle shall be pulled immediately after engine shutdown to reduce the possibility of fire or fuel migration.

Note

ECS service air pressure may be inadequate for OBOGS when operating on a single engine at idle. Increasing the throttle position for the operating engine above IDLE will increase pressure. This will also close the nozzle, increasing descent range.

14.5.3.2 Single-Engine Cruise Operations

1. FUEL SHUT OFF handle — Pull (inoperative engine).

2. If on final approach or landing, refer to single engine landing procedures, paragraphs 15.2 and 15.3.

When either fuselage tape reaches 4,500 pounds of fuel or less:

3. WING/EXT TRANS switch — OFF.

WARNING

The WING/EXT TRANS switch automatically returns to AUTO if the REFUEL PROBE switch is placed to ALL EXTEND, DUMP is selected, or there is 2,000 pounds remaining in the low side. The WING/EXT TRANS switch can be reselected to OFF after a 5-second delay, the REFUEL PROBE is retracted, or DUMP is secured.

4. FEED switch — Operating Engine Side.

When pilot workload permits close monitoring of fuel distribution:

5. FEED switch — Inoperative Engine Side.

If the fuselage quantity on the inoperative engine side begins to increase:

6. FEED switch — Immediately Move to Operating Engine Side.

CAUTION

An increase in fuel quantity on the inoperative engine side indicates that the sump tank interconnect valve is not open. Fuel available is limited to the quantity on the operating engine side.

If the fuselage fuel quantity on the inoperative engine side begins to decrease:

6. FEED switch — Remain On Inoperative Engine.

7. WING/EXT TRANSFER switch — AUTO.

8. Refer to appropriate hydraulic system failure.

14.5.4 Engine Overspeed (N_1 or N_2 OSP Legend)

1. Throttle (affected engine) — IDLE.

If overspeed continues:

2. ENG MODE SELECT — SEC. Verify ENG SEC light illuminated.

If overspeed condition persists:

3. Throttle (affected engine) — OFF.

Note

- Fuel flow is automatically secured when rpm reaches 110 percent. To regain fuel flow, the throttle must be cycled OFF then to IDLE.

- An overspeed condition in excess of 110 percent will result in temporary loss of rpm indication until N_2 falls below 110 ±.5 percent. EGT and FF indicators will continue to function normally.

4. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.

5. Land as soon as practicable.

14.5.5 Engine START VALVE Light

1. Ensure ENG CRANK switch — OFF.

2. AIR SOURCE pushbutton — OFF.

Note

If operational necessity dictates, AIR SOURCE L ENG or R ENG may be selected provided the START VALVE light remains out. Crossbleed airstarts may not be available to the affected engine after a START VALVE light illuminates, because of possible overspeed damage.

If on deck:

3. Throttle (affected engine) — OFF.

If airborne:

3. ENG START cb — Pull (RF1).

4. OBOGS master switch — BACKUP.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-81 for oxygen breathing time remaining.

Note

- When ECS service air to the OBOGS concentrator is shut off, the aircrew has approximately 30 seconds before depleting residual OBOGS pressure and mask collapse.

- Restoration of service air (selecting RAM) will return OBOGS to operation.

14.5.6 Engine Transfer to SEC Mode

CAUTION

In SEC mode, idle lockup protection is lost. Decelerate below 1.1 TMN before retarding throttle to IDLE to avoid supersonic inlet buzz and possible compressor stall.

Note

- Engine ac generator failure, indicated by loss of rpm and nozzle gauge indications, will shift the engine into SEC mode without illuminating the SEC light. Main high-energy ignition will be inoperative. Backup ignition is required for airstarts.
- SEC mode transfer while in AB may result in pop stalls. Nonemergency manual selection of SEC mode airborne should be performed in basic engine with the power set above 85-percent rpm.

If engine transfers to SEC mode:

1. Throttle (affected engine) — Less Than MIL.
2. ENG MODE SELECT — Cycle.

If PRI mode is restored:

3. Maintain constant subsonic airspeed in level flight.

WARNING

If WING SWEEP advisory light is illuminated, cycling L AICS circuit breaker (LF1) may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) cb's are pulled.

4. Affected L or R AICS cb — Cycle (LF1, left or LG1, right).

If engine remains in SEC:

3. ENG MODE SELECT — SEC.
4. Avoid abrupt throttle movements.
5. Land as soon as practicable.

CAUTION

Landing in SEC mode may increase landing roll because of loss of nozzle reset. If runway length or braking conditions warrant, make an arrested landing.

14.5.6.1 Transfer to SEC Mode Results

1. SEC mode transfer from AB may result in pop stalls.
2. Nozzle fully closed (higher taxi thrust).
3. Stall warning is inoperative (engine overtemp warning still available).
4. No nozzle position indication.
5. No AB capability.
6. Decrease stall margin at low rpm.
7. 65 to 116 percent basic engine thrust available (see Figure 14-4).
8. Main engine ignition continuously energized.
9. No idle lockup protection.
10. IGV fixed full open (lower windmill airspeed).
11. RATS inoperative.

14.5.7 Uncommanded SEC Mode Rpm Decay

WARNING

Engine will flameout if transfer is delayed to below 59-percent rpm.

1. ENG MODE SELECT — PRI (greater than 59-percent rpm).

If PRI mode is restored:

2. Maintain constant subsonic airspeed in level flight.

WARNING

If WING SWEEP advisory light is illuminated, cycling L AICS circuit breaker (LF1) may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) cb's are pulled.

3. Affected L or R AICS cb — Cycle (LF1, left or LG1, right).

% OF PRIMARY THRUST F110-GE-400 ENGINE

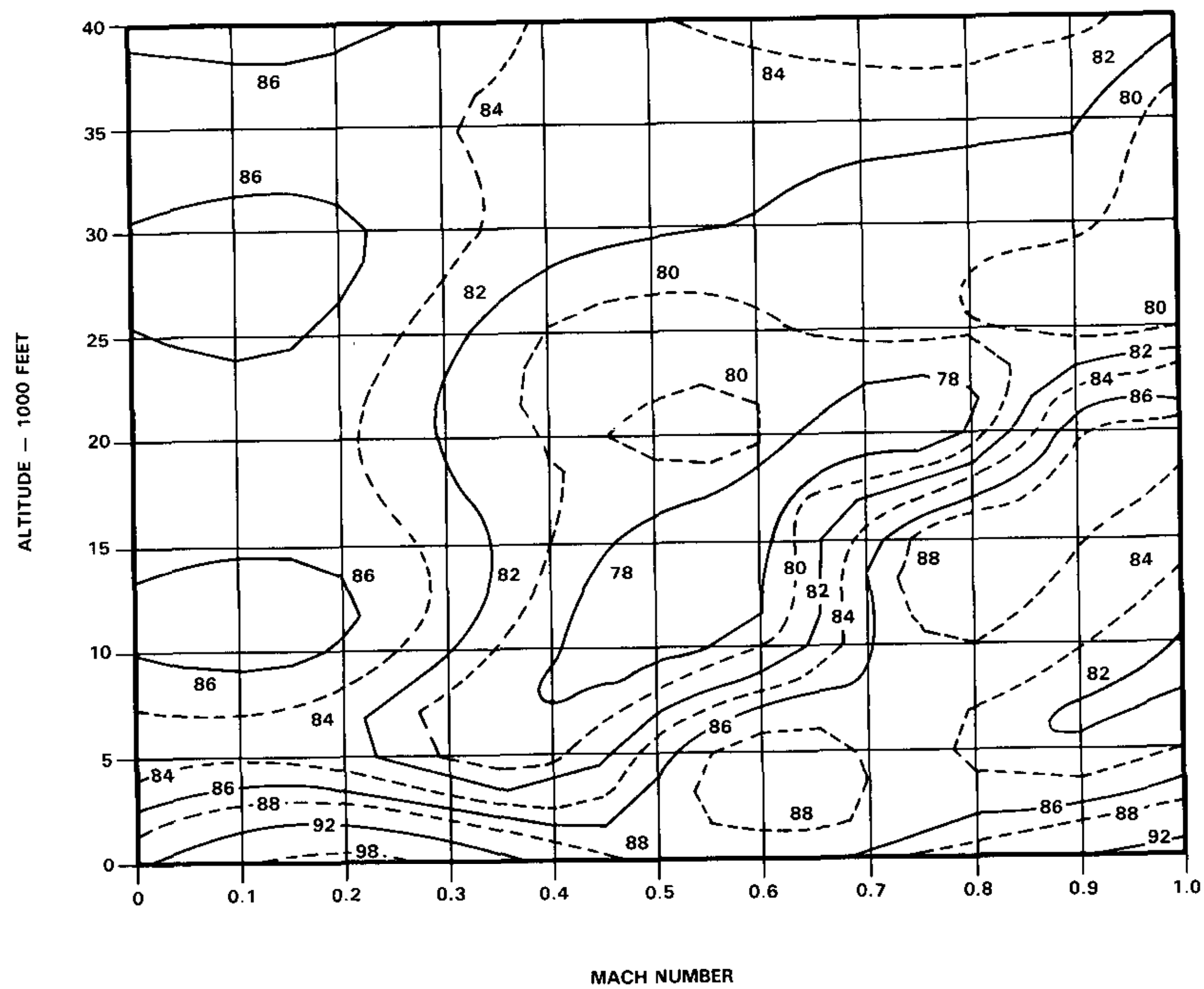


Figure 14-4. Secondary Mode Thrust Levels

14.5.8 Uncommanded Engine Acceleration Airborne (No Throttle Movement). Uncommanded engine acceleration is characterized by an increase in thrust without throttle movement as a result of an AFTC or MEC failure normally associated with one engine. Selection of the ENG MODE SELECT switch(es) to SEC may restore throttle authority.

1. ENG MODE SELECT — SEC.

If dual engine uncommanded acceleration is associated with CADC failure, normal primary mode may be regained by reselecting PRI mode with the gear handle down.

If engine is still uncommanded and engine shutdown is necessary:

2. Throttle (affected engine) — OFF.

3. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.

14.5.9 Exhaust Nozzle Failed (No Nozzle Response to Throttle Movement). Nozzle position is hydraulically operated by engine oil from a separate compartment in the oil storage tank. A rupture in this system could render the nozzles inoperative and would generally cause the nozzles to blow open. This could result in engine mislight, AB blowout, and low thrust. Exhaust nozzles failed closed could result in engine stalls if afterburner is selected, and excess residual thrust will be present on landing rollout. An exhaust nozzle electrically failed open may be closed by selecting SEC mode.

1. Monitor engine oil pressure/rpm.

2. Throttles — Basic Engine Only (use minimum power required).

Note

- SEC mode transfer while in AB may result in pop stalls. Nonemergency manual selection of SEC mode should be performed in basic engine with the power set above 85-percent rpm.

- If the fan speed limiter circuit has failed, engine rollback may occur with the selection of SEC mode. In the event of engine rollback, PRI mode must be reselected above 59-percent rpm or flameout will occur and an airstart will not be possible.

3. ENG MODE SELECT — SEC.

Note

In SEC mode, nozzle indicator is inoperative.

4. Obtain visual inspection.

If nozzle is open in SEC mode or abnormal response:

5. ENG MODE SELECT — PRI.

6. Assume mechanical failure and land as soon as practicable.

If nozzle is closed or a visual inspection is not possible:

5. ENG MODE SELECT— Remain in SEC.

6. Assume electrical failure and land as soon as practicable.

14.5.10 Stuck/Jammed Throttle(s). One or both throttles may become jammed in the afterburner range because of misadjustments or FOD within the throttle quadrant. Selection of SEC mode may be required to control rapid fuel consumption and airspeed and/or altitude. If the problem cannot be corrected, engine shutdown with the fuel shutoff handle may be necessary to abort a takeoff, to control a stalled engine, or to effect a safe landing. If the afterburner detent lever is misadjusted, the right throttle may not move inboard through the AB detent into the basic engine range.

An additional failure mode has been identified that may cause one or both throttles to become stuck in the basic engine range. If a large idler bearing in either electromechanical rotary actuator fails, it can jam the gear train and create side loads on the mechanical clutch sufficient to lock it and prevent further throttle movement. Failure may occur at any power setting between idle and military and is more likely to be observed when throttles are retarded. While failure will prevent affected throttle from being retarded any further, it may be possible to move it forward.

14.5.10.1 Stuck or Jammed Throttle(s) in Afterburner

Note

- Spoiler brake will be inoperative with either throttle stuck above idle.

- Speedbrake and DLC will be inoperative with either throttle stuck above military.

1. L ENG MODE SELECT and/or R ENG MODE SELECT — SEC.

2. Apply maximum inboard force on throttles and retard as required.

If throttle(s) will not retard below minimum AB:

3. Match throttles.

4. Relax aft pressure on throttles.

5. While forcing throttles apart laterally:

   a. Pull throttles straight aft to MIL detent.

   b. Move throttles inboard and aft.

6. Do not reselect afterburner.

If right throttle will not retard:

7. Right FUEL SHUT OFF handle — Pull (if required).

8. Right throttle — MAX AB (after shutdown).

Note

Failure to move the right throttle full forward may limit the left throttle to 88 percent or less after it is retarded below the MIL stop.

9. Refer to single-engine procedures (Chapter 15).

If left throttle will not retard:

10. Left FUEL SHUT OFF handle — Pull (if required).

11. Refer to single-engine procedures (Chapter 15).

14.5.11 AICS Malfunctions

14.5.11.1 RAMPS Light/INLET Light

*1. Avoid abrupt throttle movements.

*2. Decelerate to below 1.2 TMN.

*3. Affected INLET RAMPS switch — STOW.

Note

A RAMPS light should always be accompanied by INLET light when the landing gear handle is UP.

If RAMPS light remains illuminated:

4. Throttle (bad engine) — 80 Percent or Less.

WARNING

If WING SWEEP advisory light is illuminated, pulling L AICS circuit breaker (LF1) may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) cb's are pulled.

5. Affected L or R AICS cb — Pull (LF1, left or LG1, right).

6. Affected INLET RAMPS switch — AUTO.

7. Land as soon as practicable.

If INLET light only is illuminated, attempt AICS programmer reset:

4. Decelerate below 0.5 TMN.

WARNING

If WING SWEEP advisory light is illuminated, cycling L AICS circuit breaker LF1 may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) cb's are pulled.

5. Affected L or R AICS cb — Cycle (LF1, left or LG1, right).

If INLET light goes off:

6. Affected INLET RAMPS switch — AUTO.

If INLET light remains illuminated:

WARNING

If WING SWEEP advisory light is illuminated, pulling L AICS circuit breaker (LF1) may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) cb's are pulled.

6. Affected L or R AICS cb — Pull (LF1, left or LG1, right).

7. Affected INLET RAMPS switch — AUTO.

8. Remain below 1.2 TMN.

14.5.12 INLET ICE Light

1. ANTI-ICE switch — ORIDE/ON.

When clear of known icing conditions:

2. ANTI-ICE switch — AUTO/OFF.

WARNING

Ice may form on inlet and ramp surfaces without any other visual indications, which may cause compressor stalls and/or FOD.

14.5.13 Oil System Malfunction. Malfunctions in the oil system are indicated by an L or R OIL HOT light, OIL PRESS light, or by oil pressure below or above normal.

If oil pressure is over 65 psi, retard power until pressure is within the normal range. If pressure cannot be reduced, the engine should be shut down to avoid rupturing oil lines. If oil pressure is less than 15 psi, bearing wear can be minimized by maintaining a constant throttle setting and avoiding unnecessary aircraft maneuvers. Bearing failure is normally characterized by vibration, increasing in intensity with bearing deterioration. When vibration becomes moderate to heavy, engine seizure is imminent if engine is not shut down. Continued operation of an engine with oil pressure less than 15 psi is likely to result in illumination of OIL HOT light or an engine seizure. If conditions permit, it is advisable to shut down the engine to reduce damage and to save it for emergency use.

14.5.13.1 OIL PRESS Light and/or Abnormal Oil Pressure

1. Throttle (affected engine) — IDLE.

If oil pressure is below 15 psi, above 65 psi, or engine vibration:

If shutdown is feasible:

2. Throttle (affected engine) — OFF.

3. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.

If shutdown is not feasible:

2. Rpm — Set Minimum Rpm.

3. Avoid high-g or large throttle movements.

4. Land as soon as practicable.

14.5.13.2 L or R OIL HOT Light

CAUTION

Illumination of an OIL HOT caution light may be an indication of above normal gearbox scavenge oil temperature or high supply temperature. Continuous engine operation will result in reduced gearbox life and lubrication degradation.

Note

On deck, OIL HOT light may be caused by underservicing or by excessive temperature on deck. In the event of OIL HOT light on deck, position throttles to OFF.

1. Oil pressure — Check.

2. Throttle (affected engine) — 85-Percent Rpm.

3. If after 1 minute light is still illuminated, throttle — OFF.

4. Land as soon as practicable.

5. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.

6. Relight engine for landing, if necessary.

14.5.14 RATS Operation In Flight

1. Tailhook — DOWN.

If conditions permit:

2. ANTI ICE CONTR HOOK CONT/WSHLD/AIR cb — Pull (8C2).

WARNING

- Pulling the ANTI ICE CONTR HOOK CONT/WSHLD/AIR cb (8C2) disables RATS. Inform CV of increased wind-over-deck requirements and gross weight settings for a non-RATS arrestment.
- With the circuit breaker in and RATS operating, there is reduced thrust available for approach and use of afterburner may be required to arrest sink rate.

CAUTION

ANTI ICE CONTR HOOK CONT/WSHLD/AIR circuit breaker (8C2) must be in prior to hook transition. Avoid icing conditions and rain with circuit breaker pulled.

Note

If RATS secures when the hook is raised with no other weight-on-wheels indication, failure is internal to the RATS circuitry.

14.6 FUEL SYSTEM MALFUNCTIONS

14.6.1 Fuel Pressure Caution Lights. Afterburner operations place an extreme demand on the engine fuel feed system. Aircraft maneuvers in the zero to negative 0.5g flight regime aggravate the effect and may generate a situation where afterburner blowout and engine flameout occur. The first indication of this condition may be a fuel pressure light.

14.6.1.1 L and/or R FUEL PRESS Light(s) On

1. Both throttles — MIL Power or Less.
2. Restore aircraft to 1.0g flight.

If both lights remain on:

3. Increase positive g's to greater than 1.0g.
4. Descend below 25,000 feet.
5. Maintain cruise power settings or less.
6. Land as soon as possible.

WARNING

- Illumination of both lights may be indicative of a total motive-flow failure. Zero- or negative-g flight should be avoided.
- Complete loss of motive flow will result in the sump tank interconnect and the engine feed crossfeed valve remaining in the closed position, isolating the forward and aft systems. Consequently, single-engine operation will cause fuel on the opposite side to be unavailable.

If one light remains on:

3. No afterburner above 15,000 feet.
4. Fuel distribution — Monitor (balance if required).

WARNING

If the sump tank interconnect valve has failed, selecting AFT or FWD on the fuel feed switch could result in fuel migration to the inoperative side. If fuel migration occurs after selecting AFT or FWD on the feed switch (as indicated by a 100- to 300-pound per minute increase on the inoperative side), immediately return the feed switch to NORM.

5. Land as soon as practicable.

14.6.2 L or R FUEL LOW Light

1. DUMP switch — OFF.
2. Fuel distribution — Check (balance if required).

If wing and/or external fuel remaining:

3. WING/EXT TRANS switch — ORIDE.
4. Land as soon as practicable.

14.6.3 Fuel Transfer Failures

14.6.3.1 Wing Fuel Does Not Transfer

1. WING/EXT TRANS switch — ORIDE.

One wing still does not transfer:

2. FEED switch — Select High Fuselage Tape Side.

If wing fuel does not decrease after 2 minutes or wing fuel transfer complete:

3. FEED switch — NORM.

14.6.3.2 External Tanks Fail To Transfer or Transfer Slowly

1. WING/EXT TRANS switch — ORIDE.

If fuel continues to transfer improperly or does not transfer:

2. REFUEL PROBE switch — All Extend, Then Retract.

3. Apply cyclic positive or negative g's.

4. AIR SOURCE pushbutton — OFF Then ON (below 35,000 feet, less than 300 knots).

WARNING

CV arrestment, CV touch and go, or normal field landings with full or partial fuel in the external tanks is not authorized because of overload of the nacelle backup structure. Only minimum descent rate landings are authorized.

14.6.3.3 Wings Do Not Accept Fuel With Switch in ALL EXTD Position

1. REFUEL PROBE switch — FUS EXTD.

2. WING/EXT TRANS switch — OFF.

14.6.3.4 Wings Accept Fuel With Switch in FUS EXTD Position

1. WING/EXT TRANS switch — ORIDE.

Note

With AIR SOURCE OFF pushbutton selected, external fuel tanks will not transfer.

14.6.4 Uncommanded Dump

1. DUMP switch — Check OFF.

2. FUEL FEED/DUMP cb — Pull (RE1).

14.6.5 Fuel Leak. In the absence of actual visual detection, a fuel leak resulting from a malfunction or failure of a fuel system component will usually result in a split in the fuel quantity tapes or feeds. The flightcrew must determine from available instruments (fuel flow and total fuel quantity) whether the aircraft is losing more fuel than the engines indicate they are using. Corrective steps are based on confirmation of the leak. Upon confirmation of abnormal decrease in fuel quantity:

1. Land as soon as possible.

CAUTION

Use of afterburner with fuel leak should be limited to emergency use only.

2. WING/EXT TRANS switch — OFF.

If abnormal fuel quantity decrease ceases, fuel leak is in wing/wing pivot or attachment points for auxiliary tanks:

Note

This cannot be determined until the fuel level has decreased to below the source of the leak. Do not proceed with the below steps prematurely.

If leak is not stopped, it is in engine/nacelle area. proceed immediately with next step.

3. FUEL FEED/DUMP cb — Pull (RE1).

Note

Enough time should be allowed for quantity tapes/feeds to develop split so that leak can be isolated to left or right feed group. Affected side will be low side.

4. Throttle (affected side) — OFF.

5. Conditions permitting, allow rpm to decelerate to windmill rpm.

6. FUEL SHUT OFF handle (affected side) — Pull.

7. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.

Setting the WING/EXT TRANS switch to OFF stops motive flow to the wings and inhibits external tank transfer and fuselage tank pressurization. Pulling the FUEL

FEED/DUMP circuit breaker (RE1) isolates the right and forward system and the left and aft fuel system. This aids in determining the location of the leak and prevents loss of fuel from the good side via the fuel system interconnects. The circuit breaker also deactivates the function of the FEED switch, the automatic balance functions, and the fuel dump system. Securing the engine and, if necessary, pulling the FUEL SHUT OFF handle should stop most engine leaks.

14.7 ELECTRICAL FAILURE

14.7.1 Generator Failure. A mechanical generator failure or an overheating automatically causes the CSD unit of the generator transmission to decouple from the engine. Once disengaged, the CSD cannot be reconnected in flight.

Either generator by itself is capable of supplying the electrical requirements of the aircraft. Even double generator failure will not cause total loss of electrical power; the 5-kVA emergency generator will automatically pick up the load for the essential ac and dc buses No. 1 and No. 2, and the AFCS bus.

If the bidirectional pump is operating and pressure drops to between 2,000 and 1,100 psi (dependent upon the load placed on the generator), the emergency generator will automatically shift to the 1-kVA mode and power only the essential ac and dc No. 1 buses. If combined system hydraulic pressure subsequently recovers, the emergency generator switch must be cycled through OFF/RESET to NORM to regain the essential No. 2 ac and dc buses. Figure 14-5 lists the equipment available with only the emergency generator operating.

With both engines inoperative, windmilling engine(s) provide(s) hydraulic pressure for both the flight controls and the emergency generator. However, the flight controls have first priority and may cause the emergency generator to loiter when low airspeeds reduce engine windmilling rpm. Approximately 450 knots must be maintained to ensure adequate engine windmilling rpm for hydraulic pressure.

14.7.1.1 L or R GEN Light

1. Generator (affected generator switch) — OFF/RESET, Then NORM.

Note

If the generator fault is corrected, the generator will be reconnected and the caution light will go off.

If generator does not reset:

2. Generator (affected generator switch) — TEST.

If the light goes off with the switch in TEST, the fault is in the respective electrical distribution system. If light remains illuminated, the generator has been disconnected automatically and the fault is in IDG or generator control unit.

14.7.1.2 L or R GEN and TRANS/RECT Lights

1. Generator (affected generator switch) — OFF/RESET, Then NORM.

2. If L GEN and TRANS/RECT lights remain illuminated, select EMERG GEN on MASTER TEST panel.

Note

With R GEN and TRANS/RECT lights illuminated, ac essential power is supplied by the L GEN. Selecting EMER GEN on the MASTER TEST panel (with R GEN and TRANS/RECT lights) will not provide any additional power but may cause an interrupt as the supply is transferred from the L GEN to the EMER GEN.

3. Land as soon as practicable.

14.7.2 Double Generator Failure

1. Both generator switches — Cycle.

If operating on emergency generator, the following important systems are inoperative:

1. Emergency flight hydraulics

2. Outboard spoiler module and emergency flap activation

3. OBOGS concentrator heater (OBOGS may still function at a reduced but adequate level).

If temporary loss of combined system pressure causes emergency generator to shift to 1 kVA mode (to drop No. 2 essential bus):

2. EMERG generator switch — Cycle.

3. Land as soon as practicable.

ESSENTIAL BUSES NO. 1 (1 KVA MODE)

AICS RAMP STOW
ANGLE OF ATTACK IND
ALTITUDE LOW WARNING
BACKUP CONTR/B/U OXY LOW
BACKUP IGNITION
BACK UP OXY PRESSURE IND
BAROMETRIC ALTIMETER
CONSOLE LIGHTS (PILOT)
DC ESSENTIAL NO. 1 FEEDER
DC TEST
ENGINE INSTRUMENT GROUP
ENGINE INSTRUMENT GROUP WHITE LIGHTS
ENGINE START
FIRE DETECTION
FIRE EXTINGUISHING
FLOOD LIGHTS
FUEL QUANTITY INDICATOR
HYDRAULIC PRESSURE INDICATION
ICS
IFF/SIF
INSTRUMENT BUS FEEDER
INSTRUMENT LIGHTS
JETTISON (EMERGENCY)
MAIN LANDING GEAR SAFETY RELAYS
OBOGS CONTR
OBOGS CONCENTRATOR
PITCH/ROLL TRIM
PROBE LIGHT
RADAR ALTIMETER
RUDDER TRIM
STANDBY ATTITUDE
STORE MANAGEMENT PROCESSOR
TAIL/RUDDER/FLAP INDICATOR
TURN AND SLIP INDICATOR
VHF/UHF RADIO 1 & 2
VOICE SECURITY EQUIPMENT
WHEELS POSITION INDICATIONS
WING POSITION INDICATIONS

ESSENTIAL BUSES NO. 2

AFCS
AFCS BUS FEEDER
AICS
AICS LOCKUP POWER
AIR SOURCE CONTROL
ALPHA COMPUTER
ALPHA HEATER
ANNUNCIATOR PANEL POWER
ANTI–ICE CONTROL
ANTI–ICE PROBE
ANTI–SKID POWER
ARMAMENT GAS
ARRESTING HOOK CONTROL
AUTOMATIC DIRECTION FINDER
AUXILIARY FLAP/FLAP CONTROL
BDHI
BINGO POWER
BLEED AIR LIGHT
BLEED DUCT
CABIN PRESSURE
CADC
CANOPY LIGHT
CIU
CURSOR CONTROL
DC ESSENTIAL NO. 2 FEEDER
DEKI LIGHTS
DISPLAY PROCESSORS
ECS TEMPERATURE CONTROL
EJECTION COMMAND INDICATOR
EMERGENCY GENERATOR TEST
ENGINE AFTC
ENGINE ANTI–ICE
ENGINE ANTI–ICE VALVES
ENGINE OIL COOLING
ENGINE SECONDARY MODE
ENGINE STALL TONE
EXHAUST NOZZLE
EXTERIOR LIGHTS CONTROL
FLAP/SLAT CONTROL SHUTOFF
FLIGHT CONTROL AUTHORITY
FUEL DUMP
FUEL FEED
FUEL MANAGEMENT PANEL
FUEL PRESSURE LIGHT
FUEL TRANSFER OVERRIDE
FUEL VENT VALVE
FUEL LOW LIGHT
GENERATOR LIGHTS
GROUND ROLL BRAKING INDICATOR
HUD

Figure 14-5. Emergency Generator Distribution (Sheet 1 of 2)

HYDRAULIC PUMP SPOILER CONTROL	MISSION COMPUTER NO. 2	ROLL COMPUTER
HYDRAULIC VALVE CONTROL	MOTIVE FLOW ISOLATION	RUDDER TRIM
INBOARD SPOILER CONTROL	NOSE GEAR STRUT LAUNCH BAR LIGHT	SENSOR CONTROL
INSTRUMENT LANDING SYSTEMS (ARA−63)	NOSE WHEEL STEERING	SPEED BRAKES ENABLE
INS	OIL HOT LIGHTS	SPOILER INDICATOR
INS SYNCH	PEDAL SHAKER	STARTER VALVE LIGHT
JTIDS	PILOT ANNUNCIATOR PANEL (AUX POWER)	TAXI/FORMATION LIGHT
LADDER LIGHT	PITCH COMPUTER	TRANSFORMER/RECTIFIER LIGHTS
MACH TRIM	PITCH−ROLL TRIM ENABLE	UTILITY LIGHTS
MAIN LANDING GEAR RELAYS	PITOT HEAT	WINDSHIELD AIR
MFD NO. 1	RADAR BEACON (AN/APN−154)	WINDSHIELD DEFOG CONTROL
MISSILE POWER HUD TEST		YAW SAS POWER SUPPLY

Figure 14-5. Emergency Generator Distribution (Sheet 2 of 2)

14.7.3 Double Transformer-Rectifier Failure. The 5-kVA emergency generator will automatically activate and power the essential ac and dc No. 1 and No. 2 and AFCS buses. See Figure 14-6 for listing of inoperable dc-powered equipment.

14.7.4 TRANS/RECT Light. The TRANS/RECT light will illuminate if either or both T/R malfunction. If one T/R fails, the operating T/R will assume the dc load. If both T/Rs fail, the emergency generator will go on the line and tie to essential dc buses No. 1 and No. 2. Land as soon as practicable.

Popped circuit breakers should not be reset more than once or be held depressed unless the associated equipment is absolutely an operational necessity. A popped circuit breaker indicates an equipment malfunction or an overload condition. Repeated resets or forced depressions of popped circuit breakers can result in equipment damage and/or serious electrical fire.

The loss of one generator and failure to tie the ac main buses will illuminate the affected GEN light. The TRANS/RECT light will also illuminate because the affected generator's associated T/R is not receiving ac power to convert. Upon observing a TRANS/RECT light, the pilot can check that the aircraft is actually experiencing a T/R failure and not a bus tie failure. If the seat adjust, white floods, or instrument lights are still operative with the R GEN light illuminated, the bus is tied. If the throttles are operating on the boosted mode with a L GEN light illuminated, the bus is tied.

If the hydraulic transfer pump is operating and pressure drops to between 2,000 and 1,100 psi (dependent upon the load placed on the generator), the emergency generator will automatically shift to the 1-kVA mode and power only the essential ac and dc No. 1 buses. If combined hydraulic pressure subsequently recovers, the EMERG generator switch must be cycled through OFF/RESET to NORM to regain the essential ac and dc No. 2 and AFCS buses.

14.7.5 Electrical Fire. Electrical fires may be indicated by visual or audible arcing or an ozone odor in the cockpit and popping circuit breakers. Electrical fires produced by 400 °F air leaks can result in any one or combination of the following:

1. Pinballing caution/advisory lights and instrument indications.

2. CADC associated caution/advisory lights.

3. Uncommanded movement of electrically controlled components (SAS, spoilers, wing sweep, throttles).

4. Complete electrical failure.

5. Smoke, fumes, and/or heat in the cockpit.

The most effective method to extinguish an electrical fire is to secure all electrical power. However, some conditions may not permit securing the emergency generator after both main generators are secured. Night/IFR flight or ECS-duck-leak-induced electrical fires are cases where securing all electrical power is not feasible.

ACM LIGHT	EMERGENCY GENERATOR COOLING	MULTI-FUNCTIONAL DISPLAYS 2 AND 3
AIRBORNE SELF-PROTECTION JAMMER	FLIGHT HYDRAULIC BACKUP	NFO CONSOLE LIGHT
AIR SOURCE CONTROL	GROUND POWER COOLING INTERLOCK	OUTBOARD SPOILER CONTROL AND PUMP
ALE-39 CHAFF/FLARE	GROUND TEST	POSITION LIGHTS
ALR-67	GUN POWER	RADAR COMPONENTS
AMC BIT	HUD CAMERA	RECONNAISSANCE EQUIPMENT
AN/AWW-4	HV POWER SUPPLY	RIGHT MAIN TRANSFORMER RECTIFIER
ANNUNCIATOR PANEL DIM CONTROL	IFF AIR-TO-AIR	RIGHT DC TEST
ANTENNA LOCK	INS BATTERY POWER	SAHRS
ANTENNA HYDRAULIC SERVO	INTERFERENCE BLANKER	SEAT ADJUST
ANTI-COLLISION LIGHT	INTEGRATED TRIM	SOLENOID POWER SUPPLY
ASW 27	INTERRUPTION FREE DC BUS	STATION 1, 1A, AND 8 AIM-9 COOLING POWER
AUTO THROTTLE	IRST	STATION 1, 3, 4, 5, 6, AND 8 DECODER RELAY POWER
BEAM PS	JTIDS DATA PROCESSOR AND BATTERY HEATER	STEADY POSITION LIGHTS
BOL CHAFF DISPENSERS	LEFT/RIGHT AICS HEATER	STORES MANAGEMENT PROCESSOR
BRAKE ACCUMULATOR SHUTOFF VALVE	LEFT MAIN TRANSFORMER/RECTIFIER	STORM FLOOD LIGHTS
COUNTING ACCELERATOR	LIQUID COOLING	SUPPLEMENTAL POSITION LIGHTS
DATA LINK	MASTER ARM	TELEVISION CAMERA SET
DATA PROCESSORS	MASTER TEST	
DATA STORAGE SET	MISSILE POWER RELAY UNIT	
DEHYDRATOR	MISSION COMPUTER NO. 1	
DEU	MONITOR BUS CONTROL	
DIGITAL DISPLAY ENABLE	MULTI-FILTER ASSEMBLY	
ELECTRICAL COOLING		

N2/97

Figure 14-6. Failure of Both Transformer-Rectifiers Equipment Inoperative List

*1. L and R generators — OFF.

Note

OBOGS concentrator heater power will be lost. OBOGS may still function at a reduced but adequate level.

If uncommanded SAS or spoiler inputs are present:

*2. ROLL and PITCH CMPTR AC cb's — Pull (LA1, LB1).

CAUTION

Ground-roll braking is inhibited with LA1 and LB1 cb's pulled.

*3. YAW SAS switch — OFF.

If associated with any other direct or indirect indication of ECS malfunction, perform ECS Leak/Elimination of Smoke and Fumes procedure, paragraph 14.8.1

CAUTION

An electrical fire may affect the CADC and AICS systems causing random movements of the wings and ramps.

If conditions permit:

CAUTION

OBOGS will shut down if all electrical power is lost. BOS will be activated above 10,000 feet MSL but will not be available below 10,000 feet MSL.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-81 for oxygen breathing time remaining.

4. EMERG generator switch — OFF.

Note

Securing all electrical power while airborne causes the ECS to go full cold.

If cause of fire can be isolated:

5. Pull cb's of affected equipment.
6. All generators — NORM.

If cause of fire cannot be isolated:

5. Secure all unnecessary equipment.
6. EMERG generator switch — NORM.
7. Land as soon as possible.

CAUTION

Do not operate engines on the ground without electrical power. Ground cooling fans are shut off, causing hot bleed air to cook off oil and hydrocarbons in the ECS ducting, resulting in smoke in the cockpit and possible damage to the ECS turbine compressor.

14.7.6 Total Electrical Failure

1. Descend or climb to known VFR conditions.

Note

- The standby attitude gyro is capable of providing reliable attitude information (within 9°) for up to 3 minutes after a complete loss of power.
- Cabin pressure will be lost and ECS will go full cold.

2. Attempt to contact radar facilities or other aircraft by handheld survival radio.
3. Make arrested landing as soon as possible.

The following systems are still available:

1. Airspeed indicator
2. Altimeter
3. Cabin pressure altimeter
4. Vertical velocity indicator
5. Arresting hook
6. Standby attitude gyro (3 minutes)
7. Emergency wing sweep
8. Landing gear
9. Main flaps/slats
10. Standby compass
11. Backup oxygen system (above 10,000 feet MSL).

WARNING

Ground engine operation without electrical power supplied by either the generators or external power may cause 20-mm ammunition detonation because of excessive heat in the gun ammunition drum.

CAUTION

- OBOGS will shut down if all electrical power is lost. BOS will be activated above 10,000 feet MSL but will not be available below 10,000 feet MSL.
- Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-81 for oxygen breathing time remaining.
- Do not operate engines on the ground without electrical power. Ground cooling fans are shut off, causing hot bleed air to cook off oil and hydrocarbons in the ECS ducting, resulting in smoke and possible damage to the ECS turbine compressor.

Note

- Total electrical failure will cause the sump tank interconnect, engine crossfeed, and motive flow isolation valves to close, fully isolating both tank systems. Wing and external fuel will transfer into the fuselage.
- If possible, a section IFR descent should be conducted to VFR conditions for landing.

All other normal system and cockpit cues are not available.

When all electrical power is shut off, the cockpit dump valve closes and the environmental control system supplies only cold air to the cockpit and forced air cooled avionics. Pressurization will slowly bleed off. If operational necessity prohibits immediate descent, maintain cockpit altitude at the highest practicable level to conserve BOS. Otherwise, descend to a cabin altitude less than 10,000 feet. If the system failure occurs in the day or night VFR environment, immediate return to base and an emergency landing shall be accomplished. In the day or night IFR environment, ascend or descend to known VFR conditions. (Extreme care should be exercised because of partial panel environment.) Reduce power setting to maximum endurance. Contact nearest ground facility by handheld survival radio. Once positive radar identification is made, follow controllers' directions to landing.

14.8 ECS MALFUNCTIONS/FAILURES

14.8.1 ECS Leak/Elimination of Smoke and Fumes. Bleed air leaks, hot air leaks, and ECS turbine failures have similar indications and results and shall be treated as one failure, ECS leaks. All can cause unsurvivable damage when not recognized and corrected expeditiously. Bleed air leaks in the engine compartment illuminate the appropriate FIRE warning light, and FIRE light procedures apply. Bleed air leaks outside the engine compartment illuminate the BLEED DUCT caution light. Hot air leaks also illuminate the BLEED DUCT caution light. Illumination of the appropriate caution/warning light should be the first indication of an ECS leak. ECS turbine failures can cause hot air leaks. After a compressor-side failure, catastrophic thermal damage can be caused by heat generated during turbine winddown. Wire bundles, flight control rods, and SMDC lines are in the vicinity of the ECS turbine and hot air manifold. Both turbine and compressor-side failures may cause a whining noise emanating from below and behind the right side of the RIO cockpit, and other indications of an ECS air leak follow.

If warning or caution systems do not function, the first indication of an ECS leak can vary. The presence and order of appearance of indications depend on the size and location of the leak.

Direct and indirect indications are listed below in a representative order of appearance; however, they can appear in any sequence. The presence of any one direct indication or any two indirect indications shall be treated as an ECS leak.

Direct indications:

1. BLEED DUCT caution light
2. FIRE warning light
3. Smoke or fumes in the cockpit
4. Heat emanating from behind aft right corner of RIO cockpit
5. Complete loss of ECS airflow.

Indirect indications:

6. Audible pop or squeal from ECS
7. Rapid drop in cockpit airflow
8. Electrical fire indications
9. Any ECS advisory light (SENSOR COND or COOLING AIR).

When an ECS duct leak is indicated or ECS turbine whine is heard, AIR SOURCE should be immediately selected OFF. ECS leaks may melt wiring splice junctions and create conditions that may induce an electrical fire. If an associated electrical fire occurs, smoke, fumes, heat, and damage to the surrounding aircraft structure may intensify. Since electrical fire procedures are not compatible with measures to eliminate smoke and fumes, canopy jettison may become necessary as a last-ditch procedure.

WARNING

Failure to immediately select AIR SOURCE OFF upon indication of an ECS leak may result in severe aircraft damage and loss of aircraft.

WARNING

Selection of AIR SOURCE to RAM allows bleed air to circulate throughout the 400 °F manifold system.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-81 for oxygen breathing time remaining.

Note

- When ECS service air to the OBOGS concentrator is shut off, the aircrew has approximately 30 seconds before depleting residual OBOGS pressure and mask collapse.
- Restoration of service air (selecting RAM) will return OBOGS to operation.

*1. AIR SOURCE pushbutton — OFF.

*2. OBOGS master switch — BACKUP.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-81 for oxygen breathing time remaining.

Note

- When ECS service air to the OBOGS concentrator is shut off, the aircrew has approximately 30 seconds before depleting residual OBOGS pressure and mask collapse.
- Restoration of service air (selecting RAM) will return OBOGS to operation.

*3. If smoke or fumes are present:

a. Altitude — Below 35,000 Feet.

b. CABIN PRESS switch — DUMP.

*4. RAM AIR switch — OPEN.

Note

Ram air door may take up to 50 seconds to fully open.

5. Airspeed — Below 300 knots/0.8 Mach.

6. Nonessential electrical equipment — Secure.

7. CANOPY DEFOG/CABIN AIR lever — CANOPY DEFOG.

8. Land as soon as possible.

If electrical fire:

9. Follow Electrical Fire procedures, paragraph 14.7.5.

CAUTION

The EMERG generator switch should be left in NORM unless there are overriding considerations that mandate turning the emergency generator off.

Note

- Selecting AIR SOURCE OFF eliminates pressurization to the service system (canopy, g-suit, external fuel tanks, pressure/ventilation suit, and airbag seals). Rain removal, defog, OBOGS, and heating systems are also eliminated. Judicious reselection of AIR SOURCE to BOTH or RAM to regain critical support/service systems is predicated on severity of ECS malfunction and operational requirements.
- If ECS airflow continues, ensure AIR SOURCE CONTROL cb (RD2) is in. If cb RD2 has popped, ECS control is lost.
- Securing all electrical power while airborne closes cockpit dump valve and cabin hot air valve, opens bleed air shutoff valves and dual pressure regulator, and the ram air door remains at its last commanded position (ram air door takes up to 50 seconds to open). This results in full cold air to the cockpit, uncontrolled bleed air to circulate, and the loss of normal cabin dump capability. Minimize low- speed (less than 0.25 Mach) and ground operations as the heat exchanger cooling fan will be inoperative and ECS overheat condition will result.

Note

Elimination of smoke or fumes without electrical power may be accomplished by ECS airflow. To obtain maximum smoke/ fume removal capability under this condition, fly below 8,000 feet MSL and set the throttle to maximum practical position. This will open the cabin regulator valve for maximum ECS airflow. If smoke or fumes are not eliminated, it is most probable that smoke/fumes are being regenerated by an ECS air leak. As a last resort, jettison the canopy.

14.8.2 COOLING AIR Light

14.8.2.1 On Deck

1. AIR SOURCE pushbutton — Check L ENG, R ENG, or BOTH ENG.
2. Throttles — Advance Without Closing Nozzles.
3. CANOPY DEFOG-CABIN AIR lever — CANOPY DEFOG.
4. ECS —MAN/FULL HOT.

If light goes out:

5. THROTTLES — IDLE.
6. ECS —As Desired.

If light remains illuminated:

5. Secure systems.

14.8.2.2 In Flight

1. AIR SOURCE pushbutton — OFF.

WARNING

Failure to immediately select AIR SOURCE pushbutton OFF upon indication of an ECS leak (bleed air or hot air leak indication) or upon hearing ECS turbine whine may result in an uncontrollable electrical fire, catastrophic ECS component failure, and/or loss of flight controls.

2. OBOGS master switch — BACKUP.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-81 for oxygen breathing time remaining.

Note

- When ECS service air to the OBOGS concentrator is shut off, the aircrew has approximately 30 seconds before depleting residual OBOGS pressure and mask collapse.
- Restoration of service air (selecting RAM) will return OBOGS to operation.

If associated with any other direct or indirect indication of ECS malfunction:

3. Perform ECS Leak/Elimination of Smoke and Fumes procedure, paragraph 14.8.1.

If not associated with any other direct or indirect indication of ECS malfunction and operational requirements dictate temporary reselection of RAM to regain lost service systems (external fuel transfer, OBOGS, cabin pressure, rain removal, engine anti-ice, etc.):

3. AIR SOURCE pushbutton — RAM.
4. RAM AIR door switch — Full Increase.
5. AIR SOURCE pushbutton — OFF (when service system is no longer required).
6. Land as soon as practicable.

14.8.3 TARPS ECS Lights Illuminate

1. TARPS sensors — OFF.
2. SYSTEM switch — OFF.
3. Pull TARPS cb's:
   a. RECON ECS CONT DC (9E1)
   b. RECON ECS CONT AC (2G4)
   c. RECON HTR PWR PH A (2B1)
   d. RECON HTR PWR PH B (2D1)

e. RECON HTR PWR PH C (2F1)

f. RECON POD (1E2)

g. RECON POD CONTR (9E2)

h. RECON POD DC PWR NO 2 (9E3)

i. RECON POD DC PWR NO 1 (9E4)

4. Ask for visual check of pod by wingman.

5. Land as soon as practicable.

14.8.4 SENSOR COND Light Illuminated and/ or PUMP Phase Circuit Breakers Popped or APG-71 PM Acronym

1. RADAR COOLING switch — OFF.

2. RDR switch — OFF.

3. APG-71 PUMP PH A, B, and C cb's — Pull (2G3, 2G6, 2G7).

If other conditions exist that may indicate an ECS malfunction, either directly or indirectly, perform ECS Leak/Elimination of Smoke and Fumes procedure, paragraph 14.8.1.

4. Land as soon as practicable.

14.8.5 Cockpit Temperature Control Malfunction

1. TEMP mode switch — MAN.

2. TEMP thumbwheel — As Desired.

If temperature control is not regained:

3. VENT AIRFLOW thumbwheel — OFF.

CAUTION

Reduce airspeed to 350 knots or 1.5 Mach, whichever is lower, to prevent ram air at temperature above 110 °F from entering aircraft. After ram air flow is stabilized, airspeed may be increased as required for flightcrew comfort or to increase flow to electronic equipment.

4. AIR SOURCE pushbutton — RAM (below 35,000 feet).

5. RAM AIR switch — OPEN (select amount of ram air desired for flightcrew comfort).

CAUTION

High-cockpit temperature and smoke during ground operation indicates ECS cooling fan shutdown. This will occur with an external air source (start cart) without electric power on the aircraft. This results in an overtemperature condition caused by operating without ground cooling fans.

14.8.6 Cockpit Overpressurization on Deck.

Cockpit overpressurization is sensed by the aircrew and verified by lower than normal cockpit altitude on the cabin pressure altimeter. This condition could be caused by a faulty cabin pressure controller or regulator.

1. AIR SOURCE pushbutton — OFF.

2. CABIN PRESS switch — DUMP.

3. Canopy — OPEN (when cockpit pressure altimeter equals the field elevation).

WARNING

The canopy may explosively leave the aircraft upon unlocking of the canopy sill locks if cockpit overpressure is not reduced.

14.8.7 CABIN PRESS Light

1. Oxygen mask — ON.

If below 15,000 feet:

2. CABIN PRESS switch — Cycle.

14.8.8 WSHLD HOT Light

1. WSHLD AIR switch — OFF.

If light remains illuminated:

2. AIR SOURCE pushbutton — OFF (below 35,000 feet).

Note

If light remains illuminated after air source is off, the indication is faulty. Turn ECS on and land as soon as practicable.

3. OBOGS master switch — BACKUP.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See Figure 2-81 for oxygen breathing time remaining.

Note

- When ECS service air to the OBOGS concentrator is shut off, the aircrew has approximately 30 seconds before depleting residual OBOGS pressure and mask collapse.
- Restoration of service air (selecting RAM) will return OBOGS to operation.

4. RAM AIR switch — OPEN.
5. Reduce airspeed to less than 300 knots or 0.8 Mach.
6. Land as soon as practicable.

14.9 OXYGEN SYSTEM FAILURE

If operational necessity prohibits immediate descent, maintain cockpit altitude at the highest practicable level to conserve BOS. Depressurizing the cabin will increase the duration of the backup and emergency oxygen supply. If fuel is not a problem and flight conditions permit, descend below 10,000 MSL. BOS will not be available; therefore, it will be necessary to release one side of the oxygen mask in order to breathe unless emergency oxygen is used. Emergency oxygen can be shut off and reactivated as required. It is recommended that emergency oxygen be reserved for final approach, permitting the aircrew to refasten oxygen masks.

WARNING

The aircrew will not have any indication of a failure of the monitor. If the aircrew suspects the onset of hypoxia at any time, immediately select BACKUP. The monitor may be tested once the aircraft has descended to a cabin altitude of 10,000 feet or less and the ON position on the OBOGS master switch has been reselected.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See Figure 2-81 for oxygen breathing time remaining.

14.9.1 OBOGS Light

1. BACKUP OXY PRESS — Check.

CAUTION

Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See Figure 2-81 for oxygen breathing time remaining.

14.9.2 B/U OXY LOW Light (Both Cockpits)

1. BACKUP OXY PRESS — Check.

If BACKUP OXY PRESS is less than 200 psi:

Note

Prepare for mask collapse. Breathing time can vary from 2 to 4 minutes, depending upon cabin altitude.

2. Cabin altitude — Less Than 10,000 Feet.
3. OXYGEN SUPPLY valves — OFF.
4. Oxygen masks — Release One Side.

Before landing:

5. Oxygen masks and OXYGEN SUPPLY valves — ON.

6. Emergency oxygen — Activate.

If BACKUP OXY PRESS is greater than 200 psi:

Note

Failure of the B/U OXY LOW pressure relay will illuminate both pilot and RIO B/U OXY LOW light. BACKUP OXY PRESS indicator remains functional and displays true BOS reserve.

2. BACKUP OXY PRESS — Monitor.

Note

Emergency oxygen can be shut off and reactivated as required.

14.9.3 B/U OXY LOW Light (Pilot Only)

1. BOS CONTR/B/U OXY LOW cb — Check In (7A4).

2. BACKUP OXY PRESS — Check.

Note

Failure of the BOS CONTR/B/U OXY LOW circuit breaker will illuminate only the pilot B/U OXY LOW light. BACKUP OXY PRESS indicator remains functional and displays true BOS reserve.

14.9.4 B/U OXY LOW Light (RIO Only)

1. BACKUP OXY PRESS — Check.

14.10 LAD/CANOPY LIGHT AND/OR LOSS OF CANOPY

In the event of canopy loss in flight, the pilot will be adequately shielded by the forward windscreen to maintain control of the aircraft. Vision may be impaired briefly by dust in the cockpit, and moderate head buffet may occur, which can be alleviated by lowering the seat and/or leaning forward. The RIO will be exposed to a significantly more hazardous and disorienting environment, which will include vision impairment, loss of communications, wind blast injury, and breathing difficulties. The degree to which these will be experienced is directly related to airspeed and seat height. In addition, the possibility of helmet loss becomes greater as airspeed increases above 300 knots. ICS and RIO VHF/UHF communications will probably be impossible above 200 knots, although the pilot will be able to effectively utilize V/UHF at airspeeds up to approximately 400 knots. After lowering the seat, the RIO should lean forward to take advantage of the wind blast protection provided by the detail display and instrument panel, while the pilot decelerates the aircraft by utilizing idle power, speedbrakes, and moderate g. The RIO should deselect HOT MIC ICS to prevent interference with V/UHF communications caused by wind blast across the oxygen mask microphone. Helmet loss will result in severe disorientation because of a total loss of communications and vision impairment caused by wind blast.

If canopy loss is experienced at high speed, or if helmet loss appears to be possible because of wind blast or buffeting, retain the helmet by pulling down on the visor cover (keeping arms close to the body).

The pilot LAD/CANOPY caution light may be activated by a mispositioning of either the boarding ladder or the canopy. If both the pilot LAD/CANOPY and the RIO CANOPY lights are illuminated, then the problem is with the canopy system. If the RIO CANOPY light is working but not illuminated, then the problem is with the boarding ladder.

CAUTION

If both the pilot and RIO caution lights are illuminated, indicating a canopy problem, a later problem with the boarding ladder will not activate the LAD/CANOPY or the MASTER CAUTION lights.

Note

If the RIO CANOPY light is not illuminated, ensure that it is operating by selecting IND LT on the RIO TEST panel before assuming a boarding ladder problem.

14.10.1 LAD/CANOPY Light With RIO CANOPY Light/Canopy Loss

*1. Canopy — Boost Close (canopy remaining).

*2. EJECT CMD lever — PILOT.

3. Airspeed and altitude — Below 200 Knots/ 15,000 Feet.

4. Seats and visors — Down.

5. If canopy has departed aircraft, perform controllability check.

6. Land as soon as possible.

14.10.2 LAD/CANOPY Light Without RIO CANOPY Light

1. Airspeed — Minimum Safe Operating.

2. Obtain in-flight visual check if possible.

3. Land as soon as practicable.

14.11 HYDRAULIC SYSTEM MALFUNCTIONS

14.11.1 Combined Pressure Approximately 2,400 to 2,600 Psi

WARNING

If hammering (cavitation) is experienced in the hydraulic system, component rupture is imminent. Turn the hydraulic transfer pump switch (BIDI) OFF.

1. HYD ISOL switch — FLT.

Note

Monitor AUX BRAKE PRESSURE gauge. Tap wheelbrakes to seat priority valve if pressure is decreasing.

2. In-flight refueling PROBE switch — EXTD (in carrier environment).

3. Wing sweep — Set at 20°

4. L INLET RAMPS switch — STOW (less than 1.2 Mach).

5. Left AICS cb — Pull (LF1).

WARNING

If WING SWEEP advisory light is illuminated, pulling L AICS cb (LF1) may cause unintentional wing sweep unless WING SWEEP DRIVE NO. 1 (LD1) and WG SWP DR NO. 2/MANUV FLAP (LE1) cb's are pulled.

6. L INLET RAMPS switch — AUTO.

7. DLC — Do Not Engage.

8. EMERG FLT HYD switch — HIGH (on final, committed to landing).

9. Land as soon as possible.

CAUTION

- Loss of combined pressure may indicate impending fluid loss. Without fluid in the combined system return line, the in-flight refueling probe will not extend with the handpump. Early extension of the refueling probe at the first indication of a combined system malfunction is recommended in a carrier environment.

- Monitor remaining hydraulic system pressure since the MASTER CAUTION and HYD PRESS lights will not illuminate if the remaining systems fail.

Note

To extend or retract the refueling probe using the hydraulic handpump requires the landing gear handle to be in the up position, combined system fluid in the system return line, and essential dc No. 2 electrical power. Extension of the in-flight refueling probe requires approximately 25 cycles of the pump handle.

14.11.2 Flight Pressure Approximately 2,400 to 2,600 Psi

WARNING

If hammering (cavitation) is experienced in the hydraulic system, component rupture is imminent. Turn the hydraulic pump switch (BIDI) OFF.

1. Wing sweep — Set at 20°.

2. R INLET RAMPS switch — STOW (less than 1.2 Mach).

3. Right AICS cb — Pull (LG1).

4. R INLET RAMPS switch — AUTO.

5. EMERG FLT HYD switch — HIGH (on final, committed to landing).

CAUTION

Monitor remaining hydraulic system pressure since the MASTER CAUTION and HYD PRESS lights will not illuminate if the remaining systems fail.

The following important equipment is inoperative:

a. NORMAL HOOK — Restored by weight on wheels. Hook handle restowed.

Note

Arrested landing will require emergency hook extension.

6. Land as soon as possible.

14.11.3 Combined Pressure Zero

1. HYD ISOL switch — FLT.

2. HYD TRANSFER PUMP switch — SHUTOFF.

3. REFUEL PROBE — EXTD (in CV environment).

4. Wing sweep — Set at 20°.

5. EMERG FLT HYD switch — LOW.

WARNING

- If the INLET RAMPS switch is not placed in STOW prior to the pressure reaching zero, do not place it in STOW after complete loss of pressure. Trapped fluid may be the only thing holding the affected ramp in position.

- An outboard spoiler module failure with flaps extended, below 180 knots, and with a combined hydraulic failure rendering the inboard spoilers inoperative, can result in asymmetric spoiler float such that the aircraft may not be flyable at normal approach airspeeds. A small amount of spoiler float can significantly increase approach speeds.

- Do not return to AUTO (LOW) mode once module is selected on (HIGH or LOW) with operating flight hydraulic system. When operated in conjunction with zero combined pressure, some backup module fluid will be expelled by thermal expansion. The module will remain fully serviced and operate normally as long as elevated temperatures are maintained. Once operating, the module should not be turned off in flight without combined system pressure available to reservice it. Doing so would result in fluid contraction and an underserviced condition that could prevent subsequent pump operation.

CAUTION

- Loss of combined pressure with landing flaps down may allow the auxiliary flaps to cycle, causing moderate pitch oscillations.

- Monitor remaining hydraulic system pressure since the MASTER CAUTION and HYD PRESS lights will not illuminate if the remaining systems fail.

The following important equipment is inoperative:

a. L AICS

b. Nosewheel steering

c. Gun drive

d. Inboard spoilers

e. Hook extend (emergency actuation available)

f. Flaps and slats (emergency actuation available)

g. Landing gear (emergency actuation available)

h. Wheelbrakes (emergency actuation available)

i. *Refueling probe (emergency actuation available if fluid remains in return line)*

j. Emergency generator

k. Auxiliary flaps

l. DLC

m. Speedbrakes

n. Normal hook.

6. Hook — EMERG DN.

7. EMERG FLT HYD switch — HIGH (on final committed to landing).

8. LDG GEAR handle — EMERG DN.

9. AUX FLAP/FLAP CONTR cb — Pull (8G3).

10. Flaps (no auxiliary flaps) — DN.

11. Brake accumulator (handpump) — Check.

12. ANTI SKID SPOILER BK switch — SPOILER BK (OFF for CV).

13. Make arrested landing as soon as possible.

After landing:

14. Do not taxi out of arresting gear.

15. Engines — OFF.

14.11.4 Flight Pressure Zero

1. HYD TRANSFER PUMP switch — SHUTOFF.

2. Wing sweep — Set at 20°.

3. EMERG FLT HYD switch — LOW.

WARNING

If the INLET RAMPS switch was not placed in STOW prior to pressure reaching zero, do not place it in stow after complete loss of pressure. Trapped fluid may be the only thing holding the affected ramp in position.

CAUTION

Monitor remaining hydraulic system pressure since the MASTER CAUTION and HYD PRESS lights will not illuminate if the remaining systems fail.

The following important equipment is inoperative:

a. ACLS

b. R AICS

c. Normal hook — Restored by weight on wheels. Hook handle restowed.

4. EMERG FLT HYD switch — HIGH (on final, committed to landing).

5. Land as soon as possible.

Note

Arrested landing will require emergency hook extension.

14.11.5 Both Combined and Flight Pressure Zero

1. EMERG FLT HYD switch — LOW.

2. Do not attempt CV recovery. Divert if possible.

CAUTION

- If any undesirable motions or oscillations occur, immediately release the stick and permit the motions to dampen before resuming active control.
- Do not attempt IMC or close night formation flight while in the LOW mode.
- Operations of more than 8 minutes in HIGH may fail the BFCM motor. The LOW mode should be selected as soon as practicable following a waveoff or bolter and the HIGH mode reselected on the subsequent approach.
- Inboard spoilers can be expected to float, causing uncomfortable lateral stick requirements for level flight. Do not trim out lateral forces.

3. Reduce airspeed below 250 knots if practicable.

Note

Airspeeds less than 250 knots while operating in LOW mode will reduce susceptibility of exceeding maximum stabilizer deflection rate.

The following important equipment is operative in flight:

a. Horizontal stabs (significantly reduced rate)

b. Rudders (slightly reduced rate)

c. Main flaps and slats (reduced rate, via thumbwheel or flap handle)

d. Outboard spoilers

e. Hydraulic handpump

f. Landing gear (emergency actuation available)

g. Hook extend (emergency actuation available)

h. Refueling probe (emergency actuation available, if fluid remains in return line)

i. Wheelbrakes (emergency actuation available).

If in flight refueling required:

4. Decelerate with tanker to 180 knots.

5. Maneuver flaps — Extend.

6. EMERG FLT HYD switch — HIGH (prior to moving to precontact).

7. Avoid abrupt control inputs during contact.

WARNING

- Any abrupt control input to affect engagement can rate limit the stabilizers and result in loss of control. The pilot must resist spotting the basket and rely on RIO commentary to perform the engagement.

- Extended LOW operation (greater than 30 minutes) after in-flight refueling will permit several additional minutes in HIGH mode for subsequent landing.

- Tanking from large body tankers (KC-130, KC-10, KC-135) is hazardous and should not be attempted.

Note

If the air refueling store does not adequately transfer fuel at 180 knots, once engaged, the airspeed can be safely increased to 200 knots to improve fuel transfer rate.

8. EMERG FLT HYD switch — LOW (immediately once clear of tanker).

9. Maneuver flaps — Retract.

Field recovery:

10. Landing gear — EMERG DOWN.

11. Maneuver flaps — Extend With Thumbwheel.

12. MANEUVER FLAPS cb — Pull (LE1).

13. Hook — EMERG DOWN.

14. Brake accumulator — Check.

Established on final, committed to landing:

15. EMERG FLT HYD switch — HIGH.

WARNING

Aggressive nose movement in close can rate limit the stabilizers, resulting in low altitude loss of control. Do not use APCS.

CAUTION

Waveoff performance from low power settings is very poor. Carrying extra speed during IMC approach will improve waveoff performance by permitting smooth rotation to 15 units AOA to break the rate of descent while the engines are accelerating.

If wings are 20°:

16. Fly straight-in approach at 15 units and 180 knots.

If wings are greater than 20°:

17. Fly straight-in approach at 15 units.

Note

Control in LOW mode is satisfactory for performing transition to dirty configuration. Pitching moment because of flap transition is easily countered with electrical trim caused by very slow extension rate.

18. Make arrested landing as soon as possible.

After landing:

19. Do not taxi out of arresting gear.

20. Throttles — OFF.

14.11.6 Backup Flight Module Malfunction

CAUTION

Prolonged use of the backup flight control module in the high mode may result in a failure of the module.

1. FLT HYD BACKUP PH A, B, and C cb's — In (2A1, 2C1, 2E1).

2. Land as soon as possible.

14.11.7 Controllability Check. There are several malfunctions that may significantly affect the handling characteristics in the cruise and landing configurations. For example, these include, but are not limited to:

1. Spoiler malfunction

2. Flap/slat asymmetry

3. Structural damage

4. Uncommanded SAS inputs

5. Rudder malfunction (hardover)

6. Wing-sweep asymmetry

7. Jammed flight controls.

It is absolutely imperative that the aircrew thoroughly and safely evaluate the degraded handling characteristics of damaged or malfunctioning aircraft prior to continued flight and landing. These guidelines do not take priority over existing emergency procedures.

Upon encountering a problem that alters the handling qualities of the aircraft, the aircrew should realize that the aircraft may no longer be a stable airframe, especially in the landing configuration. In addition, the flight characteristics may rapidly degrade or even become uncontrollable when normal configuration changes are introduced or during airspeed changes. Increased awareness of flight parameters should prevail following a malfunction until the aircraft is safely on deck.

Even though the aircraft may possess significantly different or even hazardous flying qualities, the pilot and RIO have numerous cues available to them to warn of potential problems. Some of these cues include:

1. Turn needle and ball position

2. AOA

3. Buffet

4. Yaw string position

5. Flight control positions

6. Trim settings

7. Rolloff

8. Rate of descent.

All cues should be very closely monitored, as they tell the pilot what the aircraft is doing or is about to do.

Stall/departure recovery procedures should be discussed prior to any controllability check. In the event of a stall, NATOPS procedures should be applied immediately. Flaps should be left down, if already there. A rapid increase in airspeed can be attained through judicial use of forward stick and military power.

After a thorough controllability check, the aircrew must make the decision as to whether the aircraft can be safely landed aboard the carrier or should be diverted.

WARNING

If aircraft stalls or departs in dirty configuration, immediately unload and place throttles at military. Do not raise flaps until recovered. (If during flap/slat transition, follow uncommanded roll/yaw procedures.)

1. Climb to 10,000 feet AGL minimum.

2. Obtain visual check if possible.

3. Decelerate gradually to 200 knots if feasible.

4. Dirty aircraft — One configuration change at a time.

5. Slow-fly aircraft to determine approach handling characteristics.

6. Fly simulated approach with lineup corrections, power changes, and waveoff/bolter.

7. For landing, use minimum safe control speed but no slower than optimum AOA.

8. If CV landing is not possible — Divert.

WARNING

A controllability check requires the total attention and awareness of the aircrew. The aircrew must be prepared to encounter unusual handling characteristics since aerodynamic properties of the aircraft may be significantly changed. Stall speed and characteristics may be drastically different from normal.

14.11.8 Outboard Spoiler Module Malfunction

WARNING

An outboard spoiler module failure with flaps extended, below 180 knots, and with a combined hydraulic failure rendering the inboard spoilers inoperative, can result in asymmetric spoiler float such that the aircraft may not be flyable at normal approach airspeeds.

CAUTION

If outboard spoilers fail with airspeed greater than 225 knots and wing sweep is less than 62°, limit lateral stick to one-half pilot authority.

1. OUTBD SPOILER PUMP cb — Check (2B3).

   a. If OUT — Attempt Reset.

   b. If IN and outboard spoiler module flag indicates OFF — Pull.

The following important equipment is inoperative:

(1) Outboard SPOILERS

(2) FLAP and SLAT BACKUP

(3) ACL.

2. Evaluate flaps-down lateral control characteristics at safe altitude.

If unacceptable:

3. Make flaps-up landing.

14.11.9 Low Brake Accumulator Pressure

In flight:

1. HYD ISOL switch — T.O./LDG.

If pressure does not recover:

2. LDG GEAR handle — DN.

3. HYD HAND PUMP — Recharge Accumulator.

Note

- Monitor AUX BRAKE PRESSURE gauge. Tap wheelbrakes to seat priority valve if pressure is decreasing.
- Approximately 13 to 14 differential pedal applications of auxiliary brakes are available.

If accumulator cannot be recharged:

4. Make arrested landing as soon as practicable.

5. Parking brake — Pull (to lock wheels).

WARNING

Complete loss of hydraulic fluid through the wheelbrake hydraulic lines will render parking brake ineffective.

CAUTION

Maximum airspeed for wheelbrake application is 165 knots at a gross weight of 46,000 pounds and 145 knots at 51,000 pounds.

14.12 FLIGHT CONTROL FAILURES OR MALFUNCTIONS

14.12.1 Uncommanded Roll and/or Yaw

Note

- If uncommanded roll and/or yaw occurs during high AOA maneuvering (above 15 units), assume departure from controlled flight and apply appropriate departure and/or spin recovery procedures. Otherwise, perform appropriate procedures below.
- Failures that may cause uncommanded roll and/or yaw include, but are not limited to the following:

  a. Engine failure

  b. Stuck up spoilers

  c. Asymmetric flaps and slats

  d. Uncommanded differential stabilizer and/or rudder automatic flight control system inputs caused by abnormal power transients.

  e. Rudder hardover from yaw SAS (19°).

*1. If flap transition, FLAP handle — Previous Position.

*2. Rudder and stick — Opposite Roll/Yaw.

Note

For spoiler malfunctions, use lateral stick as primary lateral control and rudder only as needed to maintain balanced flight.

*3. AOA — Below 12 Units.

*4. Downwing engine — MAX THRUST (if required).

5. Roll SAS — ON.

6. Roll trim — Opposite Stick (if required).

7. Out of control below 10,000 feet — EJECT.

8. Control regained, climb and investigate for:

   a. Flap and slat asymmetry

   b. SAS malfunction

   c. Spoiler malfunction

   d. Hardover rudder

   e. Structural damage

9. Slow-fly aircraft to determine controllability at 10,000 feet AGL minimum.

14.12.2 Yaw Channel Failure. Failure of a single yaw channel does not affect yaw stabilization since the system is triply redundant. Single channel failure is indicated when the YAW STAB OP light illuminates while the STAB AUG switch remains ON. A second yaw channel failure is indicated when the YAW STAB OUT light illuminates. The YAW STAB switch is not automatically positioned to OFF. CV landings with total YAW SAS failure require increased attention to yaw oscillations in turbulence and/or adverse yaw during lineup corrections.

14.12.2.1 YAW STAB OP Light

1. MASTER RESET pushbutton — Depress.

2. If light remains illuminated — Stay Below 1.0 TMN.

14.12.2.2 YAW STAB OUT Light

1. YAW STAB switch — OFF.

2. MASTER RESET pushbutton — Depress.

If light remains illuminated:

3. Decelerate below 1.0 TMN.

4. YAW SAS PWR cb's — Cycle (LB3, LC3, LD3).

5. If light remains illuminated, remain below 1.0 TMN.

If light out:

6. Reset YAW STAB switch.

14.12.3 Pitch or Roll Channel Failure. Failure of a single pitch or roll channel damper is indicated by that channel STAB caution light. The remaining channel provides 50 percent of the scheduled gain and damping authority. The affected STAB AUG switch remains in ON if only one channel fails.

Failure of two channels illuminates both STAB lights of the affected system. The affected STAB AUG switch is automatically positioned to OFF. If the stability augmentation system self-test circuit can isolate the faulty channel, the remaining channel light will go out; however, the STAB AUG switch must be reset to the ON position. CV landings with either or both PITCH and ROLL SAS failures can be accomplished with some degradation in normal approach handling qualities.

14.12.3.1 Single PITCH or ROLL STAB Light

1. MASTER RESET pushbutton — Depress.
2. If light remains illuminated — No Limitations.

14.12.3.2 Both PITCH or Both ROLL STAB Lights

CAUTION

With both PITCH and ROLL lights illuminated, ground-roll braking may be inhibited.

1. Airspeed — Reduce to Stab Limits.
2. Pitch — Not Restricted.
3. Roll — 1.6 TMN.
4. Wait 10 seconds for self-test.
5. PITCH CMPTR AC cb or ROLL CMPTR AC cb — Cycle (LA1 or LB1).
6. Recheck lights:
   a. If one STAB light off — Reset STAB AUG Switch, No Limits.
   b. If both lights remain illuminated — Leave Appropriate STAB AUG Switches OFF, Stay Below Stab Limits.

14.12.4 STAB AUG Transients

1. Paddle switch — Depress.
2. Airspeed — Decelerate Below 1.0 TMN.
3. STAB AUG switches — All OFF.
4. MASTER RESET pushbutton — Depress.
5. STAB AUG switches — RESET (reset individually to isolate failure).

Note

Pitch SAS loss may result in loss of outboard spoilers. Roll SAS loss may result in loss of inboard spoilers.

14.12.5 Rudder Authority Failure. Scheduling of allowable rudder deflection is computed in the CADC as a function of dynamic pressure. If the command signals and position feedback do not agree, power is removed, stopping further movement and the RUDDER AUTH light illuminates. Directional authority is never less than 9.5° of rudder.

14.12.5.1 RUDDER AUTH Light

1. MASTER RESET pushbutton — Depress (10 seconds).
2. If light remains illuminated — Above 250 Knots, Restrict Rudder Inputs to Less Than 10°.

CAUTION

- With rudder authority stops failed open, excess rudder authority is available and could result in structural damage above 250 knots.
- After landing, nosewheel steering authority may be restricted to 10° (with neutral directional trim) and differential braking is required coming out of the arresting gear.

14.12.5.2 Runaway Stabilizer Trim. A runaway trim failure is sensed by the pilot by both uncommanded stick motion and by changes in aircraft pitch and load factor. This failure state causes the horizontal tail to move along the normal stick-to-tail gearing curve for the hands-off condition. Aircraft response to a runaway stabilizer trim, even in the high-speed configuration, is slow enough (about 1° per second stabilizer change) to be recovered from safely.

The most critical steady-state trim conditions are those for which the greatest stick force is required. A field or carrier landing with either a full noseup or nosedown runaway stabilizer trim requires an average stick force of 14 to 19 pounds to maintain longitudinal control. If pilot fatigue becomes a factor with full noseup trim, stick forces may be significantly reduced by placing the wings aft of 21° and lowering the FLAP handle causing the main flaps to extend while the auxiliary flaps remain retracted. This overrides the wing sweep 21° interlock and the FLAP light will be illuminated. This configuration is not recommended for landing. At approach speed, the worst nosedown trim condition requires a maximum stick pull of 27 pounds without DLC engaged and approximately 24 pounds with DLC engaged. A full noseup runaway trim requires a maximum of 17 pounds of stick push without DLC engaged and 23 pounds with DLC engaged.

Note

With abnormal stabilizer trim response, continuing to trim may preclude ability to retrim to a neutral position.

1. SPD BK/P-ROLL TRIM ENABLE cb — Pull (RB2).
2. Decelerate to below 300 knots.
3. Use AFCS, if available, in cruise configuration to reduce pilot workload.
4. Minimum stick forces are achieved under the following conditions:
   a. Runaway nosedown — flaps up.
   b. Runaway noseup — flaps down.
5. Straight-in approach.

Note

Force required (push or pull) may be as much as 30 pounds.

14.12.6 Horizontal Tail Authority Failure. Lateral stick inputs are limited by control authority stops scheduled by the CADC as a function of dynamic pressure. Failure of the lateral stick stops is indicated by the HZ TAIL AUTH caution light. Failure of the stops in the fully closed position does limit low-speed rolling performance, but ample roll control is available for all landing conditions and configurations. Failure in the open condition, with SAS on, requires the pilot to manually limit stick deflection to prevent exceeding fuselage torsional load limits.

14.12.6.1 HZ TAIL AUTH Light

1. MASTER RESET pushbutton — Depress (10 seconds).

If light remains illuminated:

2. ROLL STAB AUG switch — OFF.
3. Restrict lateral control inputs above 400 knots/0.9 Mach to one-quarter throw.
4. ROLL STAB AUG switch — ON for Landing.

Note

At low airspeeds, lateral control effectiveness may be reduced.

5. Do not select OV SW after landing.

14.12.7 Spoiler Malfunction. The inboard and outboard spoilers are powered and controlled by separate hydraulic and electrical command systems and are protected by separate spoiler failure detection circuits. The pitch computer and outboard spoiler module control the outboard spoilers, and the roll computer and the combined hydraulic system control the inboard spoilers. It is highly unlikely that both spoiler pairs on one wing would fail up/float, but if this situation occurred, controllability would be marginal to impossible.

The severity of a spoiler failure is influenced by spoiler position and deflection, aircraft configuration, and flight conditions. The rolling moment generated from a deflected spoiler varies from the inboard to most outboard spoiler. The moment generated by the No. 4 spoiler is approximately twice as great as that of the No. 1 spoiler. Sweeping the wings aft reduces the effect of a deflected spoiler by decreasing the moment arm of the spoiler and its aerodynamic effectiveness. A fully deployed No. 4 spoiler at 200 knots and 20,000 feet in the cruise configuration generates 25° per second roll rate with the wings at 22°, and a 4° per second roll rate with the wings at 62°.

In the cruise configuration, the increase in rolling moment is essentially linear with increasing spoiler deflection angle, whereas in the landing configuration, the increase in rolling moment is nonlinear with increasing spoiler deflection angle (approximately 50 percent of total rolling moment is generated in the first 10° of spoiler deflection). Flap position has a very pronounced effect on rolling moment. With the flaps down in the high-lift (landing) configuration, a deflected spoiler reduces lift considerably more than with the flaps up. Consequently, a failed-up spoiler causes a significantly higher rolling moment with the flaps down than with flaps up. Selecting flaps up with a failed-up spoiler greatly reduces the amount of lateral stick required to maintain a wings-level attitude. The same lateral stick position of 6° differential stabilizer will balance 55° of No. 4 spoiler deflection with flaps up, and only 8° of No. 4 spoiler deflection with flaps down. The use of lateral trim to reduce stick forces may result in a reduction of available opposite-wing spoiler deflection. Trimming in the direction of stick forces (normal pilot reaction) reduces effective spoiler authority from 55° to approximately 25° at full lateral trim.

The control capability remaining with a failed-up spoiler is influenced by wing-sweep angle, flap position, roll SAS operation, AOA, airspeed, sideslip, and availability of the remaining spoiler set. Spoilers are considerably more effective with flaps down than with flaps up. Any single fully deflected, failed-up spoiler is controllable even with the flaps down and the roll SAS off if the remaining spoiler set is operating, airspeed is below 180 KCAS, and sideslip is minimized. With flaps down and at slightly negative true AOA (less than 5 units), dihedral effect reverses (i.e., right rudder causes a left roll); therefore, combinations of hight sidelsip angle and high airspeed/low AOA (above 180 KCAS and/or below 5 units AOA) should be avoided in the flaps-down configuration. If uncommanded roll is experienced in the landing pattern, comply with uncommanded roll and/or yaw emergency procedure (coordinated stick and rudder inputs) to arrest roll and yaw rates. Once confirming a stuck-up spoiler, the pilot should control the aircraft using primarily lateral stick, applying only small rudder inputs to maintain balanced flight, and remain at or below 180 KCAS in preparation for raising the flaps (if practicable) to reduce lateral control requirements.

A stuck-up failure of a second spoiler panel on the same wing will further increase lateral control requirements and may necessitate coordinating rudder inputs and sideslip angle to maintain control. The pilot should use as much lateral stick as possible to minimize the required sideslip angle and avoid high airspeed/low AOA if the flaps are down. Raise flaps as soon as practicable to improve lateral controllability.

With the SPOILER FLR ORIDE switches in the ORIDE position, all spoilers on the "good" wing are available to counter rolling moment induced by the failed, stuck-up spoiler(s). Ample lateral control exists in this configuration to oppose failed spoiler moments regardless of flap position. Note that with the SPOILER FLR ORIDE switches in the ORIDE position, the SPOILERS light will not illuminate in the event of a spoiler failure. Detecting a failed-up spoiler following uncommanded roll is left up to the aircrew. Once a stuck spoiler is confirmed, counter roll primarily with lateral stick and avoid excessive rudder inputs and/or sideslip.

It is preferable to divert (to shore) an aircraft that is experiencing control problems because of a spoiler malfunction. If the decision is made to land aboard the carrier, a straight-in, no-flap approach should be flown. If conditions do not permit a no-flap CV landing, the aircrew should slow-fly the aircraft at a safe altitude to determine the flaps-down controllability and minimum controllable airspeed.

WARNING

In the event of a subsequent failed-up spoiler on the same wing, the aircraft may be uncontrollable in the flaps-down configuration.

14.12.7.1 Spoiler Malfunction/Spoiler Stuck Up

Note

- Spoilers caution light will not illuminate with SPOILER FLR ORIDE switches in the ORIDE position.
- Use lateral stick as primary control and rudder only as needed to maintain balanced flight.

1. Perform checks at a safe altitude in flaps-up configuration.
2. Affected SPOILER FLR ORIDE switch — NORM (guard down).
3. Counter roll with at lease 1 inch of lateral stick.

Note

Stick deflection of over 1 inch enables spoiler asymmetry logic and electrically fails all affected spoilers down. Spoilers light will illuminate.

4. If spoiler(s) fail down, failed SPOILER CONTR cb — Pull (8G9 INBD, 9C5 OUTBD) (go to step 13).
5. If spoiler(s) remain up or floating, affected SPOILER FLR ORIDE switch — ORIDE.
6. MASTER RESET — Depress.
7. Failed SPOILER CONTR cb — Pull (8G9 INBD, 9C5 OUTBD).
8. If spoiler(s) fail down, go to step 13.

Note

- Outboard spoiler position indicators will indicate down with cb 8C5 pulled.
- With circuit breakers 8G9 and 9C5 pulled, ground-roll braking is inhibited.

Note

Allow up to 60 seconds for spoilers to return to trail.

9. If spoiler(s) remain up, malfunction was mechanical. Failed SPOILER CONTR cb — Reset (8G9 INBD, 9C5 OUTBD).

10. Slow-fly aircraft in the flaps-up configuration to determine minimum control speed.

11. Verify full remaining spoiler authority is available by trimming laterally opposite of stick deflection.

12. Fly straight-in, flaps-up approach above minimum control speed.

If spoiler(s) fail down:

13. Slow-fly aircraft at a safe altitude in flaps-down configuration to determine minimum control speed.

14. If controllability is satisfactory, perform full-flap, straight-in landing. If controllability characteristics are not satisfactory, perform a no-flap or maneuvering-flap straight-in landing.

14.12.8 FLAP Light

14.12.8.1 Not After Landing/Takeoff Flap Transition

1. Airspeed — Below 225 Knots.

2. FLAP handle — Ensure Full Up.

3. MASTER RESET pushbutton — Depress.

4. While holding MASTER RESET pushbutton depressed, maneuver flap thumbwheel — Full Forward.

5. Check FLAP light out (light can take up to 10 seconds to reilluminate).

14.12.8.2 After Landing/Takeoff Flap Transition, or Reillumination After Above Procedures

1. MASTER RESET pushbutton — Depress.

2. If light still illuminated, check FLAP handle and indicator position, then proceed with appropriate steps below.

14.12.8.3 FLAP Handle Up and Flaps Not Fully Retracted

1. FLAP handle — EMER UP.

If FLAP handle or flaps will not respond or FLAP light remains illuminated, refer to Flap and Slat Asymmetry procedures, paragraph 14.12.9.

14.12.8.4 FLAP Handle Up and Flaps Indicating Full Up

1. Flaps — Cycle.

If FLAP handle or flaps will not respond or FLAP light remains illuminated, refer to Flap and Slat Asymmetry procedures, paragraph 14.12.9.

14.12.8.5 FLAP Handle Down and Flaps Not Fully Extended

1. Wing sweep — Ensure at 20°.

Flaps will not respond or FLAP light remains illuminated, refer to Flap and Slat Asymmetry procedures, paragraph 14.12.9.

14.12.8.6 FLAP Handle Down and Flaps Down

1. Wing sweep — Ensure at 20°.

2. MASTER RESET pushbutton — Depress (allow 10 seconds for auxiliary flaps to extend).

Note

If FLAP handle or flaps will not respond or FLAP light remains illuminated, refer to Flap and Slat Asymmetry procedures, paragraph 14.12.9.

14.12.9 Flap and Slat Asymmetry. Flap and slat asymmetry can occur with failure of an asymmetry sensor and subsequent failure of the flap and slat drive mechanism for one wing. The pilot's only indication will be an uncommanded roll followed by a FLAP light approximately 10 seconds later. The flap indicator does not indicate actual flap position, but the position to which the flap and slat control box has been driven. The slat indicator shows up, down, or transition (barber pole) for the starboard slat only. The port slat position is not monitored. Asymmetric flaps cause an immediate roll. Asymmetric slats may not be apparent until just before wing stall. Asymmetric slats can cause rapid rolloff above 15 units AOA. Slat position must be monitored by the RIO during transition.

WARNING

The use of lateral trim to reduce stick force will reduce spoiler control significantly. An uncontrollable situation can develop if lateral trim is out of neutral before flap and slat asymmetry or if the pilot trims laterally in the neutral direction (opposite the roll) during flap and slat transition. This situation will be aggravated and recovery may not be possible with roll SAS off because of reduced differential tail authority. Once asymmetry occurs, do not trim out stick forces. If lateral control is marginal, trim opposite to the natural direction until full spoiler deflection is available. For example, stick to the right, trim left.

If a roll is encountered during flap and slat transition or if RIO notes asymmetric slat extension or retraction:

Note

Uncommanded roll/yaw procedures take precedence if appropriate. Otherwise perform the procedures below.

1. FLAP/SLAT CONTR SHUT-OFF cb — Check In (RA2).

WARNING

Lack of asymmetry protection (RA2 circuit breaker out) may cause uncommanded roll and/or yaw during flap or landing gear handle movement.

2. FLAPS — Match Handle With Flaps Position.
3. Obtain visual check if possible to ascertain position of all flap and slat surfaces.
4. Slow-fly aircraft in approach configuration at or above 10,000 feet AGL to determine approach characteristics, conditions permitting.
5. Land as soon as practicable if aircraft is controllable and minimum approach airspeed is within shipboard arresting gear limits.

If asymmetry is so large as to make landing impossible or minimum safe approach speed is above shipboard arresting gear limits with no possible divert field available:

6. Climb above 10,000 feet AGL.
7. AUX FLAP/FLAP CONTR cb — Pull (8G3).

WARNING

Failure to complete step 6 before the subsequent steps can result in large uncommanded pitch trim changes because of auxiliary flap movement.

8. FLAP/SLAT CONTR SHUT-OFF cb — Pull (RA2).
9. Slowly move FLAP handle in direction to minimize asymmetry and/or lateral control requirements.
10. Stop flap and slat travel before reaching full up or down.
11. FLAP/SLAT CONTR SHUT-OFF cb — Reset (RA2).

WARNING

Asymmetric slats may not be apparent until just before wing stall. Asymmetric slats can cause rapid rolloff above 15 units AOA.

12. If asymmetry has been corrected, land using 15 units AOA.
13. If asymmetry has not been corrected, flaps and slats did not respond to above procedure, or lateral control problems exist, land using maximum safe AOA if landing is elected.

14.12.10 WING SWEEP Advisory Light and W/S Caution Legend

14.12.10.1 Advisory Light Only — No Loss of Normal Control

1. MASTER RESET pushbutton — Depress.

14.12.10.2 WING SWEEP Light and W/S Caution Legend — No Automatic or Manual Control

1. Airspeed — Decelerate to 0.9 Mach or Less.
2. Check spider detent engaged.

3. MASTER RESET pushbutton — Depress (wait 15 seconds to determine system status).

If WING SWEEP light and W/S caution legend illuminate again:

4. WING SWEEP DRIVE NO. 1 and WG SWP DR NO. 2/ MANUV FLAP cb — Pull (LD1, LE1).

5. Emergency WING SWEEP handle — Comply with below schedule:

   a. < 0.4 Mach — 20°.

   b. < 0.7 Mach — 25°.

   c. < 0.8 Mach —50°.

   d. < 0.9 Mach — 60°.

   e. > 0.9 Mach — 68°.

CAUTION

Avoid ACM and aerobatics.

6. Land as soon as practicable.

Note

- After a wing-sweep malfunction, the WING SWEEP advisory light and the W/S legend may take 15 seconds to illuminate/display.

- FLAP light will be illuminated with cb LE1 pulled.

14.12.11 Unscheduled Wing Sweep

1. Emergency WING SWEEP handle — Raise and Hold.

CAUTION

Unscheduled wing sweep at supersonic speed may cause structural damage.

2. Airspeed — Decelerate to 0.6 TMN or Less in 1g Nonmaneuvering Flight.

3. Emergency WING SWEEP handle — Full Forward.

If wings do not move full forward:

4. EMERGENCY WING SWEEP handle — Match With Actual Wing Position.

5. WING SWEEP DRIVE NO. 1 and WG SWP DR NO. 2/MANUV FLAP cb — Pull (LD1, LE1) (refer to aft wing-sweep landing).

14.12.12 CADC Light

1. MASTER RESET pushbutton — Depress.

2. CADC cb's (LA2, LB2, LC2, LD2) — Cycle.

3. MASTER RESET pushbutton — Depress.

If light still remains illuminated:

4. Remain below 1.5 Mach.

One or more of the following systems may be affected by CADC malfunction that illuminates only the CADC light.

   a. Maximum safe Mach

   b. Autopilot

   c. Idle lockup function of AFTC

   d. Wing-sweep indicator

   e. Cockpit cooling less than Mach 0.25

   f. HUD Display.

Note

- Erroneous Mach inputs to the AFTC may cause uncommanded acceleration of both engines to near-military values in the PRI engine mode.

- If illumination of the CADC light is accompanied by other caution or advisory light(s), refer to the appropriate procedure that will dictate the most restrictive limitation.

14.12.13 AUTOPILOT Light

1. MASTER RESET pushbutton — Depress.

If light remains illuminated:

2. *PITCH* and *ROLL COMPTR AC cb's* — Cycle (LB1, LA1).

14.12.14 Weight On-Off Wheels Switch Malfunction. For most systems, failure of both the left and right WOW switches is required to cause the systems to revert to the on-deck mode. Should such failures occur, the following anomalies can result:

1. Approach indexers are inoperative.
2. APC will not engage.
3. Outboard spoiler module is inoperative (flaps up).
4. Nozzles may go full open (with LDG GEAR handle down, throttles IDLE)
5. Ground-roll spoiler braking (throttles IDLE).
6. Radar will not scan.
7. Autopilot cannot be engaged.
8. BOL chaff will not dispense.
9. At high altitude, ground cooling fans may overspeed and shut down, causing smoke in cockpit.
10. RATS will be enabled airborne with the hook handle down or the hook out of the stowed position.

WARNING

With RATS enabled airborne, military power provides 20 to 25 percent less thrust than normal, resulting in less than optimum waveoff and bolter performance.

If two or more of the above anomalies are detected, the following action should be taken.

14.12.14.1 Pilot

1. Throttles — Any Position Except IDLE.

WARNING

Do not move both throttles to IDLE unless ANTI SKID SPOILER BK switch is set to OFF if weight on-off wheels switch is suspected because of loss of lift caused by spoilers deploying.

2. ANTISKID SPOILER BK switch — OFF.
3. Land as soon as practicable.

CAUTION

If weight on-off wheels switch failure is suspected, cocked up, high sink rate landing with throttles at idle can result in damage to the afterburner.

14.12.14.2 RIO

1. MLG SAFETY RLY NO. 1 and NO. 2 cb — Pull (7F5, 7F4).

Note

Circuit breakers can be reset after touchdown to enable ground-roll braking, antiskid, nozzles open at idle, and nosewheel steering.

14.13 DEPARTURE/SPIN

Successful recovery from out-of-control flight requires correct situation analysis, timely and correct application of procedures, crew coordination, and recognition of recovery. Departure from controlled flight should be recognized and the appropriate recovery procedures initiated as soon as the aircraft begins uncommanded motion. Throttles should be immediately placed to IDLE to ensure maximum stall margin and prevent asymmetric thrust from delaying recovery. If recovery is not immediately apparent, instrument cues must be cross-checked. Full departures/spins are indicated by pegged AOA (30 units for upright, 0 units for inverted), low airspeed (less than 150 knots), and sustained yaw rate as indicated by the turn needle and/or spin arrow. The spin arrow is the best indicator of yaw direction if it is available. If the above indications are not present, neutralize the controls and fly the aircraft as airspeed increases. Recovery controls should be applied and maintained until recovery is indicated, minimum altitude reached, or an increase in eyeball-out g threatens aircrew incapacitation. The most positive indication of recovery is a break in AOA as yaw rate is reduced, followed by an increase in airspeed and g load in the direction commanded by longitudinal stick. To minimize altitude loss for recovery, pull out at 17 units AOA.

Crew coordination is essential. The RIO must be able to analyze the situation and provide timely and accurate information and procedural backup to the pilot without excess communication. The RIO should use airspeed, altitude remaining, and the spin arrow as cues. Lateral stick application can be confirmed by observing spoilers deflected up on the wing pointed to by the spin arrow. Ejection in an out-of-control flight situation can best be accomplished by the RIO after consultation with the pilot. A thorough understanding of Chapter 11, Flight Characteristics, is required of the aircrew when dealing with these high task emergencies.

14.13.1 Vertical Recovery

1. Above 100 knots, use longitudinal stick to pitch the nose down. At extreme nose-high attitudes, aft stick facilitates recovery time and will avoid prolonged engine operation with zero oil pressure.

2. Below 100 knots, release controls and wait for aircraft to pitch nose down. This prevents depletion of hydraulic pressure in the event both engines are lost and provides quickest recovery.

3. If roll and/or yaw develop, wait until aircraft is in a nosedown attitude and accelerating before correcting with rudder or lateral stick.

4. Use longitudinal control as necessary to keep nose down and accelerating.

5. Above 100 knots, pull out, using 17 units AOA.

6. Recovery to level flight from point of pitchover can normally be completed in less than 10,000 feet.

14.13.2 Upright Departure/Flat Spin

*1. Stick — Forward/Neutral Lateral
Harness — Lock.

*2. Throttles — Both IDLE.

*3. Rudder — Opposite Turn Needle/Yaw.

If no recovery:

*4. Stick — Into Turn Needle.

If yaw rate is steady/increasing, spin arrow is flashing, or eyeball-out g is sensed:

*5. Roll SAS — ON
Stick — Full Into Turn Needle and Aft.

If recovery is indicated:

*6. Controls — Neutralize.

*7. Recover at 17 units AOA, thrust as required.

If flat spin verified by flat attitude, increasing yaw rate, increasing eyeball-out g, and lack of pitch and roll rates:

*8. Canopy — Jettison.

*9. EJECT — RIO Command Eject.

WARNING

Ejection guidelines are not meant to prohibit earlier canopy jettison and/or ejection. If insufficient altitude exists to recover from departed flight, the flightcrew should not hesitate to eject.

Note

- At high yaw rates where eyeball-out g is sensed, aft stick and full lateral stick into the turn needle may arrest the yaw rate and increase the possibility of recovery. At these yaw rates, the additional differential tail provided by roll SAS on will also increase the possibility of recovery.

- It may be necessary to center stick laterally momentarily to engage roll SAS.

14.13.3 Inverted Departure/Spin

*1. Stick — Full AFT/Neutral Lateral
Harness — Lock..

*2. Throttles — Both IDLE.

*3. Rudder — Opposite Turn Needle/Yaw.

If recovery is indicated:

*4. Controls — Neutralize.

*5. Recover at 17 units AOA, thrust as required.

If spinning below 10,000 feet AGL:

*6. EJECT — RIO Command Eject.

CAUTION

Dual compressor stalls may be expected in an inverted spin.

Note

If pedal adjustment and/or pilot positioning (because of negative g forces) is such that full rudder pedal travel cannot be obtained, full lateral control opposite the turn needle/yaw may provide an alternate recovery method. Aft longitudinal stick should be relaxed enough to allow full lateral stick application.

CHAPTER 15

Landing Emergencies

15.1 DUAL-ENGINE LANDING, ONE OR BOTH ENGINES IN SECONDARY MODE

With either one engine in secondary mode (the other engine in primary) or both engines in secondary mode, a straight-in approach should be conducted with slats and flaps fully extended, 15 units AOA, DLC engaged, and speedbrakes extended. Approaches can be accomplished safely up to the normal gross weight limits of the aircraft. Throttle position in secondary mode will be 5° to 10° higher than in primary mode for the same amount of thrust. Thrust response in secondary mode is nonlinear and very sluggish. Engine acceleration time can be as much as three times longer than in primary mode. Secondary mode MIL power thrust levels can vary from as little as 65 percent to as much as 116 percent of primary mode MIL thrust.

CAUTION

For shipboard landing, the LSO and tower must be informed if the landing is to be made with both engines in secondary mode to ensure wind-over-deck requirements are met as RATS is not operative in secondary mode.

During flight tests with one engine in secondary mode, optimum results were obtained by matching the engine rpm's prior to commencing final approach and maintaining the throttle split when making power corrections. Use of DLC to make small glideslope changes will improve lineup control by reducing throttle activity and and the associated yaw excursions. Waveoff and bolter performance is essentially the same as in dual-engine primary mode except for a slight yaw into the secondary mode engine.

With both engines in secondary mode, expect very sluggish power response and throttle positions 5° to 10° more forward than in primary mode. Extreme care should be taken to avoid an underpowered condition as this will significantly degrade waveoff performance. The LSO should move the waveoff window such that only minor glideslope/lineup corrections are required from in the middle position.

WARNING

Waveoff performance with both engines in SEC mode may be severely degraded. Extreme care should be used to avoid an underpowered, high-rate-of-descent situation.

15.2 SINGLE-ENGINE LANDING PRIMARY MODE

Perform a straight-in approach with flaps and slats extended and speedbrakes retracted (to reduce thrust required). External tanks have a negligible effect on thrust required and need to be dropped only if necessary for gross weight considerations. If operating on the left engine, DLC is available and is recommended. DLC can be used to aid in the control of glideslope, thereby minimizing required power changes and the resultant lateral/directional deviations. The 8-knot increase in airspeed with DLC engaged results in more control authority and improved waveoff and bolter performance. Flight in the power approach configuration is critical. Turns should be made away from the failed engine using bank angles that do not exceed 20°. Remain below 12 units AOA until established on final approach. Final approach should be conducted at 15 units AOA with DLC engaged/14 units with DLC stowed (DLC is not available when combined hydraulic system is pressurized by the BIDI pump). Small rudder inputs should be made in conjunction with power changes to reduce the amount of yaw.

Waveoff and bolter (with RATS) may be accomplished up to normal gross weight limits of the aircraft. Test results have shown that MIL power provides satisfactory waveoff performance. Minimum AB (ATLS on) reduces altitude loss when waveoff occurs from a high rate of descent. The use of maximum AB is prohibited.

No significant difference in altitude loss during waveoff was noted between minimum AB and maximum AB. The aircraft is extremely difficult to control in maximum AB and large bank angles into the operating engine are required to maintain centerline. Late or inadequate control inputs during a maximum AB waveoff can result in large lateral flightpath deviations. Waveoff technique is to select MIL or minimum AB (ATLS on), maintain approach AOA until a positive rate of climb is established, then accelerate and climb out at the airspeed indicated in the Climb Performance After Takeoff (Single Engine) Charts in NAVAIR 01-F14AAP-1.1.

Note

Altitude loss during a single-engine waveoff is minimized by maintaining approach AOA until a positive rate of climb is established. Avoid overrotating in close as this will increase the chance of an in-flight engagement. Minimum AB (ATLS on) will improve waveoff performance (minimize altitude loss) from high sink rates.

The bolter maneuver is affected by selecting MIL or minimum AB (ATLS on) and slight aft control stick until the desired flyaway attitude is established. During a bolter following a DLC stowed approach, nose rotation will be more sluggish than normal (because of the slower approach speed) requiring a slightly more aggressive aft control stick input.

CAUTION

The use of excessive backstick on a bolter may cause the tail surface to stall, delaying aircraft rotation and causing the aircraft to settle off the angle deck.

As power is advanced during a waveoff or bolter, simultaneously apply rudder (approximately two-thirds to three-fourths of full deflection) to counter the asymmetric thrust and prevent lateral drift. Rudder may be supplemented with small lateral stick inputs. If yaw rate develops into the dead engine, immediately apply full opposite rudder to arrest the yaw rate and then reduce the rudder as required to track centerline. If unable to control yaw rate during AB waveoff (possible ATLS failure), immediately reduce power to MIL.

WARNING

Use of maximum AB during waveoff or bolter is prohibited. If unable to control yaw rate (possible ATLS failure), immediately reduce power to MIL.

During single-engine operations at fuel states above 4,000 pounds, a fuel split will develop between the aft/left and forward/right sides. When either cell No. 2 or cell No. 5 thermistor is uncovered (at approximately 2,000 pounds on either tape), or when FWD or AFT is selected on the FEED switch, the motive flow isolation and sump tank interconnect valves open, making wing and fuselage fuel on both sides available to the operating engine. However, if the sump tank interconnect valve fails to open, fuel will migrate to the wing and fuselage tanks on the inoperative engine side and will not be available to the operating engine. Under these conditions, the maximum migration rate could reach 300 ppm. If the FUEL SHUT-OFF handle on the inoperative engine is not pulled, an additional migration path could exist through the engine crossfeed valve. During single-engine operation, the following procedures will minimize fuel migration if the sump tank interconnect valve fails to open.

1. FUEL SHUT OFF handle (inoperative engine) — Pull.

If not on final approach:

2. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.

If after commencing final approach or in landing pattern:

2. ATLS — Check ON.

WARNING

If ATLS is inoperative, the use of afterburner is prohibited.

Note

Altitude loss during waveoff is minimized by maintaining approach AOA until positive rate of climb is established. Avoid overrotating in close as this will increase the chance of an in-flight engagement. Minimum AB will improve waveoff performance (minimize altitude loss) from high sink rates. Maximum AB provides little or no improvement over minimum AB and is prohibited.

3. Afterburner operation (airspeed > 170 knots, fuel permitting, and full rudder authority) (RUDDER AUTH light out) — Stage to Verify Proper Operation of ATLS.

4. Wing sweep — Set at 20° (EMER).

WARNING

If hammering (cavitation) is experienced in the hydraulic system, component rupture is imminent. Turn the HYD TRANSFER PUMP switch (BIDI) off.

5. Hook — As Required.

6. Reduce gross weight/minimize lateral asymmetry into the inoperative engine as required.

7. Speedbrakes — RET (on final approach).

8. LDG GEAR handle — DN (if combined hydraulic pressure zero — EMERG DN).

9. Check SAS — ON.

10. If combined pressure is zero — Pull AUX FLAP/FLAP CONT Cb (8G3).

11. Flaps — DN.

12. DLC (if operating on right engine) — Do Not Engage.

If operating on the left engine and 3,000 psi combined pressure — Engage on Final.

13. EMERG FLT HYD switch — HIGH (on final, committed to landing).

WARNING

If combined hydraulic pressure is zero, do not return to AUTO (LOW) mode once module is selected on. If module is shut off after operation commences, it may not restart.

14. For landing pattern use 12 units AOA for pattern airspeed and do not attempt turns greater than 20° angle of bank. Avoid turns into the dead engine.

WARNING

Extreme caution must be exercised when performing turn into dead engine. Decaying airspeed/increasing AOA can rapidly result in a situation where there is not enough rudder authority to return the aircraft to level flight, and insufficient altitude to affect a recovery.

15. Final approach airspeed:
    DLC engaged — 15 Units AOA.
    DLC stowed — 14 Units AOA.

WARNING

Military power climb performance during heavy waveoffs may not adequately arrest high-sink-rate conditions. Use of AB provides an increase in climb performance. Up to full rudder may be required to counter AB asymmetric thrust yawing moment during waveoff or bolter. Do not exceed 14 units AOA during waveoff or bolter.

15.3 SINGLE-ENGINE LANDING SECONDARY MODE

Approaches in single-engine secondary (SEC) mode are considered extremely hazardous. Engine military (MIL) power thrust levels can vary from as little as 65 percent to as much as 116 percent of primary mode MIL thrust. Although the majority of engines produce greater than 90 percent of primary mode thrust (at MIL power), the possibility exists that in the full-flap configuration, a low-thrust engine will not provide enough thrust for level flight. Engine acceleration times also vary and can be as much as three times longer than in primary mode. Aircraft in this configuration should recover shore based. Shipboard landings should be attempted only as a last resort and only if performance is adequate. For example, 72 percent of primary mode MIL thrust is considered the minimum required for a safe CV approach with a 48,000-pound aircraft with no stores.

To accomplish the performance check, configure the aircraft at 2,000 feet AGL or greater and 10 units AOA with the maneuvering flaps down (if available) and leave the landing gear up. With the engine at MIL thrust, establish a constant airspeed climb (±5 knots) at the airspeed corresponding to 10 units AOA. The minimum change in altitude required in 30 seconds is as follows:

	CHANGE IN ALTITUDE — FEET	
	MANEUVER FLAPS DN	MANEUVER FLAPS UP
2,000 feet	950 feet	900 feet
4,000 feet	800 feet	750 feet
6,000 feet	700 feet	650 feet

Note

Climb performance will improve by 20 feet in a 30-second climb for every 1,000-pound gross weight reduction.

If the test is passed based on predicted gross weight, do not lower the landing gear and flaps until the predicted gross weight is reached. If the performance test is passed and divert is not possible, a CV approach may be attempted. The minimum performance is required for optimum conditions (day, VMC, steady deck, experienced aircrew, normal wind over deck, etc.). For degraded conditions, the minimum performance should be increased based on judgment. If the minimum performance test is not passed, and all other options are exhausted (stores jettisoned, gross weight minimized, divert not possible), eject under controlled conditions.

For shore-based landings, conduct a straight-in approach with flaps up and speedbrakes retracted. If conditions warrant a full-flap landing, conduct a performance test and proceed as in the case of a shipboard landing. Gross weight should be reduced as much as practicable to improve flyaway performance. Maintain 10 units AOA in the pattern slowing to 15 units AOA at touchdown when a safe landing is assured. Use extreme caution when working off a high and/or fast situation, avoiding any large power reductions. The natural tendency will be to underestimate the sluggish power response resulting in an underpowered condition. Waveoff capability is dependent on engine thrust/thrust response, aircraft rate of descent, and power setting at waveoff initiation. Waveoffs should be conducted by rotating toward 14 units (maximum) AOA until a positive rate of climb is attained, then slowly reducing AOA to 10 units AOA to achieve maximum rate of climb. Bolters should be conducted by rotating to 10° pitch attitude not to exceed 14 units AOA. Avoid increasing AOA, as performance will degrade and wing drop will occur at 16.5 to 17.5 units AOA.

WARNING

Waveoff performance from high rates of descent in SEC mode may be severely degraded. Extreme care should be used to avoid an underpowered, high rate-of-descent situation.

Shipboard landings in single-engine SEC mode are not recommended and should be attempted as a last resort (divert not available) and if the performance check is successful. Jettison all external stores and reduce fuel weight as much as practicable to reduce gross weight and drag. Configure the aircraft for landing no lower than 2,000 feet AGL. Approaches should be conducted with the flaps and slats fully extended, speedbrake retracted, and DLC stowed.

Conduct a straight-in approach. Any turns should be made away from the dead engine using bank angles that do not exceed 20°. Maintain 10 units AOA until established on final, at which time the aircraft should be slowed to 13 units (maximum) AOA. Extreme care should be used when working off a high and/or fast condition, as any large power reductions could result in an underpowered situation. A high and/or fast condition should be corrected using only small power reductions. Upon detection of a deceleration or settle, immediate selection of MIL power may be required to correct the situation in a timely manner. To minimize the chance of a hook-skip bolter, it is important to maintain aft stick pressure on touchdown. Waveoffs should be conducted by rotating the aircraft to 14 units (maximum) AOA until a positive rate of climb is attained, then slowly reducing AOA to 11 to 12 units to achieve a maximum rate of climb. Bolters should be conducted by rotating to 10° pitch attitude not to exceed 14 units AOA.

15.3.1 Single-Engine Landing — SEC Mode

1. FUEL SHUTOFF handle (inoperative engine) — Pull.

2. In CV environment — Divert.

3. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2, and Engine Transfer to SEC Mode procedures, paragraph 14.5.6.

If not preparing for CV approach:

See step 6.

If divert is not possible:

WARNING

Engine thrust and thrust response can be severely degraded such that level flight cannot be maintained in the full-flap landing configuration. DO NOT configure for landing until the performance test has been accomplished.

If not configured for landing:

4. Perform constant airspeed climb (±5 knots) at 10 units AOA, landing gear up, maneuvering flaps down (if possible), above 2,000 feet. Minimum climb required in 30 seconds is as follows:

	CHANGE IN ALTITUDE — FEET	
	MANEUVER FLAPS DN	MANEUVER FLAPS UP
2,000 feet	950 feet	900 feet
4,000 feet	800 feet	750 feet
6,000 feet	700 feet	650 feet

CAUTION

If minimum performance test is passed based on predicted gross weight, do not lower landing gear and flaps until predicted gross weight is reached.

Note

Climb performance will improve by 20 feet in a 30-second climb for every 1,000-pound gross weight reduction. Minimum performance criteria are based on optimum conditions (day, VMC, steady deck, experienced aircrew, normal wind over deck, etc.) and should be increased for degraded conditions based on judgment.

5. If minimum performance criteria are not passed and all options are exhausted (stores jettisoned, minimum gross weight, and divert not possible), eject under controlled conditions.

If configured for landing:

4. Throttle — MIL.

5. Ensure a minimum of 500-fpm rate of climb at 14 units AOA available for CV approach.

When preparing for landing:

WARNING

Shipboard recovery in single-engine SEC mode is considered extremely hazardous and should be conducted only as a last resort and if the performance check is successful.

6. RUDDER AUTH light — Out, Check.

7. Wing sweep — Set at 20°.

WARNING

If hammering (cavitation) is experienced in the hydraulic system, component rupture is imminent. Turn the HYD TRANSFER PUMP switch (BIDI) off.

8. Hook — As Required.

9. External stores — Jettison for Shipboard Recovery.

10. Fuel — Dump or Burn (reduce as much as practicable).

11. Speedbrakes — RET (on final approach).

12. LDG GEAR handle — DN (if combined hydraulic pressure zero — EMERG DN).

WARNING

Shore-based landings should be conducted with flaps up. If conditions warrant a full-flap landing, conduct a performance test and proceed as in the case of shipboard landing.

13. Check SAS — ON.

14. If combined pressure is zero — Pull AUX FLAP/FLAP CONTR Cb (8G3).

15. Flaps — DN (shipboard recovery), As Required (field landing).

16. DLC — Do Not Engage.

17. EMERG FLT HYD switch — HIGH (on final, committed to landing).

WARNING

If combined hydraulic pressure is zero, do not return to AUTO (LOW) mode once module is selected on. If module is shut off after operation commences, it may not restart.

18. For landing pattern, use 10 units AOA for pattern airspeed and do not attempt turns greater than 20° angle of bank.

19. Final approach airspeed — 13 Units (CV), (field landing slow to 15 units, no flaps at touchdown).

Note

- Waveoff should be conducted by rotating to 14 units (maximum) AOA until a positive rate of climb is attained.

- Bolters should be conducted by rotating to 10° pitch attitude not to exceed 14 units AOA.

15.4 LANDING GEAR EMERGENCIES

15.4.1 Landing Gear Emergency Lowering. Use emergency lowering of the landing gear only as a last resort. Once this system is used, the gear cannot be retracted; therefore, the landing must be made in whatever configuration you have at that time. If a long flight is necessary to make a field landing, it will have to be made with the gear down (see Figure 15-1).

1. Airspeed — Less Than 280 Knots.

2. LDG GEAR handle — DN.

CAUTION

The LDG GEAR handle should be pulled with a rapid and continuous 55-pound force until the handle is loose (fore and aft) in its housing as an indication of complete extension of the handle.

3. Push LDG GEAR handle in hard, turn it 90° clockwise, pull, and hold.

4. Gear position indication — Check (12 seconds).

5. Make arrested landing if available.

Note

- The nosegear cannot be confirmed as locked by visual observation. If both the indicator and transition light indicate unsafe, assume that the downlock is not in place.

- If there is disagreement between the indicator and light and the gear appears down, the malfunction may be because of a faulty contact on the nosegear downlock microswitch.

- Use of emergency gear extension results in loss of nosewheel steering.

- To facilitate in-flight refueling probe extension when the gear has been blown down, raise the LDG GEAR handle to give priority to the refueling probe system.

If any gear does not come down:

6. Increase airspeed. Do not exceed 280 Knots.

7. Apply positive and negative g to force gear down.

8. Obtain visual in-flight check if possible.

9. Refer to Figure 15-1 (as appropriate).

15.4.2 Landing Gear Malfunctions

1. Remain below 280 knots.

FINAL CONFIGURATION	CARRIER LANDINGS		FIELD LANDING			
			ARRESTING GEAR AVAILABLE		NO ARRESTING GEAR AVAILABLE	
		NOTES		NOTES		NOTES
Cocked Nose Gear	Land	1, 8,11	Arrested Landing	6, 8, 9, 11, 12, 13	Land	6, 9, 11, 13
Side–Brace Not In Place	Land	1, 2, 8, 11	No Arrested Landing	3, 6, 7, 8, 11	Land	3, 6, 7, 8, 11
Nose Gear Up/Unsafe Down	Land	1, 2, 4, 8, 11	No Arrested Landing	4, 6, 8, 9, 10, 11	Land	6, 8, 9, 10, 11
Stub Nose Gear	Land	1, 2, 4, 8, 11	No Arrested Landing	4, 6, 8, 9, 10, 11	Land	6, 8, 9, 10, 11
Nose Gear Up, One Main Up	Eject Pilot Option To Land If Tanks Installed	1, 2, 4, 8, 11	Pilot Option Eject Or Arrest	6, 8, 10, 11, 12	Eject	–
One Main Up Unsafe	Land	1, 2, 8, 11	Arrested Landing	6, 8, 10, 11, 12, 13	Pilot Option Eject Or Land	5, 6, 8, 10, 11, 13
Both Main Up Unsafe	Eject Pilot Option To Land If Tanks Installed	1, 2, 8, 11	Pilot Option Eject Or Arrest	6, 8, 10, 11, 12	Pilot Option Eject Or Land	6, 8, 10, 11
Mains One Or Both Stub/Mount/ Hyperextended/ Wheel Cocked	Land	1, 2, 4, 8, 11	NO Arrested Landing	4, 5, 6, 8, 11	Land	5, 6, 8, 11
All Gear Up	Eject Pilot Option To Land If Tanks Installed	1, 2, 8, 11	Pilot Option Eject Or Land	4, 6, 8, 10, 11	Pilot Option Eject or Land	6, 8, 10, 11

1. Divert if possible
2. Hook down barricade engagement
3. Minimize skid and drift rollout
4. Remove all arresting gear
5. Land off center to gear down side
6. Minimum rate of descent landing (480 fpm max)
7. Gradual symmetrical braking
8. Retain empty drop tanks
9. Lower nose gently prior to fall through
10. Secure engines at airframe contact
11. External ordnance –SEL JETT if required. Activate emerg landing gear lowering to enable raising gear handle for SEL or ACM JETT
12. Hold damaged gear off deck until pendant engagement.
13. Engage NWS if operable, use as required.

Figure 15-1. Landing Gear Malfunction Emergency Landing Guide

2. Combined hydraulic pressure — Check.

3. If less than 3,000 psi, refer to combined hydraulic failure procedures in Chapter 14.

15.4.2.1 Landing Gear Indicates Unsafe Gear Up or Transition Light Illuminated

1. LDG GEAR handle — DN.

If safe gear down indication is obtained and transition light out:

2. Landing gear — Leave Down.

3. Obtain visual check of gear condition.

CAUTION

A hyperextended main strut, whether because of a broken piston or overextended piston barrel and/or main strut with a cocked wheel, will likely result in a combined hydraulic system failure while airborne and a sheared strut upon touchdown. A hyperextended main strut is evident to a wingman by full vertical extension of the scissors and broken brake lines and to the tower or LSO by one main gear hanging noticeably lower than the other. When either of these situations occurs, landing procedures for a stub (MLG) mount must be followed.

4. Land as soon as practicable.

CAUTION

If landing gear indicates unsafe after retraction and a down-and-locked indication can be obtained, the brake pedals should be depressed for 60 seconds to ascertain whether brake hydraulic lines have been severed. If brake hydraulic lines are severed and a combined hydraulic failure occurs, refer to combined hydraulic system failure procedures in Chapter 14.

15.4.2.2 Landing Gear Indicates Unsafe Gear Down, Transition Light Out. This indication means a failure in one of the dual-pole downlock microswitches.

1. Transition light bulb — Check (LTS TEST).

CAUTION

If associated with LAUNCH BAR light, leave gear down and obtain visual check.

2. Landing gear — Cycle.

If condition still exists:

3. Obtain visual check if possible.

4. Make normal landing.

15.4.2.3 Landing Gear Indicates Unsafe, Gear Down, Transition Light Illuminated. Nosegear unsafe indicates that the downlock pin through the drag brace is not in place. Visual determination of nosegear-unlocked status is assisted by a red band painted on the landing nosegear brace oleo. However, a positive check for locked nosegear is not possible visually. Main gear unsafe should be verified by visual inspection. If the drag brace is fully extended, the main gear should be down and locked.

1. Obtain visual check if possible.

CAUTION

- Visual determination of nose landing gear-unlocked status is assisted by a red band painted on the nose landing gear drag brace. If red is visible, the nosegear is not locked.

- During an airborne visual inspection of the main landing gear (even if the paint stripe across the drag brace knee pin appears to be straight), the possibility exists that the downlock actuator has failed and the gear may not be locked in the down position.

2. LDG GEAR handle — Cycle.

If still unsafe:

3. Increase airspeed to 280 knots, pull positive g's and yaw aircraft.

If main landing gear is still unsafe go to step 5.

If nose landing gear indicates unsafe, transition light illuminated, continue with step 4:

4. LDG GEAR handle — Cycle UP then DN in Less Than 2 Seconds.

WARNING

Failure to place the LDG GEAR handle to DN immediately after selecting UP may allow the main landing gear doors to receive the signal to close with main gear struts extended, causing damage to the doors and inducing a possible combined hydraulic or brake system failure. Do not reselect UP with the LDG GEAR handle after the doors attempt to close, as indicated by an unsafe main mount or visual inspection.

Note

Use of the above procedure should be done at the intended point of landing or within range of an acceptable divert field exercising a gear-down bingo profile.

5. LDG GEAR handle — EMERG DOWN (refer to landing gear emergency lowering).

Note

Use of the emergency gear lowering procedure will result in loss of nosewheel steering.

If still unsafe and visually confirmed unsafe, or gear position cannot be confirmed:

6. Refer to Figure 15-1.

CAUTION

- When landing with nosegear unsafe-down indication, anticipate possible nose landing gear collapse.
- Do not attempt to tow aircraft by nosegear until gear is secured in down position.
- Nose landing gear ground safety pin installation will not prevent nosegear collapse. The nose landing gear strut must be restrained against forward rotation.

15.4.2.4 Landing Gear Indicates Safe Gear Down, Transition Light Illuminated. This indication can be caused by a malfunction of the following:

a. Half of the dual-pole micro in the nosegear downlock.

b. Half of the dual-pole micros in either of the main gear downlocks.

c. The proximity micros in the sidebraces.

d. Failure of the LDG GEAR handle position micro.

e. If a visual check confirms the gear is extended and both sidebraces are in place, a malfunction of one of the transition light micros is indicated.

1. LDG GEAR handle — Cycle.

CAUTION

If associated with LAUNCH BAR light, leave gear down and obtain visual check.

If transition light remains on:

2. Obtain visual check.

3. Gear/sidebraces appear in place — Normal Landing.

Sidebraces confirmed not in place:

4. Refer to Figure 15-1.

15.4.3 LAUNCH BAR Light

1. Landing gear — Leave Down.

2. Obtain visual inspection.

If nosegear cocked, see Figure 15-1.

If launch bar is down or visual inspection is not available:

3. Request removal of arresting cables for field landing.

4. Request removal of cross-deck pendants Nos. 1 and 4 for CV landing.

15.5 BLOWN-TIRE LANDING

Blown-tire landings should be performed into arresting gear whenever possible. Rollout is extremely rough on blown tires. If go-around is elected, do not apply full aft stick in attempt to rotate the aircraft before reaching flying speed. The drag from full-up deflection of the stabilizers is large and significantly delays acceleration. Blown tires will frequently result in damaged main landing gear hydraulic lines. Anticipate possible combined hydraulic system failure and attendant committal to gear-down bingo following a blown tire.

CAUTION

- Blown tire(s) can cause engine FOD and/or structural damage. Leave flaps and slats as set. Aircraft should have ground locks installed and engines secured before moving aircraft.
- Do not allow the aircraft to roll backward after the arrestment. The downlock actuator may have been damaged by tire failure and rearward movement of the aircraft could cause the gear to collapse.

1. Obtain in-flight visual check if possible.
2. ANTI SKID SPOILER BK switch — SPOILER BK (OFF for CV).
3. HOOK — DN.
4. Make carrier or short-field fly-in arrested landing as soon as practicable.
5. HYD ISOL switch — T.O./LND (on final).

If arresting gear is not available:

6. Land on centerline.
7. Nosewheel steering — Engaged.

CAUTION

Do not delay engaging nosewheel steering in order to center rudder pedals.

Note

Antiskid will sense a constant release on a dragging blown tire.

15.6 FLAP AND SLAT LANDING EMERGENCIES

15.6.1 No-Flaps and No-Slats Landing. A no-flaps and no-slats landing is basically the same as a normal landing except that the pattern is extended and the approach speed is approximately 15 knots faster than a full-flap approach. Field arresting gear should be used if necessary. CV arrestments are permitted. Consult applicable recovery bulletins for WOD requirements.

1. Gross weight — Reduce (weight consistent with existing runway length and conditions).
2. Flaps — UP.

Note

If outboard spoilers are needed for ground-roll braking, FLAP handle must be set to DN.

3. Fly landing pattern slightly wider than normal or make straight-in approach at 15 units AOA.
4. Use normal braking technique.

CAUTION

- Maximum airspeed for wheelbrake application is 165 knots at a gross weight of 46,000 pounds and 145 knots at 51,000 pounds.
- Use of full aft stick during landing in this configuration can result in tailpipe ground contact.
- Avoid slow approaches. Wing drop and increased sink rate may occur at 16.5 to 17.5 units AOA.

15.6.2 Auxiliary Flap Failure. A no-auxiliary-flaps landing is basically the same as a normal landing except that the approach speed is 6 knots faster than with auxiliary flaps extended, and the longitudinal stick position during the approach is further aft. CV arrestments are permitted; consult applicable recovery bulletin for WOD requirements.

1. Wing sweep — Ensure at 20°.

2. AUX FLAP/FLAP CONTR cb — Pull (8G3).

3. Approach — 15 Units AOA.

Note

With AUX FLAP/FLAP CONTR cb pulled, wings will not sweep aft.

15.7 WING-SWEEP EMERGENCIES

15.7.1 Aft Wing-Sweep Landings. CV arrestments are permitted with up to 40° of wing sweep, and emergency barricade engagements are permitted with up to 35° of wing sweep. Shipboard aft wing-sweep landings should be conducted at 15 units AOA. Field aft wing-sweep landings may be conducted at AOAs up to 17 units when wings are stuck aft of 50° to minimize approach airspeed for normal landings or remain within published field arresting gear limitations for short-field arrested landings. Main flaps and slats should be utilized to reduce approach speed with aft wing sweeps up to 50°. Maneuver flaps may be utilized if main flaps and slats fail to extend.

If wings are determined to be stuck aft of 20° position:

1. Emergency WING SWEEP handle — Match Captain Bars With Actual Wing Sweep Position Tape.

CAUTION

Closely monitor wing-sweep movement when attempting to match handle with wing-sweep position. If abnormal movement is noticed, immediately return handle to previous position.

2. Gross weight — Reduce as Required.

If wings ≤ 50°:

3. Main flaps — FULL DN.

Note

Main flap/slat extension with the wings aft of 20° will result in a large nosedown pitch transient.

If main flaps are inoperative:

4. Maneuvering flaps — Extend.

WARNING

If maneuvering flaps are used, ensure that maneuver flap thumbwheel is not actuated during the approach.

5. DLC and APC — Do Not Engage.

6. Slow-fly aircraft at a safe altitude to determine approach airspeed (up to 17 units AOA for field landings with wings aft of 50°) and to evaluate handling/stall characteristics and waveoff performance.

Note

- Refer to emergency field arrestment guide for maximum engagement speed if field arrestment is desired.
- Refer to Figure 11-1 for approach airspeeds.

7. Fly straight-in approach at 15 units AOA (up to 17 units for field landings with wings aft of 50°).

CAUTION

Nozzle clearance is reduced at elevated approach AOA. Ensure that a maximum of 17 units is maintained at touchdown.

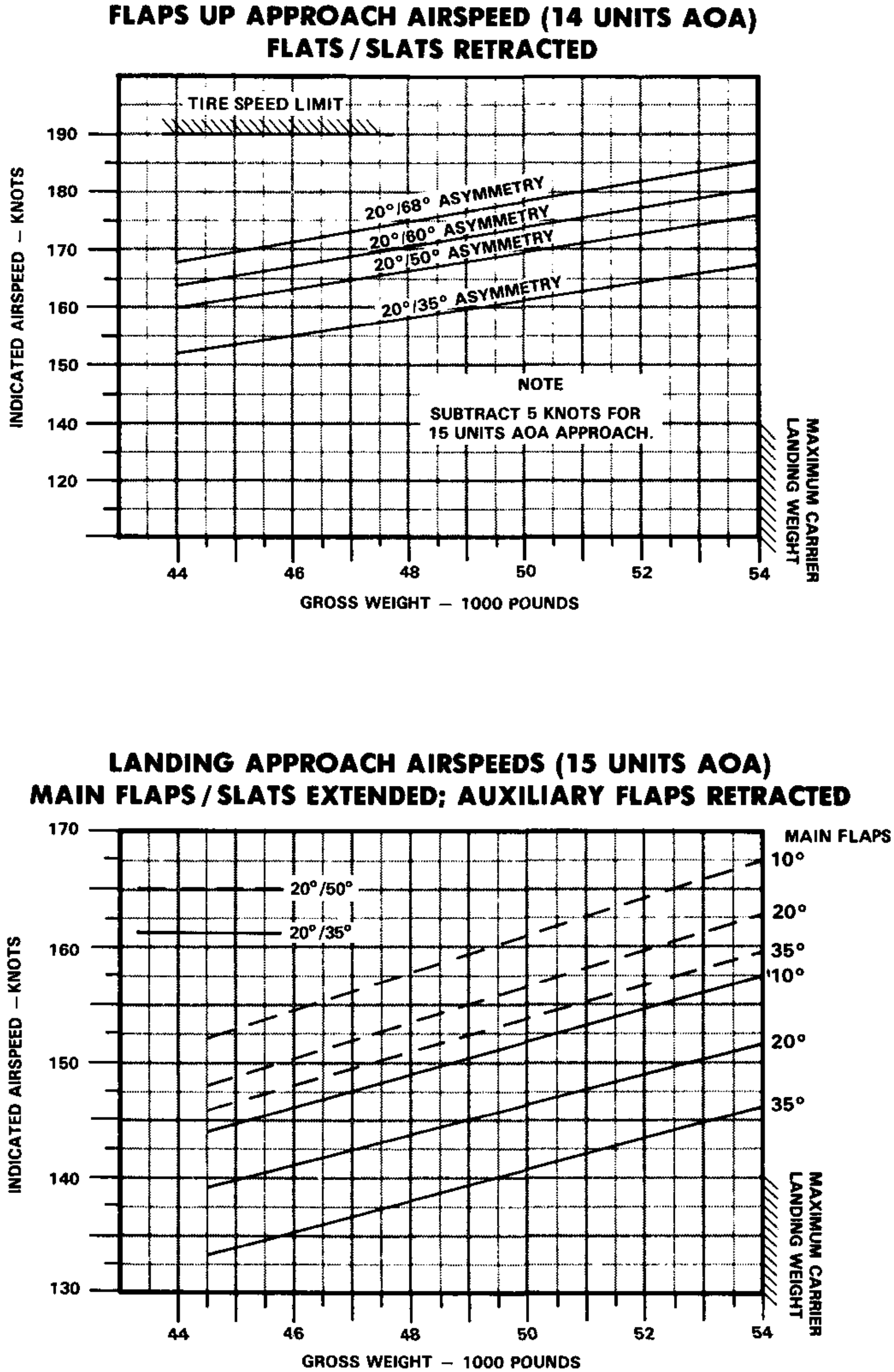
Note

Maximum airspeed for wheelbrake application is 165 knots at gross weight of 46,000 pounds and 145 knots at 51,000 pounds.

15.7.2 Asymmetric Wing Sweep. Refer to Chapter 11 for asymmetric wing-sweep design limitations and flight characteristics.

With asymmetric wing-sweep emergency condition, divert field landing is preferable to CV landing attempt. Aircrew must fully consider approach speed and aircraft controllability characteristics prior to attempting CV arrestment. See Figure 15-2 for recommended approach airspeed for 14 or 15 units AOA with asymmetric wing configurations.

DATE: AUGUST 1986
DATA BASIS: FLIGHT TEST



0-F50D-108-0

Figure 15-2. Asymmetric Wing-Sweep Landing Approach Airspeed

CAUTION

To preclude potential damage to aircraft, avoid all wing-sweep commands prior to performing steps 1 through 9. Limit maneuvering envelope to 350 knots and 1.5g's.

1. Leave wings and flaps as set.

2. Altitude — Climb/Remain Above 10,000 Feet AGL.

3. Airspeed — 250 Knots/Do Not Exceed 12 Units AOA.

4. Maneuver devices — Thumbwheel Manual Retract.

5. WING SWEEP DRIVE NO. 1 and WG SWP DR NO. 2/MANUV FLAP cb's — Pull (LD1, LE1).

6. ALPHA COMP/PEDAL SHAKER cb — Pull (RB1).

7. All SASs — ON.

Note

If roll SAS will not engage, accelerate and attempt to reset at approximately 20-knot intervals. Stick may have to be released laterally in order to reengage roll SAS.

8. Confirm left and right wing position.

Note

Wing-sweep tape indicates actual right-wing position. All other cockpit wing position indications may be unreliable, including wing-sweep handle position. Visually verify left-wing position.

If left wing is aft of 57°/62° spoiler cutout and right wing is 20°, perform Asymmetric Wing Sweep Unacceptable for Landing procedure, paragraph 15.7.2.2.

9. Perform preliminary controllability check as follows:

   a. Trim away from forward wing (opposite stick force) to ensure that maximum spoiler deflection is available.

   b. Assess spoiler function by controlled left- and right-stick inputs.

WARNING

Aircraft controllability in approach configuration with spoilers inoperative and a large wing-sweep asymmetry will range from difficult to impossible depending on split.

   c. Landing gear — Down.

   d. Leave flaps as set until further determinations are complete.

   e. Slowly increase AOA to no more than 15 units (attempt to maintain 0° sideslip).

   f. Make small lateral stick inputs to simulate line-up corrections.

If aircraft controllability is questionable for safe landing, perform Asymmetric Wing Sweep Unacceptable for Landing procedure, paragraph 15.7.2.2.

If aircraft controllability is safe for landing, perform Asymmetric Wing Sweep Acceptable for Landing procedure, paragraph 15.7.2.2.

15.7.2.1 Asymmetric Wing Sweep Acceptable for Landing. Establish final landing configuration as follows:

1. AUX FLAP/FLAP CONTR cb — Pull (8G3).

Note

Pulling the AUX FLAP/FLAP CONTR cb (8G3) with the emergency WING SWEEP handle at the 20° position disables wing-sweep commands.

If both wings are forward of 50°:

   a. Airspeed — Below 225 Knots.

CAUTION

Extending the main flaps with either wing aft of 50° could result in damage to both the flaps and the aft fuselage.

   b. Flaps — Lower Incrementally 20° to 25°.

CAUTION

When flaps are set greater than 25°, lateral pilot-induced oscillations are likely and may result in wingtip damage at touchdown and/or hard landings.

Note

The 25° flap position can be established by first noting when the spoiler position indicators switch to the drooped position during flap extension. An uncommanded but controllable roll transient because of spoiler gearing change will also occur. Upon observing either event, retract the flaps to just less than 25°. The roll transient will occur in the opposite direction as the flaps pass through 25°. Main flap extension without auxiliary flaps will require greater than normal aft stick trim.

c. Approach airspeed — 15 Units AOA.

Note

Indicated AOA is subject to a 1- to 2-unit sideslip-induced error. Verify proper AOA at zero sideslip.

If either wing is aft of 50°:

a. Flaps — UP.

b. Approach airspeed — 14 Units AOA.

CAUTION

Wing rock and wing stall may occur at 16 to 16-1/2 units AOA during flaps-up approaches. Rapid lateral stick inputs will result in pitch coupling. Excessive descent rates may develop and/or wingtip damage at touchdown may occur. Precise AOA control and smooth lateral control inputs are required.

Note

Indicated AOA is subject to a 1- to 2-unit sideslip-induced error. Verify proper AOA at zero sideslip.

2. Emergency WING SWEEP handle — Leave in Position that Established Satisfactory Controllability.

3. Gross weight — Reduce as Required.

4. DLC — Stowed.

5. Autothrottles (APC) — Do Not Engage.

6. Confirm flight characteristics by flying simulated landing approach at safe altitude, to include lineup corrections, power changes, and waveoff.

CAUTION

Full spoiler authority will be required for landing with large wing-sweep asymmetry. Before attempting actual approach, trim away from the forward wing (opposite stick forces) to ensure maximum spoiler deflection is available.

7. Fly straight-in approach to arrested or normal landing.

CAUTION

Avoid rapid lateral stick inputs, as significant pitch-roll coupling may result in roll ratcheting, pitching motion, and lateral PIO tendency; an excessive descent rate may develop and/or wingtip damage at touchdown may occur.

Note

- A crosswind from the swept-wing side is favorable while a crosswind from the forward-wing side is unfavorable.

- To reduce lateral stick force, the landing approach can be flown with rudder trim into the forward wing, allowing aircraft to yaw into the forward wing. Sideslip should be reduced with rudder just prior to touchdown.

Note

- If desired, sideslip can be reduced to zero with rudder at the beginning of the approach and held to touchdown. Lateral stick force increases as sideslip is reduced. Method of approach is at pilot's option.
- In the event of bolter or go-around, as airspeed increases, the aircraft will roll toward the swept wing and yaw toward the forward wing.
- Maximum airspeed for wheelbrake application is 165 knots at gross weights of 46,000 pounds and 145 knots at 51,000 pounds.

15.7.2.2 Asymmetric Wing Sweep Unacceptable for Landing

WARNING

Efforts to improve controllability by attempting to minimize or eliminate wing-sweep mismatch could result in an acceptable condition becoming unacceptable.

Note

Once spoiler operation is assessed, stick forces may be trimmed to reduce pilot workload during transit to field or CV. The use of lateral trim to reduce stick forces during actual approach and landing should be avoided as this reduces the spoiler deflection available for roll control.

1. Flaps — UP.
2. AUX FLAP/FLAP CONTR cb — In (8G3).

- At any point during the following procedures, if wing-sweep symmetry is regained at aft wing-sweep position and runway length/approach speed permit, aircrew may elect to perform Aft Wing-Sweep Landing emergency procedure, paragraph 15.7.1.
- If left wing is jammed, wing-sweep command can result in right wing driving to either 19° (forward command) or 69° (aft command) actuator overtravel stop. Subsequent wing-sweep commands may not move the right wing.

If spoilers are operational:

a. Emergency WING SWEEP handle — Input a Small Forward Command.

If spoilers are not operational:

a. Emergency WING SWEEP handle — Input a Small Aft Command.

3. Note movement of left and right wings and attempt to regain wing-sweep asymmetry by using the following wing-sweep commands.

If both wings are moveable and left wing is forward of right wing:

a. Airspeed — 300 Knots.

b. Emergency WING SWEEP handle — 68°.

c. Emergency WING SWEEP handle — 20°.

d. AUX FLAP/FLAP CONTR cb — Pull (8G3).

e. Repeat preliminary landing controllability check (step 9 of paragraph 15.7.2).

If both wings are moveable and right wing is forward of left wing:

a. Emergency WING SWEEP handle — 20°.

b. AUX FLAP/FLAP CONTR cb — Pull (8G3).

c. Repeat preliminary landing controllability check (step 9 of paragraph 15.7.2).

If right wing is jammed and left wing is moveable:

a. Airspeed — 300 Knots.

Note

If right wing is jammed aft of spoiler cutout angle, matching left wing will result in loss of spoiler control. If this reduced lateral control is undesirable, left wing should be commanded just forward of spoiler cutout to regain spoiler control.

b. Emergency WING SWEEP handle — Match Left Wing to Right-Wing Position.

c. AUX FLAP/FLAP CONTR cb — Pull (8G3).

d. Repeat preliminary landing controllability check (step 9 of paragraph 15.7.2).

If left wing is jammed and spoilers are operational:

a. Emergency WING SWEEP handle — 20°.

b. AUX FLAP/FLAP CONTR cb — Pull (8G3).

c. Repeat preliminary landing controllability check (step 9 of paragraph 15.7.2).

If left wing is jammed aft of spoiler cutout wing-sweep angle and spoilers are inoperative:

a. Airspeed — 300 Knots.

b. Emergency WING SWEEP handle — 68°.

c. AUX FLAP/FLAP CONTR cb — Pull (8G3).

d. Repeat preliminary landing controllability check (step 9 of paragraph 15.7.2).

If final wing configuration is unsafe for landing:

a. Prepare for and execute controlled ejection.

15.8 AFT HUNG ORDNANCE LANDINGS

The normal NATOPS cg ZFGW limit for tunnel-mounted stores is 17.0 percent. On a typical fleet aircraft, one Mk 84 2,000-pound bomb placed on station No. 4 or 5 results in a ZFGW cg aft of 17.0 percent MAC, possibly as far aft as 18.5 to 19.0 percent MAC. Two aft hung Mk 84s can produce a ZFGW cg of up to 22 percent MAC. These aft cg locations reduce the normal static stability of the F-14, producing a marked degradation in landing flying qualities. Aft wing sweep can be used to restore the normal static longitudinal stability margin, regaining normal flying qualities even with extremely aft cg locations.

Aircrew may have difficulty detecting aft hung ordnance following bomb release. The only cockpit indication of an unsuccessful release will be a hot trigger light that remains illuminated following the intended release of all selected stations. With MA ARM ON, individually selecting stations will illuminate the HOT TRIG light when the hung station is selected. Obtain a visual check if possible to validate this check as failures of the stores-aboard switch regularly occurred during flight test and will indicate hung stores when none actually exists.

In-flight actual cg location varies as fuel is burned but remains relatively constant at its most forward position between 5,000 to 10,000 pounds. Below 5,000 pounds, the cg moves aft towards the ZFGW position. Landing should be accomplished at 5,000 pounds of fuel or more if possible. Wing-mounted AIM-7/9s move the cg location slightly forward and have no adverse effects on flying qualities. External tanks produce no change to the cg location and also have no adverse effects. Combinations of forward and aft stores will produce a cg change slightly less than considering the difference as hung on the aft stations alone (i.e., the cg location with 2,000 pounds forward and 4,000 pounds aft will be slightly more forward than 2,000 pounds aft alone).

Flying qualities at aft cg locations with gear and flaps up are only slightly degraded. This degradation will probably not be apparent to the pilot. Stick force per g remains relatively nominal even with 4,000 pounds of aft hung bombs. No change in flying qualities is noted during dive recoveries between 400 and 500 KCAS. At 20° of wing sweep with the gear and flaps down and an aft cg, the aircraft is extremely susceptible to pilot-induced oscillations during closely controlled tasks such as flying the ball. Loss of control is likely.

The transition to landing configuration should be performed in straight-and-level flight to allow handling qualities to be evaluated in benign conditions. Wings should be swept to the desired position before the gear and flaps are lowered. The AUX FLAP/FLAP CONTR (8G3) cb should be pulled in case of a wing/flap interlock failure and also to prevent the auxiliary flaps from deploying if 20° of wing sweep is inadvertently selected. Sweeping the wings with auxiliary flaps retracted results in significant pitch-trim changes. A straight-in approach should be flown as power requirements with aft wing sweep in a turn are significantly different than normal and could produce a severely underpowered approach. Once established in the optimum wing-sweep configuration appropriate for the amount of ordnance hung on the aft stations, normal approach techniques can be used. No abnormalities in aircraft response or performance are apparent during landing approaches at 15 units, even with 4,000 pounds of aft hung ordnance. APC is not optimized for aft wing-sweep landings and should not be used. DLC should not be used as it adds 8 knots to recovery WOD requirements and has improper pitch trim response at aft wing sweep. Expect onspeed airspeed for 25° of wing sweep to increase 6 knots over the normal DLC on, 20° of wing-sweep approach speed, and a 12-knot increase if wings are at 30°. For CV arrestments, the appropriate recovery bulletin should be consulted.

Ashore, a field arrestment is recommended with spoiler brakes dearmed because of the large noseup pitch occurring at spoiler deployment. If a field arrestment is not possible, expect to use full forward stick to counter the noseup pitching moment and to maintain forward stick until below 80 KCAS with a resultant longer rollout.

15.8.1 Landing with Aft Hung Ordnance

1. Determine location of hung stores. Obtain visual check if possible.
2. Wing sweep — Set at 25° if ≤ 2,000-Pounds Hung Aft; Set at 30° if > 2,000 Pounds Hung Aft.
3. Perform transition to gear-down configuration in straight-and-level flight.
4. AUX FLAP/FLAP CONTR cb — Pull (8G3)
5. Flaps — Full DN.
6. Fly straight-in approach at 15 units AOA. Do not engage APC or DLC.

CV approach:

7. Perform CV arrestment in accordance with applicable recovery bulletin.

Field approach:

7. Spoiler brake — OFF.
8. Perform field arrestment.

Note

Refer to emergency arrestment guide for maximum engagement speed.

If arresting gear is not available.

8. If field arrestment is not available, spoiler brake — BOTH.

WARNING

Expect a significant nose pitchup during landing rollout as spoilers deploy. Full forward stick may be required to avoid a tail strike.

15.9 FIELD ARRESTMENTS

15.9.1 Field Arresting Gear. The types of field arresting gear in use include the anchor chain cable, water squeezer, and Morest-type equipment. All require engagement of the arresting hook in a cable pendant rigged across the runway. Location of the pendant in relation to the runway will classify the gear as follows:

1. Short-field gear — Located 1,500 to 2,000 feet past approach end of runway. Usually requires prior notification in order to rig for arrestment.
2. Midfield gear — Located near the halfway point of the runway. Usually requires prior notification in order to rig for arrestment in the direction desired.
3. Abort gear — Located 1,500 to 2,500 feet short of the departure end of the duty runway and usually rigged for immediate use.
4. Overrun gear — Located shortly past the upwind end of the duty runway. Usually rigged for immediate use.

Some fields will have all types of gear, others none. For this reason, it is imperative that all pilots be aware of the type, location, and compatibility of gear in use with the aircraft, and the policy of the local air station with regard to which gear is rigged for use and when.

As various modifications to the basic types of arresting gear are made, exact speeds will vary accordingly. Certain aircraft service changes may also affect engaging speed and weight limitations.

CAUTION

An engagement in the wrong direction into chain gear can severely damage the aircraft.

In general, arresting gear is engaged on the centerline at as slow a speed as possible. Burn or dump down to an acceptable landing weight. Conditions permitting, make practice passes to accurately locate the arresting gear. Engagement should be made with feet off the brakes, shoulder harness locked, and with the aircraft in a three-point attitude. After engaging the gear, good common sense and existing conditions dictate whether to keep the engines running or to shut down and egress the aircraft.

In an emergency situation, first determine the extent of the emergency by whatever means are available (instruments, other aircraft, LSO, RDO, tower or other ground personnel). Next, determine the most advantageous arresting gear available and the type of arrestment to be made under the conditions. Whenever deliberate field arrestment is intended, notify control tower personnel as much in advance as possible and state estimated landing time in minutes.

If gear is not rigged, it will probably require 10 to 20 minutes to prepare. If foaming of the runway or area of arrestment is required or desired, it should be requested by the pilot at this time.

If fuel is streaming from the bottom of the aircraft, a field arrested landing is not recommended because of the high probability of sparks and heat from the arresting hook igniting the streaming fuel and air mixture. If an arrested landing is mandated because of the lack of adequate braking or runway conditions, an effort should be made to foam the runway in the runout area of the arresting gear.

15.9.2 Short-Field Arrestment. If at any time before landing a directional control problem exists or a minimum rollout is desired, a short-field arrestment should be made and the assistance of LSO requested. The LSO should be stationed near the touchdown point and equipped with a radio. Inform the LSO of the desired touchdown point. A constant glideslope approach to touchdown is permitted (mirror or Fresnel lens landing aid) with touchdown on centerline at or just before the arresting wire with the hook extended. The hook should be lowered while airborne and a positive hook-down check should be made. Use midfield gear or Morest-type, whenever available. If neither is available, use abort gear. Use an approach speed commensurate with the emergency experienced. Landing approach power will be maintained until arrestment is assured or a waveoff is taken. Be prepared for a waveoff if the gear is missed. After engaging the gear, retard the throttles to IDLE or secure engines and abandon aircraft, depending on existing conditions.

15.9.3 Long-Field Arrestment. The long-field arrestment is used when a stopping problem exists with insufficient runway remaining (that is, aborted takeoffs, icy or wet runways, loss of brakes after touchdown, etc.). Lower the hook, allowing sufficient time for it to extend fully before engagement (normally 1,000 feet before reaching the arresting gear). Do not lower the hook too early and weaken the hook point. Line up the aircraft on the runway centerline. Inform the control tower of your intentions to engage the arresting gear, so that aircraft landing behind you may be waved off. If leaving the runway is inevitable, secure the engines.

15.9.4 Engaging Speeds. The maximum permissible engaging speed, gross weight, and off-center engagement distance for field arrestment are listed in Figure 15-3. The data in the long-field landing columns may be used for lightweight aborted takeoff where applicable; data in the aborted takeoff columns may be used for heavy gross weight landings.

As various modifications to the basic types of arresting gear are incorporated, engaging speeds or gross-weight limitations may change. For this reason and for more detailed information, the applicable aircraft recovery bulletin should be consulted.

15.10 BARRICADE ARRESTMENT

1. External stores — Jettison (except AIM-7 or AIM-54 on fuselage stations if wing is at full forward sweep).

2. External tanks — Jettison (empty tanks retained only for landing gear malfunction).

3. Fuel — Dump or burn (reduce to 2,000 pounds).

4. HOOK — DN (Lower to permit engagement of a cross-deck pendant, which will minimize barricade engagement speed and damage to aircraft).

5. Fly normal pattern and approach, on-speed, angle of attack, centerline, and meatball.

Note

Anticipate loss of meatball for a short period of time during the approach. Barricade stanchions may obscure the meatball.

Upon engaging the barricade:

6. Throttles — OFF.

7. Evacuate aircraft as soon as practical.

TYPE OF ARRESTING GEAR	MAXIMUM ENGAGING SPEED (KNOTS) (D)											MAXIMUM OFF-CENTER ENGAGEMENT (FT)
	GROSS WEIGHT X 1,000 POUNDS											
	SHORT-FIELD LANDING (K)(L)					LONG-FIELD LANDING (M)		ABORTED TAKEOFF (A)				
	40	44	48	51.8	54	57	60	64	68	69.8	72	
E-28	176 (B)	180	179	178	177	176	175	174	172	172	171	40
E-28 (G)	176 (B)	176	160	160	160	160	156	145	145	145	145	40
M-21	130	130	130	130	125	125	120	115	115	115	113	10
BAK-9	160	160	160	155	150	144	138	131	124	122	118	30
BAK-12 (H)	160	160	159	146	137	118	(J)	(J)	(J)	(J)	(J)	50
DUAL BAK-12 (C)	160	160	160	160	160	160	160	160	160	160	160	30
BAK-13	160	160	160	160	160	160	160	160	160	160	160	40

(A) Data provided in aborted takeoff column may be used for emergency high gross weight arrestment.

(B) Maximum engaging speed limited by aircraft limit horizontal-drag load factor (mass item limit "g").

(C) Dual BAK-12 limits are based on 150- to 300-foot span, 1-1/4-inch cross-deck pendant, 50,000-pound weight setting, and 1,200-foot runout. No information is available regarding applicability to other configurations.

(D) Maximum engaging speed is limited by arresting gear capacity except as noted.

(E) Off-center engagement may not exceed 25 percent of the runway span.

(F) Before making an arrestment, the pilot must check with the air station to confirm the maximum engaging speed because of a possible installation with less than minimum required rated chain length.

(G) Only for the E-28 systems at Keflavik and Bermuda with 920-foot tapes.

(H) Standard BAK-12 limits are based on 150-foot span, 1-inch cross-deck pendant, 40,000-pound weight setting, and 950-foot runout. No information is available regarding applicability to other configurations.

(J) Engaging speed limit is 96 knots at 59,000 pounds. Because of runout limitations, it it recommended this gear not be engaged at weights greater than 59,000 pounds.

(K) Maximum of 3.0° glideslope.

(L) Consult appropriate section for recommended approach speed.

(M) Flared or minimum rate of descent landing.

Figure 15-3. Emergency Field Arrestment Guide (Sheet 1 of 2)

AIRCRAFT ENGAGING SPEED LIMITS FOR E-5 EMERGENCY ARRESTING GEAR

AIRCRAFT: F-14 D

ARRESTING GEAR RATING	SHORT-FIELD LANDING UP TO 54,000 POUNDS				LONG-FIELD LANDING UP TO 60,000 POUNDS				ABORTED TAKEOFF 60,100 TO 72,000 POUNDS			
	STANDARD CHAIN		HEAVY CHAIN		STANDARD CHAIN		HEAVY CHAIN		STANDARD CHAIN		HEAVY CHAIN	
	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3	E-5 E-5-2	E-5-1 E-5-3
COL. 1	COL. 2	COL. 3	COL. 4	COL. 5	COL. 6	COL. 7	COL. 8	COL. 9	COL. 10	COL.11	COL.12	COL.13
300 to 349	39 (D)	39 (D)	40 (D)	40 (D)	37 (D)	37 (D)	38 (D)	38 (D)	33 (D)	33 (D)	34 (D)	34 (D)
350 to 399	45 (D)	45 (D)	47 (D)	47 (D)	43 (D)	43 (D)	44 (D)	44 (D)	39 (D)	39 (D)	40 (D)	40 (D)
400 to 449	51 (D)	51 (D)	54 (D)	54 (D)	48 (D)	48 (D)	51 (D)	51 (D)	44 (D)	44 (D)	47 (D)	47 (D)
450 to 499	57 (D)	57 (D)	61 (D)	61 (D)	54 (D)	54 (D)	58 (D)	58 (D)	49 (D)	49 (D)	53 (D)	53 (D)
500 to 549	63 (D)	63 (D)	68 (D)	68 (D)	60 (D)	60 (D)	65 (D)	65 (D)	55 (D)	55 (D)	59 (D)	59 (D)
550 to 599	69 (D)	69 (D)	76 (D)	76 (D)	65 (D)	65 (D)	72 (D)	72 (D)	60 (D)	60 (D)	66 (D)	66 (D)
600 to 649	75 (D)	75 (D)	84 (D)	84 (D)	71 (D)	71 (D)	79 (D)	79 (D)	65 (D)	65 (D)	73 (D)	73 (D)
650 to 699	81 (D)	81 (D)	91 (D)	91 (D)	77 (D)	77 (D)	87 (D)	87 (D)	71 (D)	71 (D)	79 (D)	79 (D)
700 to 749	87 (D)	87 (D)	99 (D)	99 (D)	83 (D)	83 (D)	94 (D)	94 (D)	76 (D)	76 (D)	86 (D)	86 (D)
750 to 799	93 (D)	93 (D)	107 (D)	107 (D)	89 (D)	89 (D)	102 (D)	102 (D)	82 (D)	82 (D)	93 (D)	93 (D)
800 to 849	99 (D)	99 (D)	115 (D)	115 (D)	94 (D)	94 (D)	109 (D)	109 (D)	87 (D)	87 (D)	100 (D)	100 (D)
850 to 899	105 (D)	105 (D)	123 (D)	123 (D)	100 (D)	100 (D)	117 (D)	117 (D)	93 (D)	93 (D)	107 (D)	107 (D)
900 to 949	111 (D)	111 (D)	131 (D)	131 (D)	106 (D)	106 (D)	125 (D)	125 (D)	98 (D)	98 (D)	114 (D)	114 (D)
950 to 999	117 (D)	117 (D)	140 (D)	140 (D)	112 (D)	112 (D)	133 (D)	133 (D)	104 (D)	104 (D)	121 (D)	121 (D)
1,000 to 1,049	123 (D)	123 (D)	148 (D)	148 (D)	118 (D)	118 (D)	140 (D)	140 (D)	109 (D)	109 (D)	129 (D)	129 (D)
1,050 to 1,099	129 (D)	129 (D)	150 (D)	156 (D)	123 (D)	123 (D)	148 (D)	148 (D)	115 (D)	115 (D)	136 (D)	136 (D)
1,100	135 (D)	135 (D)	150 (D)	165 (D)	129 (D)	129 (D)	150 (D)	156 (D)	120 (D)	120 (D)	143 (D)	143 (D)
NOTES (E) AND (F) APPLY												

Figure 15-3. Emergency Field Arrestment Guide (Sheet 2 of 2)

WARNING

Weight limits for barricade engagement are as follows:

a. Wings at 20° — 51,800 pounds (maximum).

b. Wings > 20° < 35° — 46,000 pounds (maximum).

c. Wings 35° — Not permitted.

15.11 ARRESTING HOOK EMERGENCY DOWN

1. HOOK handle — DN.

2. HOOK handle — Pull, Then Rotate.

Note

Pull handle aft approximately 4 inches and turn counterclockwise. This will mechanically release the uplatch mechanism and allow hook to extend.

3. Hook transition light — Check OFF.

If light is illuminated and hook visually is checked up:

4. HOOK handle — Restow in Down Position.

5. HYD VALVE CONTR cb — Pull and Reset After 5 Seconds (8E5).

If light is illuminated and hook visually is checked down:

6. WSHLD AIR/ANTI-ICE HOOK CONT cb — Pull (8C2).

Note

Cb 8C2 also controls windshield air and anti-ice.

15.12 FORCED LANDING

Landing the aircraft on unprepared surfaces is not recommended. If it is necessary to do so, landing with the landing gear down, regardless of the terrain, will assist in absorbing the shock of ground impact and reduce possibility of flightcrew injuries. External stores should be jettisoned in a safe area prior to touchdown. External tanks should be jettisoned if they contain fuel, but retained to absorb landing shock if they are empty. If time permits, dump fuel to allow touchdown at the slowest possible speed with full flaps.

CHAPTER 16

Ejection

16.1 EJECTION

Responsibility for the decision to eject shall be determined and briefed before flight. Thereafter the decision to abandon the aircraft shall rest with the crewmember assigned responsibility for that particular situation. The decision should be made before sink rate, altitude, and attitude conditions jeopardize safe ejections for both occupants. In flight, the aircraft must be abandoned by means of the ejection seats since there is no provision for manual bailout. Prior to ejection from a flyable or controllable aircraft, it is the pilot's responsibility to do everything reasonable to ensure that the abandoned aircraft will inflict the least possible damage on impact.

Ejection may be necessary as a result of fire, engine failure, structural failure, midair collision, or when the aircraft becomes uncontrollable. In each case, the pilot must decide when to eject, using the following as a guide:

1. Ejection is mandatory under the following conditions except when unusual circumstances clearly indicate to pilot that cause of safety to self and others will be better served by a flameout approach than by ejection.

   a. Serious, uncontrolled fire.

   b. If aircraft is in uncontrolled flight at 10,000 feet AGL or below.

   c. When dual-engine flameout occurs below 1,500 feet AGL and 250 knots.

   d. If repeated relight attempts are not successful between 30,000 and 10,000 feet, eject by 10,000 feet AGL.

   e. If still on first or second relight attempt when passing through 10,000 feet AGL and it appears that a relight is likely, airstart attempt may be continued to a minimum of 5,000 feet AGL.

2. If dual-engine flameout occurs below 10,000 feet, zoom to convert excess airspeed to altitude. Attempt airstart as time permits. If peak altitude is above 5,000 feet AGL and airstart attempt is not successful, eject no lower than 5,000 feet AGL. If peak altitude is below 5,000 feet AGL and airstart attempt is made during zoom and there is no evidence of a relight, eject at peak altitude. If no airstart attempt is made, eject at peak altitude.

3. If decision to abandon aircraft is made at high altitude, the recommended minimum altitude for ejection is 10,000 feet AGL, or higher, if conditions so indicate. Under any circumstances and if at all possible, ejection should be accomplished prior to descending below 2,000 feet AGL.

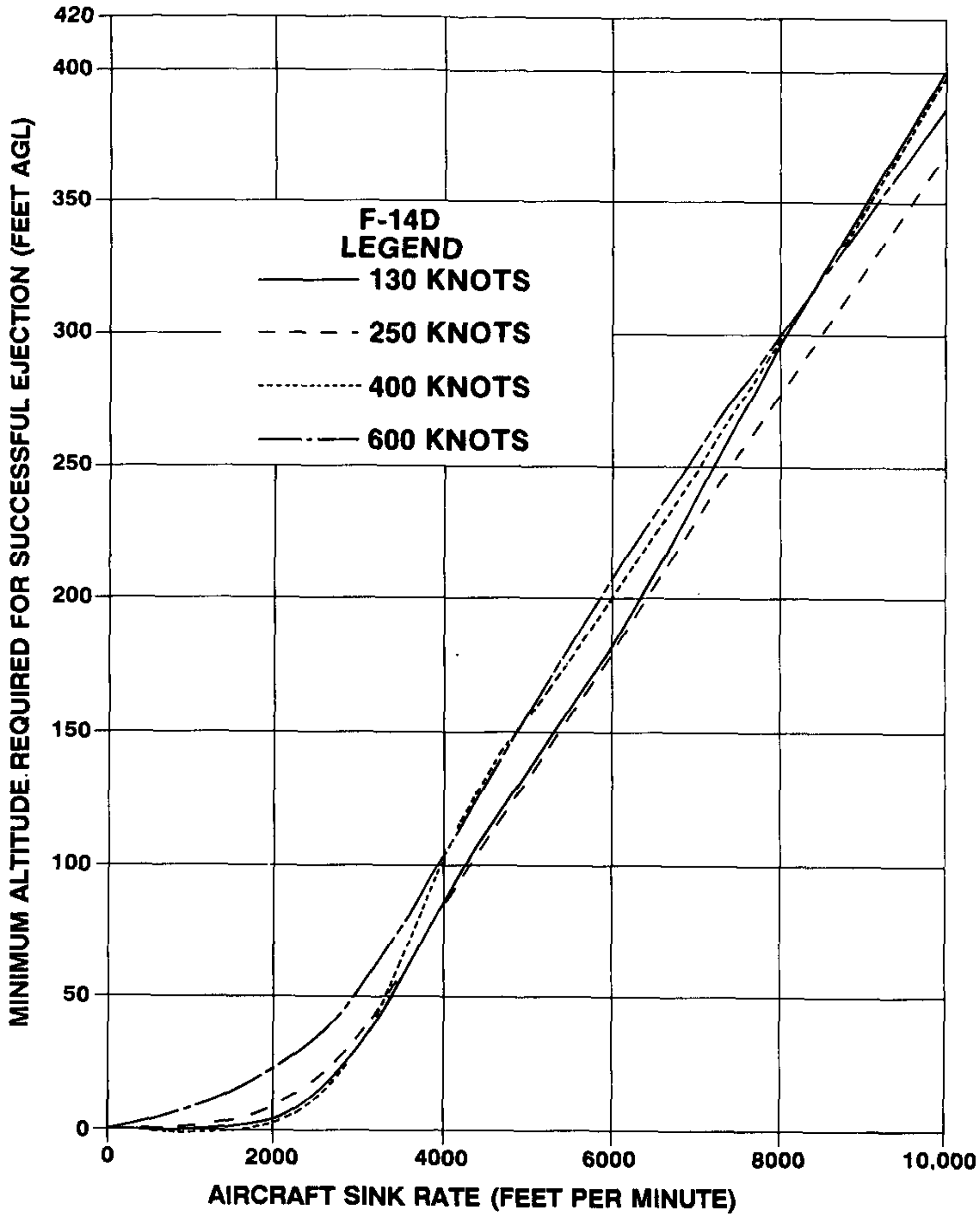
16.1.1 Ejection Envelope. Figure 16-1 shows minimum ejection altitude for a given airspeed and sink rate, bank angle, and dive angle. For all ejections, it is recommended that airspeed be reduced as slow as practicable; however, in uncontrolled situations, do not delay ejection because the aircraft is not within the published safe escape envelope. For ejection at low altitude, it is recommended that a climb be initiated to convert excess airspeed into altitude. Although the escape system is capable of zero-zero ejection, it should be borne in mind that a combination of low airspeed and high rate of descent at low altitude can present a condition more severe than zero-zero. Ejection sequences are shown in FO-16 and FO-17. For details of ejection seat mechanical operation, see paragraph 2.38.

The escape system will function up to 600 knots; however, human limitations are more restrictive as indicated below:

1. Zero to 350 knots — Safe Ejection (injury improbable).

2. 350 to 450 knots — Hazardous Ejection (injury may be sustained).

MINIMUM EJECTION ALTITUDE
AIRSPEED AND SINK RATE EFFECTS



NOTES
1. MINIMUM EJECTION HEIGHTS ARE BASED ON INITIATION OF THE ESCAPE SYSTEM, AND THE TIME REQUIRED FOR A COMPLETE DUAL SEQUENCED EJECTION IS INCLUDED.
2. PILOT REACTION TIME IS NOT INCLUDED.
3. EJECTION ALTITUDE IS BELOW 5,000 FEET MSL.

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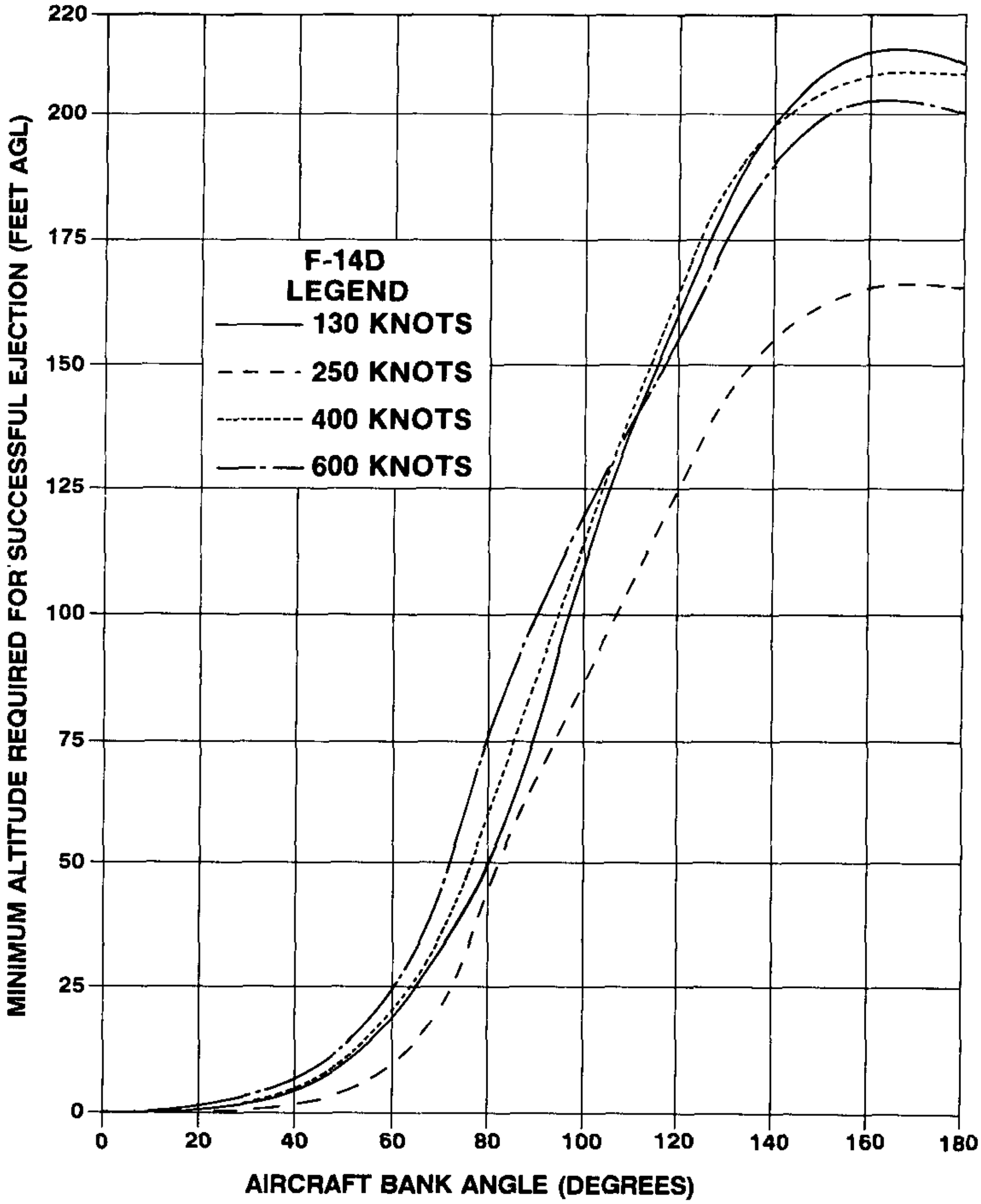
Figure 16-1. Minimum Ejection Altitude (Sheet 1 of 3)

MINIMUM EJECTION ALTITUDE

AIRSPEED AND BANK ANGLE EFFECTS



NOTES
1. MINIMUM EJECTION HEIGHTS ARE BASED ON INITIATION OF THE ESCAPE SYSTEM, AND THE TIME REQUIRED FOR A COMPLETE DUAL SEQUENCED EJECTION IS INCLUDED.
2. BANK ANGLE DATA IS FOR COORDINATED FLIGHT. YAW OR SLIP WILL INCREASE THE HEIGHT REQUIRED FOR RECOVERY.
3. PILOT REACTION TIME IS NOT INCLUDED.
4. EJECTION ALTITUDE IS BELOW 5,000 FEET MSL.

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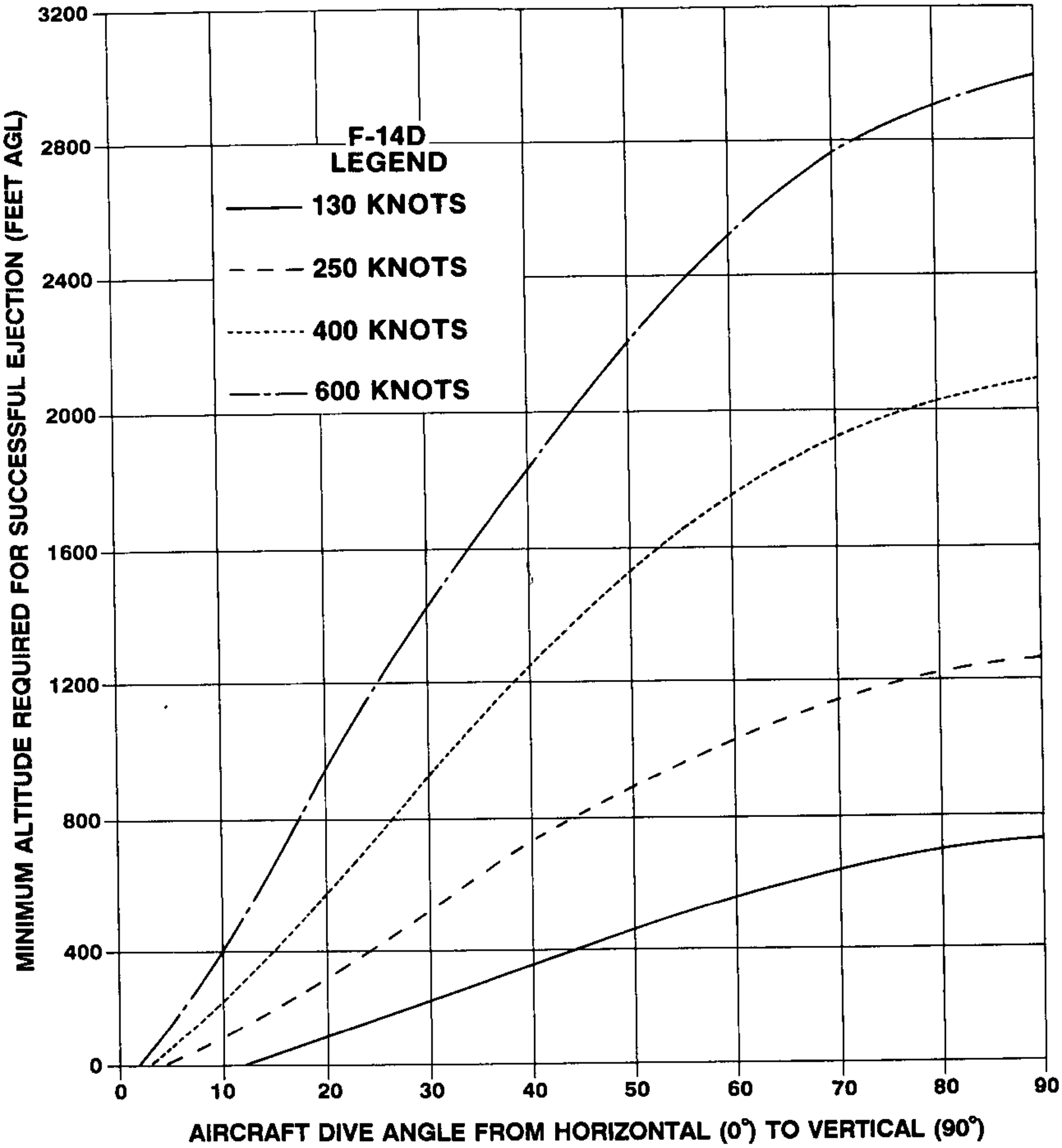
Figure 16-1. Minimum Ejection Altitude (Sheet 2 of 3)

MINIMUM EJECTION ALTITUDE

AIRSPEED AND DIVE ANGLE EFFECTS



NOTES:
1. MINIMUM EJECTION HEIGHTS ARE BASED ON INITIATION OF THE ESCAPE SYSTEM, AND THE TIME REQUIRED FOR A COMPLETE DUAL SEQUENCED EJECTION IS INCLUDED.
2. PILOT REACTION TIME IS NOT INCLUDED.
3. EJECTION ALTITUDE IS BELOW 5,000 FEET MSL.

0-F50D-472-3

Figure 16-1. Minimum Ejection Altitude (Sheet 3 of 3)

3. Above 450 knots — Extremely Hazardous (serious injury highly probable).

Usually, there will be enough time to do several things to prepare for a successful ejection prior to pulling the seat firing handle. However, when the emergency condition requiring ejection is such that ejection must be made without hesitation, simply grasp the handle and pull forcibly to the fullest extent until the seat ejects. If the seat fails to eject, immediately pull again. If the handle will not move, ensure that the ground safety pin has been removed and that the ARMED/SAFE handle is at ARMED before trying again. Ejection through the canopy is an automatic backup. There is no provision for manual bailout.

16.1.2 Ejection Preparation

WARNING

Never pull the manual override handle before ejection. Pulling the handle releases the crewmember from the seat and moves the ARMED/SAFE handle to SAFE, making it impossible to initiate ejection from the seat. Further, if ejection is initiated by the other crewmember, results could be fatal.

Time permitting, perform all or as much as possible of the following:

1. Place aircraft in safe envelope and attitude for ejection.
2. Warn other crewmember.
3. EJECT CMD lever — Select (RIO).
4. IFF/SIF — EMERG/7700 (RIO).
5. Position report — Transmit.
6. Check altimeter.

WARNING

- Positioning the legs aft prior to ejection will cause the spine to flex and will increase the possibility of spinal injury, and will also increase likelihood of seat/thigh slap with attendant leg injury.
- Proper body position is a critical factor in preventing ejection injuries.

7. Assume proper ejection position (see Figure 16-2).
   a. Head pressed back against headrest.
   b. Chin slightly elevated (10° up).
   c. Back straight.
   d. Hips against seat back.
   e. Thighs flat on seat survival kit.
   f. Outside of thighs pressed against side of seat.
   g. Elbows and arms pressed firmly against body.
   h. Feet on rudder pedals, heels on deck.
   i. Visor down, oxygen mask tightened, helmet secure.

16.1.3 Ejection Initiation. See Figure 16-3 for ejection initiation.

After the seat firing handle is pulled:

1. The harness retraction unit retracts the shoulder harness pulling the occupant to an upright position. The leg garters are retracted as the seat moves up the rail.
2. Ejection through the canopy is a backup method only; therefore, canopy is jettisoned as part of normal ejection sequence. Ejection through the canopy or out of the aircraft occurs after a delay if the normal sequence fails.
3. Seats eject individually and in opposite directions (pilot right, RIO left).

16.2 MANUAL BAILOUT

There is no provision for manual bailout. Ejection through the canopy is an automatic backup if the canopy fails to jettison or the safe and arm unit fails to fire.

16.3 SURVIVAL/POSTEJECTION PROCEDURES

Figure 16-4 describes step-by-step procedures for inflation of the LPA configured with beaded handles and the 35-gram CO_2 cylinder.

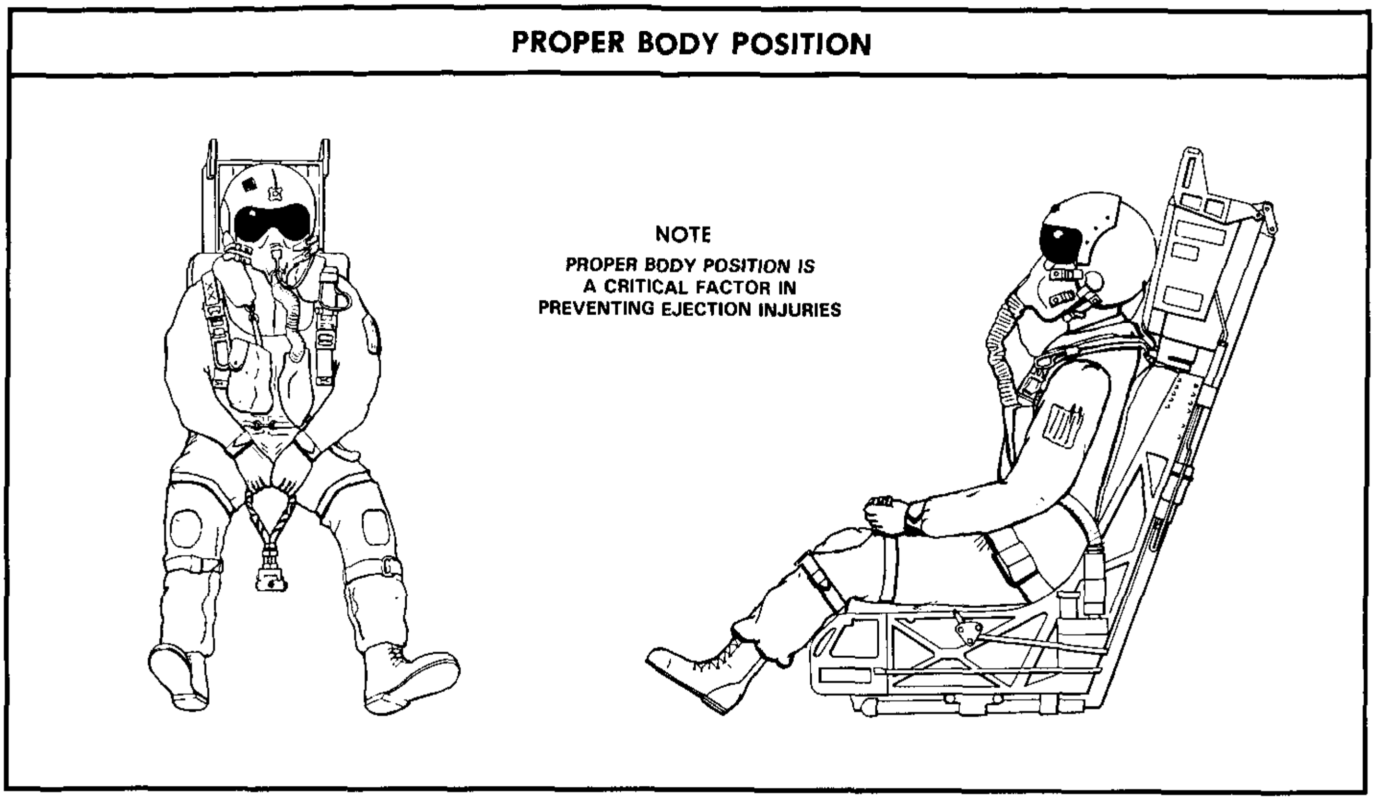
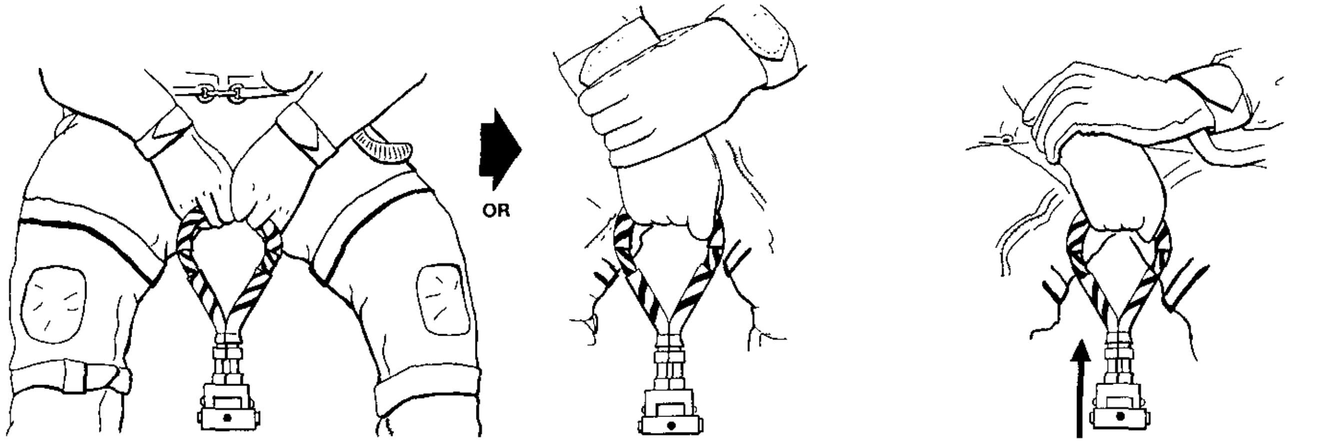


Figure 16-2. Proper Ejection Position

THERE ARE TWO ACCEPTABLE METHODS FOR EJECTION INITIATION: THE TWO-HAND GRIP AND THE SINGLE-HAND GRIP.



1. GRIP THE SEAT FIRING HANDLE WITH THE THUMB AND AT LEAST TWO FINGERS OF EACH HAND, PALMS TOWARD BODY AND ELBOWS CLOSE TO BODY.

1. GRIP HANDLE WITH STRONG HAND, PALM INWARD, GRIP WRIST OF STRONG HAND WITH OTHER HAND, PALM TOWARD BODY AND ELBOWS CLOSE TO BODY.

2. PULL HANDLE SHARPLY UP AND TOWARD ABDOMEN, KEEPING ELBOWS IN. ENSURE HANDLE IS PULLED TO END OF TRAVEL.

NOTE

IN LOW-ALTITUDE, LOW-AIRSPEED SITUATIONS, A ONE-HANDED METHOD, USING ONE HAND TO INITIATE EJECTION AND THE OTHER TO MAINTAIN THE AIRCRAFT IN THE SAFE OPERATING ENVELOPE OF THE EJECTION SEAT, MAY BE REQUIRED. PARTICULAR ATTENTION MUST BE PAID TO MAINTAINING PROPER HEAD, NECK, AND BODY POSITION.

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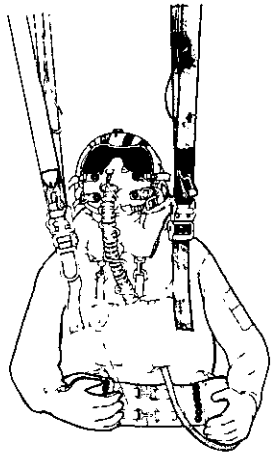
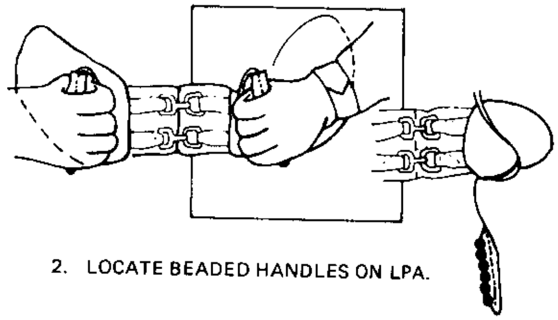
Figure 16-3. Ejection Initiation

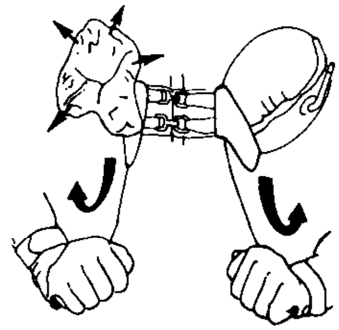
LPU INFLATION



1. IMMEDIATELY FOLLOWING OPENING SHOCK, CHECK CONDITION OF PARACHUTE. IF THERE IS NO DAMAGE/MALFUNCTION. . . . .



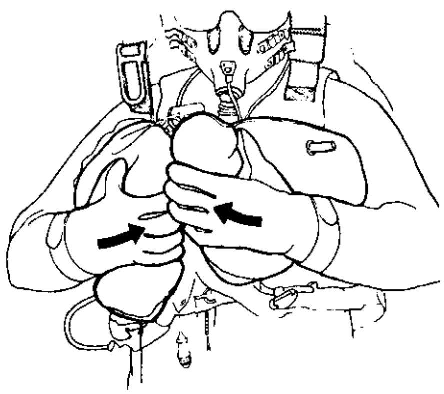
2. LOCATE BEADED HANDLES ON LPA.



3. PULL BEADED HANDLES DOWN AND STRAIGHT OUT TO INFLATE.

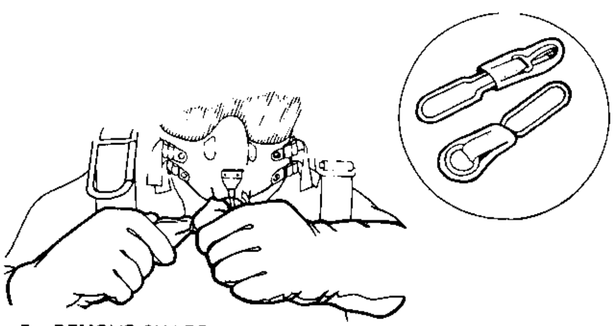
WARNING

ALTHOUGH THE FLU-8 AUTOMATIC INFLATION DEVICE IS DESIGNED TO INFLATE THE LPA UPON WATER CONTACT, MANUAL INFLATION REMAINS THE PRIMARY MODE OF OPERATION. AUTOMATIC ACTUATION IS INTENDED FOR DISABLED OR UNCONSCIOUS SURVIVORS OR IF THERE IS INSUFFICIENT TIME TO MANUALLY ACTIVATE THE LPA.

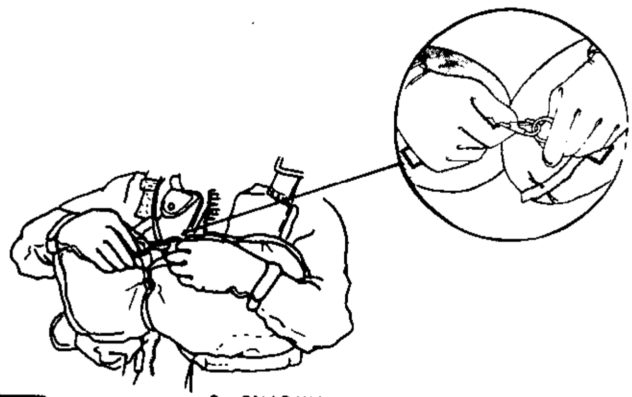


4. SQUEEZE LPA WAIST LOBES TOGETHER TO HELP RELEASE VELCRO ON COLLAR LOBE OR MANUALLY RELEASE VELCRO ON COLLAR, IF NECESSARY, TO ACHIEVE COMPLETE COLLAR LOBE INFLATION.

OPTIONAL PROCEDURE



5. REMOVE CHAFFING MATERIAL (WHEN REQUIRED) FROM WAIST LOBE SNAPS.



6. SNAP WAIST LOBES TOGETHER.

WARNING

FAILURE TO SNAP WAIST LOBES BEFORE WATER ENTRY MAY RESULT IN FACE DOWN FLOTATION.

0-F50D-262-1

Figure 16-4. Life Preserver Assembly Inflation

Note

LPA inflation may not be desirable over land.

The paragraphs that follow provide procedures applicable to the NACES seat. Additional post-ejection/survival procedures are to be found in the NATOPS Survival Manual, NAVAIR 00-80T-101.

WARNING

- Ejection at low altitude allows only a matter of seconds to prepare for landing. Over water, inflation of the LPA is the most important step to be accomplished. Release of the parachute quick-release fittings as the feet contact the water is the second most important step to prevent entanglement in the parachute shroud lines.

- When ejection is in the immediate vicinity of the carrier, parachute entanglement combined with wake and associated turbulence can rapidly pull a survivor under. The deployed seat survival kit may contribute to shroud-line entanglement. The survivor must be prepared to cut shroud lines that are dragging him down.

- The crashed aircraft may release large quantities of jet fuel and fumes that could hamper breathing and create a fire hazard if smoke or flare marker is present. The emergency oxygen system may be invaluable in this case and discarding the seat pan would terminate its use. However, totally discarding the seat pan may be appropriate after considering weather, sea conditions, and rescue potential.

Note

The variety and complexity of conditions encountered during the time-critical movements following a low-altitude, overwater ejection make it impossible to formulate procedures to cover every contingency.

16.3.1 Manual Man/Seat Separation. If below 14,000 feet and man/seat separation have not occurred, the procedure will have to be initiated manually. Locate the manual override handle on the right side of the seat bucket, depress the handle release button and pull handle sharply upward as far as possible. This fires a cartridge to activate the parachute deployment rocket and release the upper and lower harness locks. Man/seat separation occurs when the main parachute is extracted and deployed.

16.3.2 Survival Kit Deployment

Note

Survival kit deployment is not recommended in an overland ejection situation. The kit can be opened after landing by removing the closure pins from the cones.

With either hand, locate one of the deployment handles at the rear of the seat kit. Firmly pull on the handle until it is free of the kit and the survival package falls away on its dropline. The package remains attached to the kit lid by the dropline. At full dropline stretch, the liferaft is inflated automatically.

16.3.3 Parachute Steering. A gentle pull of approximately 6 inches on the left or right steering line (attached to the riser) will rotate the canopy to enable steering. Pulling on the left line steers left. The canopy will continue to rotate for a time after the steering line is released, so it is necessary to compensate for this lag by releasing the steering line before the desired direction is reached.

16.3.4 Parachute Landing Preparation. Preparations over land and over water are essentially the same except that over land the visor should be kept down, the gloves worn, and the survival kit should not be deployed. In low-level, overwater situations, the mask and regulator should be retained since they provide an underwater breathing capability. If there is time before a water landing, the gloves may be removed and stowed safely. This may make it easier to operate the canopy releases.

Try to determine the direction of the wind at the surface using white caps, smoke from the wreckage, or known surface winds in the vicinity. Note that surface winds may be quite different from those at altitude. When nearing the surface, steer into the wind and assume the proper body position for landing:

1. Feet together, knees slightly bent, toes pointed slightly downward.

2. Eyes on the horizon.

3. Grasp canopy risers and tuck elbows in prior to water entry.

4. On water entry, release the canopy manually. The SEWARS releases will operate the canopy release fittings on saltwater entry as a backup.

16.3.5 Raft Boarding

Note

- If the liferaft has not inflated automatically, pull on the red operating handle on the dropline to inflate.
- If the survival package has not been deployed before water entry, first pull the yellow deployment handle then the red operating handle.

When clear of the canopy, retrieve the raft by locating the dropline and pulling the raft to you. The raft retaining lanyard is in a pocket next to the CO_2 cylinder. Attach the end of the lanyard securely to the gated helo hoist ring on the harness, then ensure that the oxygen hose is disconnected from the kit lid and release the lapbelt quick-release fittings, releasing the kit lid. Bring the raft around for entry from the small end (stern); grasp the stern, and forcibly push under LPA waist lobes. Using the boarding handles, pull into the raft and turn into a comfortable, balanced, seated position. Locate the dropline and retrieve the survival package.

WARNING

Do not attempt to retrieve the kit lid. Any attempt to do so could capsize the raft.

Close the canopy and orally inflate the canopy and floor. An integral baler is provided to bale the raft as necessary.

PART VI

All-Weather Operations

Chapter 17 — Instrument Procedures

Chapter 18 — Extreme Weather

CHAPTER 17

Instrument Procedures

17.1 AUTOMATIC CARRIER LANDING SYSTEM

ACLS approaches apply to properly configured aircraft utilizing carrier or shore-based AN/SPN-10 or AN/SPN-42 ACLS radar facilities. Three primary modes of operation and two submodes are available.

1. Mode I approach automatically controlled to touchdown

2. Mode IA approach automatically controlled to a minimum of 200 feet and one-half mile; manual control remainder of approach

3. Mode II approach manually controlled using AN/SPN-41 or AN/SPN-42 vertical display indicator and/or heads-up display presentation for glideslope and lineup information

4. Mode III approach manually controlled using only CCA-controller-supplied information

5. Flight director approach manually controlled using HUD flight director presentation derived from AN/SPN-42/46 information and navigation system data for glidepath intercept and following.

17.1.1 Mode I. Mode I provides a fully automatic, hands-off landing capability, called automatic carrier landing or all-weather landing. The landing radar system (AN/SPN-42) tracks the aircraft and compares its position with the desired position. The aircraft position is corrected to fly the desired glidepath by commands from the naval tactical data system using the radar computer. These commands are transmitted over the UHF data link to the aircraft, where the automatic flight control system executes the pitch and bank commands. Additional ramp input commands tailored to each specific ship or field are applied at the proper time to assist the aircraft through the burble. In addition to control of the aircraft, discrete words and glideslope error signals are transmitted for cockpit displays to show the pilot where his aircraft is in relation to the desired glideslope. Independent glideslope error signals from the AN/SPN-41 instrument landing system may also be displayed. The pilot may take control at any time and continue the landing via Mode II.

17.1.2 Mode II. The control of the aircraft remains with the pilot along the entire glideslope to touchdown. Glideslope error signals are transmitted to the aircraft for cockpit displays from the AN/SPN-41 or the AN/SPN-42. The pilot flies the aircraft to null the error and to keep the vertical and lateral crosshairs centered. During a Mode II T approach, the final controller provides a Mode III-type talkdown to assist the pilot in flying his needles or for controller training.

17.1.3 Mode III. The pilot flies the aircraft in response to voice radio commands from the final controller to keep the aircraft on the proper glideslope. From the radar azimuth and elevation displays, the final controller determines the aircraft position with respect to the desired glidepath and gives guidance to the pilot.

17.1.4 Flight Director. The pilot flies the aircraft so that the FPM stays inside the flight director symbol on the HUD. The flight director symbol provides glideslope and centerline steering information computed by the mission computer using navigation system parameters and data-link information from the SPN-42/46 ACLS system. The box with the three dots provides the pilot with optimal glidepath intercept and following when the flightpath marker is inside the flight director box and the three dots are aligned with the wings and the tail of the flightpath marker. The horizontal deviation of the flight director symbol from the FPM represents the error between the commanded and actual bank angle. The vertical deviation represents the error between the commanded vertical rate. The flight director symbol also rotates an amount corresponding to the error between the bank command and the bank attitude to give an indication of the size of the bank correction required (primarily useful for following large bank commands during centerline captures). The vertical deviation is scaled on the HUD so that it gives an indication of the vertical flightpath angle correction required.

17.2 AIRCRAFT SUBSYSTEMS

Mode I (automatic) landings are possible only if the ACLS installation, including data link, AFCS, radar beacon and augmentor, inertial navigation system, and ACLS displays (MFD and/or HUD) are all fully operational. The approach power compensator should be used during the coupled portion of the approach. Mode II (manual) landings can be made using displayed crosspointer information from either the data link or the AN/ARA-63 receiver decoder, or both (providing dual displays).

17.2.1 Data Link. Data-link (link 4A) messages are received and transmitted by a UHF frequency-shift-key-modulated radio link. Data link receives control messages in serial form from the NTDS and processes each message as necessary. For ACL, the position error information is furnished to the MFD and/or HUD ACL steering indicator, discrete messages appear on MFDs 1 and 3, and control information is provided for the AFCS. Reply messages are transmitted to the NTDS with detailed information on aircraft heading, speed, altitude, fuel quantity, weapons, stores, and autopilot status.

The shipboard data link continuously transmits a universal test message and a monitor control message. When in operation, the UTM or MCM is used by the aircraft as a self-test feature. The aircraft data-link system self-test is performed by selecting AWL steering on the MFD. Only the pilot can deselect AWL steering from the MFD VDI format once selected.

Note

AWL steering is only available in the TLN mode. In A/A and A/G, the AWL pushbutton selection on the MFD VDI format is removed.

17.2.2 Automatic Flight Control System. The AFCS performs two functions: stability augmentation and autopilot.

Stability augmentation (STAB AUG) provides added stability to the aircraft and is, in general, necessary for effective aircraft control.

The autopilot ACL mode can be engaged only after engaging all STAB AUG axes and then by placing the AUTO PILOT ENGAGE switch in ON. Selection of ACL on the AFCS control panel arms the mode and displays the A/P REF advisory on the pilot MFD No. 1. A/P REF indicates that an AFCS pilot relief mode has been selected (in this case, ACL), but not engaged. The pilot engages ACL through the reference engage switch on the stick grip, at which time the A/P REF advisory goes out.

Note

If a pitch parallel actuator force link disconnect occurs prior to an ACLS approach, the A/P REF advisory may go out when coupling is attempted, but the aircraft will not respond to SPN-42 commands and the aircraft will uncouple when the first pitch commands are received.

Following ACL engagement, the pilot can take control of the aircraft by simply overriding the data-link commands with his control stick. This causes immediate disengagement, and the AFCS will again revert to STAB AUG. Refer to paragraph 2.24.4.7, Automatic Carrier Landing, for further information on ACL.

17.2.3 Radar Beacon (AN/APN-154). The radar beacon enhances aircraft tracking (range and accuracy) by ship and/or ground-based I-band radars for precision vectoring. Pulsed (coded) I-band signals transmitted by the surface radar station are received by the beacon and decoded; if they match the mode (six available) selected by the RIO, the beacon responds with a return pulse to the radar site. The reply signal, considerably stronger than a normal radar echo, enhances the radar acquisition and tracking capability of the surface station.

17.2.4 ACLS Beacon Augmentor (R-1623). The beacon augmentor is a crossband receiver that extends the tracking capability of the AN/SPN-42 shipboard radar with the capability of operating with either or both channels of the AN/SPN-42 without interference.

The beacon augmentor eliminates radar scintillation by providing a large source of reply energy from one point on the aircraft. The beacon augmentor receives interrogations from the AN/SPN-42 carrier-based radar in the Ka-band at 33.0 to 33.4 GHz, processes them, and retransmits modulated I-band pulses at 8.8 to 9.5 GHz to the AN/SPN-42, which has an I-band receiving system mounted contiguous with the basic Ka-band radar transmitting antenna. The unique feature of the augmentor is that it uses the AN/APN-154 beacon as its I-band transmitter. This is accomplished by coupling the output of the augmentor to the AN/APN-154 and triggering its modulator and transmitter. During the landing phase, it is necessary to manually place the radar beacon MODE switch to ACLS. In this mode, the AN/APN-154 receiver is disabled to ensure that I-band signals in the area will not trigger the AN/APN-154 transmitter during landing.

17.2.4.1 Beacon Controls. The RADAR BEACON panel (Figure 17-1) is on the RIO right console. POWER or STBY can be used for radar beacon warm-up; to preclude response to a premature or unintentional interrogation, the STBY (ACLS not selected) position should be used.

There are no cockpit displays for the beacon, although the ACLS TEST button will be illuminated if the beacon is responding during an ACLS approach. A self-check of the beacon ACLS mode is accomplished by depressing the ACLS TEST or performing an on-board check. Either of these two use the receiver video processing circuits of the augmentor in the same manner as a Ka-band input from the AN/SPN-42. If operation of the receiver is normal, the ACLS TEST pushbutton light on the RADAR BEACON panel will illuminate. A BAG acronym will be displayed when performing an OBC and in the event of a beacon augmentor failure. The radar beacon has a minimum warmup time of 5 minutes. During this time, failure indications will be displayed and self-test results should be regarded as inconclusive. A NO GO light during OBC should be verified by depressing the ACLS TEST pushbutton. If the ACLS test light illuminates, the system is functioning regardless of the NO GO light indication.

WARNING

If the aircraft is parked on the flight deck aft of the island, the radar beacon should be in either OFF or STBY with ACLS not selected. With ACLS selected, stray energy can trigger beacon response and may seriously degrade performance or preclude lock-on of aircraft attempting ACLS approaches. After shipboard arrestment and upon clearing the landing area, the radar beacon power switch should be turned to OFF to prevent possible beacon signal interference with other aircraft.

Note

Do not depress the ACLS TEST pushbutton after coupling on a Mode I approach as it will cause the ground station to break lock.

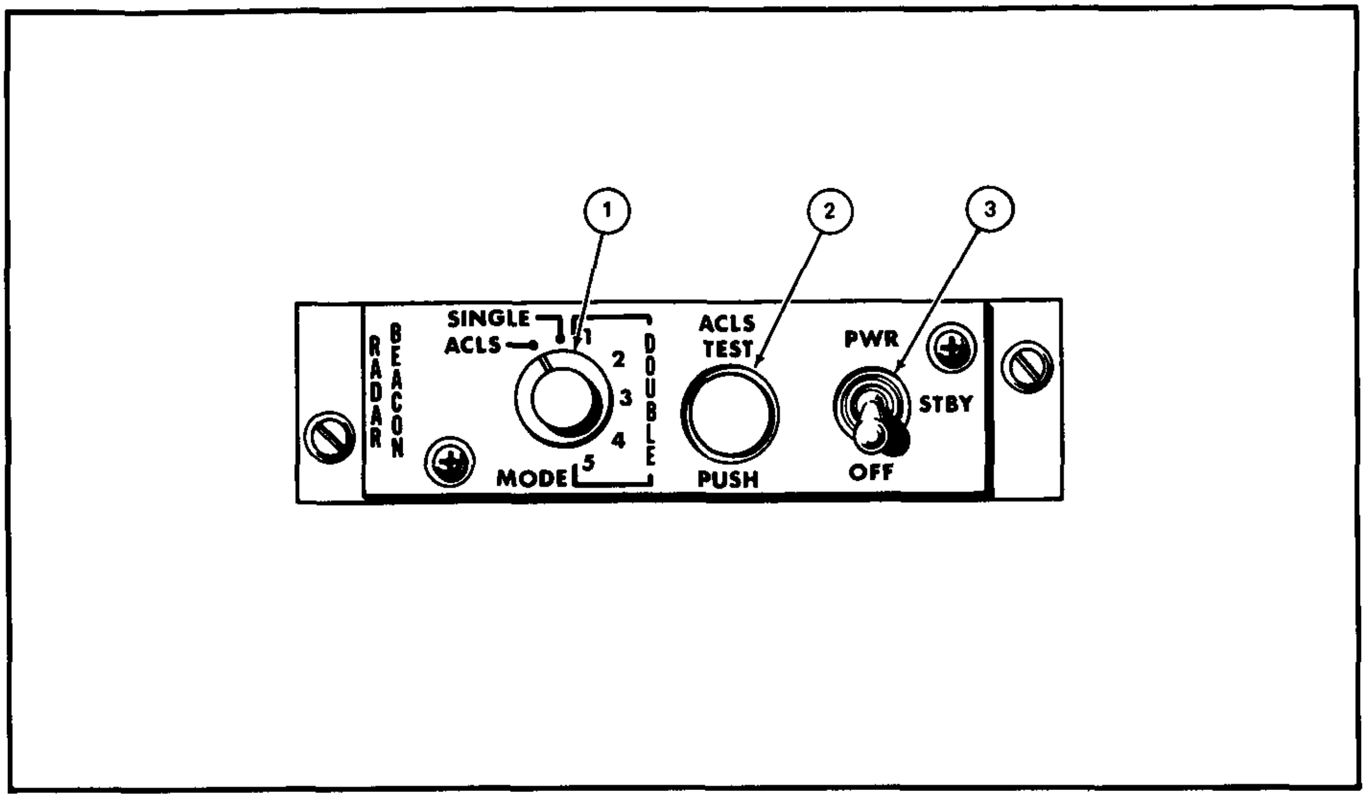
17.2.5 Approach Power Compensator Performance. For successful Mode I and Mode IA ACLS approaches, it is essential that the APC be functioning satisfactorily. Sluggish APC performance or its inability to maintain on-speed accurately during the approach will result in degraded control on the glideslope and unacceptable touchdown dispersion. A properly functioning APC should hold the aircraft on-speed ±0.5 unit throughout the majority of the approach. At tipover, the aircraft may accelerate to as much as two units faster but should correct to on-speed within 5 seconds. The APC should be checked for satisfactory operation prior to coupling. If the performance of the APC does not meet the above criteria, the approach should be downgraded to Mode II.

17.2.6 ACLS/ILS Displays (MFD and HUD). ACLS and instrument landing system steering information can be displayed on any MFD and the HUD (Figure 17-2). When the AWL pushbutton is depressed, final determination of the display submode is governed by the HUD and MFD pushbuttons on the MFD when in AWL steering, which provide for separate ILS and ACLS selection for both the HUD and MFD VDI format. This enables any mix of ILS (ANN/SPN-41/AN/ARA-63), ACL (AN/SPN-42/data link), or no displays at the pilot's option.

The ILS and ACL displays differ in that the ILS errors are displayed by needles and the ACL errors are displayed with the ACL steering indicator. The ACL steering indicator (Figure 17-2) represents where the intersection of ACL needles would be if presented. Azimuth and glideslope deviation are represented by the relationship of the velocity vector to the needles/ACL steering indicator. Two different means of displaying ILS and ACL steering are used to allow the option of displaying both sources of information simultaneously on either display (MFD or HUD). Both displays in the ACL mode display a command heading marker. This marker, during AN/SPN-42 approaches, indicates final bearing.

The ILS steering displays approach information in the form of precision course vectors. A vertical vector is used for azimuth steering while the horizontal vector is for elevation. The pair form a crosspointer and are displayed on the HUD and VDI presentations simultaneously. Full-scale deflection limits of the HUD and VDI vector symbols are 2° and 1.5 inches, respectively. The vectors are limited to this deflection to ensure the displayed symbol will always have an intersection. Full scale deflection limits correspond to 6° of lateral deviation from centerline and 1.4° of vertical deviation from glideslope.

The ACL submode uses the ACL steering indicator that is driven by the data link instead of the AN/ARA-63 receiver decoder. Any combination of ILS needles, ACL steering indicator, or neither is available for the HUD or VDI presentations. Selection of each is controlled by the pushbuttons contained on the MFD once AWL steering is selected.



NOMENCLATURE	FUNCTION
(1) MODE switch	SINGLE – Limits beacon response to single pulse of any code group received. DOUBLE – Beacon response set to one of five double-pulse interrogations. ACLS – Enables augmentor operation. **WARNING** ACLS shall not be selected on the flight deck when the power switch is in STBY or PWR, or during the 5-minute beacon warm up period.
(2) ACLS TEST PUSH light/pushbutton	On (green) – Indicates a AN/SPN-42 lockon in ACLS mode; when pressed with radar beacon mode selector in ACLS, indicates a satisfactory self-test of ACLS mode only. Flashing – Indicates AN/SPN-42 is sweeping through aircraft but has not locked on. Intermittent (or no light) – During self-test indicates a fault in the ACLS mode only.

Figure 17-1. Radar Beacon Panel (Sheet 1 of 2)

NOMENCLATURE	FUNCTION	
(3) Power switch	PWR -	With radar beacon mode selector in ACLS, enables I-band replies to Ka-band interrogations.
	STBY -	Used for warmup with radar beacon MODE switch in SINGLE or DOUBLE. **Note** The beacon will warm up with the switch in either position STBY or PWR. To prohibit response to premature or unintentional interrogations, warmup should be accomplished in STBY. For optimum performance allow 5-minute warmup.
	OFF -	Turns off all power to radar beacon.

Figure 17-1. Radar Beacon Panel (Sheet 2 of 2)

Additionally, certain ACLS commands that are uplinked to aircraft via the data-link system are displayed to both aircrew on MFD No. 1 and No. 3.

Note

For more detailed information on the data link symbology, refer to NAVAIR 01-F14AAD-1A.

The ACLS and ILS systems provide angular situation information (ILS needles and ACLS tadpole) of glidepath errors that requires the pilot to determine the corrections needed to eliminate those errors, resulting in higher workload and possible degraded approach performance (overshoots and oscillations). The flight director display provides the optimum glidepath steering information (as computed by the mission computer using navigation system parameters and data-link information from the SPN-42/46 ACLS system) to intercept and follow the glideslope and centerline, which reduces pilot workload and improves approach performance. The flight director symbol can be selected for display on the HUD by boxing the FLT DIR pushbutton on the pilot AWL VDI MFD format.

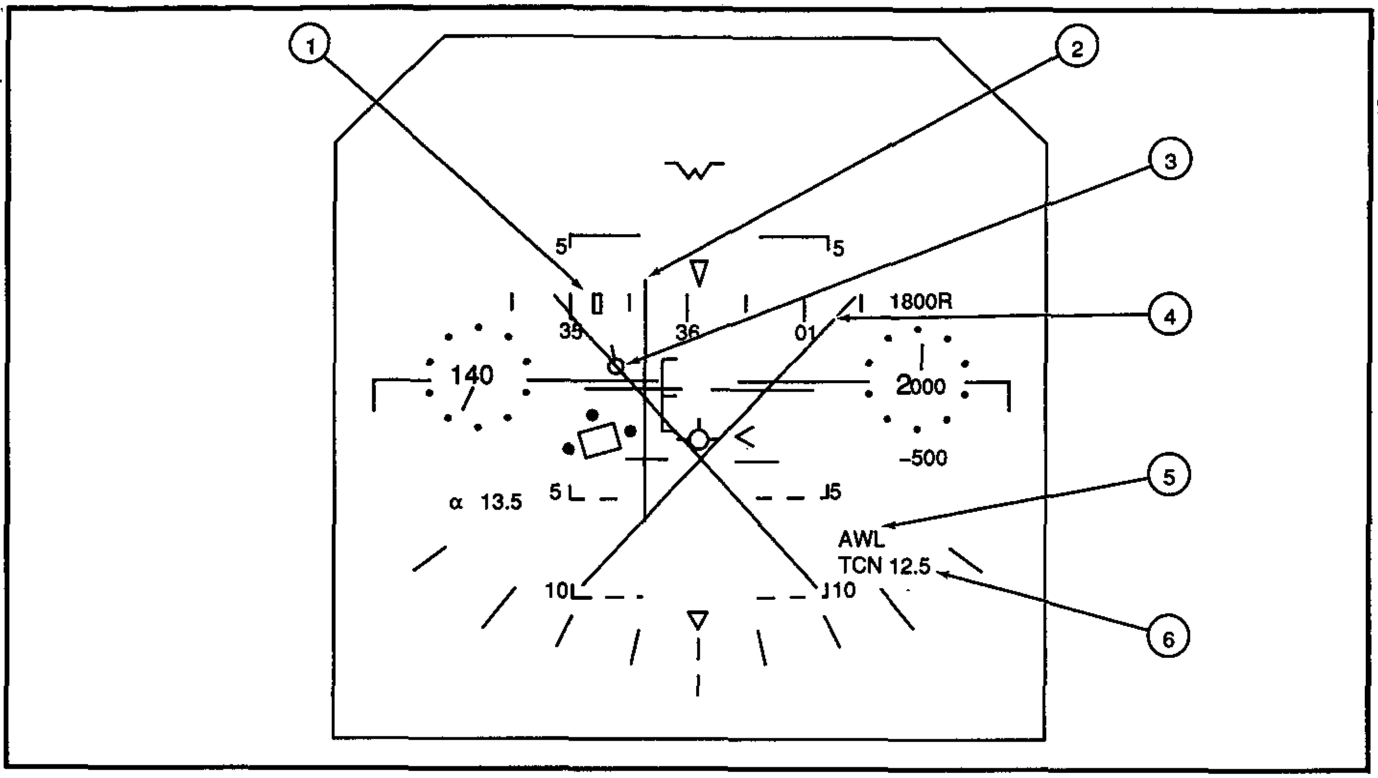
17.2.7 Instrument Landing System (AN/ARA-63). The aircraft ILS uses the AN/ARA-63 receiver decoder to process AN/SPN-41 confirmation. This system is used for manual instrument landing approaches or as an independent monitor during final approach with the ACLS. The AN/ARA-63 decoder panel (Figure 17-3) is located on the pilot right-side outboard console.

The aircraft system receives and decodes glideslope azimuth and elevation signals that are converted into command fly-to indications in the CIU and displayed via VDI and/or HUD in the TLN mode (Figure 17-2). If the ILS or ACL landing submodes selected on the pilot display control panel becomes invalid, the invalid submode symbology will be removed. A computer message informing the aircrew which submode became invalid will be posted on MFD No. 1 and No. 3. As a backup to the display subsystem, ILS steering indications are also displayed directly on the pilot standby attitude indicator vertical and horizontal needles.

Note

The ILS has a minimum warmup time of 1 minute. During this time, a failure indication should be disregarded.

The ILS performs a self-test when the BIT pushbutton on AN/ARA-63 decoder panel is depressed and held. Response to the ILS self-test is displayed, providing ILS or BOTH is selected on HUD and MFD. The correct ILS landing mode display on the HUD and VDI display during system checkout shows the vertical precision course vector symbol slowly oscillating on the right side of the display, then on the left side. The horizontal precision course vector symbol remains stationary in the center of the display.



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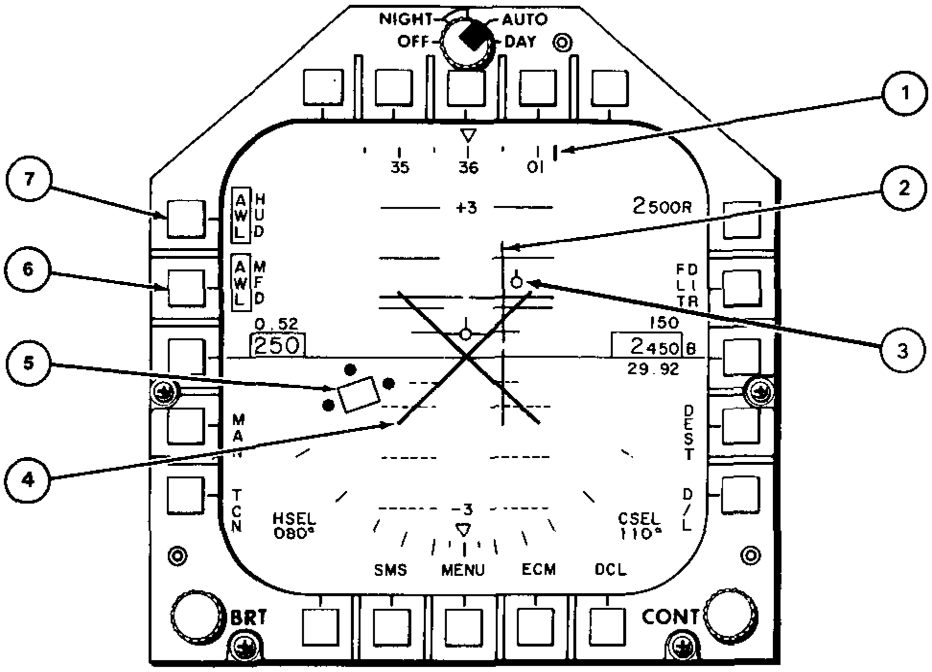
NOMENCLATURE	FUNCTION
	HUD Symbology –TLN Gear Up Basic Format
1 Command Heading Marker	Indicates ACL data link final bearing. Where final bearing is beyond display scale limits the marker will be pegged at the edge nearest to the final bearing.
2 ILS Precision Course Vectors	Consists of two independent vectors (vertical and horizontal) that form a cross pointer. The horizontal vector responds to ILS glide slope error and the vertical vector responds to ILS localizer error. Null/center indications are provided to enable the pilot to null the error and keep the vertical and horizontal needles centered.
3 ACLS Tadpole	Provides ACL Steering commands driven by the SPN–42 data link.
4 Waveoff	A large "X" will appear flashing in the center of the display to indicate a waveoff.
5 All Weather Landing Steering Legend	Indicates the selection of AWL Steering.
6 Tacan Range	Indicates distance to the tacan station.

Figure 17-2. ACLS/ILS Steering (Sheet 1 of 3)



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NOMENCLATURE	FUNCTION
	VDI Symbology –AWL Steering Mode
(1) Command Heading Marker	Positioned relative to the magnetic heading scale to indicate ACL data link final bearing. Where final bearing is beyond display scale limits, the marker will be pegged at the edge nearest to the final bearing.
(2) ILS Precision Course Vector	Consists of two independent vectors (vertical and horizontal) that form a cross pointer. The horizontal vector responds to ILS glide slope error and the vertical vector responds to ILS localizer error. Null/center indications are provided to enable the pilot to null the error and keep the vertical and horizontal needles centered.
(3) ACL Steering Indicator	Provides ACL Steering commands driven by the SPN–42 data link.
(4) Waveoff	During carrier landings, a large "X" will appear flashing in the center of the display to indicate a waveoff.

Figure 17-2. ACLS/ILS Steering (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
(5) Flight Director	The flight director symbol provides glide slope and centerline steering information computed by the mission computer using navigation system parameters and Data Link information from the SPN−42/46 ACLS system. The flight director provides the pilot with optimal glide path intercept and following when the flight path marker is inside the flight director box and the three dots are aligned with the wings and the tail of the flight path marker. The same procedures are used whether the flight path marker is caged or uncaged. The flight director symbol is removed from the HUD when the FLT DIR pushbutton on the VDI is unboxed. The pushbutton is removed from the VDI if the Flight director is not available for display (for example, a/c vector or ACL data link mode is not selected).
(6) MFD AWL Display Option pushbutton	Permits option to display AWL (both ACL and ILS), ACL, ILS or NO STEERING information on the MFD. Initial selection of the AWL steering mode on the basic VDI format displays both ACL and ILS steering information on the MFD. This will be indicated by AWL in the box adjacent to the MFD legend. Successive depression of the pushbutton cycles AWL, ACL, ILS and NO STEERING information on the MFD in that order.
(7) HUD AWL Display Option pushbutton	Permits option to display AWL (both ACL and ILS), ACL, ILS, or NO STEERING information on the HUD. Initial selection of the AWL steering mode on the basic VDI format displays both ACL and ILS steering information on the HUD. This will be indicated by AWL in the box adjacent to the HUD legend. Successive depression of the pushbutton cycles AWL, ACL, ILS, and NO STEERING information on the HUD in that order. **Note** The RIO is inhibited from deselecting AWL steering once selected from any MFD.

Figure 17-2. ACLS/ILS Steering (Sheet 3 of 3)

17.3 SURFACE SUBSYSTEMS

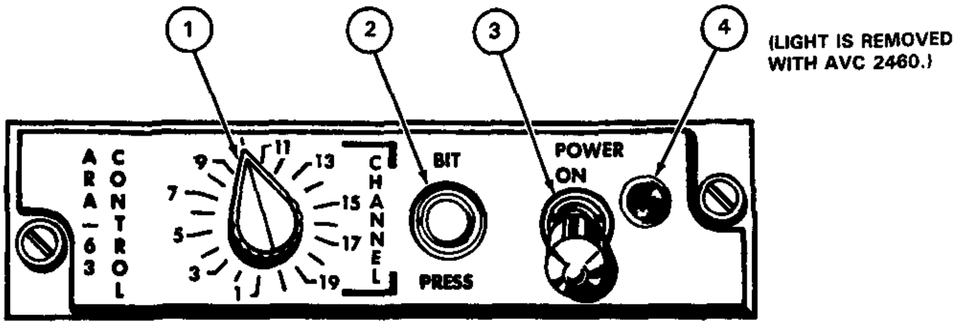
17.3.1 Automatic Landing System (AN/SPN-42).

The AN/SPN-42 radar uses a conically scanning antenna beam of Ka-band energy, which is received at the aircraft in direct proportion to its position within the antenna coverage area. This microwave energy is received as amplitude modulation of the pulsed carrier and, by means of the beacon augmentor, the AM is put on the I-band beacon for retransmission back to the ship as an active radar signal. The AM on this retransmitted signal is therefore identical to the AM received at the aircraft. By relating the amplitude of the returned signal to the AN/SPN-42 antenna position within its conical scanning area, the system knows the exact location of the aircraft in relation to the axis of the conical scan, which is the desired glidepath. From this information, the system can generate corrections to bring the aircraft to the desired glidepath. Additional ramp input pitch commands, tailored to each specific ship or field by the Naval Air Test Center during Mode I certification, are applied at the proper time to assist the aircraft through the burble.

To satisfy the system capability and landing-rate requirements, the shipboard subsystem landing control central AN/SPN-42 has a dual-channel configuration. This provides increased system reliability through redundancy. At full operational capability, both channels are in use, controlling two aircraft on the glideslope at the same time. Two aircraft are normally spaced approximately 60 seconds apart along the glideslope. In addition, the three operating modes act as backups for each other should partial system failure occur.

17.3.2 Instrument Landing System (AN/SPN-41).

The aircraft ILS uses carrier or shore-based AN/SPN-41 (C-scan) transmitters. The system operates in the K-band, between 15.4 and 15.7 GHz, on any of 20 channels. The transmitted azimuth signal produces a 2° beam, which is scanned +20° from the deck centerline. The transmitted elevation signal produces a 1.3° beam with a scan pattern from 0° to 10° above the horizon. A proportional azimuth angle for steering is 6° right or left of centerline; proportional elevation angle for steering is 1.4° from the reference glideslope (above or below).



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NOMENCLATURE	FUNCTION
(1) CHANNEL selector	Twenty possible channel selections by rotation of selector knob.
(2) BIT PRESS-to-test button	Depressing button activates BIT test circuitry. Landing symbols available on HUD and/or VDI if AWL or ILS display option is selected, and on pilot's standby attitude indicator.
(3) POWER switch (lock-lever)	ON - Activates receiver decoder for all-weather carrier landing. OFF - Turns system off. Lock-lever switch must be lifted to OFF.
(4) Indicator light (light is removed with AVC 2460)	Lights when AN/ARA-63 is on.

Figure 17-3. AN/ARA-63 Decoder Panel

Operating range is approximately 20 nautical miles. The signal is transmitted in J-band on a carrier frequency of 15.4 to 15.7 GHz.

The AN/SPN-41 can be used to guide the pilot to the window of the AN/SPN-42 radar for an ACL Mode I approach and as an independent glideslope and azimuth display during a Mode I approach. Should the AN/SPN-42 radar system fail, the AN/SPN-41 can be used for Mode II approaches.

17.4 ACLS PROCEDURES

The successful completion of a Mode I or Mode IA ACLS approach is dependent on the proper performance and complex interaction of a variety of shipboard and aircraft systems. It is the responsibility of the aircrew to verify that all ACLS-related aircraft systems are functioning properly and that proper procedures are followed in order to ensure a safe coupled approach.

17.4.1 Preflight. During the exterior preflight, the aircrew should ensure that both beacon antennas are in good repair and not painted. The receive antenna is located on the lower starboard fuselage just aft of the radome and is mounted flush with the fuselage. The transmit antenna is a blade antenna located on the aft portion of the chin dome (IR/TV pod). Poor condition of these antennas will seriously degrade beacon performance and will result in degraded tracking capability by the AN/SPN-42 system.

17.4.2 Poststart Checks. Following start, the aircrew should verify proper operation of the beacon and data-link systems along with associated lights and advisories and indications by performing the prescribed built-in tests. In addition, the pitch parallel actuator should be checked during OBC to make sure that the force link is not totally or partially disconnected. If any of these systems are not functioning properly, a coupled approach will not be possible.

17.4.3 Approach Phase. In ACL, the purpose of the approach phase is to get the aircraft to the acquisition window (Figure 17-4). At the marshaling area, some 20 miles astern of the carrier, the aircraft about to land are stacked according to fuel status and other relevant parameters that determine landing priority, the ILS (AN/ARA-63) system is energized, and the proper channel and displays are selected. The pilot, in concurrence with the controller, has the option of choosing from three display submodes to aid him in reaching the radar acquisition window:

1. Data-link vector
2. Tacan
3. AWL.

All are directly selectable on the VDI format of the MFD. Switching between submodes requires a choice between DATA LINK, TACAN, and AWL steering. If a submode selected becomes invalid, the steering information will cease. The pilot has the option of reselecting another landing display submode. A computer message will also inform the aircrew of invalid steering modes.

During the letdown from marshaling, an AN/SPN-42 channel is assigned to the aircraft and a computer program of aircraft control parameters is selected. A data-link discrete message (the first of a series to be transmitted), LANDING CHECK, is sent to the aircraft to initiate communications with CATCC and to indicate to the pilot that an AN/SPN-42 channel is available. The aircraft will usually already be in a landing configuration upon receipt of LANDING CHECK.

17.4.3.1 Data-Link Vector Approach. When DATA LINK is selected, the D/L vector display is added to the basic landing display. Command heading relative to the heading tape is added to the HUD and VID display along with commanded altitude and airspeed on the right and left side of the VDI display. Data-link vector information is available only for the approach phase (i.e., to the radar acquisition window). When the aircraft is vectored (D/L vector commands) to the acquisition window, the pilot has to make a new submode selection for the descent phase. This is not the case with the tacan submode, as tacan information is available throughout landing, from marshaling to touchdown.

17.4.3.2 Tacan Approach. The course deviation indicator is used for tacan deviation along with a manually set command heading indicator on both the HUD and VDI display.

17.4.3.3 AWL Approach. ILS information from the AN/SPN-41 is available during both the approach and descent phase. Selection of AWL on the VDI display enables vertical and lateral glideslope error display. Final determination of the AWL/PCD mode is governed by the ILS/ACL selection, which provides for separate HUD and VDI selection. Additionally, the pilot may independently select HUD flight director for display by boxing the FLT DIR pushbutton on the AWL VDI.

The normal ACLS approach mode will display the ACL tadpole situation information, the ILS needles situation information, and the ACL flight director steering information on the HUD. If the pilot intends to make a Mode I approach, he must advise the ground controller

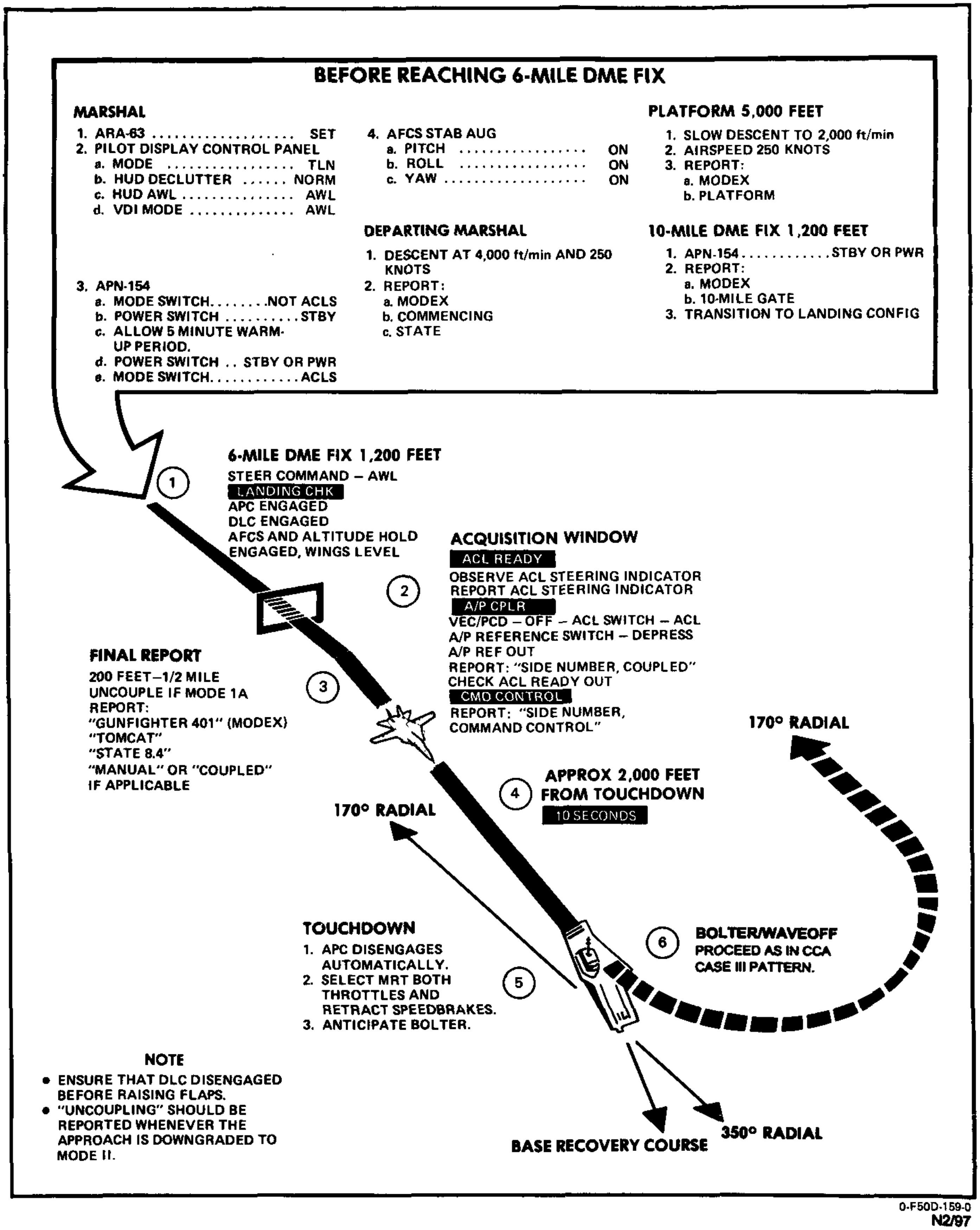


Figure 17-4. ACLS Mode I and II Approaches

of his intentions. The ground controller will then disable the flight director commands and enable the autopilot commands. Until this is done, the pilot will not have the capability to couple the autopilot to the ACLS commands. The only information that is displayed on the HUD during Mode I approaches is the ACLS tadpole situation information and the ILS needles situation information.

17.4.4 Landing Phase. As the aircraft continues its approach and passes through the 4-nm ACLS radar acquisition window, a smooth transition, not requiring pilot action, occurs. If tacan information has previously been selected (for the approach phase), the pilot could use this information to land. Assume, however, that AWL has been selected, ILS and ACL information is being displayed on the HUD and VDI.

At the radar acquisition window, the AN/SPN-42 radar acquires the aircraft with the aid of the airborne radar beacon augmentor, and the system automatically sends a discrete indicating radar lock-on that illuminates the ACL READY advisory. Transmission of vertical and lateral glidepath errors and flight director commands, derived by the AN/SPN-42/46 radar, commences. The glidepath error signals drive the ACL tadpole on the VDI and HUD. The flight director symbol is selected for display by boxing the FLT DIR pushbutton on the AWL VDI MFD format. The flight director display information is computed by the mission computer using navigation system parameters and data-link information, if desired. If the pilot intends to make a Mode I approach, he must advise the ground controller of his intentions. The ground controller will then disable the flight director commands and enable the autopilot commands. Until this is done, the pilot will not have the capability to couple the autopilot to the ACLS commands. The only information that is displayed on the HUD during Mode I approaches is the ACLS tadpole situation information and the ILS needles situation information.

The HUD and VDI symbology has thus been determined for the landing phase and no further pilot selection is required (unless a system malfunction occurs). The mode of operation for this phase of the landing is a function of the type of equipment used. In particular, there are three modes of landing applicable: Mode I, Mode II, and Mode III.

17.4.4.1 Mode I Landing Sequence

Note

Refer to paragraph 2.24.4.7, Automatic Carrier Landing (ACL), for further information on ACL.

The landing system (CATCC) (Figure 17-4) generates a coupler available discrete that illuminates the A/P CPLR advisory and indicates that the pilot has the option of coupling the AFCS to data-link commands of pitch and bank. At this time, the aircraft should be in a landing configuration with APC, DLC, AFCS, and altitude hold engaged.

Note

The radar should be in STBY or PULSE search to avoid beacon interference problems.

The AFCS should be armed in the ACL relief mode with the A/P REF advisory on, indicating that a pilot relief mode (in this case, ACL) has been selected but not engaged. The pilot can couple the AFCS to the data link by means of the autopilot engage button on his control stick, at which time, if the AFCS is functioning properly and the ACL interlock is true, the AP REF advisory will go out. The pilot should report coupled; at which time, the controller will send a discrete command control message that illuminates the CMD CONTROL advisory. The NTDS begins transmitting data-link and pitch and bank commands to the aircraft. The autopilot (AFCS) actuates the appropriate control surface to execute the desired command, while the autothrottle (APC) maintains approach angle of attack by controlling the throttle setting.

Whenever the aircraft exceeds the Mode I flightpath control envelope, the system automatically sends a signal to uncouple the AFCS (A/P CPLR advisory goes out). The approach may be continued in Mode II or Mode III. If the flightpath error increases to the point where a large maneuver is required to bring the aircraft back on course, the controller will send a waveoff message that is displayed on the HUD and VDI and turns on the WAVEOFF advisory. This discrete also disconnects the autopilot (if engaged) and the AFCS reverts to stability augmentation. The controller then transfers the guidance of the aircraft to the bolter/waveoff controller, who directs the pilot back into the landing sequences.

If the information stored in the data link is not updated within any 2-second period during the descent, the TLT advisory goes on (missed message) and the AFCS automatically disconnects and reverts to STAB AUG. The pilot can continue the descent in Mode II or Mode III.

At 12.5 seconds from touchdown (approximately 2,200 feet from the touchdown point), the 10 SECOND advisory goes on, indicating deck motion data are being added to the glidepath commands. This information is in the form of a slight increase (or decrease) in aircraft altitude to adjust for the movement of the touchdown point caused by the ship's motion (roll, pitch, and heave). Between 12.5 and 1.5 seconds from touchdown, the CATCC sends an automatic waveoff if any part of the carrier-based equipment fails and up to 5 seconds from touchdown if the aircraft exceeds the AN/SPN-42 flightpath control envelope. Waveoff signals also may be issued by the final controller (between lock-on and touchdown) and the landing signal officer between 1 mile and touchdown. Approaches must be waved off at weather minimums (200-feet altitude and 1/2-mile visibility) if the pilot cannot see the meatball.

At 2 seconds from touchdown, the landing system freezes the pitch and bank commands and the AFCS holds the aircraft's attitude to touchdown unless the pilot elects to override the AFCS either by maneuvering the control stick or by manually disengaging the AFCS and assuming control. If the aircraft bolters or if the pilot decides to go around, the AFCS is disengaged automatically by means of overriding the control stick, and the pilot enters the bolter/waveoff pattern.

Note

> Use of paddle switch to disengage AFCS for Mode IA landing is not recommended since DLC, pitch SAS, and roll SAS will also be disengaged.

17.4.4.2 Mode II Landing Sequence. The early phases of a Mode II descent (Figure 17-5) are identical to a Mode I descent sequence. The aircraft to be recovered is directed through the marshaling area, received LANDING CHK, and arrives at the ACLS radar acquisition gate. When the lock-on discrete (ACL READY) message is received, the pilot continues to fly the aircraft manually (using APC as desired) in response to VDI and/or HUD displays.

If there is an equipment failure, the system (CATCC) will send a voice discrete signal that turns on the VOICE advisory, and the AN/SPN-42 error information displayed will be invalid and thus removed. The pilot then expects to receive standard voice commands and will probably use the redundant ILS information or switch to tacan steering.

As long as the aircraft is located within the AN/SPN-42 flightpath control envelope for Mode II, the descent is continued until visual contact is made with the Fresnel lens optical landing system meatball. All waveoffs in Mode II are given by the final controller of the LSO. Approaches are terminated at weather minimums (200-feet altitude and 1/2-mile visibility) if the pilot cannot see the meatball.

At any time before 12.5 seconds from touchdown, the pilot can switch from a Mode II manual to a Mode I automatic flightpath control, provided the coupler available discrete is being received and the ACL interlock is true.

17.4.4.3 Mode III Landing Sequence. Mode III descents follow the same general sequence as that of Modes I and II, but Mode III approaches are talkdown landings; that is, all flightpath corrections are provided by voice and no computerized discrete signals are sent. The use of APC is optional. Approaches are terminated at the weather minimums if the FLOLS (meatball) is not visible to the pilot for continuing the landing.

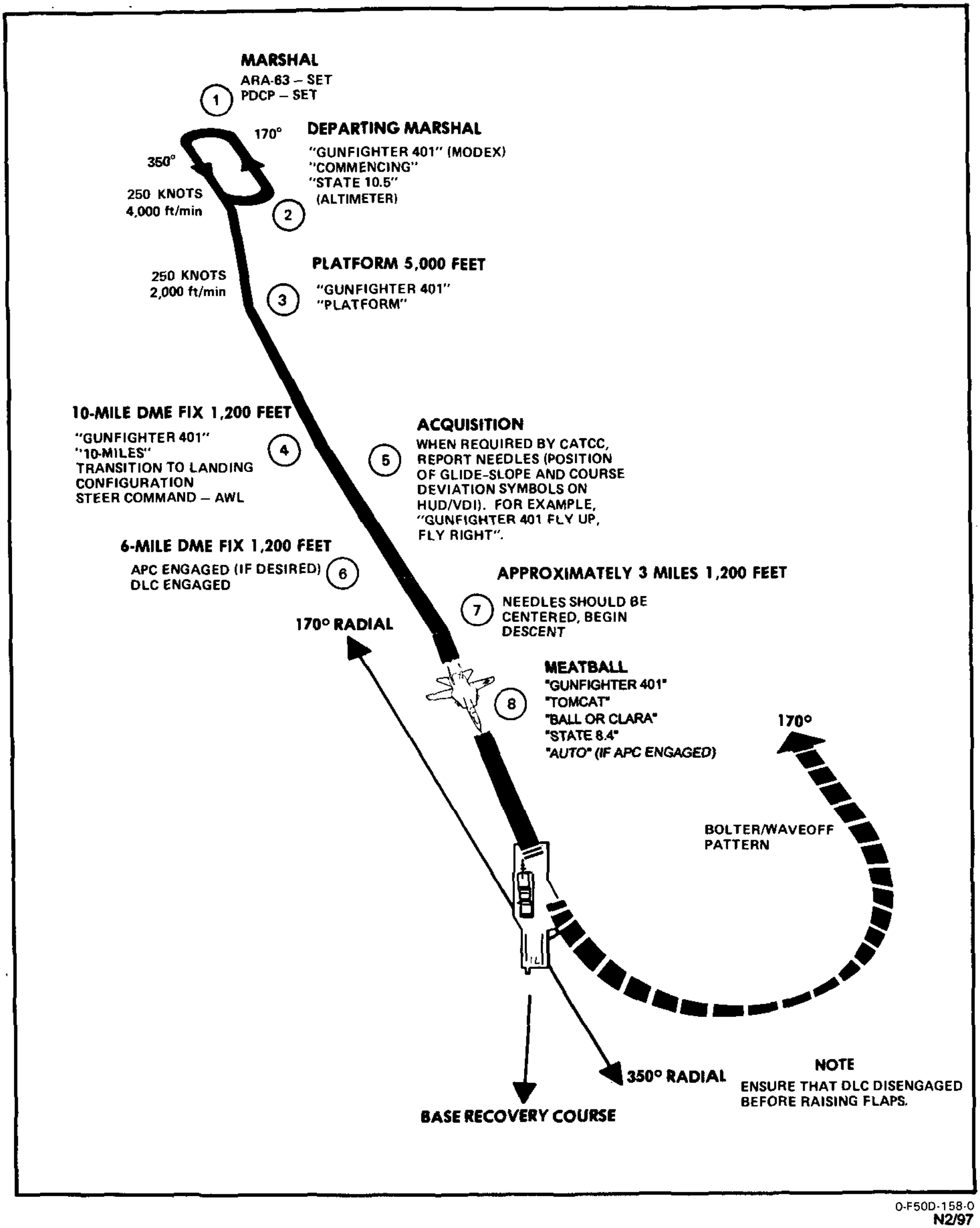


Figure 17-5. SPN-41 ILS Approach

CHAPTER 18

Extreme Weather Operations

18.1 ICE AND RAIN

18.1.1 Icing. Icing conditions should be avoided whenever possible. Before flight, check freezing levels and areas of probable icing from weather service.

The primary concern with flying in icing conditions is ice accumulation sufficient to cause engine damage. Ice accumulation on engine probes located between the engine guide vanes and above the number three inlet ramp is not detectable from the cockpit. Aircraft maneuvers or landing impact can dislodge accumulated ice and can cause severe FOD to the engine. Visual detection of icing on exterior surfaces and/or illumination of the pilot's INLET ICE caution light should be treated as indications of the potentially more serious problems described above. The following precautionary action should be taken immediately in known or suspected icing environments:

1. ANTI-ICE switch — ORIDE/ON.

2. CABIN AIR DEFOG lever — FWD DEFOG.

3. Engine instruments — Monitor Frequently.

   Carefully monitor rpm and EGT indications. A reduction of rpm or an increase in EGT accompanied by a loss of thrust is an indication of engine icing.

4. Avoid clouds and other areas of visible precipitation.

5. If unable to avoid precipitation, adjust aircraft Mach or altitude as necessary to remain outside of the icing zone shown in Figure 18-1.

Extended operations in icing conditions should be considered an emergency situation. If time and fuel permit, a descent below the freezing level is recommended. If unable, altitudes above approximately 25,000 feet or ambient temperatures below -30 °C are generally free of icing conditions. If inadvertent or unavoidable operation in known or suspected icing conditions has occurred, an effort should be made to eliminate the ice before landing by remaining well below the freezing level for an extended period of time.

WARNING

Icing conditions can cause heavy ice accumulation in the inlet ramp areas or on engine probes and the compressor face. Aircraft maneuvers and arrested landings may dislodge this accumulation and cause extensive engine FOD or failure. A straight-in field landing is preferred. Minimum power setting after landing is recommended.

CAUTION

Operation of main flaps/slats and maneuvering devices increases the likelihood of a flap/slat lockout because of shearing of the torque tube. Attempt to descend below the freezing level for 20 to 30 minutes before operating main or maneuvering flaps/slats.

18.1.2 Rain. Whenever rain is encountered, turn ANTI-ICE switch to AUTO/OFF.

Note

In heavy rainfall, maintain a minimum engine power setting of 70-percent rpm. This will assure adequate acceleration margin and prevent possible engine speed hangup.

18.1.2.1 Takeoff in Rain. Takeoffs performed with standing water on the runway may result in unstable engine operation because of water ingestion.

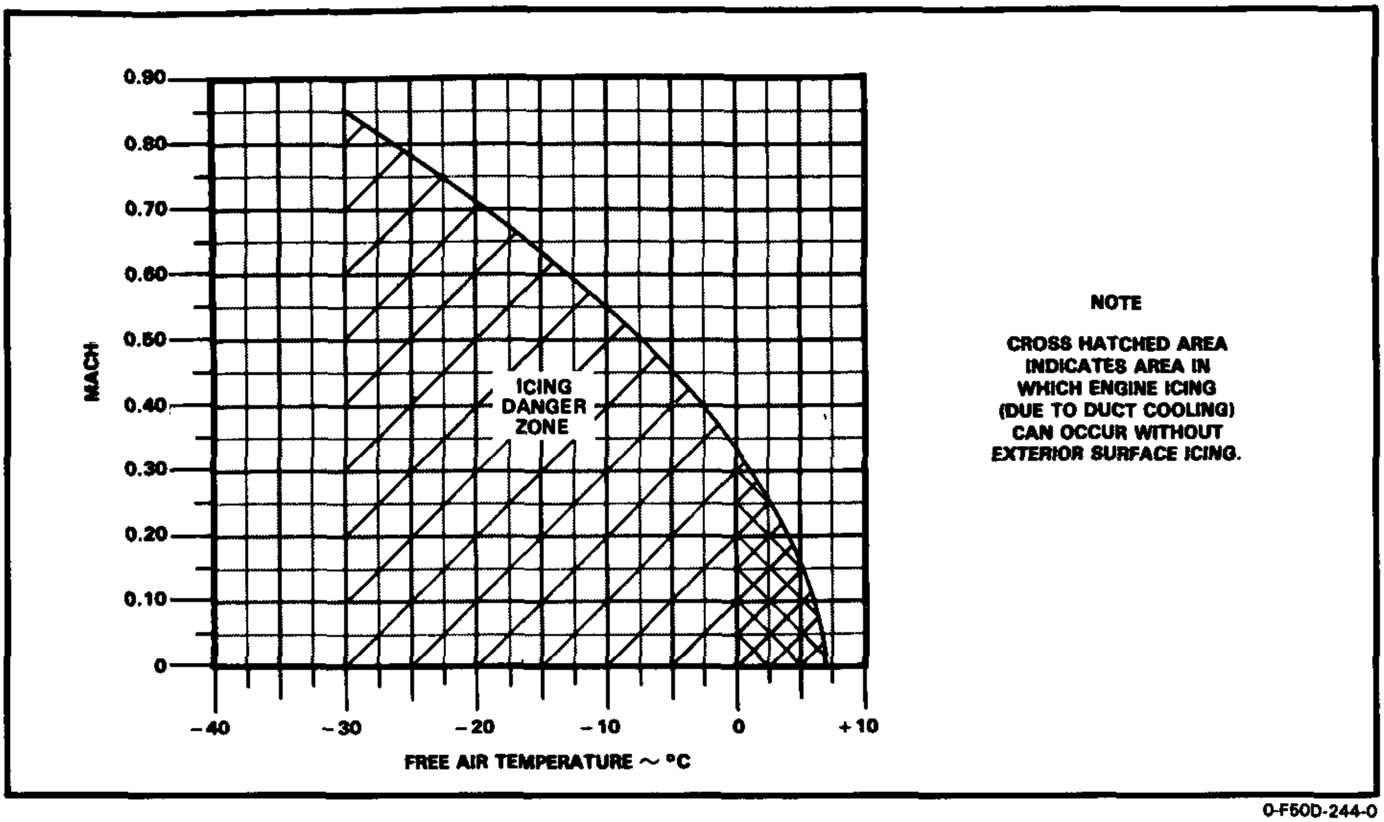


Figure 18-1. Icing Danger Zone

18.1.2.2 Landing in Rain. Selecting ON with the WSHLD AIR switch controls a blast of air that blows rain off the windshield. Be aware of the possibility of flameout in a heavy rain and of reduced braking action because of a wet runway.

18.2 HYDROPLANING

Operations on wet or flooded runways may produce four conditions under which tire traction may be reduced to an insignificant value.

1. Dynamic hydroplaning
2. Viscous hydroplaning
3. Reverted rubber skids
4. Combined viscous and dynamic hydroplaning.

Note

Hydroplaning has been experienced in the F-14 at speeds down to 40 knots.

18.2.1 Dynamic Hydroplaning. Dynamic hydroplaning is a condition in which a fluid separates the tires from the runway surface. When standing water on a wet runway is not displaced by the tire fast enough to allow contact over the complete footprint area of the tire, the tire rides on a wedge (or film) of water over all or part of the footprint area. Total dynamic hydroplaning occurs when the pressure between the tires and the runway lifts the tires off the runway surface to the extent that a nonrotating tire will not spin up (landing) or a rolling, unbraked tire will slow in rotation and may actually stop (takeoff). Total dynamic hydroplaning speed is represented by the following mathematical formulas: 9 times the square root of the tire inflation pressure for a rotating tire (as in takeoff); 7.7 times the square root of the tire inflation pressure for a nonrotating tire (as in landing).

Dynamic hydroplaning is insensitive to vertical load changes (weight), but is greatly affected by tire inflation pressure and tire wear. Since the fluid cushion is incapable of developing any appreciable shear force, braking and sideforce coefficients become almost nonexistent.

18.2.2 Viscous Hydroplaning. Viscous hydroplaning occurs when the tires are separated from the runway surface by a thin film. Viscous fluid pressures in the tire-ground contact zone of rolling tires build up with speed to the danger levels required for hydroplaning only when water-covered pavements are smooth or smooth acting, as when contaminants considerably more viscous than water coat the pavements. Since a tire operating on a surface with rubber deposits, paint, fuel, or oil can only partially displace the trapped water film, considerably higher hydroplaning pressures will be developed in the tire footprint area with these more viscous fluids. Even slight amounts of precipitation, for example, a heavy dew that coats the pavement with a thin film of fluid, can produce this effect. Because the tire footprint separates from the runway with less fluid depth and at a lower relative groundspeed than dynamic hydroplaning speed, viscous hydroplaning is potentially more dangerous than dynamic hydroplaning and is not greatly affected by changes in vertical tire load or tire inflation pressure. Grooved tires offer a greater advantage than smooth tires in reducing the effects of viscous hydroplaning. The runway pavement surface texture is also an important factor in combating viscous hydroplaning effects.

18.2.3 Combined Dynamic and Viscous Hydroplaning. Loss of tire friction with increasing or decreasing speed on wet or flooded runway pavements can be caused by the combined effects of viscous and dynamic hydroplaning. Figure 18-2 shows a pneumatic tire rolling at medium speed across a flooded pavement in a partial hydroplaning condition. The first zone shows the fraction of the tire footprint that is supported by bulk water (dynamic); the second zone, the fraction supported by a thin film of water (viscous); and the third zone, the fraction essentially in dry contact with the peaks of the pavement surface texture. The length of the first zone represents the time required for a rolling tire in this speed condition to expel bulk water from under the footprint; correspondingly, the length of the second zone represents the time required for the tire to squeeze out the residual thin water film remaining under the footprint after the bulk water has been removed. Since fluids cannot develop shear forces of appreciable magnitude, it is only in the third zone (essentially dry region) that friction can be developed between the tire and the pavement for steering, decelerating, and accelerating a vehicle. The ratio of the dry contact area (third zone) to the total tire footprint area (zones 1, 2, and 3) multiplied by the coefficient the tire develops on a dry pavement, yields the friction coefficient the tire develops for this flooded pavement and speed condition. As speed is increased, a point is reached where the third zone disappears and the entire footprint is supported by either bulk water or a thin film. This speed condition is called combined viscous and dynamic hydroplaning. As speed is further increased, a point is reached where bulk water penetrates the entire footprint; this condition is called dynamic hydroplaning. If the runway is not flooded (no bulk water), such as on a runway covered with heavy dew, it is possible for the second zone to cover the entire footprint as speed is increased or decreased. The pavement would have to be smooth or smooth acting, as in the case where contaminants are present, for this to take place; this is called viscous hydroplaning.

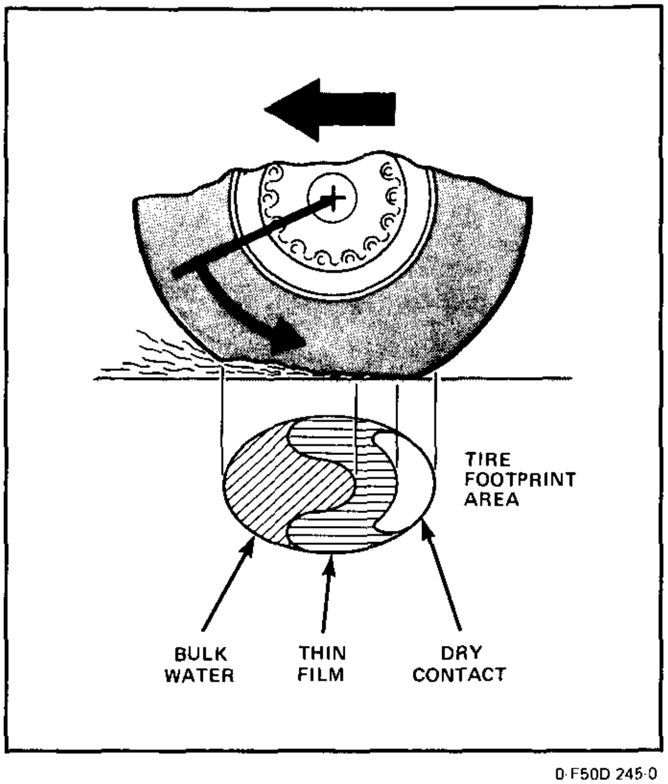


Figure 18-2. Combined Viscous and Dynamic Tire Hydroplaning

18.2.4 Reverted Rubber Skids. A reverted rubber hydroplaning condition (also called reverted rubber skid) takes place when a wheel skid has started on a wet runway and enough heat is produced to turn the entrapped water to steam. The steam in turn melts the rubber in the tire footprint. The molten rubber forms a seal preventing the escape of water and steam. Thus, the tire rides on a cushion of steam that greatly reduces the coefficient of friction. On inspection of the portion of the tire involved, a patch of rubber would show signs of reverting to its uncured state and hence the name, reverted rubber. Once established, this condition may persist to very low groundspeeds. The characteristic marks on a pavement for the reverted rubber skid are white, as opposed to the black marks left on the pavement during a dry skid. These white marks are associated with the cleaning process of super-heated steam and high pressures that are present in the skid. The reverted rubber condition tends to make all runway surfaces smooth acting. Pavement surface texture, which has a large effect on traction losses from dynamic and viscous hydroplaning, has but little effect for the reverted rubber case with the possible exception of grooved surfaces. NASA research confirms the theory that the reverted rubber skid is the most catastrophic for aircraft operational safety because of the low-braking friction and the additional fact that tire cornering capability drops to zero when the wheels rotation is stopped.

18.2.5 Landing On Wet Runway. Refer to Chapter 7 for landing discussion.

18.3 TURBULENCE AND THUNDERSTORMS

Unless the urgency of the mission precludes a deviation from course, intentional flight through thunderstorms should be avoided to preclude the high probability of damage to the airframe and components by impact of ice, hail, and lightning. Flameouts because of water ingestion or compressor stalls caused by rapid changes in flight attitudes could also occur. Radar provides a means of navigating between or around storm cells. If circumnavigating the storm is impossible, penetrate the thunderstorm in the lower third of the storm cell, away from the leading edge of the storm cloud, if possible. It is recommended that the AFCS be disengaged. Structural damage could result with the automatic functions operating.

18.3.1 In the Storm. Maintain a normal instrument scan with added emphasis on attitude displays. Attempt to maintain a constant pitch attitude and, if necessary, accept moderate altitude and airspeed fluctuations. In heavy precipitation, a reduction in engine speed may be necessary because of the increased thrust resulting from water ingestion. If compressor stalls or engine stagnation develops, attempt to regain normal engine operation by momentarily retarding the throttle to IDLE then advance to the operating range. If the stall persists, shut down the engine and attempt to relight. If the engine remains stagnated at reduced power and the EGT is within limits, maintain reduced power until clear of the thunderstorm. While in the storm, the longitudinal feel trim, angle-of-attack, total temperature, windshield overheat, static pressure correction, and cabin pressurization systems may experience some abnormalities because of rain, ice, or hail damage. No difficulty should be encountered in maintaining control of the aircraft; however, the rapid illumination of numerous warning lights may be somewhat distracting to the pilot if he is not prepared.

18.3.1.1 If Necessary to Penetrate a Thunderstorm:

1. Slow to between 275 to 300 KIAS.
2. ANTI-ICE switch — AUTO/OFF.
3. AUTO PILOT switch — OFF.
4. Loose equipment — Secured.
5. Tighten lapbelt and lock shoulder harness.
6. Cockpit lights — On Bright.
7. Fly attitude and heading indicators primarily while in extreme turbulence, because altimeter and airspeed will fluctuate.

Note

During severe icing conditions, the pilot can expect to lose airspeed indications even with the pitot heat on. Ground-controlled intercept stations, if available, can aid the pilot with tracking assistance through thunderstorm areas.

Severe turbulent air at high altitudes may cause the inlet airflow distribution to exceed acceptable limits of the engine, thereby inducing compressor stalls. To avoid compressor stalls during flight because of turbulent air, maintain 275 to 300 KIAS at all altitudes.

18.4 COLD-WEATHER OPERATIONS

A careful preflight will eliminate many potential hazards found in cold-weather operations. Inspect engine intakes for accumulation of ice and snow. If possible, preheat the engine for easier engine starts. When removing ice and snow from the aircraft surfaces, be careful not to damage the aircraft. Also, use precautions not to step on any no-step surfaces that could be covered with ice or snow. Check the pitot-static tube for ice as well as the fuel pressurization ram/air intakes, and yaw, pitch, and angle-of-attack transducers.

Moisture in the fuel system greatly increases operational problems in cold weather. At lower temperatures, the water-dissolving capacity of fuel is greatly reduced and will result in considerably more water accumulation (as much as several gallons of water to 1,000 gallons of fuel). If the water separation occurs at below freezing temperatures, the water will crystallize on the fuel drain and internal valves. Any water accumulation will settle to the bottom of the tanks and freeze up the fuel drains.

Normal operating procedures as outlined in Chapter 7, Shore-Based Procedures, should be adhered to with the following additions and exceptions.

18.4.1 Preflight

1. Check entire aircraft to ensure that all snow, ice, or frost is removed.

WARNING

Snow, ice, and frost on the aircraft surface are a major flight hazard. The result of this condition is a loss of lift and increased stall speeds.

2. Shock struts and actuation cylinders — Free of Ice and Dirt.

3. Fuel drain cocks — Free of Ice and Drain Condensation

4. Pitot tubes — Ice and Dirt Removed.

5. Exterior protective covers — Removed.

18.4.2 Engine Start. Be sure that the aircraft is adequately checked before engine start.

When operating in subfreezing temperatures, moisture in the air entering the aircraft from the starting unit may freeze, causing ECS malfunctions. Starting the aircraft with the AIR SOURCE in OFF will prevent the problem. The AIR SOURCE in BOTH ENG should be selected after both engines have been started and the starter air disconnected. ECS malfunctions after engine start may still occur because of moisture internally present in the aircraft.

If this occurs, select:

1. TEMP mode selector switch — MAN.

2. TEMP control thumbwheel — Full Hot (14)

3. WSHLD AIR switch — ON.

4. With both engines at IDLE, the ECS should thaw in about 20 minutes. During this warmup period, leave all avionics and radar off.

If external fuel tanks are installed:

5. MASTER TEST switch — FLT GR UP.

   Advance throttles as necessary to 80 percent maximum to check for GO light and positive external transfer. Once airborne, external fuel transfer should not be delayed to ensure complete external tank transfer.

Note

If external transfer does not initiate or is incomplete, flight below the freezing level for 20 to 30 minutes will allow frozen valves to thaw permitting external transfer.

In severely cold weather, allow a short time for warmup before increasing rpm out of the idle range. If oil pressure is low or fails to come up in a reasonable length of time, shut down. Attempt another start after heating the engines.

WARNING

If abnormal sounds or noises are present during starting, discontinue starting and apply intake duct preheating for 10 to 15 minutes.

18.4.3 Taxiing. Avoid taxiing in deep or rutted snow since frozen brakes will likely result.

To ensure safe stopping distance and prevent icing of aircraft surfaces by melted snow and ice blown by jet blast of a preceding aircraft, increase spacing between aircraft while taxiing at subfreezing temperatures.

18.4.4 Takeoff. When operating from runways that are covered with excessive water, snow, or slush, high-speed aborts may result in engine flameout because of precipitation ingestion. The probability of flameout is highest when throttles are chopped. With a double flameout, normal braking, anti-skid and nosegear steering will be lost as hydraulic pressure decreases with engine spool down. Check applicable takeoff distance charts in NAVAIR 01-F14AAP-1.1.

Thrust available will be noticeably greater in cold temperatures during the takeoff run.

CAUTION

Before initial takeoff roll, ensure that all instruments are sufficiently warmed up. After takeoff, cycle landing gear a few times to prevent the possibility of the gear freezing in the wheelwells.

18.4.5 Landing. Frozen downlock microswitch actuators, because of moisture combined with extremely cold temperatures, can cause spurious unsafe down indications when landing gear is extended. Use antiskid during the landing roll.

Note

> Hard braking on ice or a wet runway, even with ANTISKID on, could result in dangerous skidding.

18.4.6 After Landing. During operations where the temperature is below freezing with heavy rain, or expected to drop below freezing with heavy rain, the aircraft may be parked with wings forward (20°) and flaps in the full down position.

18.4.7 Before Leaving Aircraft. Weather permitting, leave the canopy partially open to allow for air circulation. This will help prevent canopy cracking from differential cooling and decrease the possibility of windshield and canopy frosting.

18.5 HOT-WEATHER AND DESERT OPERATIONS

Check for accumulation of sand or dust in the intakes. Normal starting procedures will be employed.

Normal operating procedures as outlined in Chapter 7, Shore-Based Procedures, should be adhered to with the following additions and exceptions:

1. Expect higher temperatures than normally obtained in operating ranges.
2. Engine ground operation should be minimized as much as possible.

18.5.1 Taxiing. While taxiing in hot weather, the canopies may be opened, if necessary, to augment crew comfort.

CAUTION

> Do not operate the engines in a sand or dust storm, if avoidable. Park the aircraft crosswind and shut down the engines to minimize damage from sand or dust.

18.5.2 Takeoff. The required takeoff distances are increased by a temperature increase. Check the applicable takeoff distance charts in NAVAIR 01-F14AAP-1.1.

CAUTION

> Do not attempt takeoff in a sand or dust storm, if avoidable, to prevent sand or dirt from blowing into the intake ducts and causing engine damage.

18.5.3 Landing. Anticipate a slightly longer landing distance and the possibility of turbulence because of thermal action of the air close to the ground. Use the defogging system if necessary, in warm, humid weather.

PART VII

Communications-Navigation Equipment and Procedures

Chapter 19 — Communications

Chapter 20 — Navigation

Chapter 21 — Identification

CHAPTER 19

Communications

19.1 COMMUNICATIONS AND ASSOCIATED EQUIPMENT

Figure 19-1 lists the CNI equipment associated with the aircraft/weapons systems.

CAUTION

Operation of electronic equipment for more than 5 minutes without adequate cooling will permanently damage the equipment.

19.1.1 Communications Antennas. Four V/UHF/L-band, dual-blade antennas provide omnidirectional coverage for V/UHF voice, JTIDS voice, UHF D/L, JTIDS Link 16, tacan, and IFF/SIF transponder operation. V/UHF 2, JTIDS voice and data, and tacan share one set of antennas; the upper is immediately aft of the canopy turtleback and the lower is embedded in the left ventral fin. The V/UHF 1, D/L, and IFF/SIF share the second set; the upper is the second antenna aft of the canopy turtleback and the lower is embedded in the right ventral fin. Each system is connected to the appropriate portion of an upper and lower antenna through a coaxial switch and diplexer. For information on the AN/ASW-27 DL (Link 4), and JTIDS (Link 16), refer to NAVAIR 01-F14AAD-1A.

The APX-76 IFF interrogator antenna is an integral part of the radar antenna. See FO-1 and FO-2 for antenna locations.

19.1.2 Communications Antenna Selection. Selection of the upper or lower antenna for use by the two communication radios and the D/L or JTIDS is manual and is controlled by switches on the RIO ANT SEL panel (Figure 19-2). The D/L is always on the opposite antenna from V/UHF 1. Antenna selection for the IFF/SIF can be either automatic or manual. The ANT switch on the IFF control panel controls antenna selection and is described in Chapter 21. Tacan antenna selection is completely automatic. If a signal is lost or is too weak to maintain receiver lockup, the tacan cycles between the upper and lower seeking a stronger signal. See Chapter 20 for tacan operation.

19.1.3 Mutual Interference. Mutual interference among the V/UHF communication radios and between the V/UHF communication radios and D/L can occur. In the UHF band, minimize mutual interference by selecting opposite antennas or a frequency separation of at least 55 MHz between radios if both are being used. When D/L is in use, mutual interference can be minimized by using VHF channels for voice communications. If this is not possible, frequency separation of at least 55 MHz and selection of opposite antennas for voice and D/L are recommended. If necessary, V/UHF 1 or 2 can be shut off. UHF communications interference with D/L may cause the TILT computer message to appear and the autopilot ACL or VEC/PCD mode to disengage. D/L interference with the radios may cause audible chirping at the D/L message reply rate.

In the VHF band, both radios should not be operated simultaneously at VHF frequencies.

JTIDS will not interfere with any of the V/UHF communication radios or data link because it uses a higher frequency band. Tacan compatibility, which is in the same frequency band (L-band) as JTIDS, is performed internally by JTIDS.

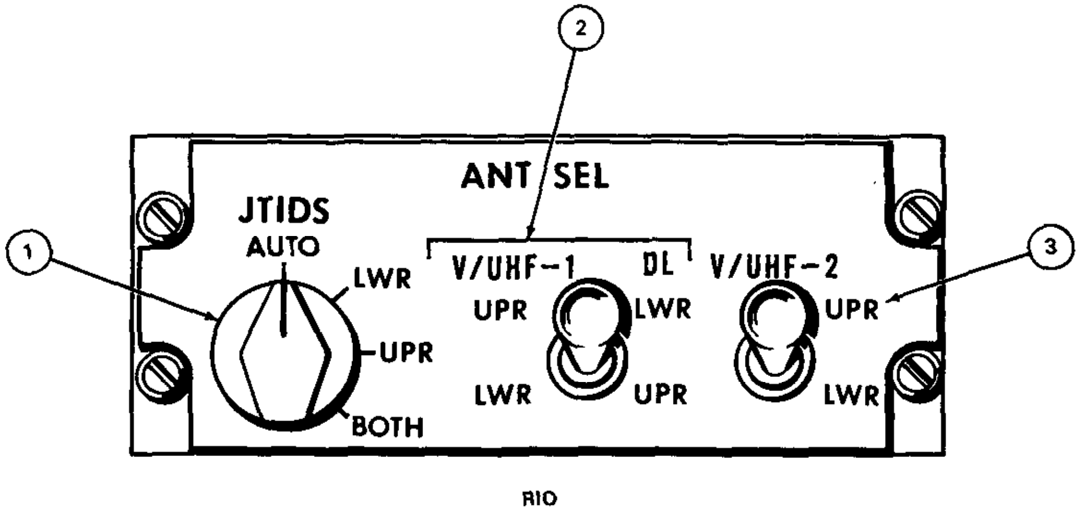
19.2 INTERCOMMUNICATIONS

The ICS provides normal, backup, or emergency communications between crewmembers. It also combines and amplifies audio signals received from other electronic receiving equipment (ECM, Sidewinder tone, IFF/SIF, radar altimeter, and voice radios, etc.).

Identical ICS control panels (Figure 19-3) are on the pilot and RIO left-side consoles. The ICS includes four amplifiers, two at each cockpit station, that permit duplex operation during normal operation. If one amplifier fails, it may be bypassed by selecting either the B/U (backup) or EMER (emergency) position on the ICS control panel. This permits continued ICS operation.

TYPE AND DESIGNATION	FUNCTION	RANGE	OPERATOR	LOCATION OF CONTROLS
INTERCOM (LS−460B)	Provides voice communications between crewmembers and between cockpit and groundcrew, also amplifies various warning and weapon tones, and voice communications.	Within the aircraft and groundcrew personnel	Both, and groundcrew personnel	Pilot and RIO left console and in the nosewheel well
JTIDS (AN/URC−107)	Provides jam−resistant, cryptographically secure digital voice and data, navigation, relay, and tacan.	Line of sight (LOS) up to 300 nautical miles.	Both	Pilot left console, RIO right and left consoles
TACAN (AN/ARN−118(V)) (AN/URC−107)	Navigation aid provides bearing and distance information to local stations.	LOS up to 390 nm, depending on altitude.	Both	Pilot and RIO left console
UHF DATA LINK (AN/ASW−27C)	Provides two−way digital message communication.	LOS up to 180 nautical miles.	Both	RIO right console
V/UHF 1 COMMUNICATIONS SET (AN/ARC−182(V))	Provides two−way voice and tone communication.	LOS up to 200 nautical miles.	Both	Pilot left console
V/UHF 2 COMMUNICATIONS SET (AN/ARC−182(V))	Provides two−way voice and tone communication.	LOS up to 200 nautical miles.	Both	RIO left console
V/UHF DIRECTION FINDER (OA−8697/ARD)	Provides bearing information to selected stations.	LOS up to 180 nautical miles.	Both	Pilot and RIO left console
UHF VOICE SECURITY EQUIPMENT (KY−58)	Cryptographic encoding and decoding of UHF voice communications.	Same as radio in use.	RIO	Left console
IFF TRANSPONDER (AN/APX−100)	Responds to interrogations by other aircraft or ground stations.	LOS.	RIO	Right console
IFF INTERROGATOR (AN/APX−76B)	Requests identification from other aircraft.	LOS.	RIO	DD and right console
RECEIVER DECODER (AN/ARA−63A)	Provides glideslope signals for carrier landing system.	LOS up to 20 nautical miles.	Pilot	Right console
RADAR ALTIMETER (AN/APN−194)	Displays height above earth's surface.	0 to 5,000 feet.	Pilot	Pilot's instrument panel
RADAR BEACON (AN/APN−154)	Aids in tracking by ship and ground−based x−band radars. Provides down link for automatic carrier landing system.	LOS.	RIO	Right console

Figure 19-1. Communications and Associated Equipment



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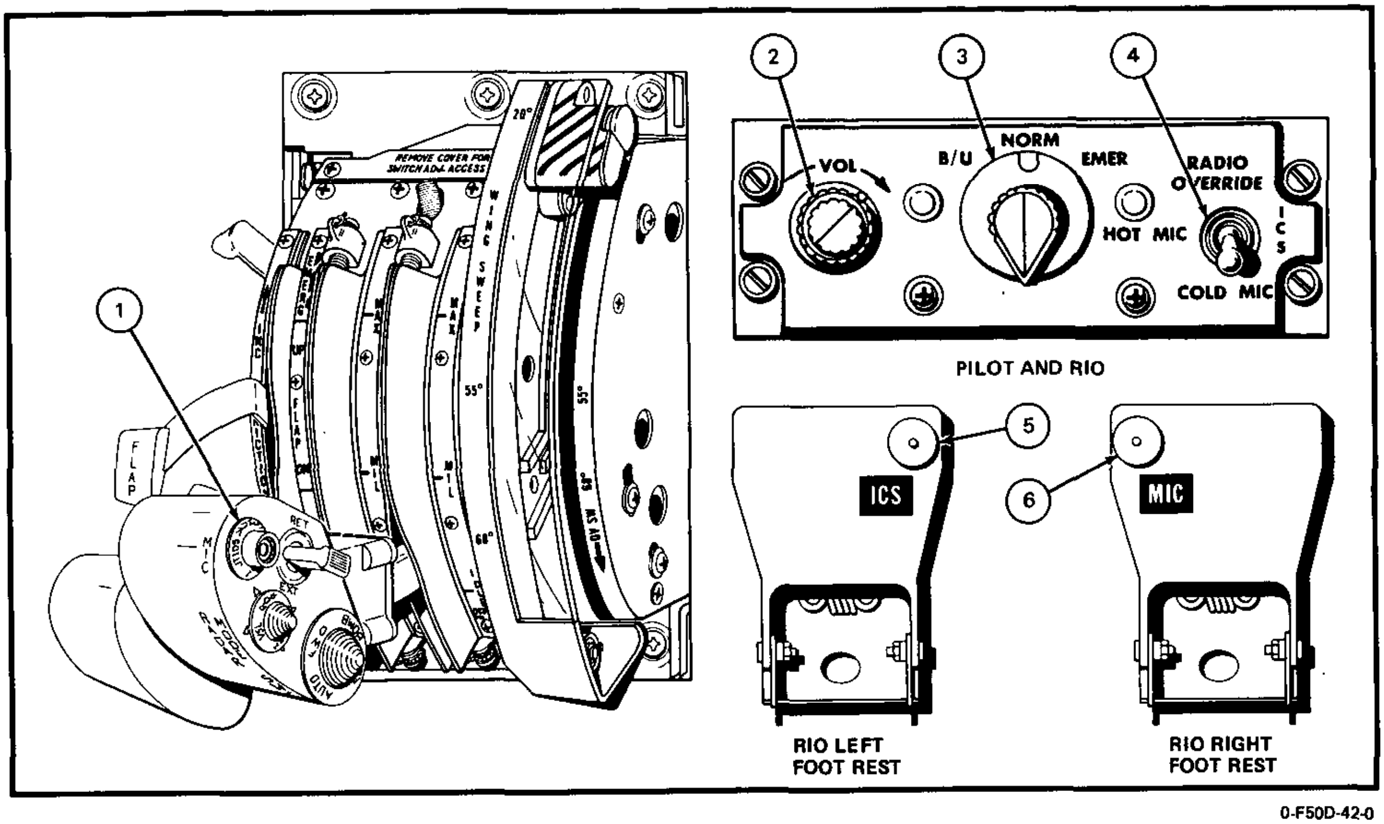
NOMENCLATURE		FUNCTION
(1) JTIDS antenna select switch	AUTO –	Enables JTIDS to transmit on the upper antenna and to receive on either the upper or lower antenna depending upon signal strength.
	LWR –	Enables JTIDS to transmit and receive on the lower antenna.
	UPR –	Enables JTIDS to transmit and receive on the upper antenna.
	BOTH –	Enables JTIDS to transmit and receive on both the upper and lower antenna. 200 watt output power is equally divided between the upper and lower antenna, 100 watts each.
(2) V/UHF–1 DL antenna select switch	UPR/LWR –	Selects upper V/UHF 1 and lower D/L antenna.
	LWR/UPR –	Selects lower V/UHF 1 and upper D/L antenna.
(3) V/UHF–2 antenna select switch	UPR –	Selects upper V/UHF 2 antenna.
	LWR –	Selects lower V/UHF 2 antenna.

Figure 19-2. Antenna Select Panel



NOMENCLATURE	FUNCTION	
(1) Pilot's COMM switch	ICS –	Permits intercommunication when *COLD MIC* is selected on function selector. Overrides V/UHF communications.
	JTIDS –	Keys the JTIDS terminal for voice communications.
	V/UHF 1 –	Keys ARC–182 radio for operation.
	V/UHF 2 –	Keys ARC–182 radio for operation.
(2) VOL control	Controls intercommunication audio level at that cockpit station. Audio level at other station not affected; however in EMER volume is controlled by other station.	

Figure 19-3. Intercommunication Controls (Sheet 1 of 2)

NOMENCLATURE	FUNCTION	
3 Amplifier selector	B/U –	(Backup) used to bypass a fault amplifier and uses a backup output amplifier at own station.
	NORM –	(Normal) used when all amplifiers are functioning properly.
	EMER –	(Emergency) uses the backup amplifier at own station, and makes use of input amplifier of other station over the emergency line. Volume is controlled by other station.
4 Function selector	RADIO OVERRIDE –	Attenuates non critical radio audio to emphasize intercommunication when urgent.
	HOT MIC –	Intercommunication without keying.
	COLD MIC –	Intercommunication only when pilot actuates COMM switch on inboard throttle or RIO actuates keying switch on left foot rest.
5 RIO's ICS button (left foot rest)	Permits intercommunication if COLD MIC is selected on the function selector control. Overrides V/UHF communications.	
6 RIO's MIC button (right foot rest)	Permits transmission on V/UHF 1, V/UHF 2, or BOTH radios as well as JTIDS as selected on the radio frequency channel indicator (RFCI).	

Figure 19-3. Intercommunication Controls (Sheet 2 of 2)

Note

If two amplifiers fail at the same station, intercommunication is impossible.

The external interphone connection is in the nose wheelwell. When the pilot's COMM switch is set to HOT MIC, ground personnel can communicate with the cockpit stations.

19.2.1 Audio Warning Signals. Audio warning signals from the weapon system are available to either or both crewmen through the ICS. Each signal has a distinct tone. A visual display accompanies most audio signals so that the flightcrew can expect the tone and interpret its meaning. Most audio signals may be attenuated or turned off if not required, allowing the flightcrew to concentrate on more critical tones. Critical warning tones cannot be attenuated by any mode of ICS operation.

CAUTION

With the front cockpit ICS amplifier selector knob in the EMER position, engine stall/overtemperature and Sidewinder tones will not be available to the pilot.

Note

- Selection of EMER via the ICS amplifier selector knob in either cockpit allows use of the other cockpit's input amplifier.
- The RIO can obtain a Sidewinder and engine stall/overtemperature tone by selecting EMER on his ICS panel. This allows the RIO to use the pilot's input amplifier.

Figure 19-4 provides a glossary of audio warning signals available within the aircraft weapon systems. Two 28-Vdc circuit breakers, ICS NFO (7F3) and ICS PILOT (7F2), control power to and provide circuit protection for the ICS. Power to both circuit breakers is

TONE	POSITION	CONTROLS	FUNCTION	CHARACTERISTICS
SIDEWINDER	*Pilot*	TONE· VOLUME/TACAN CMD panel	*Missile acquisition*	*High frequency.Changes* to indicate missile self−track.
ALR−67	Pilot and RIO	TONE VOLUME/TACAN panel (PILOT) RADAR WARNING RCVR panel (RIO)	Indicates a missile alert, missile launch, critical threat, and/or status change.	Low to high frequency, determined by scan rate and PRF of threat radar. Low− to high−frequency warble when missile launch is detected.
Radar Altimeter	Pilot and RIO	Radar altimeter indicator (pilot)	Low−altitude warning	1,000 Hz tone, modulated at 2 pulses per second, lasting 5 seconds or until altitude is increased/limit bug is lowered.
APX−100	RIO	IFF control panel	Valid mode 4 interrogation	PRF of interrogation pulse 2,000 and 6,000 Hz.
Tacan	Pilot and RIO	Tacan control panel	Station identification	International morse code with three−letter designation.
AN/ARC−182	Pilot and RIO	V/UHF control panel	Other aircraft *direction find (DF)* reception.	International morse code, voice.
ENGINE STALL/ OVERTEMPERATURE	Pilot	None	Engine stall detection and/or EGT over−temperature warning.	Modulated 320 Hz for 10 seconds maximum or until fault is removed, whichever comes first.

Figure 19-4. Glossary of Tones

from dc essential bus No. 1. Approximately 1 minute of warmup is required in order to achieve normal operating temperature.

19.2.2 Pilot Tone Volume/Tacan Command Panel. The TONE VOLUME/TACAN CMD panel (Figure 19-5) on the pilot left console has two volume controls for regulating audio signals from the ALR-67 and Sidewinder missile lock-on.

19.3 V/UHF RADIO (AN/ARC-182)

The ARC-182 radio provides multimode, multichannel, air-to-air/air-to-surface voice, tone, and antijam (Have Quick) communications. The ARC-182 control panel (Figure 19-6) is located on the pilot and RIO left console. Frequency range extends in four bands from 30 to 87.975, 108 to 155.975, 156 to 173.975, and 225 to 399.975 MHz on any of 11,960 channels (separated by 25 kHz). Transmission and reception are available in AM or FM bands. The modulation is selected automatically by the radio except in the 225 to 399.975 band, which is reserved for antijam use. There are 40 preset channels available. Channels 1 through 30 are used for normal voice communications. Channels 31 through 40 are used for antijam Have Quick communications. Guard frequency of each band may be monitored simultaneously with any other frequency selected. The radio is used with the OA-8697/ARO to provide automatic direction finding to the transmitting station. The ARC-182 operates with secure voice equipment (KY-58). Upper and lower antenna installations provide reliable line-of-sight communications to 200 nm (depending on altitude and atmospheric conditions). A radio frequency/channel indicator (Figure 19-7) on the pilot and RIO instrument panel displays the frequency or channel selected. A separate VOLUME control panel (Figure 19-8) for the pilot is located on the pilot left console.

Note

Transmissions on both V/UHF 1 and V/UHF 2 radios, while operating on the same frequency, may result in a squeal. This is a normal condition caused by RF interaction between the two radios operating on the same frequency in close proximity to each other.

19.3.1 Preset Channel(s) Load

1. MODE selector — T/R or T/R&G.
2. Frequency mode control — Reset.
3. CHAN SEL switch — Select Channel 1.
4. Frequency mode control — Read.
5. Frequency select switches — Slew to Desired Frequency.
6. Frequency mode control — LOAD (frequency is stored in memory for CH 1).
7. Frequency mode control — READ, Verify Frequency Display.
8. Enter frequency in quick reference directory for CH 1 (if desired).
9. Repeat steps 2 through 8 for subsequent channels.

19.3.2 Built-In Test. BIT isolates faults in the RT to one module, two modules, and three modules. BIT should be initiated anytime the FREQ/(CHAN) display blanks or indicates an erroneous readout. Proceed as follows:

1. MODE selector — TEST.
2. BRT control — As Required.
3. BIT requires approximately 10 seconds; observe FREQ/(CHAN) display.
   a. No fault is indicated by 888.888.
   b. Faults are indicated by a number that identifies the module or modules at fault.

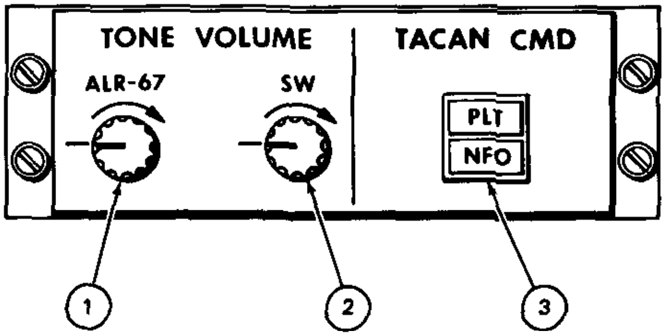
Note

If readouts 061 or 651 display, select other antenna and key transmitter for 5 seconds, then repeat steps 1 through 3.

Figure 19-9 lists the most common BIT fault codes and their respective module failures.

19.3.3 Have Quick (Antijam) Mode. Have Quick is a tactical antijam system that utilizes frequency hopping, a method where frequencies are changed many times per second. The frequency hopping patterns, stored in memory and frequency tables, are selected by word-of-day, net numbers, and a given date. The antijam mode of the ARC-182 is enabled by selecting a net number and by placing the NORM/AJ switch to AJ once all the variables have been entered into the radio. For two or more radios to successfully communicate on a Have Quick net, each radio must have the same TOD, WOD, and operating net.

The ARC-182's Have Quick II system is compatible with older Have Quick I systems.



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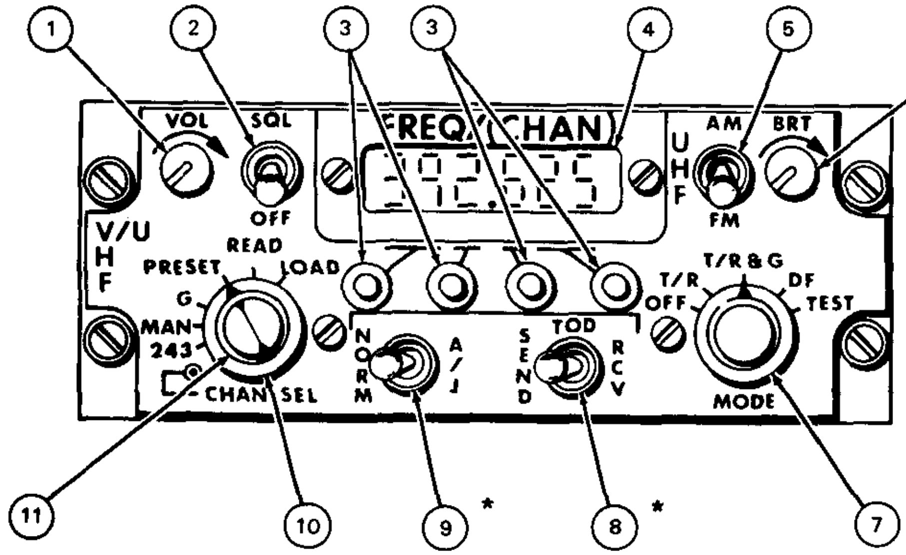
NOMENCLATURE	FUNCTION
1 ALR−67 volume control	Clockwise rotation increases tone in pilot's headset. Provides threat alert, status and warning tones representing received threat radar signals.
2 SW (Sidewinder) volume control	Clockwise rotation increases missile tone in pilot's headset. Counterclockwise rotation turns tone to low.
3 TACAN CMD control switch/indicator	Illuminates when selected PLT or NFO, indicating crewman in command of tacan.

Figure 19-5. Pilot TONE VOLUME/TACAN CMD Panel



PILOT AND RIO

* THESE SWITCHES ONLY AVAILABLE ON C-11128A AND C-11984 CONTROL PANEL.

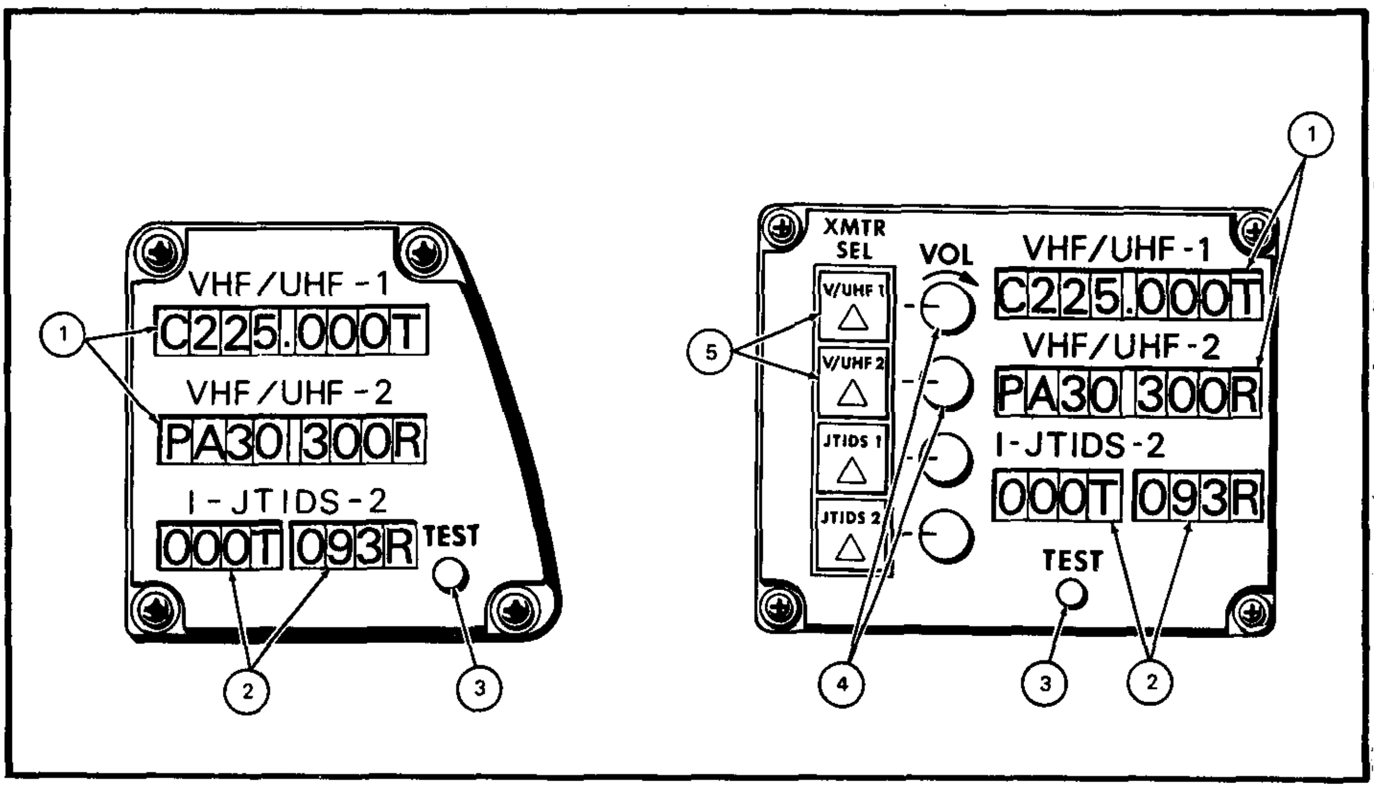
0-F50D-473-0

NOMENCLATURE	FUNCTION
(1) VOL control	Adjusts level of audio signal. Clockwise rotation increases audio level. RIO's adjustments made only via the RFCI.
(2) Squelch switch	SQL – Squelch circuit is operational and background noise is removed by reducing receiver gain. OFF – Disables squelch circuit restoring receiver to full gain.
(3) Frequency select switches (spring return)	Four frequency tuning switches are used to tune transceiver when the tuning selector switch is set to MAN (manual). The spring–loaded switches increase the frequency in the up position and decrease frequency in the down position. The left switch controls the hundreds and tens digits, the second switch controls units, the third switch controls tenths, and the right switch controls hundredths and thousandths.
(4) FREQ/(CHAN) display	Displays incandescent digital readouts of selected frequency or channel. In TEST mode indicates receiver transmitter fault locations.
(5) UHF mode selector	Operational when tuned to frequencies in the 225.000 to 399.000 MHz band. AM – Selects amplitude modulation signals. Varies with atmospheric conditions, susceptible to electromagnetic interference. FM – Selects frequency modulation signals. Reduces electromagnetic interference.

Figure 19-6. AN/ARC-182 V/UHF Control Panel (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(6) BRT control	Varies the FREQ/(CHAN) display light intensity. Clockwise maximum intensity.
(7) MODE switch	OFF – Secures V/UHF radio, unless frequency mode switch is set to 243. T/R – Energizes transmitter and main receiver. T/R&G – Energizes transmitter, main, and guard receivers. DF – Provides automatic direction finding from 108 to 399.975 MHz. TEST – Indicates built-in-test (BIT) RT; displayed on FREQ/(CHAN) indicator. Refer to Built-In-Test this chapter. Generates 1020 Hz unattenuated tone.
(8) TOD switch	RCV – Allows reception of TOD messages on preset channel selected. SEND – Allows transmission of TOD messages on preset channel selected.
(9) NORM/AJ switch	NORM – Used for normal V/UHF communications. A/J – Provides jam resistant communications.
(10) Frequency mode switch (outer dial)	243 – Turns on the receiver-transmitter (takes precedence over operational mode control) and causes the transmitter main receiver, and guard receiver to tune to 243.000 MHz (UHF guard frequency). All functions except VOL, SQL and BRT are disabled. MAN – Permits manual selection of an operating frequency using the frequency tuning switches. Transmitter and receiver are disabled during a frequency change. G – Tunes the receiver-transmitter to the guard frequency in the band to which the RT was last tuned. PRESET – Allows selection of any 1 of 40 present operating frequencies with CHAN SEL switch. Selected channel is displayed in the two center digit readouts of the FREQ/(CHAN) display. Channels 31 through 40 are for Have Quick (antijam) use. READ – Displays the frequency (rather than channel) of preset channel selected. LOAD – Automatically places the displayed frequency into the memory for the selected preset channel.
(11) CHAN SEL switch (inner dial)	Enables any 1 of 40 preset channels when the frequency mode switch is set to PRESET.

Figure 19-6. AN/ARC-182 V/UHF Control Panel (Sheet 2 of 2)



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NOMENCLATURE	FUNCTION
(1) VHF/UHF−1 and −2 frequency/channel indicator	Displays information for each radio (pilot and RIO) as follows: • Left most LCD indicates secure voice selection : C (cypher) or P (plain) • Right most LCD indicates whether radio is in use for transmission (T) or reception (R) • Displays frequency, channel number, or WOD channel number • With anti−jam selected, the net number is prefixed by an A • F is displayed if the RFCI fails periodic BIT • If there is bad or no V/UHF data for 3 seconds, displays only a decimal point.
(2) 1−JTIDS−2 channel indicator	Displays channel selected (0 − 127) for JTIDS−1 and JTIDS−2 voice links (pilot and RIO) with alpha designator indicating transmit (T) or receive (R) for radio in use.
(3) TEST button	Activates 10−second maximum internal test of the RFCI. On successful completion of the test, the LCDs show the test display. If the TEST button is held for more than 10 seconds the display will automatically return to the display prior to test.

Figure 19-7. Radio Frequency/Channel Indicator (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(4) VOL control	Enable RIO to adjust level of audio signal. Clockwise rotation increases audio level.
(5) XMTR SEL buttons	Enables RIO to select desired radio for voice communications (V/UHF or JTIDS). **Note** When JTIDS voice communications is selected V/UHF plain voice communications are inhibited. If V/UHF encrypted voice communication is selected, both V/UHF (encrypted) and JTIDS will transmit simultaneously.

Figure 19-7. Radio Frequency/Channel Indicator (Sheet 2 of 2)

19.3.4 Have Quick Load Instructions. Have Quick antijam voice communications entry uses preset channel 40. The contents of preset channel 40 designates the loading mode in which the unit is operating. The following loading codes are used to operate and load in Have Quick II:

1. 220.000 — Operate in Have Quick II.
2. 220.025 — MWOD load mode.
3. 220.050 — MWOD erase mode.
4. 220.075 — FMT load mode.

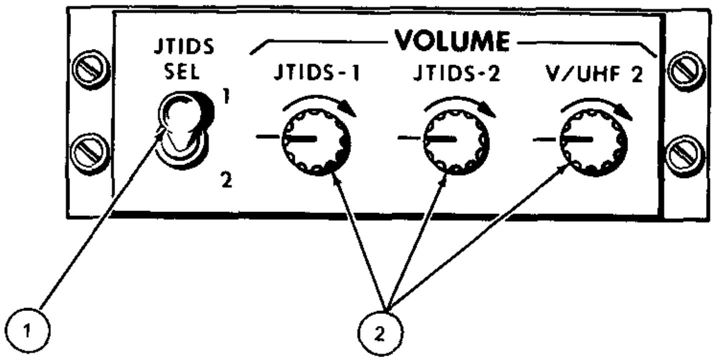
If the aircrew desires to enter Have Quick without loading or verifying, 220.000 should be loaded into preset channel 40 using the procedures in paragraph 19.3.4.13. Otherwise, Have Quick I processing is used.

19.3.4.1 Net Selection. Have Quick I and II use the same method of net selection. A net is a six-digit number that selects the frequency table that will be hopped on. Net numbers are in the form of AXX.XYY, where A indicates a Have Quick net, X is a number from 0 to 9 defining the net, and YY is either 00, 25, 50, or 75, which determines the combat or training operational mode. The operational modes are

1. COMBAT
   a. 00 — Operate in Have Quick I.
   b. 25 — Have Quick II NATO.
   c. 50 — Have Quick II Non-NATO.
   d. 75 — Not Used.
2. TRAINING
   a. 00 — Have Quick I Training.
   b. 25 — Have Quick II Training.
   c. 50/75 — Not Used.

The 1,000 combat nets range from 000 to 999. The variables in these net numbers refer the radio to specific frequencies and algorithms within the radio's memory. There are five Have Quick I training nets displayed as A00.X00, where X is 0 to 4. There are 16 Have Quick II training nets displayed as A0X.X25, where X.X is 0.0 to 1.5. The variables in these training net numbers tell the radio the training frequency on which to begin hopping. Training nets are activated by a special WOD (300.0XX) in segment one of the WOD used for that day. The last two digits determine the hop rate. The same applies to the last two digits of the first segment of combat WODs.

19.3.4.2 Word of Day/Multiple Word of Day. A WOD/MWOD is a transmission security variable. Have Quick I radios use a WOD consisting of six segments of six digits each. Have Quick II radios use a MWOD that adds a seventh segment containing a two-digit date tag and five more MWODs for 6 days of operation without reloading WODs. The WOD/MWOD is loaded into the radio to key the Have Quick system to the proper hopping pattern, dwell time, and hop rate. The hop rate is included in the first segment of each WOD/MWOD, XXX.XYY, where YY is 00, 25, 50, 75, denoting slow to fast hop rates. When operating with Have Quick I systems, only one of the six MWODs is used. See Figure 19-10.



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NOMENCLATURE	FUNCTION
(1) JTIDS SEL switch	Selects JTIDS 1 or 2 voice channel for pilot's voice transmissions. Both channels are always selected to receive.
(2) JTIDS−1, JTIDS−2, V/UHF−2 volume control	Clockwise rotation increases audio level of received transmission (Pilot only).

Figure 19-8. Pilot VOLUME Control Panel

MODE	DISPLAY	FAULT	INTERPRETATION
RCV	·	RMT or RT	SELECT TEST MODE
XMT	·	LOW PWR	SELECT TEST MODE
TEST	·	RMT CTRL	DEFECTIVE CONTROL
TEST	888.888	NONE	RT AND CTRL OK
TEST	4 6 5	RT	MODULES 4, 5, OR 6 BAD
TEST	0 6 1	VSWR	RT OR ANTENNA SYSTEM
TEST	6 5 1	FWD PWR	RT OR ANTENNA SYSTEM
TEST	1 5 7	RT	MODULES 1, 5, OR 7
TEST	3 3 3	RT	MODULE 3 BAD

Figure 19-9. Common BIT Indications

1.1	289.950	2.1	295.850	3.1	290.450	4.1	275.950	5.1	270.450	6.1	300.050
1.2	299.000	2.2	289.600	3.2	279.000	4.2	269.300	5.2	259.000	6.2	249.000
1.3	298.100	2.3	288.000	3.3	278.600	4.3	268.000	5.3	258.600	6.3	248.900
1.4	297.000	2.4	287.900	3.4	277.400	4.4	267.000	5.4	257.800	6.4	247.100
1.5	296.000	2.5	286.300	3.5	276.500	4.5	266.700	5.5	256.000	6.5	246.100
1.6	295.000	2.6	285.300	3.6	275.100	4.6	265.500	5.6	255.500	6.6	245.200
1.7	11	2.7	12	3.7	13	4.7	14	5.7	15	6.7	16

8.1 = OPERATIONAL DAY

1.1 through 1.6 are WOD 1 segment numbers.

1.7 is the date tag for WOD 1.

2.1 through 2.6 are WOD 2 segment numbers

2.7 is the date tag for WOD 2.

3.1 through 6.7 is the same as above for WOD's 3 through 6.

8.1 is the current Operational Day, which should match one of the date tags.

Note:

(1) If the current operational day was 11 (MWOD location 1), Have Quick II Combat net would be used with a hop rate of 50 (included in the last two digits of segment 1.1). An appropriate Have Quick II operational net should be chosen.

(2) If the current operational day was 16, Have Quick II Training Net would be used because the first segment of MWOD location 6 (6.1) is the special training segment. The hop rate would be 50 (last two digits of first segment). An appropriate Have Quick II Training Net number should be chosen.

Figure 19-10. Example of an ARC-182 Have Quick II MWOD Fill

19.3.4.3 Time of Day. TOD is a signal that synchronizes Have Quick radios to a common time for antijam operation. There are two ways to enter TOD. One method involves receiving UTC over the air on a manually selected UHF frequency after power up. The second method involves using the self-start (emergency time start) mode, which is used when acting as master clock to transmit that time to other Have Quick systems. Within this TOD signal is the operational day. This is transmitted with the TOD or loaded manually as in the self-start procedure. Refer to paragraph 19.3.4.12, TOD Load. The codeword for TOD is "Mickey."

19.3.4.4 MWOD Load Entry

1. Frequency mode control — Preset.
2. CHAN SEL switch — Select Channel 40.
3. Frequency mode control — READ.
4. Frequency select switches — Select 220.025.
5. Frequency mode control — LOAD.

Note

If MWODs are being loaded to replace existing ones, the old MWODs should be erased using the procedures in paragraph 19.3.4.9. This procedure will erase all MWODs in the radio's memory.

19.3.4.5 MWOD Load

1. Frequency mode control — Preset (1.1 will be displayed).
2. Frequency select switches — Select Desired WOD and MWOD Segment Using Middle Two Frequency Select Switches.
3. Frequency mode control — READ (display shows frequency indicating desired WOD segment).

Note

If the MWODs were erased using the MWOD erase procedure in paragraph 19.3.4.9, the display will show 000.000 indicating that they had been erased.

4. Frequency select switches — Select Desired Frequency WOD Segment.
5. Frequency mode control — LOAD (desired frequency loaded into memory).
6. Repeat steps 1 through 5 to load remaining MWODs.

Note

- The desired frequencies are loaded in segments 1 through 6 of each MWOD. The date tag for each MWOD is loaded into the seventh segment and is a two-digit number corresponding to the operational day on which that MWOD is to be used. It can be loaded or changed using the two middle frequency select switches and the MWOD segment loading procedures above.
- The crew may not enter an out-of-range WOD frequency, segment, or date tag. When two identical date tags are loaded, the last date entered is valid and the old date is set to zero. If the old date is viewed, 00 will be displayed.
- The MWOD is not entered into the memory of the unit until the date tag is loaded. Thus, if a segment of an MWOD has been changed after the MWOD was initially entered, the date tag must be reentered to accept the MWOD change.

19.3.4.6 MWOD Load Exit

1. Frequency mode control — MAN (ready to receive TOD).

Note

When manual is selected on the frequency mode control to exit a load mode, the code to operate in Have Quick II antijam without entering a load mode (220.000) will automatically be loaded into preset channel 40.

19.3.4.7 Operational Date Load. The operational date is the calendar date of the mission day. The range is 1 through 31. The MWOD that is used by the unit for frequency hopping is the MWOD whose date tag matches the operational day. Thus, if an operational day is entered or received via TOD transmission and no date tag exists for that operational day, an error will occur and be displayed. The operational day is loaded as follows:

1. Perform steps 1 through 5 of paragraph 19.3.4.4. Step 1 is not required if already in MWOD Load.
2. Frequency mode control — PRESET (last WOD and segment selected will be displayed).

3. Frequency select switches — Select 8.1.

4. Frequency mode control — READ (last operational date or 00 is displayed).

5. Frequency select switches — Selected Desired Date.

6. Frequency mode control — LOAD (Operational date is loaded into memory).

Note

Out of range (<1 or >31) operational dates may not be entered.

19.3.4.8 MWOD Verify. The aircrew may view the MWODs at any time for verification by reading the MWOD locations by using steps 1 through 3 in paragraph 19.3.4.5.

19.3.4.9 MWOD Erase. The following procedure enables the aircrew to erase all MWODs stored in the nonvolatile memory. This procedure is recommended before reloading all MWODs with new frequencies.

1. Frequency mode control — PRESET.

2. CHAN SEL switch — Select Channel 40.

3. Frequency mode control — READ.

4. Frequency select switches — Select 220.050 To Initiate MWOD Erase Function.

5. Function mode control — LOAD (display will go blank indicating MWODs have been erased).

19.3.4.10 FMT Training Frequency Load. The Have Quick II FMT training net operates similar to combat Have Quick II, as both the date tag and operational day functions are used. The FMT net, however, hops on its own set of 16 frequencies loaded into a separate training WOD. Additionally, a special MWOD segment for FMT (300.0XX, where XX is the hop rate) is loaded into the first segment of the MWOD being used (usually 1.1, but any of the six MWODs can be used as long as the date tag for the MWOD whose first segment contains 300.0XX matches the operational day). The frequencies actually hopped on, however, are loaded into a separate FMT WOD that can be accessed with the FMT load code loaded into preset channel 40. Once the 16 training frequencies (7.01 through 7.16) are loaded, it is not necessary to reload them. Additionally, it is not necessary to reload the special FMT MWOD segment once it is loaded, as long as the date tag used is within the same MWOD as the special FMT segment. If using the self-start method of TOD, the operational day as well as the date tag must be loaded into segments 8.1 and 1.7 (or the seventh segment of whichever MWOD is being used), respectively. Thus, combat Have Quick II and FMT can be used interchangeably simply by loading one or more of the MWOD first segments with the special training WOD segment. On every day that the operational day matches the date tag of the MWOD with the special FMT segment loaded into its first segment, the unit will hop on the FMT training frequencies, regardless of the contents of the other segments within that MWOD. See Figure 19-10, Note 2.

1. Frequency mode control — PRESET.

2. CHAN SEL switch — Select Channel 40.

3. Frequency mode control — READ.

4. Frequency select switches — Select 220.075.

5. Frequency mode control — LOAD.

6. Frequency mode control — PRESET (first FMT frequency segment 7.01 is displayed).

7. Frequency select switch — Select Desired FMT Segment.

8. Frequency mode control — READ.

9. Frequency select switches — Select Desired FMT Training Frequency.

10. Frequency mode control — LOAD (desired FMT training frequency is stored in memory).

11. Repeat steps 6 through 10 to load remaining desired FMT training frequencies. The load function is exited by placing the frequency mode control to MAN.

19.3.4.11 FMT Net Operation. Once the training frequencies have been loaded or verified, Have Quick II FMT net can be operated as follows:

1. Perform steps 1 through 5 of paragraph 19.3.4.4.

2. Frequency mode control — PRESET.

3. Frequency select switches — Select Segment 1 of Desired MWOD To Be Used (1.1, 2.1, 3.1, etc.).

4. Frequency mode control — READ (display shows frequency indicating desired WOD segment).

5. Frequency select switch — Select Special FMT Segment With Desired Hop Rate (300.0XX XX = 00, 25, 50, 75).

6. Frequency mode control — LOAD (desired frequency loaded into memory).

7. Frequency mode control — PRESET.

8. Frequency select switches — Select Segment 7 (date tag) of the Same MWOD Used Above (1.7, 2.7, 3.7, etc.).

9. Frequency mode control — READ (display shows two-digit date tag previously loaded or 00).

10. Frequency select switches — Select Desired Date Tag.

11. Frequency mode control — LOAD (desired date tag loaded into memory)

12. Frequency mode control — MAN (ready to receive TOD).

19.3.4.12 TOD Load. TOD may be loaded in any of the following ways.

1. Emergency or forced start entry of time/date is performed by holding the TOD switch in receive (RCV) position until decimal point flashes, then momentarily setting TOD switch to SEND. Selecting the operational day is performed using steps in paragraph 19.3.4.7.

2. To receive time/date over air (broadcast) in normal mode, momentarily push TOD switch to RCV when TOD is transmitted over manually selected UHF frequency. This will allow acceptance of TOD for 1 minute.

3. To transmit time/date over air (broadcast) in normal mode, momentarily push TOD switch to SEND while on a manually selected UHF frequency. At this time, TOD signal is sent and a tone will be heard.

4. To receive new time in A/J mode or to update clock, momentarily push TOD switch to RCV. This will allow acceptance of TOD for 1 minute.

5. To transmit time/date over air (broadcast) in A/J mode, momentarily push TOD switch to SEND. This will send TOD signal to all units that are in A/J and using the same net.

19.3.4.13 Antijam Mode Selection If entering Have Quick II from a previous load mode, selecting MAN from that mode will automatically perform steps 1 through 5 below. In this case, proceed to step 6.

Note

TOD can be received from power up. It is not necessary to enter any other load or operate mode first.

1. Frequency mode control — PRESET.

2. CHAN SEL switch — Select Channel 40.

3. Frequency mode control — READ.

4. Frequency select switches — Select 220.00.

5. Frequency mode control — LOAD (the radio is now prepared to operate in Have Quick II).

6. Frequency mode control — MAN.

7. TOD — Received.

8. Frequency select switches — Select Desired Net Frequency.

9. NORM/A/J switch — Select A/J on Command to "GO ACTIVE" (first digit of net frequency will display as "A").

19.3.4.14 Have Quick II Error Codes. The Have Quick II radio generates different error displays for three possible entry errors. If the radio has been initialized properly, an (A) will display in the left-most display segment. If a question mark (?) displays, the net number is invalid. If a backward question mark (⸮) displays, the MWOD or operational data is invalid. If the display does not change when AJ is selected, then TOD has not been received or entered. The error display for each error is shown in Figure 19-11.

19.3.4.15 Have Quick Basic Troubleshooting Procedures

1. Broken communications when A/J is selected — Verify all segments of the current WOD or all the FMT frequencies are correct.

ERROR DISPLAY	FREQUENCY MODE CONTROL	CONTROL ERROR
?XX.XXX	MAN	Invalid MWOD and Date
XX.XXX	MAN	Invalid Net Number
?XX	MAN	No TOD
?XX	PRESET	Invalid MWOD and Date
XX	PRESET	No TOD
The "X"s in the error display column respresents digits 0 to 9.		

Figure 19-11. Have Quick II Error Codes

2. Lack of an "A" in the first digit of the net frequency displayed on the radio — Receive another TOD transmission to resynchronize the radio.

3. Broken communications after time, once good communications have been established — Receive another TOD transmission either in A/J or normal mode to resynchronize the radio.

4. Invalid MWOD or date tag error code — Verify all MWOD segments for the current day.

5. Invalid net error code — Verify that the correct net is being used.

6. No TOD error code — Attempt to receive another TOD from the master. If still unable to receive TOD, use the self-start method and attempt to transmit TOD to other net participants if practical.

19.3.5 Radio Frequency Control/Indicators. Two RFCIs (Figure 19-7) are provided. Each has LCDs that show the frequency or channel selected for V/UHF 1 and 2 and JTIDS 1 and 2, their transmit/receive status, and antijam and secure voice selection. The RFCIs are tested by pressing the TEST button on the panel. An indication is provided if the RFCI fails BIT.

The RIO RFCI also contains transmit select buttons for V/UHF 1 and 2 and JTIDS 1 and 2 as well as volume controls for adjusting their audio level.

Note

- The RIO volume control knob on the ARC-182 control panel is not functional. The volume control knob on the RIO RFCI is used to control volume.

- When JTIDS voice communication is selected, V/UHF plain voice communications are inhibited. If V/UHF encrypted voice communication is selected and JTIDS voice communication is selected, both V/UHF (encrypted) and JTIDS will transmit simultaneously.

19.4 V/UHF AUTOMATIC DIRECTION FINDER (OA-8697)

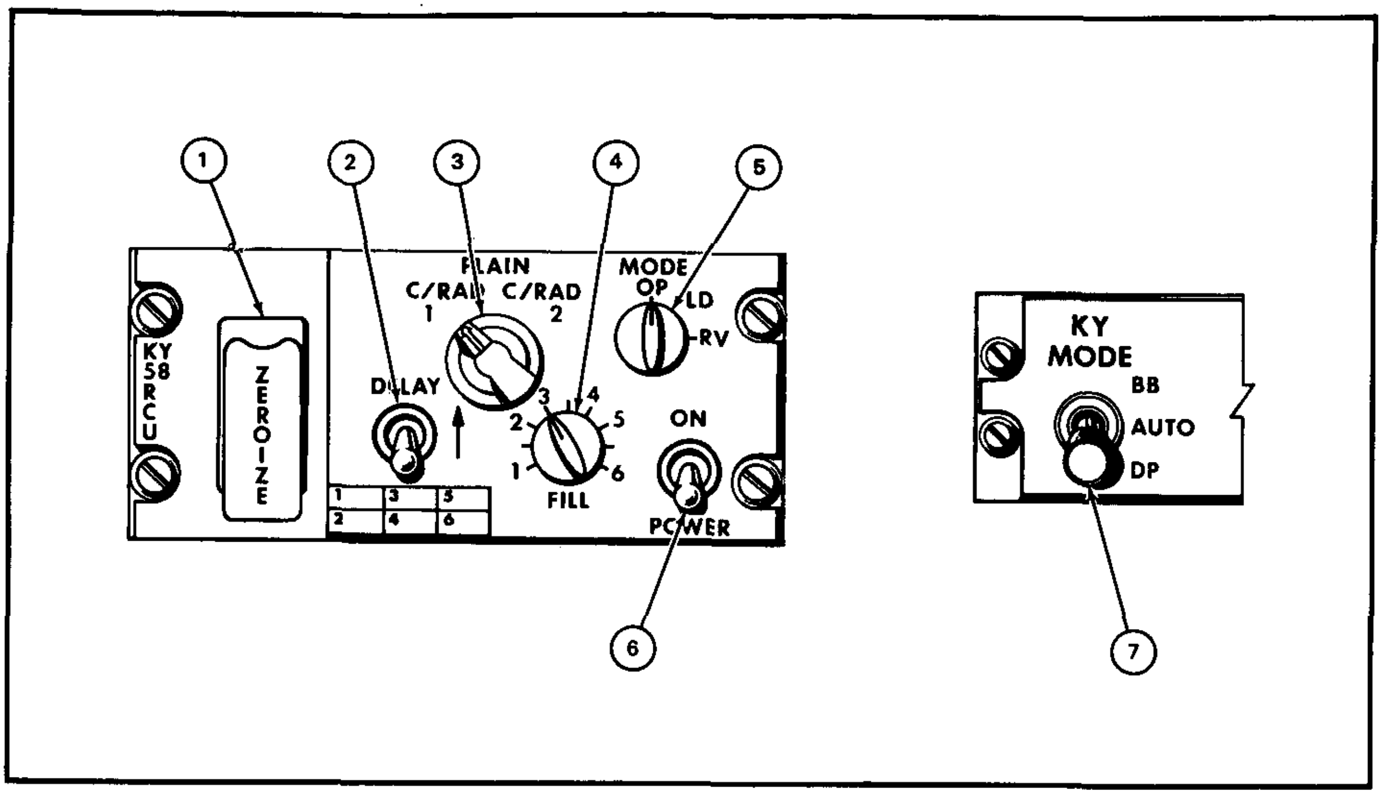
The V/UHF automatic direction finder is used with the ARC-182 radio in the AM mode (voice is suppressed). ADF provides relative bearings to transmitting ground stations or other aircraft. It can receive signals on any 1 of 30 preset channels or on any manually set frequencies in the 108 to 399.975 MHz range.

The system has a line-of-sight range, varying with altitude. Operating power is 115 Vac from the essential No. 2 bus, 28 Vdc from the essential No. 2 bus, and 26 Vac through the RIO circuit breaker panels. The system requires a 5-minute warmup period. During the warmup time, failure indications should be disregarded. The system uses a solid-state segment rotation ADF antenna. Bearing to transmitting stations is displayed on the pilot/RIO BDHI (No. 1 needle), and on the HSD format of any MFD. The ADF signal is interrupted during voice transmissions.

19.5 UHF VOICE SECURITY EQUIPMENT (TSEC/KY-58)

The security equipment is integrated, and operates, with the V/UHF 1 and 2 communications sets to permit UHF secure voice in a hostile environment. It shall be operated as directed by appropriate authority. Theory of operation and practical application are covered in the KY-58 operation manual.

The KY MODE switch and the KY-58 control panel (Figure 19-12) on the RIO left side console are the only cockpit controls for operating the KY-58 in either cipher or plain language. Electrical power is from the dc essential bus No. 1 with circuit protection on the RIO dc essential No. 1 circuit breaker panel, (7C3) KY-58/Z AHP.



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NOMENCLATURE	FUNCTION	
(1) *ZEROIZE switch*	ZEROIZE –	*Guard lifted. The preset codes are erased and must be reset on the ground by qualified personnel before the cipher mode can be used.*
(2) DELAY switch	DELAY –	Provides a time delay between push–to–talk and actual transmit.
(3) Cipher switch	C/RAD–2 –	Selects V/UHF 2 for secure voice.
	PLAIN –	Enables plain audio to pass through without encryption.
	C/RAD–1 –	Selects V/UHF 1 for secure voice.
(4) FILL switch	Selects the position to be loaded with data. MODE switch must be in LD to load.	
(5) MODE switch	OP –	Enables KY–58 operation after unit is loaded.
	LD –	Used for loading data into KY–58 control panel.
	RV –	Receiver variable is not operational at this time.

Figure 19-12. KY-58 Controls (Sheet 1 of 2)

NOMENCLATURE	FUNCTION	
(6) POWER switch	ON –	Used to transmit and receive secure voice communications over V/UHF radio. Applies operating power to KY–58 system.
(7) KY MODE switch (operational only with KY–58 installed)	BB –	Normal mode for FM transmission
	AUTO –	Provides automatic selection of BB/FM and DP/AM. Changes as the frequency on the V/UHF is changed.
	DP –	Normal mode for AM transmission.

Figure 19-12. KY-58 Controls (Sheet 2 of 2)

The KY-58 has two states of operation: plain and cipher (C). Plain is used during normal UHF communications. Cipher is used when secure voice communications are desired. There are two cypher modes: BB (baseband) for use with FM transmissions and DP (diphase) for use with AM. The radio sets must be ON to attain secure operation. The receiving station must be properly equipped to receive transmissions in the proper cipher mode.

Note

- Do not transmit plain voice on one radio during cipher receptions or while transmitting on the other radio.
- Communications between KY-28 and KY-58 voice security equipment is not possible.

19.5.1 KY-58 Operation

19.5.2 Prelaunch

1. Determine that proper code has been set by personnel qualified in voice security equipment.
2. V/UHF radios — ON.
3. Power switch — ON.
4. Cypher switch — C/RAD 1 or C/RAD 2.
5. KY MODE switch — As Required.
6. If a ground test of equipment is desired, establish two-way plain text radio communications on the plain voice radio with a suitable ground station and request an equipment check.
7. After a 2-minute warmup period, on the cipher selected radio, listen for a steady, unbroken tone in the headset followed by a double-pitched broken tone.
8. Key the appropriate radio selected for transmission, hold for approximately 2 seconds, and release. Double-pitched broken tone will cease and no sound will be heard.
9. Key radio and hold. A single beep tone will be heard in approximately 1-1/2 seconds, if delay is selected; otherwise, beep is immediate. When this tone is heard, the equipment is ready for cipher transmission.
10. After beep tone is heard, establish two-way cipher radio communications with a cooperating ground station and check for readability and signal strength.
11. Set power and radio selector switches in accordance with the tactical situation.

Note

If a ground check of the equipment is not practical, the above procedures may be used to perform an in-flight check of the equipment.

19.5.3 Postlaunch. The speech security equipment shall be operated as directed by appropriate authority.

19.5.4 After Landing

1. ZEROIZE switch — ZEROIZE (as briefed).

   Zeroize the code as directed by appropriate authority.

2. Power switch — OFF.

19.6 JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM

The JTIDS is a high-capacity communications system providing jam-resistant, secure digital voice and data. This system also provides voice and data relay, dual navigation grid operation, and tacan data.

The JTIDS digital voice function provides two secure, jam-resistant, separate (J1 and J2) 16 KBS voice channels. These are integrated into both the pilot and RIO cockpits.

The JTIDS data communications function provides a two-way data transfer between the F-14D and other JTIDS users for position and identification, air intercept control, and fighter-to-fighter functions. Identification is accomplished among participants, Navy (CVs, CGs, DDGs, E-2Cs, and F-14Ds) and other services (E-3s, F-15s etc.) by the PPLI message. The AIC function provides the exchange of command and control information and own-ship sensor tracks/status between the F-14D and a control platform (E-2C or ship). Fighter-to-fighter functions provide the direct exchange of fighter tracks and status among fighters.

The relay function provides the capability for JTIDS to retransmit voice or data messages for extended-range communications. This function provides expanded battle group operations by expanding communication ranges (voice, PPLI, etc.) beyond line of sight, greater than 300 nm, air to air.

JTIDS operates in both the geodetic and relative navigation modes simultaneously. JTIDS also provides the MCS corrections to the own-ship navigation position, which is calculated using data received from the link, and own-ship INS or SAHRS data. See Chapter 20 for additional explanation of JTIDS navigation functions.

The JTIDS communication system utilizes three major tactical modes: one-way AIC (pass), two-way AIC, and F/F. These modes are integrated into the aircraft controls and displays utilizing the TID, DD, MFDs (TSD, VDI, and HSD formats) and DEU. Refer to NAVAIR 01-F14AAD-1A for the detailed operation of the TID, DD, and TSD. The JTIDS terminal interfaces with the various aircraft systems via 1553 mission bus No. 2 and MCS. The majority of JTIDS processing is performed by mission computer 1. In the event of a mission computer failure, the other computer will support tacan operation and provide own-ship position for the PPLI message. JTIDS BIT function is provided via the OBC page on the MFD.

When installed, the JTIDS receiver/transmitter replaces the AN/ARN-118 tacan system. Within the JTIDS terminal (DPG and R/T), the equivalent functionality of the AN/ARN-118 tacan system exists.

19.6.1 JTIDS Terminal. The JTIDS AN/URC-107 Class 2 terminal consists of the following WRAs:

1. Data processor group (interface unit and digital data processor)
2. Secure data unit
3. JTIDS receiver transmitter
4. Battery assembly.
5. Circuit breaker protection is provided through the 28-Vdc essential and 115-Vac essential buses.

19.6.1.1 Digital Data Processor. The DDP is part of the JTIDS data processor group and the heart of the JTIDS Link-16 operation. It contains the net interface computer program. The DDP is common among all Navy and most non-Navy JTIDS platforms. The DDP performs the following functions.

1. TDMA and message management
2. Network synchronization and relative navigation processing
3. Receiver/transmitter control
4. Signal decoding and decryption.

19.6.1.2 JTIDS Interface Unit. The IU is part of the JTIDS DPG and is unique for the Navy air platforms (F-14D and E-2C). The IU provides all the unique interfaces for the aircraft. A 1553 digital mux bus connects the IU to the MCS via mission bus 2. The IU contains the SICP that is also unique for the Navy air platforms. The IU performs the following functions.

1. TADIL-J (Link 16) message generation and reception processing.
2. System control (TDMA — OFF/STBY/NORM, Tacan — OFF/ON).
3. Navigation data conversion.
4. JTIDS initialization.
5. Voice conversions (analog/digital and digital/analog) and processing.

6. Tacan data (BDHI and 1553) and control panel interface.

7. Aircraft interfaces (1553 and hardwired discrete signals).

19.6.1.3 Secure Data Unit. There are two types of KGV-8 SDUs currently in use: the KGV-8(E2) for lot 1 JTIDS systems and the KGV-8B for lot 2 and newer systems. The KGV-8B will eventually replace the older KGV-8(E2) SDU. The KGV-8 SDU is bolted to the front of the IU and provides MSEC and TSEC for JTIDS operations. Up to eight crypto variables can be loaded into the KGV-8 and are addressable on a time slot-to-time slot basis by the DDP. The eight locations are split into two groups of four locations. This allows loading and storage of crypto variables for 2-day operation. This provides uninterrupted JTIDS operation through roll-over (00:00:00 Zulu). The JTIDS initialization loads are set up to use locations 0, 2, 4, and 6 for crypto period (day) 0 and locations 1, 3, 5, and 7 for crypto period 1. Refer to the Users' Guide to Link-16/JTIDS Crypto, OPNAVINST C3120.43, Annex D, to determine the correct crypto period for the day.

19.6.1.3.1 Load Control Unit. The LCU is used to control the loading of the crypto variables into the KGV-8(E2) SDU. The LCU and KYK-13 are connected to the remote fill assembly located in the aircraft crypto access panel. The remote fill assembly provides access to the JTIDS terminal from the crypto access panel. This access allows the loading of JTIDS crypto variables without opening the avionics bay containing JTIDS. To load variables, the KYK-13 fill device (containing the crypto variables) and LCU are connected at the crypto access panel. The LCU is then used to select the SDU location, load the variable, and verify the load.

19.6.1.3.2 Data Transfer Device. The AN/CZY-10 DTD is a handheld keyboard device used to control the loading of the crypto variables into the KGV-8B SDU or KGV-8(E2) SDU. The use of the DTD eliminates the need for KYK-13 and LCU when used with the KGV-8B SDU. With the KGV-8(E2), the DTD eliminates the KYK-13 but requires the addition of the LCU. The DTD interfaces directly with the KGV-8(E2) or KGV-8B via a cable that connects to the remote fill assembly. The remote fill assembly is located behind the aircraft crypto access panel. The DTD can then be used to select the SDU location and load and verify the crypto variables. Refer to the AN/CZY-10 DTD Users Manual NSA ON477340, and the User's Guide To Link-16/JTIDS Crypto, OPNAVINST C3120.43, Annex D.

19.6.1.4 JTIDS Receiver-Transmitter. The JTIDS R/T provides RF detection and frequency translation between the L-band RF at the antennas and the 75-MHz IF at the DDP. The RT also contains an RF power amplifier that provides 100 watts to each of two antenna ports or 200 watts to one antenna port. Frequency tuning control for the RT is provided from the DDP based on a pseudo random sequence generated by the SDU. The JTIDS R/T also performs most of the JTIDS tacan processing. It provides tacan data (range and bearing) in a digital format to the DPG.

19.6.1.5 Battery Assembly. A battery assembly containing lithium and nickel-cadmium cells is used to maintain the following:

1. NICAD

   a. Crypto variables (STBY — up to 48 hours, DATA SIL/NORM — during power transients).

   b. Initialization (STBY — 5 minutes, DATA SIL/NORM — during power transients).

2. LITHIUM

   a. JTIDS chronometer (all modes).

Note

The battery assembly maintains terminal memory during switchover from ground power to engine power but does not maintain terminal synchronization or communication.

19.6.2 JTIDS Controls. The JTIDS control panel and DATA LINK MODE panel are shown in Figure 19-13. In addition to the basic panels (ANT SEL, VOLUME, and the RFCIs) the MFD (TSD formats), TID, DD, DSS, and DEU enable the crew to interface with the aircraft weapon system to support JTIDS functions.

19.6.3 Data Storage Set. The DSS is located in the RIO cockpit. It consists of a receptacle that is mounted in the aircraft, and a removable storage unit. The DSU provides storage of JTIDS initialization data and the recording of engine and CSS data for postflight analysis. Refer to Chapter 2 for the DSS engine data recording and Chapter 27 for the CSS data recording. The DSU is loaded with JTIDS initialization data using the TAMPS. On the selection of DOWNLOAD on the DEU, the mission computer requests the JTIDS initialization data stored on the DSU, processes it, and transfers it to the JTIDS terminal. The exchange of JTIDS initialization data is performed between the DSS, mission computer, and JTIDS via the 1553 bus and takes approximately 5 seconds to complete. Without initialization data, JTIDS tacan and BIT functions will operate but JTIDS synchronization, navigation, and communication functions will not be available.

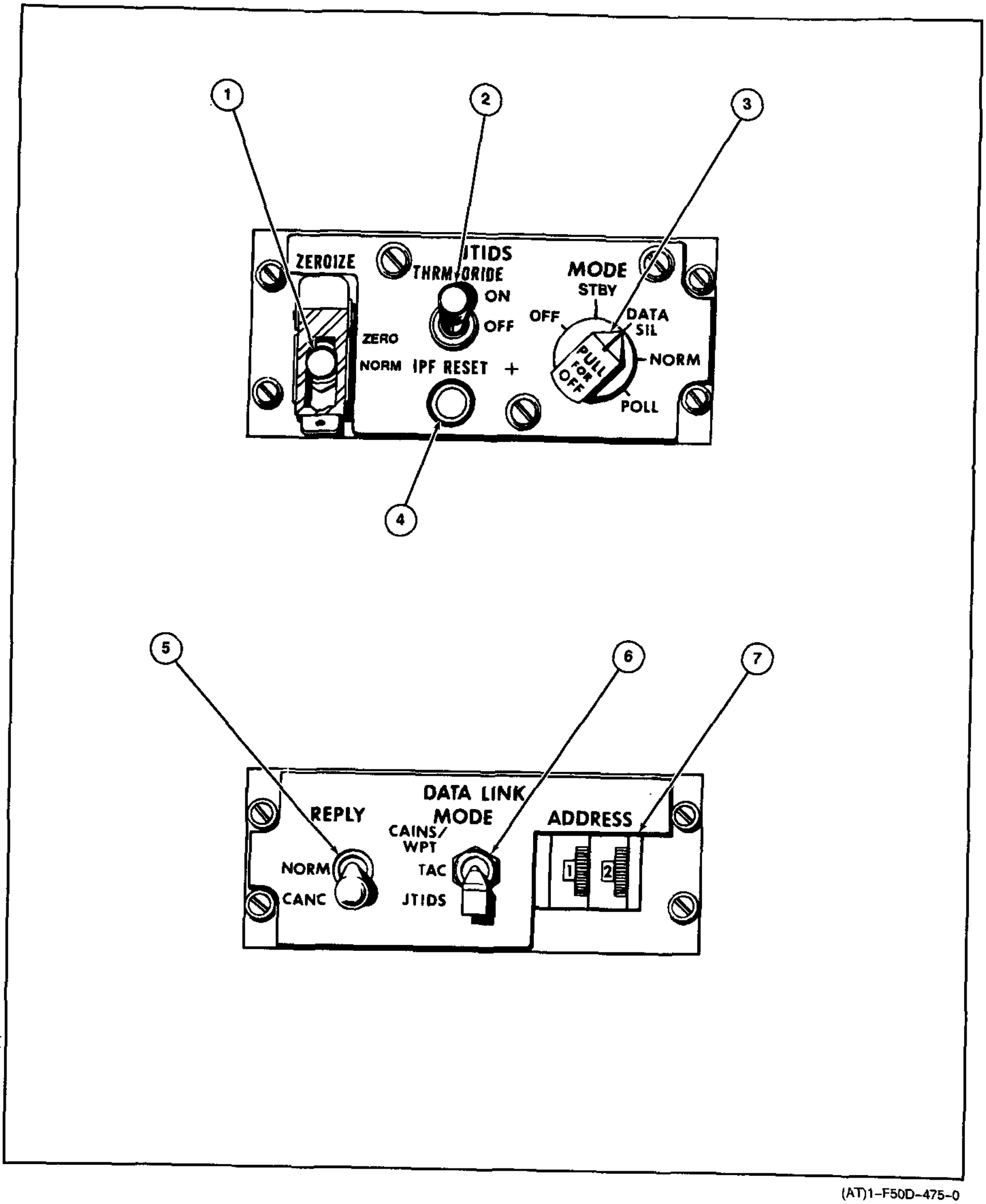


Figure 19-13. JTIDS Control Panels (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
(1) ZEROIZE switch	ZERO – Zeroizes the crypto variables in the interface unit and the DSS JTIDS initialization load. NORM – Normal switch position (spring loaded).
(2) THRM ORIDE switch	ON/OFF – Enables manual override of thermal shutdown. Indicated by a JTIDS HOT on the MFD caution advisory window.
(3) JTIDS MODE switch	OFF – Removes all power from the JTIDS/Link–16 functions of the JTIDS terminal and zeroizes the crypto. To power down the JTIDS terminal, both JTIDS and Tacan have to be off. STBY – The JTIDS/Link–16 functions are off, the battery will hold crypto for up to 48 hours and initialization data for 5 minutes. DATA SIL – The JTIDS/Link–16 is on but will not transmit except during BIT and voice. Net Entry will perform passive sync and once sync is achieved voice will transmit when keyed. Tacan transmissions are not affected by this selection. Digital tacan is available for display on the MFDs and HUD. NORM – The JTIDS/Link–16 is on. Net Entry will perform active synchronization and once sync is achieved all Link–16 transmit functions are available. Tacan transmissions are unaffected by this selection. Digital tacan is available for display on the MFDs and HUD. POLL – This mode is currently not used; however if selected JTIDS/Link–16 is on and digital tacan is available for display on the MFDs and HUD.
(4) IPF RESET switch	Re–enables Link – 16 transmission when they are shut down by an IPF detected failure.
(5) REPLY switch	NORM – Enables Link–4 reply message transmission (no JTIDS function) CANC – Inhibits Link–4 reply message transmission (no JTIDS function)
(6) DATA LINK MODE switch	TAC – Selects Link–4 (AN/ASW–27C) as the primary link system. The following JTIDS functions operate in this mode. • Synchronization • Ownship PPLI messages are transmitted (Ownship System Status messages are inhibited) • JTIDS voice (transmit and receive) • JTIDS navigation updates • Tacan JTIDS – Selects Link–16 (AN/URC–107) as the primary link system. All Link–4 functions are disabled.

Figure 19-13. JTIDS Control Panels (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
	CAINS/ WPT – Enables Link–4 carrier alignment and waypoint data to be received every 16 ms with no reply data. The same JTIDS functions operate in this mode as when TAC is selected. **Note** The status of this switch is sent to the MCS by the DEU. In the event the DEU is not ready (No 1553 communications) the mode will default to Link–4 (D/L). This will prevent loss of the ACLS function in the event of a failure.
7 ADDRESS thumbwheel	Selects fourth and fifth least significant octal digit for Link–4 address.

Figure 19-13. JTIDS Control Panels (Sheet 3 of 3)

19.6.4 JTIDS System Operation. Procedures for the operational use of the JTIDS system are provided in the following paragraphs. These paragraphs include power-up, initialization, and synchronization. These procedures are normally performed on the ground during aircraft startup; however, they can be performed anytime power is applied to the aircraft and the MCS is in full-up operation.

Note

For other participants to display the F-14D PPLI, the INS or SAHRS has to complete alignment. During alignment, the PPLI message will be transmitted with position set to no statement.

The following steps are required to power-up and initialize JTIDS.

19.6.4.1 Powerup

1. Verify STBY is selected on the JTIDS control panel and crypto has been loaded.

2. Verify/install the DSU cartridge.

Note

- With aircraft power ON, the DSU 28 VDC C/B (9G3) should be disengaged before installing or removing the DSU from its receptacle. Failure to remove the power can erase or damage the DSU cartridge.
- JTIDS manually initiated BIT shall not be performed without a fault indication by either background BIT or startup BIT. Manual BIT operation with no posted fault(s) can give false indications of JTIDS WRA/SRA failures.

3. Select JTIDS mode — DATA SIL or NORM. This will power up the JTIDS part of the system.

19.6.4.2 Initialization

1.. MFD3 — Select JTIDS own-aircraft data page and ACK all computer messages.

2. DEU — Select DOWNLOAD then ENTR (initiates MCS download of DSU JTIDS load to the JTIDS system).

3. MFD3 — Verify DSS LOAD on own-aircraft data page changes to IN PROG (2 to 3 seconds) and finally to OK (6 to 8 seconds). Verify none of the following JTIDS computer messages are displayed.

   a. JTIDS NOT AVAIL — Verify JTIDS is powered up and communicating on the bus.

   b. NO LOAD – NEED DSS — Verify DSU installed and powered up.

   c. NO LOAD – DSS FAIL — DSS fail; try to clear failure.

   d. LOAD ERROR – JTIDS — Bad JTIDS load; net operations will be effected.

4. MFD3 (own-aircraft data page) — Verify correct crypto period. To change crypto period:

   a. DEU — Select JTIDS COMM page, toggle CRYPTO option switch to 0 or 1, then press ENTR.

   b. MFD3 (own-aircraft data page) — Verify crypto period selected.

   c. JTIDS MODE switch — Cycle MODE switch from NORM or DATA SIL to STBY then back to NORM or DATA SIL.

Note

Cycling the JTIDS MODE switch is required to direct the DPG to access the desired crypto variables. If the MODE switch is not cycled, the DPG will continue to access the previous crypto variables while displaying the desired crypto period on the own-aircraft data page and net entry will not occur.

19.6.4.3 Synchronization. The following steps are required to synchronize JTIDS with the network.

1. Verify/select desired JTIDS antenna.

2. MFD3 (own-aircraft data page) — Verify JTIDS time is ±6 seconds of net time (GOES time, NTR, or any participant in the net).

3. DEU (time entry, JTIDS COMM page, TIME pushbutton) — Enter hours, minutes, seconds, and select ENT.

4. MFD3 (own-aircraft data page) — Verify correct time.

5. MFD3 (own-aircraft data page) — Verify NET ENTR – NS (net entry not started), IN PROG (attempting sync or course achieved), OK (synchronization complete/fine synchronization achieved).

6. DEU (net entry, JTIDS MODE page) — Press NET ENTR pushbutton and ENT.

7. MFD3 (own-aircraft data page) — Verify NET ENTR – IN PROG. Changes to OK synchronization complete (3 to 5 minutes normal mode, 7 to 10 minutes data-silent mode).

Note

Course sync can be verified by verifying the display of PPLI messages on TSD, TID, JTIDS data readout pages, or IRST summary page. JTIDS must be selected on the DATA LINK control panel to process PPLI messages.

8. DATA LINK control panel — Verify/select JTIDS for JTIDS tactical functions.

19.6.4.4 JTIDS Shutdown. If network operations are anticipated within 24 hours:

1. JTIDS MODE switch — STBY.

If network operations are not anticipated within 24 hours:

1. JTIDS MODE switch — OFF.

Note

Under no circumstances should the JTIDS MODE switch be left in DATA SILENT or NORM for greater than 90 seconds without electrical power on the aircraft. Doing this will deplete the battery and require it to be charged by maintenance personnel. Crypto variables cannot be accepted or maintained if the battery is depleted.

19.7 IN-FLIGHT VISUAL COMMUNICATIONS

Communications between aircraft are visual whenever practicable. Flight leaders shall ensure that all pilots in the formation receive and acknowledge signals when given. The visual communication chapters of NAVAIR 00-80T-113, the Aircraft Signals NATOPS Manual, should be reviewed and practiced by all pilots and RIOs. Common visual signals applicable to flight operation are listed in Figure 19-14.

19.8 GROUND HANDLING SIGNALS

Communications between aircraft and ground personnel are visual whenever practicable, operations permitting. The visual communication chapters of NAVAIR 00-80T-113 should be reviewed and practiced by all flightcrew and groundcrew personnel. For ease of reference, visual signals applicable to F-14 deck/ground handling are listed on Figure 19-15. During night operations, flashlights or wands shall be substituted for hand and finger movements. Refer to NAVAIR 00-80T-103 for aircraft arming and safing hand signals.

MEANING	SIGNAL	RESPONSE
GENERAL CONVERSATION		
Affirmative (I understand.)	Thumb up, or nod of head.	
Negative (I do not know.)	Thumb down, or turn of head from side to side.	
Question (repeat); used in conjunction with another signal, this gesture indicates that the signal is interrogatory.	Hand cupped behind ear as if listening.	As appropriate.
Wait	Hand held up in a fist with palm outward.	
Ignore last signal	Hand waved in an erasing motion in front of face, with palm forward.	
Perfect, well done	Hand held up, with thumb and forefinger forming an O and remaining three fingers extended.	
Numerals, as indicated	With forearm in vertical position, employ fingers to indicate desired numerals 1 through 5. With forearm and fingers horizontal, indicate number which, added to 5, gives desired number from 6 through 9. A clenched fist indicates zero.	Nod of head (I understand). To verify numerals, addressee repeats. If originator nods, interpretation is correct. If originator repeats numerals, addressee should continue to verify them until they are understood.
Take over communications.	Tap earphones, followed by lead change signal.	Execute.
CONFIGURATION CHANGES		
Lower or raise landing gear.	Rotary movement of hand (flashlight at night) in cockpit, as if cranking wheels, pause, drop below canopy rail.	Execute when hand/flashlight drops.
Speed brakes	Open and close four fingers rapidly and repeatedly. Flashlight at night —a series of flashes followed by a steady light; light out for execution.	Execute on head nod/light out.
Lower or raise flaps.	Rotary movement of hand (flashlight at night) in cockpit, as if cranking wheels, pause, drop below canopy rail.	Execute when hand/flashlight drops.

Figure 19-14. In-Flight Communications (Sheet 1 of 4)

MEANING	SIGNAL	RESPONSE
FUEL AND ARMAMENT		
Sweep wings aft.	Hand held up, palm aft, and swept aft along canopy rail; at night, flashlight swept aft along canopy rail.	Execute on head nod/light out.
Sweep wings forward.	Hand held up, palm forward, and swept forward along canopy rail; at night, flashlight swept forward along canopy rail.	Execute on head nod/light out.
How much fuel have you?	Raise fist with thumb extended in a drinking position.	Indicate fuel in tens of gallons or hundreds of pounds by finger numbers.
Arm or safety missiles and ordnance.	Pistol cocking motion with either hand.	Execute and return signal.
FORMATION		
OK	Section leader gives thumbs–up signal.	Stands by for reply from wingman, holding thumbs–up until answered.
Commence take off power turn–up.	Leader gives a two–finger turn–up signal.	Wingman returns two–finger signal and executes.
I have completed my takeoff checklist and am, in all respects, ready for (section) takeoff.	Section takeoff leader raises arm overhead and waits for response from wingman.	Wingman gives thumbs–up indicating checklist complete, and ready in all respects for takeoff then lowers arm and stands by for immediate section takeoff.
Takeoff path is clear. I am commencing takeoff.	Section takeoff leader lowers arm.	Wingman executes section takeoff.
Take combat cruise.	Leader holds up open hand palm out towards his wingman and pushes out and in.	Execute.
Leader shifting lead to wingman.	Leader pats self on head and points to wingman. At night, leader aircraft switches lights to bright, and turns anti–collision light on. If an external light failure, leader shines flashlight on helmet, then shines light on wingman.	Wingman pats head and assumes lead. At night, wingman puts external lights on dim, and turns anti–collision light off when he accepts the lead. If an external light failure, wingman shines flashlight at leader, then on his helmet.

Figure 19-14. JTIDS Control Panels (Sheet 2 of 4)

MEANING	SIGNAL	RESPONSE
Leader shifting lead to division designated by numerals.	Leader pats self on head, points to wingman, and holds up two or more fingers.	Wingman relays signal; designated division leader assumes lead.
Take cruising formation.	Thumb waved backward over the shoulder.	Execute.
I am leaving formation.	Any pilot blows kiss.	Nod (I understand.)
Aircraft pointed out, leave formation.	Leader blows kiss and points to aircraft.	Execute.
Directs plane to investigate object or vessel.	Leader beckons wing plane, then points to eye, then to vessel or object.	Wingman indicated blows kiss and executes.
Refers to landing of aircraft, generally used in conjunction with another signal: 1. I am landing 2. Directs indicated aircraft to land.	Landing motion with open hand: 1. Pats head. 2. Points to another aircraft.	Execute. Alternate signal – Lower gear.
1. Join up or break up, as appropriate 2. On GCA/CCA final: Leader has runway/ship in sight.	Flashing external lights.	1. Comply. 2. Wingman continues approach in accordance with standard operating procedures.
Wingman cross under.	Leader raises forearm vertically.	Execute.
Section cross under.	Leader raises forearm vertically and moves arm in pumping motion.	Execute.
Refers to CV Case I/Case II Pattern: 1. Spin whole flight. 2. Indicated aircraft spin.	1. Leader gives a two finger turnup signal. 2. Turnup signal followed by number of aircraft to spin.	1. Execute 2. Counting from last aircraft in flight specified number of aircraft execute spin.
AIR REFUELING		
Extend Drogue	Form cone–shape with hand, and move hand aft.	Tanker execute.
Retract Drogue	Form cone–shape with hand, and move hand forward.	Tanker execute.
Secure Turbine	One finger turn–up signal followed by cut signal.	Tanker execute.

Figure 19-14. In-Flight Communications (Sheet 3 of 4)

FORMATION SIGNALS MADE BY AIRCRAFT MANEUVER (COMBAT OR FREE CRUISE)		
Single aircraft cross under in direction of wing dip.	Single wing dip	Execute.
Section cross under.	Double wing dip	Execute.
Close up.	Series of small zooms	Execute.
Join up; join up on me.	Porpoise aircraft	Expedite join–up.

Figure 19-14. In-Flight Communications (Sheet 4 of 4)

WING SWEEP 20°

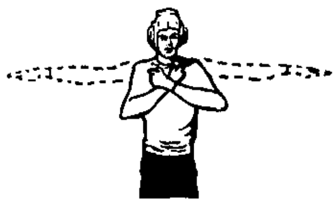
ARMS IN HUGGING POSITION ACROSS THE CHEST, THEN SWEPT OUT TO SIDES, ARMS HELD STRAIGHT OUT.

WING SWEEP 50°

ARMS FROM STRAIGHT OUT SWEPT HALF WAY DOWN TO SIDE.

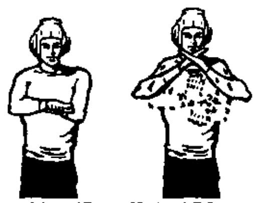
WING SWEEP 68°

ARMS FROM STRAIGHT OUT DROPPED TO SIDE.



OVERSWEEP

ARMS, FROM STRAIGHT OUT SWEPT IN ACROSS THE CHEST HUGGING THE SHOULDERS



MANEUVER FLAPS DOWN

ARMS IN CLOSE TO BODY, HANDS FLAT TOGETHER, THEN OPENED WIDE FROM WRISTS, FOLLOWED BY HAND HELD IN "X".

BACKUP MODULE CHECK/ FLIGHT CONTROLS CYCLE CHECK

PILOT ROTATES CLENCHED FIST IN A HORIZONTAL PLANE. SIGNALMAN REPEATS SIGNAL IF ALL CONTROL SURFACES ARE CLEAR OF PERSONNEL/EQUIPMENT.

DLC CHECK/ RAISE SPOILERS

ARMS EXTENDED HORIZONTAL AND DIRECTLY AHEAD, HANDS POP UP FROM WRIST TO SHOW PALMS.

LOWER SPOILER

ARMS EXTENDED HORIZONTAL DIRECTLY AHEAD WITH PALMS SHOWING, DROP PALMS FROM WRIST.

OBC

HANDS HELD CHEST HIGH TO FORM A "T".

NIGHT SIGNAL

NIGHT SIGNALS ARE THE SAME AS DAY SIGNALS EXCEPT AS NOTED. FLASHLIGHTS OR WANDS WILL SUBSTITUTE FOR HAND AND FINGER MOVEMENTS DURING NIGHT OPERATIONS.

CARRIER FLIGHT DECK PERSONNEL COLOR CODING

RED SHIRTS—	ORDNANCE and CRASH CREW
YELLOW SHIRTS—	PRI FLY, PLANE DIRECTORS, CATAPULT OFFICER, and ARRESTMENT OFFICER
BLUE SHIRTS—	PLANE HANDLERS (Pushers, Chock Men, etc.)
PURPLE SHIRTS—	FUEL HANDLING
GREEN SHIRTS—	AIRCRAFT MAINTENANCE, CATAPULT CREW, AND ARRESTMENT CREW
BROWN SHIRTS—	PLANE CAPTAINS
WHITE SHIRTS—	MEDICAL, SAFETY, TROUBLESHOOTERS, AND LSO

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Figure 19-15. Deck/Ground Handling Signals

CHAPTER 20

Navigation System

20.1 NAVIGATION SYSTEM

The navigation system (Figure 20-1) combines inputs from various on-board sensors with inputs entered by the crew and provides the following outputs of aircraft position: velocity, attitude, heading, accelerations, and angular rates. This information is displayed to the crew and also used by the weapons system and other aircraft functions. The system also provides steering and control commands for display to the crew as required.

The AN/ASN-139 inertial navigation set is the primary navigation sensor. It provides inertial information to the MCS via a standard data bus. As a backup to the INS, the AN/USN-2(V) SAHRS can provide similar, but somewhat degraded inertial information. Selection of SAHRS data is either automatic on failure of the INS or by operator selection. The MCS processes inertial data along with information from other navigation aids to provide smoothed and optimized outputs for display or for use by other aircraft systems and functions.

The AN/URC-107 JTIDS provides navigation correction data for use in updating the navigation system and velocity data for aligning the INS in flight. When installed, the JTIDS receiver/transmitter replaces the AN/ARN-118 tacan. With JTIDS installed, the CIU is not used to convert the tacan data to a 1553 format; the data goes directly from JTIDS to the MCS on the 1553 bus.

Navigation information that requires data entry is normally inserted by the RIO using the DEU; however, most parameters can also be entered on the RIO digital display keyboard. Navigation and steering displays are provided to the pilot and RIO by means of various formats on the three MFDs and to the pilot on the HUD. The TID can also provide most navigation displays to the RIO. A BDHI in each cockpit can display aircraft heading from the SAHRS, tacan range, bearing, and UHF/ADF bearing.

Navigation information from equipment not on the standard data bus is converted to the proper format by the CIU. These units and the information they provide are as follows:

1. Central air data computer — Altitude, airspeed, and other air related data.
2. AN/ARN-118 tacan — Range and bearing from tuned tacan station.
3. AN/ASW-27C data link — Ship inertial navigation system data for carrier alignment, waypoint coordinates, automatic carrier landing system commands, and vector steering commands.
4. Instrument landing system — SPN-42 course and glideslope deviation inputs.
5. UHF/ADF — Relative bearing to the tuned station.
6. AN/APN-194 radar altimeter — Height above the surface.

The CIU also converts MCS steering command outputs and roll and pitch attitude information from the INS into analog form for the AFCS.

20.1.1 AN/ASN-139 Inertial Navigation Set.

The INS is the primary navigation sensor. It is a self-contained system that includes an inertial measurement unit, processing equipment, and the supporting electronics and power supply. It provides inertial navigation inputs to the MCS.

The IMU is an all-attitude strapdown navigation set that mounts three laser gyros for angular rate sensing and three single-axis accelerometers for acceleration measurement.

In the strapdown configuration, the sensor assembly is not isolated from the airframe by gimbals and senses aircraft angular rate and accelerations directly. However, local level and wander angle (the difference between initial pointing angle and true north) must be

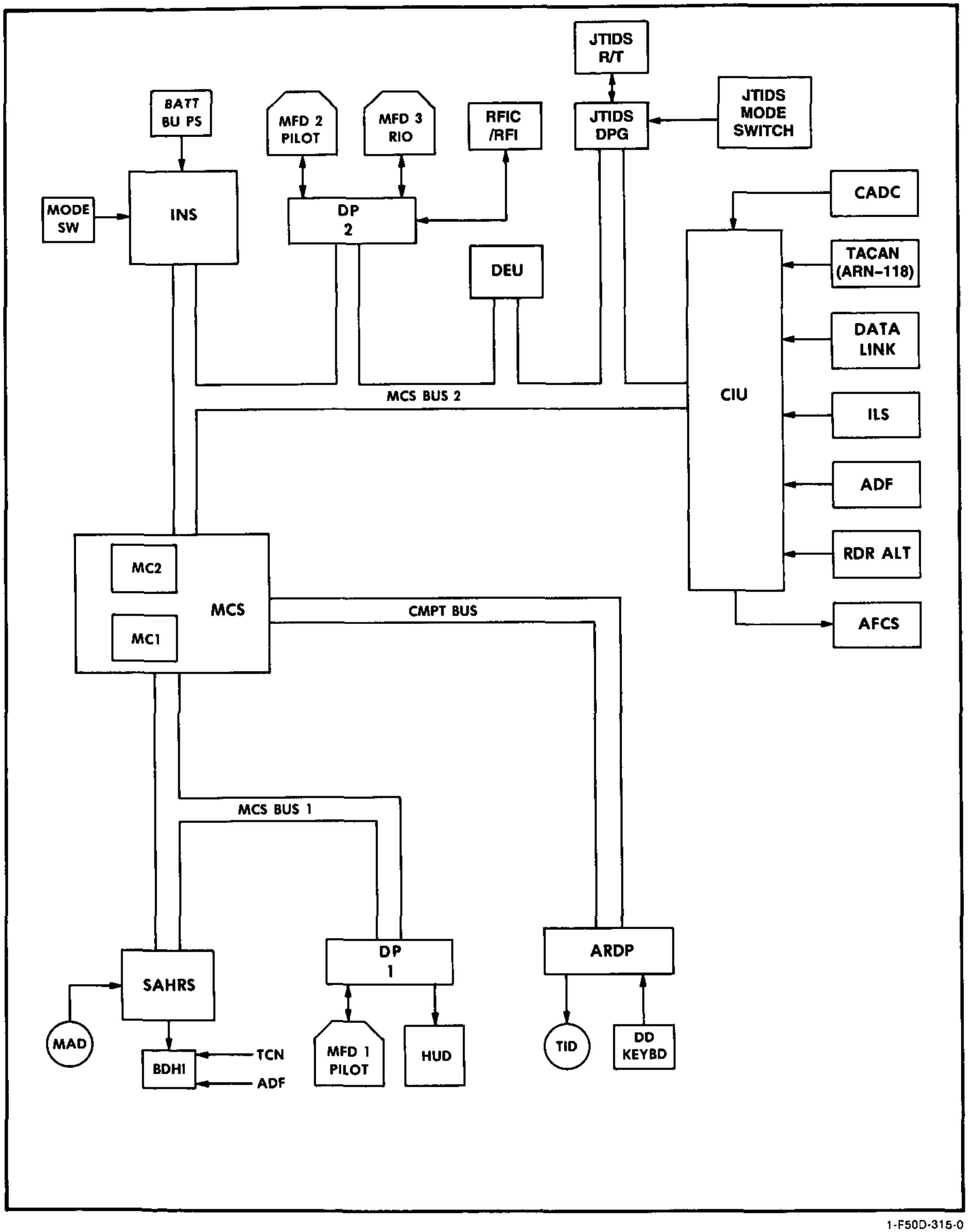

Figure 20-1. Navigation System

established by alignment for the INS to provide useful information. After alignment, the INS processor keeps track of the sensor assembly's orientation with respect to local level and true north by integrating the sensed angular rates. The sensed accelerations are resolved into north, east, and down components; corrected for coriolis and other factors; and integrated to provide velocity and position information.

This information as well as accelerations, body rates, altitude, and time tagging data is provided in digital form to the MCS. Analog outputs of roll and pitch are provided to the AFCS via the CIU.

The INS is controlled by the NAV MODE switch (Figure 20-2) on the RIO right console. This switch controls power to the INS and selection of modes of alignment and navigation. This switch is also used to control SAHRS alignment mode during concurrent alignment when both the INS and SAHRS are being aligned in the same mode to the same data source. Data entry and selection of INS submodes are by means of the MFD and DEU.

The INS uses 115 Vac from ac essential No. 2 bus through circuit breakers 3C7, 4C1, and 4C2. Refer to Chapter 2 for the alphanumeric listing of circuit breakers.

The INS backup power supply is a separate unit that provides 28-Vdc power to the INS for transient protection for up to 20 seconds in flight and to 2 seconds on the ground. Battery charging power is provided by the ac left main bus through circuit breaker 1I7.

20.1.2 AN/USN-2(V) Standard Attitude Heading Reference System. The SAHRS is the secondary navigation sensor. It is a self-contained strapdown all-attitude INS that uses three laser gyros for angular rate sensing and three single-axis accelerometers for acceleration measurement. The SAHRS includes a power supply, processor/memory, and other electronics to provide outputs to the MCS.

In the strapdown configuration, the sensor assembly is not isolated from the airframe by gimbals and senses aircraft angular rate and accelerations directly. However, local level and wander angle must be established by alignment for SAHRS to provide useful information. After alignment, the SAHRS processor keeps track of the sensor assembly's orientation with respect to local level and true north by integrating the sensed angular rates. The sensed accelerations are resolved into north, east, and down components; corrected for coriolis and other factors; and integrated to provide velocity and position information.

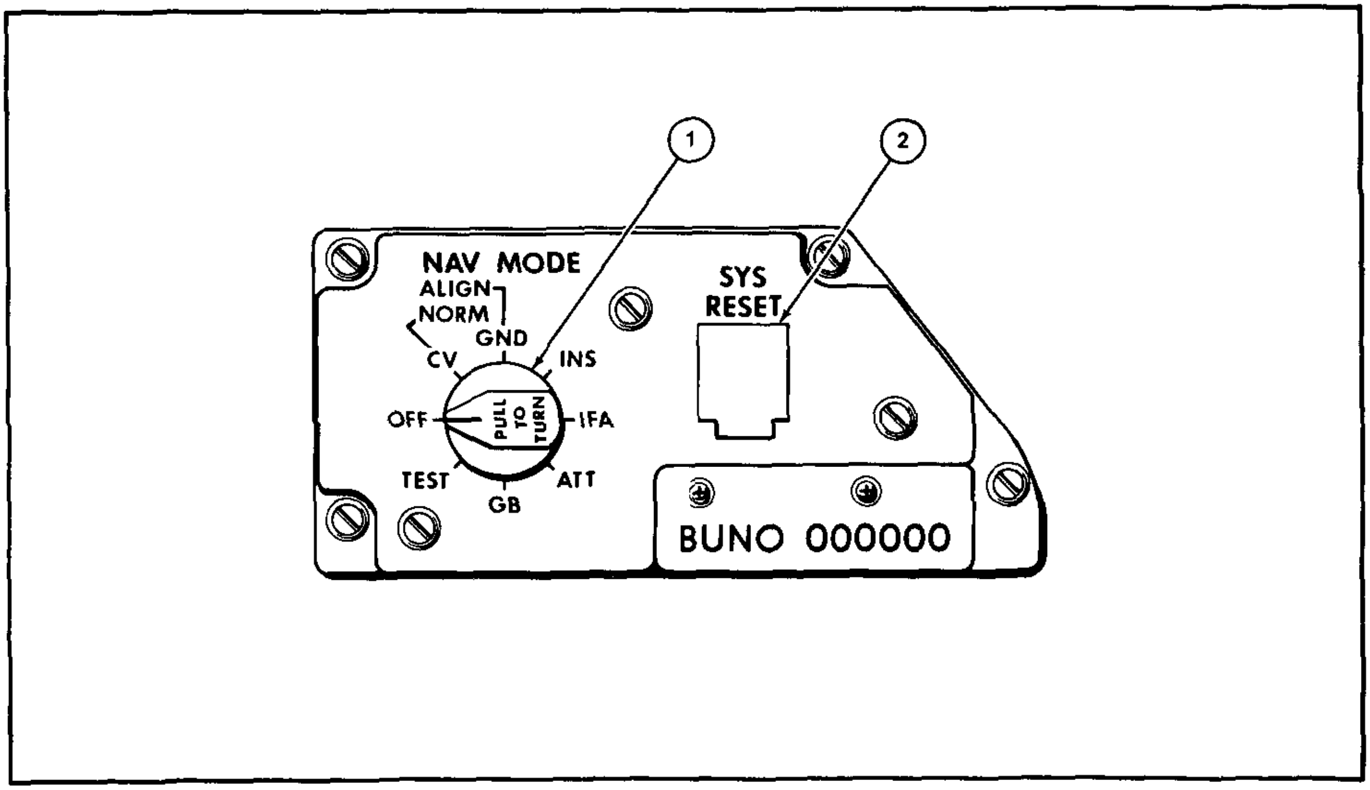

Figure 20-2. NAV MODE Select/Computer Reset Panel (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(1) NAV MODE selector	NORM CV - Initiates alignment with or without ships inertial navigation system (SINS) data. Without SINS data, manual entry of the ships latitude, longitude, true heading, and speed is required. ALIGN GND - Initiates alignment for shore based operations. Own aircraft latitude and longitude required for initialization. INS - Selects INS navigation. IFA - Initiates inflight alignment (airborne). Requires a valid source of true heading from SAHRS or manual entry of best estimated true heading. ATT - Selects the IMU backup navigation mode. May require entry of aircraft true heading at least one time, via the DEU Own Aircraft format. GB - Gyro Bias mode, not functional TEST - Provides Built-In-Test for installation and functional verification (on deck only). OFF - Secures system function.
(2) SYS RESET switch	Resets transient failures in the data processors and mission computers.

Figure 20-2. NAV MODE Select/Computer Reset Pane (Sheet 2 of 2)

Outputs to the MCS include velocity, heading, attitude, linear accelerations, angular rates, and time tagging data. The SAHRS also generates synchro outputs of roll and pitch for direct use by the AFCS, and magnetic heading for the BDHI.

The SAHRS is controlled by MFD formats. During concurrent alignment with the INS, the NAV MODE select switch also controls the SAHRS. In its normal operating mode, the SAHRS is an inertial system with velocity aiding selectable. It can also operate as a conventional attitude heading reference system having slaved, directional gyro, or emergency compass modes available. The SAHRS receives magnetic heading from the magnetic azimuth detector; provides compensation for aircraft magnetic errors; and provides magnetic heading to the BDHI using the best source available as determined by the navigation system.

The SAHRS uses 115 Vac from the ac left main bus through circuit breakers 1I3, 1I5, and 1I6. It may also use 28-Vdc power from the interrupt-free bus via circuit breaker 9I3 if ac power is not available. Refer to Chapter 2 for the alphanumeric circuit breaker listing.

20.1.3 Mission Computer System. The navigation system includes the navigation computations performed by the MCS. The computations of inertial parameters are performed respectively in the INS and SAHRS processing modules that interface with the MCS. The MCS processes this inertial data as well as initial entered data and navigation aiding inputs. Processing includes generating other navigation parameters, filtering, time tagging, storing, and distributing data to the displays and other system functions.

The MCS consists of two AN/AYK-14(XN-6) tactical computers: MC1 and MC2. Normally MC2 performs navigation system processing and computations. Should MC2 fail, MC1 will perform virtually all navigation system functions with the exception of data link, JTIDS and radar position updates, JTIDS continuous position update, JTIDS in-flight align, and surface waypoint position determination.

The MCS is the data bus controller; it accepts INS data and SAHRS data. It accepts navigation initialization data from the DEU or the DD and submode selections from the MFDs, providing this information to the INS and SAHRS in the required formats. It also provides JTIDS the INS or SAHRS data and accepts navigation correction and tacan data from JTIDS. Inputs from the various navigation aids are provided to the MCS via the data bus after formatting in the CIU.

Based on crew mode selection, equipment availability and input data received, the MCS determines the mode of operation and the parameters to be computed. It processes and stores these values, using them for other functions within the MCS as well as distributing them to the displays and other aircraft functions.

20.1.4 Navigation Data Initialization. Initial manual entry of required navigation information is accomplished by the RIO. Either the DEU or the DD control panel can be used.

20.1.4.1 Data Entry Unit. The DEU allows the RIO to manually enter the initial navigation information required for INS and SAHRS alignments and for waypoint location. Such required data inputs include latitude, longitude, altitude, carrier speed and heading, directional gyro magnetic heading, aircraft true heading, and surface waypoint range and bearing. The various DEU formats used are shown in Figure 20-3. This Figure shows the DEU MENU display and the five DEU formats used for entry of initial data and navigation related information. Use of these formats is discussed in paragraph 20.3, Navigation System Operation. Refer to Chapter 2 for detailed information on the DEU.

20.1.4.2 Digital Display. The APG-71 DD provides the RIO with an alternate means of entering most initial navigation data into the system except for SAHRS DG heading and barometric altimeter setting and control of JTIDS navigation functions. Use of the DD for entry of navigation is provided in paragraph 20.3, Navigation System Operation.

20.1.5 Displays Subsystem. Navigation information is provided to the pilot and RIO in both graphic and alphanumeric formats via HUD for the pilot and the three MFDs for both crewmembers. In addition, certain MFD formats provide pushbutton legends that permit submode selection and selection of other related display formats. These include HUD, VDI, HSD, OWN A/C, NAV AID, SURFACE WPT, INS UPDATE, and several alignment formats. A description of the outputs available and the use of these outputs can be found in paragraph 20.2, Navigation System Data Distribution, and paragraph 20.3, Navigation System Operation. The displays are discussed in detail in Chapter 2.

20.1.6 Tactical Information Display. The TID provides the RIO an alternate means of display for many of the alphanumeric and graphic outputs of the navigation system. Information is transmitted from the MCS to the APG-71 and then to the TID. Selection of display data is made via the DD.

20.1.7 Converter Interface Unit. The CIU accepts all nondata, bus-compatible navigation aid inputs and converts them to the proper format. The CIU also converts the steering error commands generated by the MCS into the required analog signals for the AFCS. These navigation aids, as they pertain to the navigation system, are described in the following paragraphs.

20.1.8 Central Air Data Computer. The CADC is a single processor digital computer that gathers, stores, and processes pitot pressure, static pressure, total airstream temperature, and angle-of-attack data from aircraft airstream sensors. In addition to performing wing sweep, flap and slat schedule computations, and limit controls for the flight control systems, the CADC provides air data related parameters to the MCS via the CIU. This information includes pressure altitude, pressure altitude rate of change, true and calibrated airspeed, angle of attack, and Mach number. True and calibrated airspeed, angle of attack, and Mach number are displayed directly to the crew on the HUD and VDI format of the MFDs. Pressure altitude is corrected for nonstandard day conditions and then displayed as system altitude. True airspeed may also be used in the computation of wind. Wind provides a reference velocity source for the INS or SAHRS for in-flight alignment and is a component of system velocity during backup navigation modes. A description of the pitot-static system and the CADC is provided in Chapter 2.

20.1.9 AN/ARN-118 Tactical Air Navigation System or AN/URC-107 Joint Tactical Information Distribtuion System. The tacan system is a UHF navigation receiver-transmitter that is used to provide navigation information by determining slant range and bearing to a selected tacan station. Operating range is line of sight to approximately 300 nm. Accuracies are 0.1 nm in range and 0.5° in bearing. The tacan station can be surface (land based or shipborne) or airborne. Surface stations can be either tacan or vortac. When operating in the REC or T/R modes, the system is capable of receiving signals from a ground station simultaneously with 99 other aircraft. When in the A/A mode, the system is capable of transponding with each of five cooperating aircraft, providing slant range information to each; however, the system will interrogate and lock

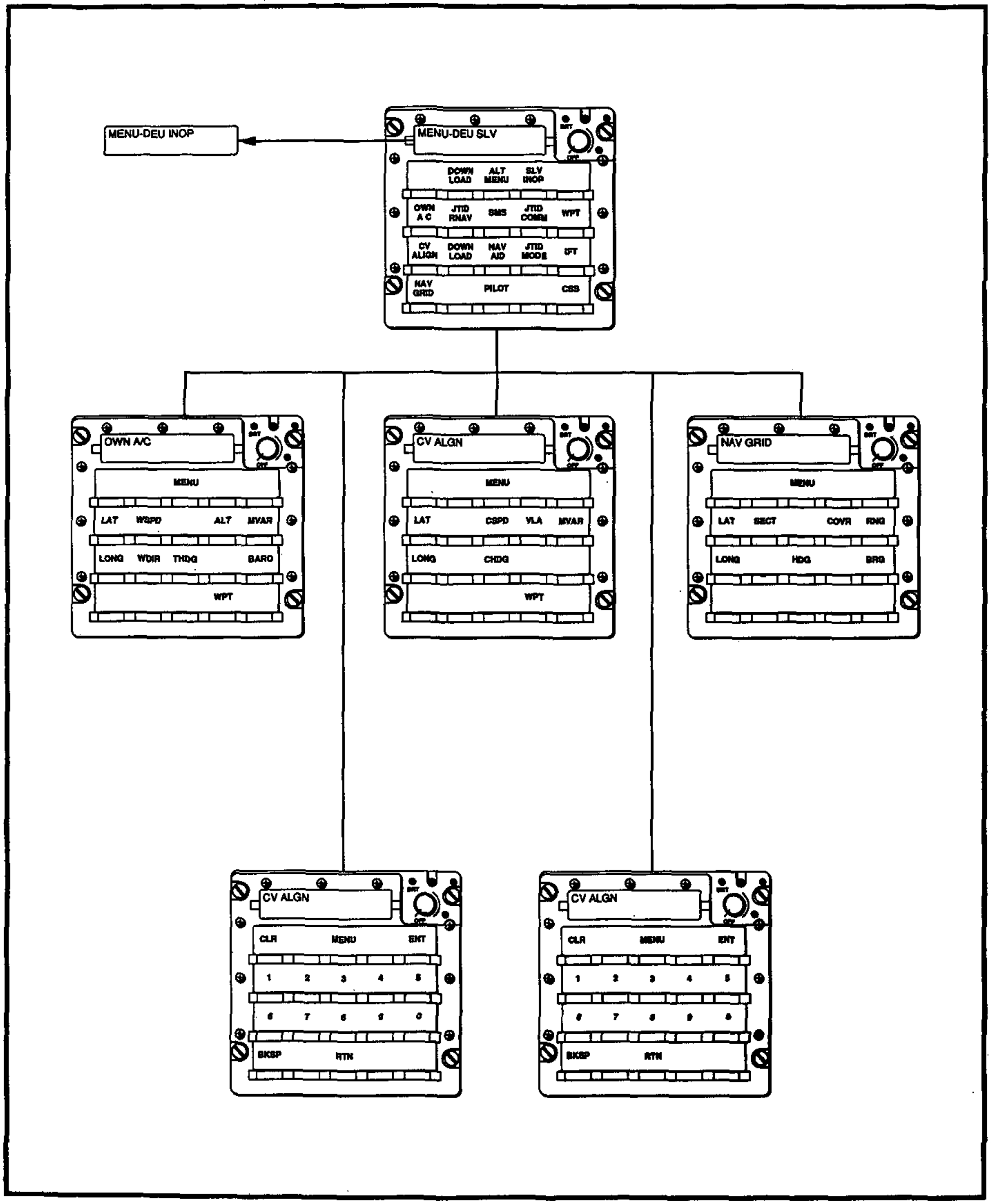

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Figure 20-3. DEU Navigation Formats

on to only one. In A/A mode, the second aircraft must be 63 channels apart. An airborne station provides only slant range distance unless the aircraft is equipped with a bearing transmitter and a rotating antenna. The AN/ARN-118 or AN/URC-107 are not able to transmit bearing information but can receive it from a specially equipped aircraft.

Available tacan range and bearing information is always displayed on the pilot and RIO BDHIs and can be selected for display on the HUD and MFDs. The tacan data supplied to the MCS can be used for a one-fix update of the INS and SAHRS, continuous update of the system navigation solution, or for steering. The AN/URC-107 (JTIDS) tacan requires the selection of DATA SIL, NORM, or POLL on the JTIDS control panel (Figure 20-4) to supply digital tacan information to the MCS. This is required for tacan displays on the MFD, navigation updates, and tacan steering. Refer to paragraphs 20.3.6.2, Updates, 20.3.6.3, Continuous Position Updating, and 20.3.6.5, Display Steering Modes.

The tacan has 126 X channels and 126 Y channels available 1 MHz apart. The tacan uses two aircraft antennas, automatically switching between the two at 5-second intervals until a threshold signal is received. The AN/ARN-118 requires approximately 2 minutes for warmup; AN/URC-107 (JTIDS) is operational once tacan self-test is complete. If stable range and bearing indications are not available after this time, tune another station or check circuit breakers.

Note

JTIDS tacan has shown reduced receiver sensitivity on channel 83. Use of channel 83Y (G/A and A/A) and 83X (A/A only) may not receive accurate information outside 40 miles.

The tacan has a memory feature that allows tracking to continue uninterrupted by momentary loss of received signals. A range signal that has been tracked for at least 10 seconds will be retained in memory for 13 to 17 seconds after signal loss; a bearing signal tracked for at least 15 seconds is retained for 2 to 4 seconds after signal loss. This feature allows for automatic antenna switching without loss of tacan outputs.

If the signal from a tacan station becomes unreliable or is lost for more than memory time, then the tacan switches to self-test automatically. This may cause the BDHI relative bearing to be 270° for 2 to 4 seconds. If the signal is not acquired during the self-test, the BDHI bearing pointer will continuously slew in a counterclockwise direction and the TEST light on the tacan control panel will light. If the light remains on, a failure is indicated and tacan information should be disregarded. As in all tacan sets, undetected failures can occur, so information provided by the tacan should be cross-checked with other available navigation information.

The AN/ARN-118 tacan uses 115 Vac from the ac essential No. 2 bus through circuit breaker 3D5, 28 Vdc from dc essential bus No. 2 via circuit breaker 8E7, and 26 Vac from the 26-volt essential bus through circuit breaker 3D4. In addition to the power and circuit breakers used by the AN/ARN-118, the AN/URC-107 tacan also requires 115 Vac from essential No. 2 bus through circuit breaker 4D3 and 4D4. Refer to Chapter 2 for the alphanumeric circuit breaker listing.

20.1.9.1 Tacan Controls and Indicators. Two identical TCN control panels (Figure 20-4), one in each cockpit, are provided to permit either crewmember to operate the tacan. To determine which crewmember controls the tacan, each cockpit has an alternate action TACAN CMD pushbutton that illuminates either PLT or NFO to show which cockpit has command. Both buttons allow each crewmember to either give or take command of the tacan. A BDHI in each cockpit provides range and bearing to a tuned tacan station. Other tacan displays may be selected.

20.1.9.2 Tacan Testing. Tacan testing includes continuous monitoring and commanded self-test. Continuous monitoring checks certain internal functions of the tacan on a continuous basis. Failure of one of these checks causes the TEST light on the TCN panel to illuminate. Commanded self-test is either manually or automatically initiated. The TEST button is a momentary action pushbutton switch that is pressed to place the tacan into the commanded self-test mode manually. The test may be accomplished in all operating modes. Commanded self-test interrupts normal operation for a 22-second cycle and provides a high-confidence test of the tacan except for the antennas. When TEST is selected in T/R, a power check is initiated for the transmitter, receiver, distance, and bearing circuits. The BDHI bearing pointer should swing to 270° in 2 to 7 seconds and the range OFF flag should appear. After approximately 7-seconds, the BDHI bearing pointer should swing to 180° and the OFF flag should disappear. The distance indicator should read 000.0 nm. The BDHI should return to its original bearing and distance readings after 15 seconds. The TEST light will momentarily flash when the test is initiated. If the light goes on and stays on during test, a malfunction is indicated. In addition, the OBC CNI format on the MFD displays a tacan NO-GO or NOT READY indication if there is a test failure. If a self-test in the T/R mode results in a failure indication, select REC and perform the test again. If the failure

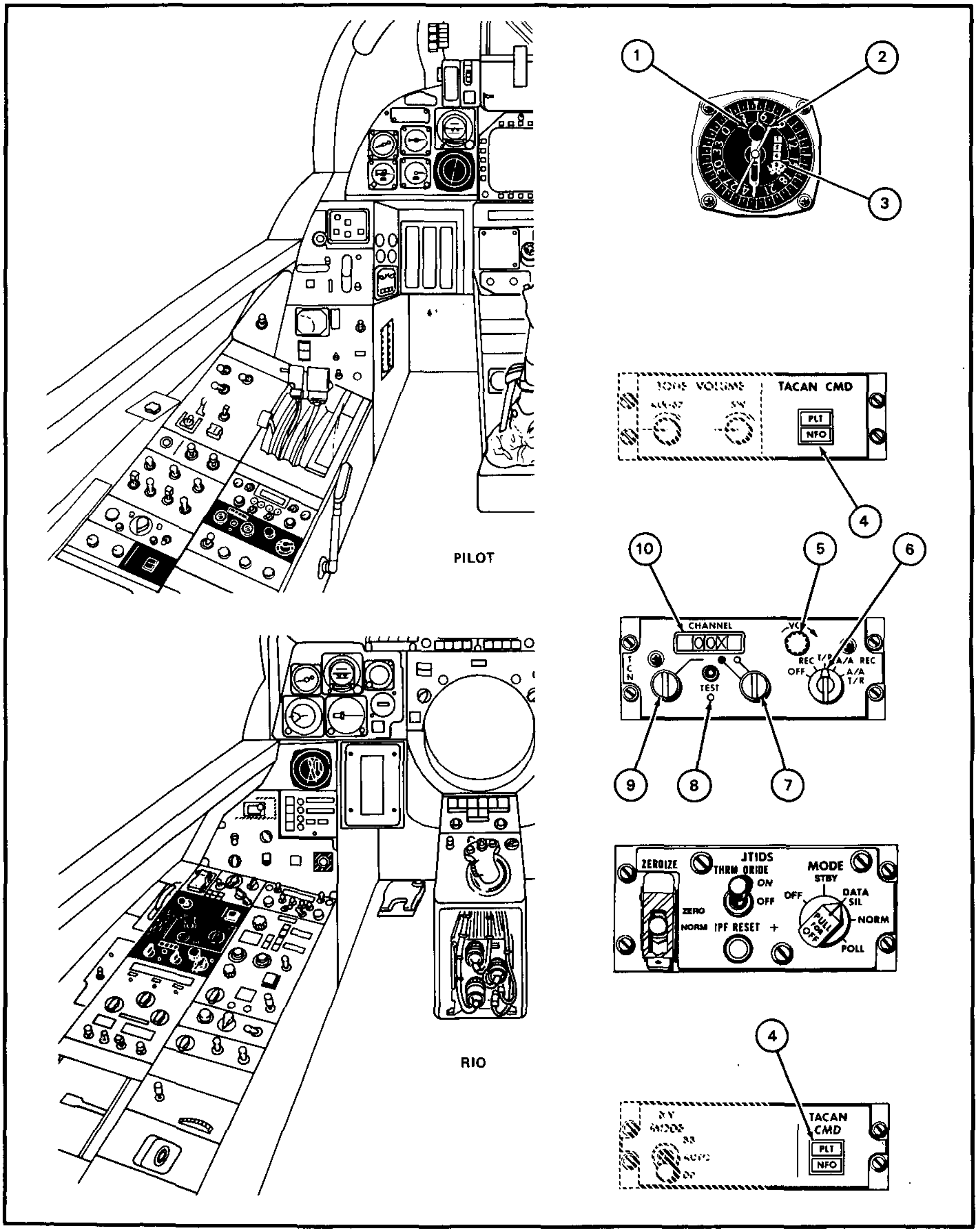

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Figure 20-4. Tacan Controls and Indicators (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
(1) BDHI tacan needle	Displays relative bearing to the selected tacan station
(2) BDHI UHF/ADF needle	Displays relative bearing to a tuned UHF transmitter.
(3) BDHI tacan range window	Displays slant range to a selected tacan station.
(4) TACAN CMD buttons (Pilot and RIO)	Alternate action lighted pushbutton that lights PLT or NFO to indicate which cockpit has command of the tacan. Pressing the button cycles command to the other cockpit and changes light indication.
(5) Tacan VOL control	Varies level of the tacan audio signal to the headsets. Clockwise rotation increases volume.
(6) Tacan mode switch	OFF – Power not applied to tacan REC – Receive: Tacan determines bearing from aircraft to selected tacan station. Bearing displayed on BDHI; available for MFD, HUD. Station identifier is received, no range is calculated. T/R – Transmit–receive: In addition to the REC functions, tacan determines slant range to selected tacan station. Distance displayed on BDHI; available for MFD, HUD. A/A REC – Air–to–air receive: Tacan receives bearing information from a suitably equipped cooperating aircraft and calculates the relative bearing to the cooperating aircraft. No distance information is available. A/A T/R – Air–to–air transmit–receive mode: Tacan receives both distance and bearing information from a suitably equipped cooperating aircraft and calculates the slant range distance and relative bearing of the aircraft. If the aircraft is not equipped with bearing transmitting capabilities, only slant range is available. **Note** • Air–to–air tacan operation requires a 63 channel separation between cooperating aircraft. Channel use should be prearranged. Air–to–air tacan between F–14s is limited to slant range, no bearing is provided. • When the AN/URC–107 (JTIDS) is installed, tacan data on the HUD and MFD requires the selection of DATA SIL, NORM, or POLL on the JTIDS control panel.
(7) Right hand channel knob	The inner knob sets the channel number units digit. The outer knob sets X and Y channels.

Figure 20-4. Tacan Controls and Indicators (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
8 TEST button/light	The TEST button is used to initiate self–test. The light illuminates to indicate failure of continuous monitor test or either manually or automatically initiated self–test.
9 Left hand channel knob	Sets channel number hundreds and tens digits.
10 CHANNEL window	Displays selected channel number and X or Y.

Figure 20-4. Tacan Controls and Indicators (Sheet 3 of 3)

indication is removed, bearing information is still valid. The AN/URC-107 performs all the same tacan tests as the AN/ARN-118. It also performs a commanded self-test when a JTIDS OBC is selected on the MFD OBC page. JTIDS OBC provides tacan fail data on the JTIDS fail data page. Refer to JTIDS self-test Chapter 27. The following will cause the tacan lock to break for 4 seconds: the power up or down of JTIDS, going from OFF or STBY to DATA SIL, NORM, or POLL or back to STBY or OFF on the JTIDS control panel. The range off flag will appear and bearing will swing to 270° for 2 seconds then reacquire lock to the station.

Whenever a signal becomes unreliable (loss exceeds memory time), self-test is initiated automatically. If the TEST light goes on at any time during flight, it indicates a failure of automatic self-test and all tacan information should be disregarded.

20.1.10 AN/ASW-27C Data Link. During carrier alignment, D/L provides SINS data to the INS via the CIU. This data is also provided to the SAHRS during concurrent carrier alignment. Before takeoff the D/L can be used to provide waypoint coordinates to the MCS via the CIU for later use in steering and position updating. After takeoff, the D/L provides control and steering commands that are available for display or may be coupled to the autopilot during vector steering or ACL operation.

Refer to NAVAIR 01-F14AAD-1A for a complete discussion of data link.

20.1.11 UHF Automatic Direction Finder. The UHF/ADF provides the relative bearing to a UHF transmitting station from the aircraft. This information is displayed directly on the BDHI and on the MFD HSD format.

20.1.12 Bearing Distance Heading Indicator. A BDHI is on the left side of the pilot and RIO instrument panels (Figure 20-4). The BDHI is a remote heading indicator that displays aircraft magnetic heading, tacan and UHF/ADF bearings, and tacan slant range. The rotating compass card receives its heading reference from the SAHRS. Aircraft heading is read against a fixed index mark at the 12-o'clock position. The two servo-driven needles are positioned by relative bearing information provided by the UHF/ADF to the single bar (No. 1) needle and by the tacan to the double bar (No. 2) needle. Magnetic bearing to the station is read under the head of the needle. Relative bearing can be determined by comparing the bearing reading with magnetic heading. The range window on the right side of the indicator displays tacan slant range. When the tacan is off or range is unreliable, an OFF flag covers the window.

20.1.13 AN/URC-107 Joint Tactical Information Distribution System. JTIDS is a jam-resistant communication system that provides the F-14D with two-way secure data and digital voice communication. In addition to the JTIDS communication functions, it also provides the F-14D with navigation and tacan data.

The JTIDS system internally computes relative navigation and position location information. All participants (JTIDS terminals) in the same net determine their position relative to each other. This is referred to as the JTIDS relative navigation function. The basis of this function is the TDMA architecture and precise synchronization of all participants to a common time base (net time reference). This allows each JTIDS system to accurately determine the time a message was transmitted and its TOA, and then compute the range from the source of the message. JTIDS computes an estimate of its own relative position coupled with the position and navigation quality contained in each participants PPLI message. With data from multiple participants with equal or better position plus the navigation data from the INS or SAHRS, JTIDS can compute an excellent estimate of own-ship position and velocities. JTIDS will automatically update the own-ship position in the PPLI message with its estimated position. It also provides an estimated quality (accuracy) of the position it computed. This quality is provided to the MCS and included in the PPLI message.

JTIDS is a dual grid system utilizing a geodetic and an independent relative grid. JTIDS can operate in both grids simultaneously, but the MCS is limited to operating in one grid at a time. The relative mode requires a coordinated grid origin (latitude and longitude) and the selection of NAV controller (a high-quality navigation source). The geodetic grid is the F-14D default mode and, unlike the relative grid, requires no special coordination. Refer to NAVAIR 01-F14AAD-1A for the MFD displays of JTIDS navigation parameters.

JTIDS receives navigation sensor data from the MCS and returns navigation corrections. The sensor data is used by JTIDS in its relative navigation calculations, own-ship position in the PPLI message, and for calculating navigation corrections.

The JTIDS navigation correction data sent back to the MCS is used to perform track conversions and navigation updates. The JTIDS correction data will only be used for track conversions and navigation updates when it is valid and has a quality ≤ 3 ($\leq 18{,}080$ feet in error). The track conversion function uses the JTIDS delta navigation corrections to pad all received and transmitted tracks on the JTIDS link into the JTIDS navigation reference. This function is performed automatically by the MCS.

The navigation update function has to be manually selected. These selections are JTIDS one-fix, continuous position, and INS in-flight alignment. The aircrew has the ability to select either of the JTIDS grids via the NAV SYSTEM AID page. This selection determines which data the MCS will use to perform the track conversion and continuous position updates. Independent of this selection, JTIDS one-fix and INS in-flight alignments will always be performed using the geodetic data.

Internal to the JTIDS system is the equivalent of an AN/ARN-118 tacan system. Installation of JTIDS in the aircraft replaces the AN/ARN-118 with the JTIDS receiver/transmitter. Refer to 20.1.9 for JTIDS tacan operation.

20.2 NAVIGATION SYSTEM DATA DISTRIBUTION

The navigation system provides data to other systems and functions as well as for display to the crew. In general, this is similar to displayed data, but such parameters as aircraft angular rates, accelerations, and time tag data are also included. Figure 20-5 summarizes navigation system outputs.

20.2.1. Navigation Data Display. Navigation information is displayed to the aircrew in graphic form on the HUD and MFD and in tabular form on the MFD.

With the DISPLAYS panel TLN (takeoff, landing, navigation) MODE button is selected, both the HUD and the MFD VDI format show navigation information graphically in the vertical plane. The MFD can also show a HSD format that provides graphic navigation information in the horizontal plane.

Tabular information relating to alignment, waypoints, and own aircraft can be displayed on the MFDs.

The navigation information provided by the various display selections is described in the paragraphs that follow.

20.2.1.1 HUD TLN Basic. The HUD provides primary flight and navigation information in graphic and numeric form in a portion of the pilot's field of view through the windscreen encompassing ±10° in azimuth and elevation (Figure 20-6). A repeat of this information can be displayed on the MFD by selecting the HUD pushbutton on the MENU1 format.

In addition to the information in Figure 20-6, other HUD formats provide indications of glideslope and centerline errors for ACL and ILS steering modes as well as flight director steering information and commanded heading.

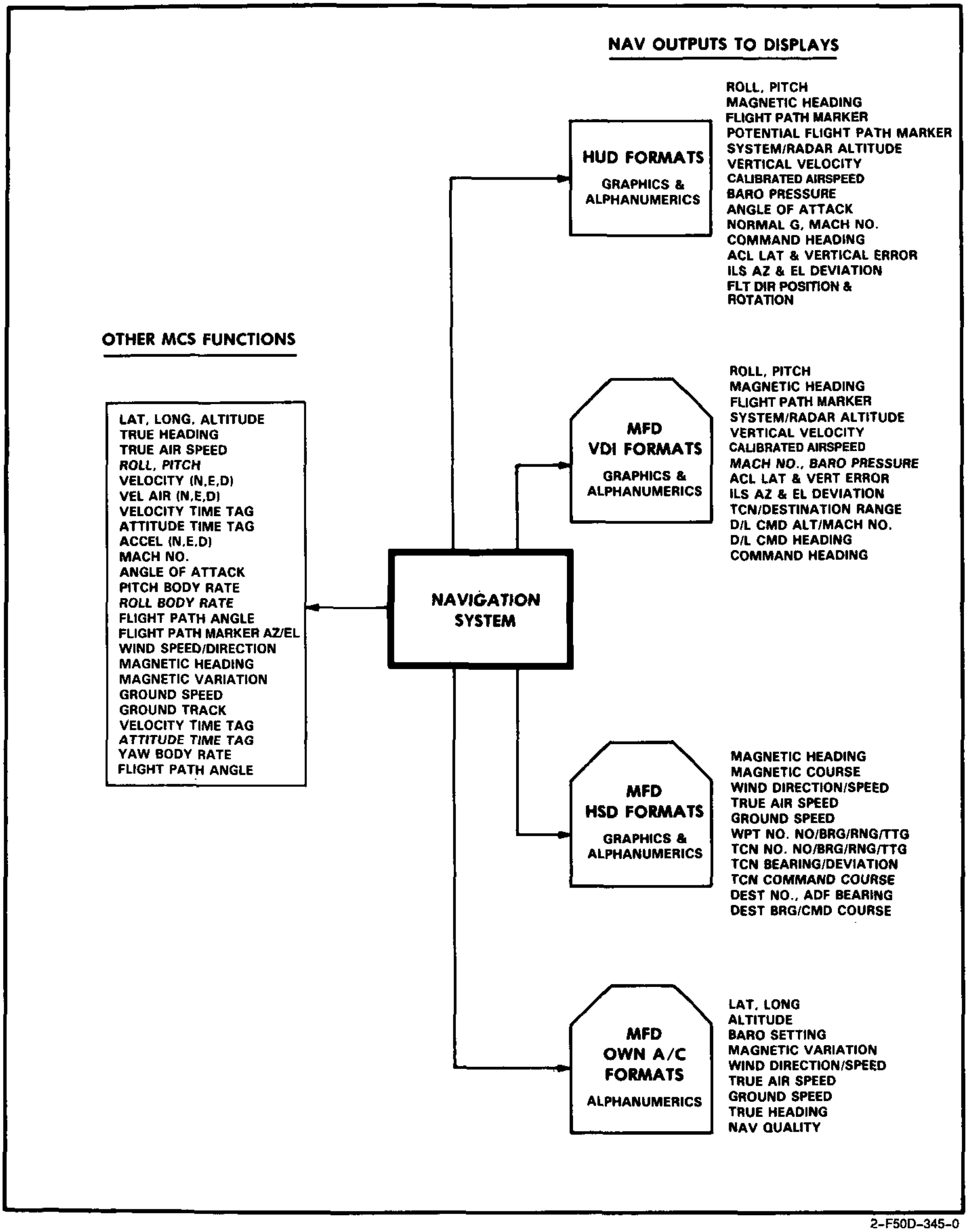
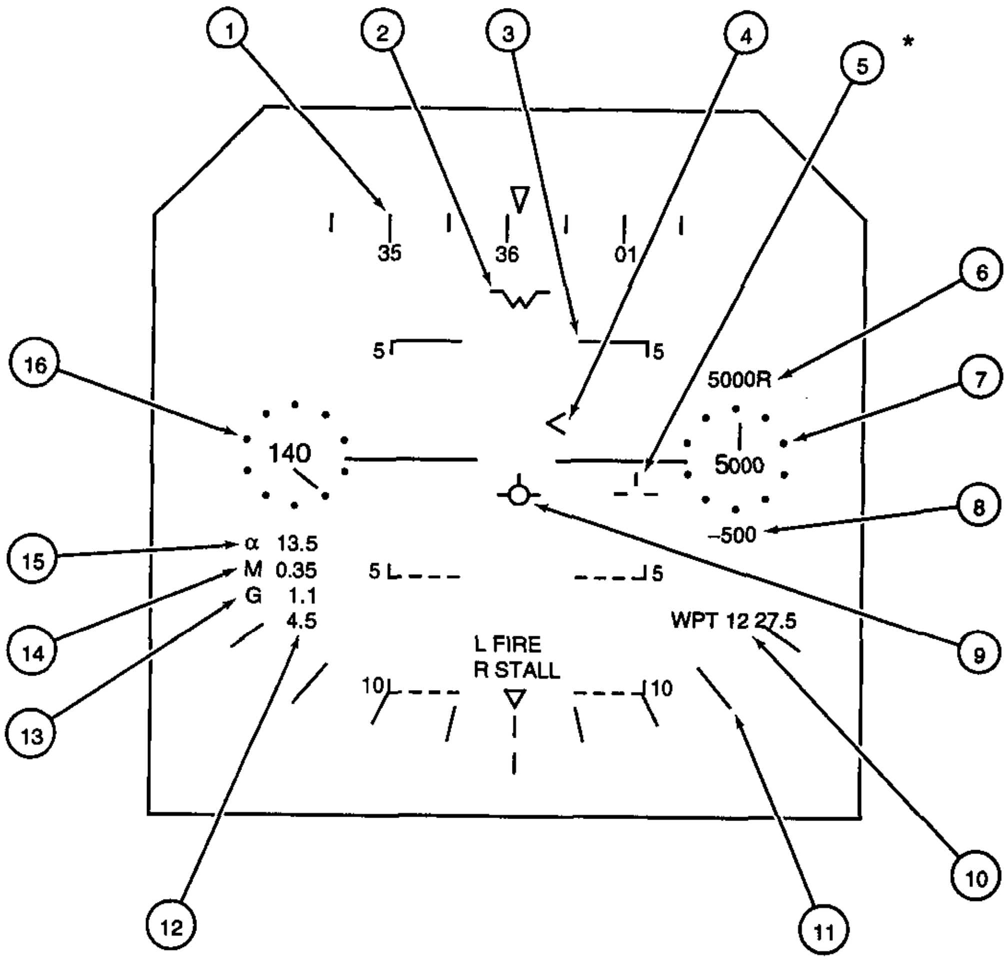


Figure 20-5. Navigation System Data Distribution

TLN GEAR UP, FORMAT SWITCH–ANALOG



LEGEND

1. HEADING SCALE
2. WATER LINE
3. PITCH LADDER
4. POTENTIAL FLIGHT PATH MARKER
5. GHOST FLIGHT PATH MARKER
6. RADAR ALTITUDE READOUT
7. ALTITUDE ANALOG DIAL
8. VERTICAL VELOCITY
9. FLIGHT PATH MARKER
10. NAV RANGE
11. ANGLE–OF–BANK SCALE
12. PEAK G
13. AIRCRAFT G
14. MACH NUMBER
15. ANGLE–OF–ATTACK READOUT
16. AIRSPEED ANALOG DIAL

*DISPLAYED AS REQUIRED

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Figure 20-6. HUD Navigation Outputs (TLN Basic)

20.2.1.2 MFD VDI (Basic) Format, TLN Mode. The MFDs provide a VDI format that is a representation in the vertical plane of a field of view of ±45° in azimuth and elevation. In the TLN basic mode (Figure 20-7), the VDI format displays the same information as the HUD except for the airspeed and altitude dials, angle of attack, and g readouts.

This format also provides readouts of the course and heading selected using the CRS and HDG knobs on the pilot center instrument panel (FO-3). Pushbutton legends permit selection of destination (DEST), data link (D/L), tacan (TCN), manual (MAN), or all-weather landing (AWL) steering.

In addition to the information in Figure 20-7, other MFD formats provide indications of ACL glideslope and centerline errors, glideslope and centerline errors from ILS, flight director glideslope and centerline steering information, commanded heading, commanded speed and altitude information, and HUD flight director declutter.

20.2.1.3 MFD Own-Aircraft (Basic) Data Format. The MFD own-aircraft (basic) data format (Figure 20-8) furnishes navigational data in tabular form. This format can be called up from several of the MFD formats by selecting the DATA pushbutton legend.

In addition to the parameters shown in Figure 20-8, other own-aircraft MFD formats are available. During alignment, these provide indications of alignment progress in both numeric and graphic form and INS north and east velocities.

20.2.1.4 MFD HSD (Basic) Format, TLN Mode. The MFDs provide a HSD format (Figure 20-9) showing an aircraft centered representation of the situation in the horizontal plane. In the TLN basic mode, it furnishes information on the position of waypoints, tacan stations, and destination points with respect to the aircraft that is at the display center. The distance scale from the aircraft symbol to the inner edge of the compass rose can be set at 200, 100, 50, 25, or 10 miles. Numeric displays of range, bearing, and time-to-go to a selected waypoint and to a selected tacan station are provided.

In addition to the information shown in Figure 20-9, other HSD formats provide two tacan steering displays as well as data-link, destination, and manual steering displays (see paragraph 20.3.6.5, Display Steering Modes).

20.2.1.5 Navigation Data DisplaySummary. Figure 20-10 summarizes the navigation data available on HUD and MFD formats.

20.3 NAVIGATION SYSTEM OPERATION

Procedures for operational use of the navigation system are provided in the paragraphs that follow including display formats and control selections for alignment, data initialization, in-flight navigation, sensor selection, degraded mode operation, and tactical navigation. Tactical navigation includes position updating, surface waypoint position determination, range and bearing to selected waypoints, display steering, autopilot steering, and AWL aircraft control. These procedures are normally performed in the TLN mode; however navigation outputs are available to other aircraft functions and displays in all modes.

20.3.1 INS and SAHRS Concurrent Alignment. In all modes of concurrent alignment, both the INS and the SAHRS are aligned in the mode selected on the NAV MODE switch (Figure 20-2). The system will always align to WPT 1 unless manual entries are made. Normal operation of the MCS and MFD is required for any alignment.

20.3.1.1 Normal Concurrent Ground Alignment

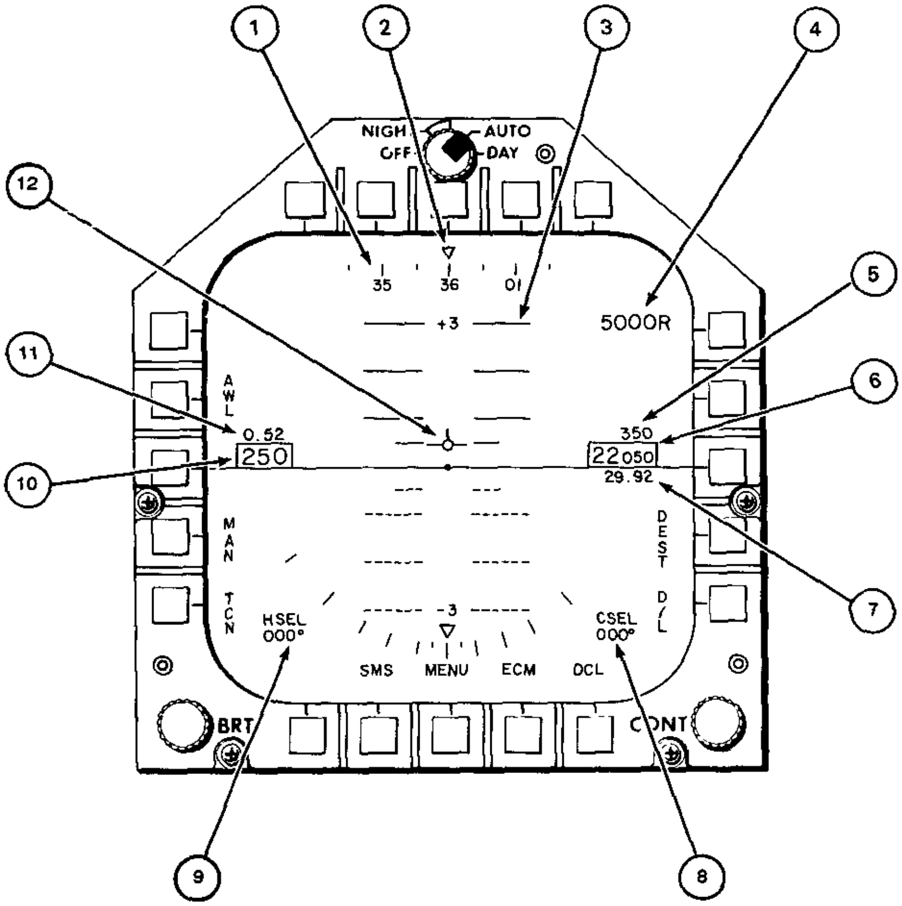
1. Select own-aircraft MFD format, (Figure 20-8) by depressing "DATA" pushtile on the MFD MENU1 page (Figure 20-11).

2. Verify displayed latitude and longitude. If incorrect, enter correct coordinates via the DEU or DD. For DEU data entry, the DEU OWN A/C page is selected and the latitude and longitude coordinates may be entered to 0.01 arc minute using the LAT and LONG pushtiles and the proper hemisphere numerals (Figure 20-12). On the DEU, longitude entries less than 100° require a 0 be entered prior to the value. For DD data entry the DD control panel is used with the NAV category selected using the MFK pushtile (Figure 20-13). The OWN A/C acronym is then boxed by depressing the corresponding pushtile and the coordinates are entered via the LAT, LONG, hemisphere, and numeric pushtiles shown on the computer address panel on the lower left portion of the DD control panel. Latitude and longitude coordinates may be entered via the DD to the nearest 0.1 arc minute. Longitude entries on the DD below 100° do not require a 0 prior to entering the numerals.

3. Verify parking brake is set.

4. Set NAV MODE switch to GND. The OWN A/C GRND format will be displayed on the MFD (Figure 20-14).

TLN BASIC



LEGEND

1 MAGNETIC HEADING SCALE	7 BAROMETRIC PRESSURE SETTING
2 MAGNETIC HEADING POINTER	8 SELECTED COURSE
3 PITCH LADDER	9 SELECTED HEADING
4 RADAR ALTITUDE	10 CALIBRATED AIRSPEED
5 VERTICAL VELOCITY	11 MACH
6 ALTITUDE	12 FLIGHT PATH MARKER

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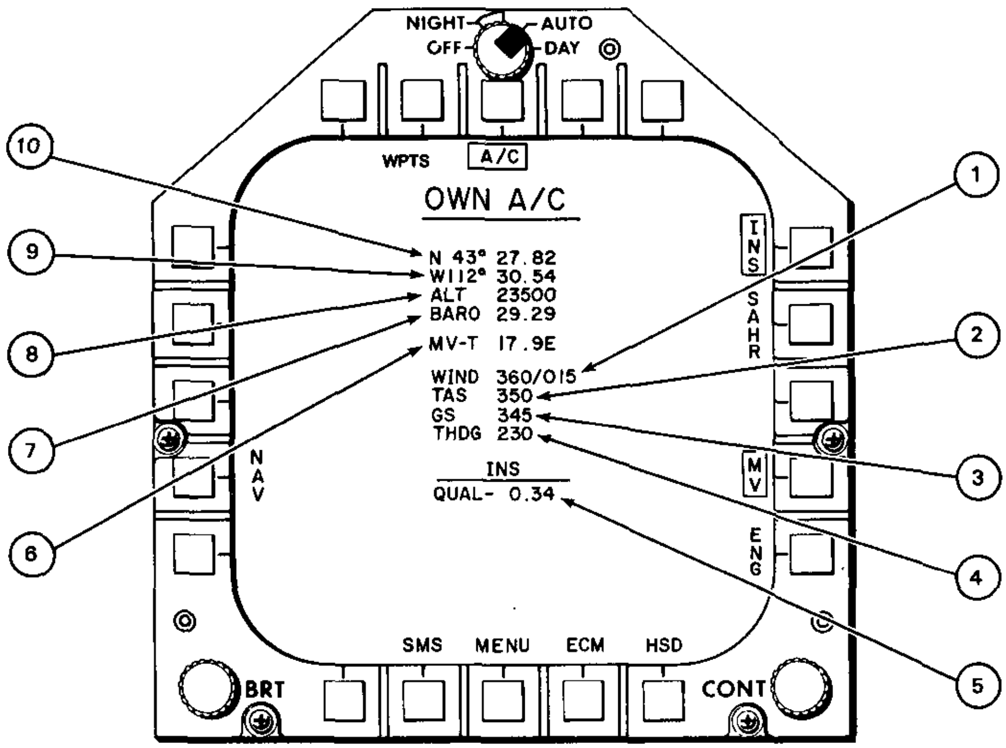
Figure 20-7. MFD VDI (TLN Basic) Navigation Outputs



LEGEND

1. WIND DIRECTION/VELOCITY
2. TRUE AIRSPEED
3. GROUND SPEED
4. TRUE HEADING
5. NAVIGATION SOURCE AND QUALITY
6. MAGNETIC VARIATION
7. BAROMETERIC PRESSURE SETTING
8. BAROMETRIC ALTITUDE
9. OWN AIRCRAFT LONGITUDE
10. OWN AIRCRAFT LATITUDE

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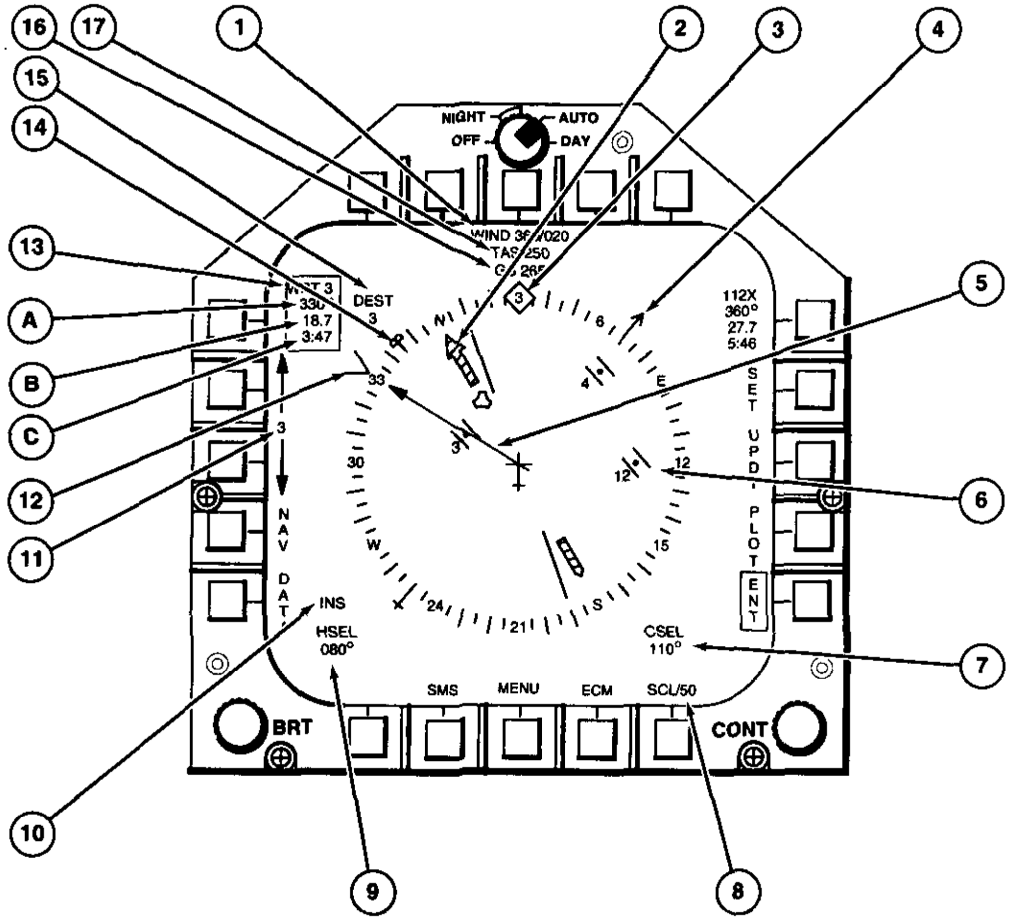
Figure 20-8. Own-Aircraft Basic Data Format



LEGEND

1. WIND DIRECTION/VELOCITY
2. TACAN BEARING POINTER
3. MAGNETIC HEADING
4. ADF BEARING POINTER
5. SELECTED COURSE
6. WAYPOINT SYMBOL
7. SELECTED COURSE READOUT
8. COMPASS ROSE RANGE SCALE
9. SELECTED HEADING READOUT
10. INS/SAHRS HEADING SOURCE INDICATION
11. SELECTED WAYPOINT
12. DESTINATION BEARING
13. SELECTED WAYPOINT DATA
    - A. BEARING
    - B. RANGE
    - C. TIME-TO-GO
14. COMMANDED HEADING (DESTINATION MANUAL AND DATA LINK), SELECTED HEADING (TACAN)
15. DESTINATION WAYPOINT
16. GROUND SPEED
17. TRUE AIRSPEED

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Figure 20-9. MFD HSD Format — Navigation Outputs

DISPLAY	NAVIGATION DATA DISPLAYED
Own Aircraft Inflight	Latitude Longitude Altitude Barometric Setting Magnetic Variation Wind Direction/Speed True Airspeed Groundspeed True Heading Navigation Quality
Own Aircraft Ground Align	Latitude Longitude Altitude Barometric Setting Magnetic Variation Groundspeed True Heading Align Time/Quality North/East Velocities
Aircraft Carrier (CV) Alignment	Latitude Longitude Magnetic Variation CV Speed CV Heading Vertical Lever Arm Align Time/Quality
SAHRS Alignment	Latitude Longitude CV Speed CV Heading
HUD Display	Roll (Symbols) Pitch (Symbols) Magnetic Heading (Symbol) Flight Path Marker (Symbol) Potential Flight Path Marker (Symbol) System Altitude Radar Altitude Vertical Velocity Calibrated Airspeed Barometric Setting

Figure 20-10. Navigation Data Display Summary (Sheet 1 of 2)

DISPLAY	NAVIGATION DATA DISPLAYED
	Flight Director Position and Rotation Angle−of−Attack Mach Number Normal Acceleration (g) ACL Lateral & Vertical Errors (Symbol) ILS Azimuth & Elevation Deviation (Symbols) Command Heading (Symbol)
MFD VDI Format	Roll (Symbols) Pitch (Symbols) Magnetic Heading (Symbol) Flight Path Marker (Symbol) System Altitude Radar Altitude Vertical Velocity Calibrated Airspeed Barometric Setting Mach Number ACL Lateral & Vertical Errors (Symbol) ILS Azimuth & Elevation Deviation (Symbols) Command Heading (Symbol) Range to Tacan/Destination D/L Command Alt/Mach No D/L Command Heading (Symbol)
MFD HSD Format	Magnetic Heading (Symbol) Magnetic Course (Symbol) Wind Direction/Speed True Airspeed Groundspeed Way Point No/Brg/Range/TTG Tacan Sta No/Brg/Range/TTG Tacan Brg/Deviation (Symbols) Tacan Command Course (Symbol) Destination No Destination Brg/Cmd Course (Symbols) ADF Bearing (Symbol) Command Heading Course Select Heading Select

Figure 20-10. Navigation Data Display Summary (Sheet 2 of 2)

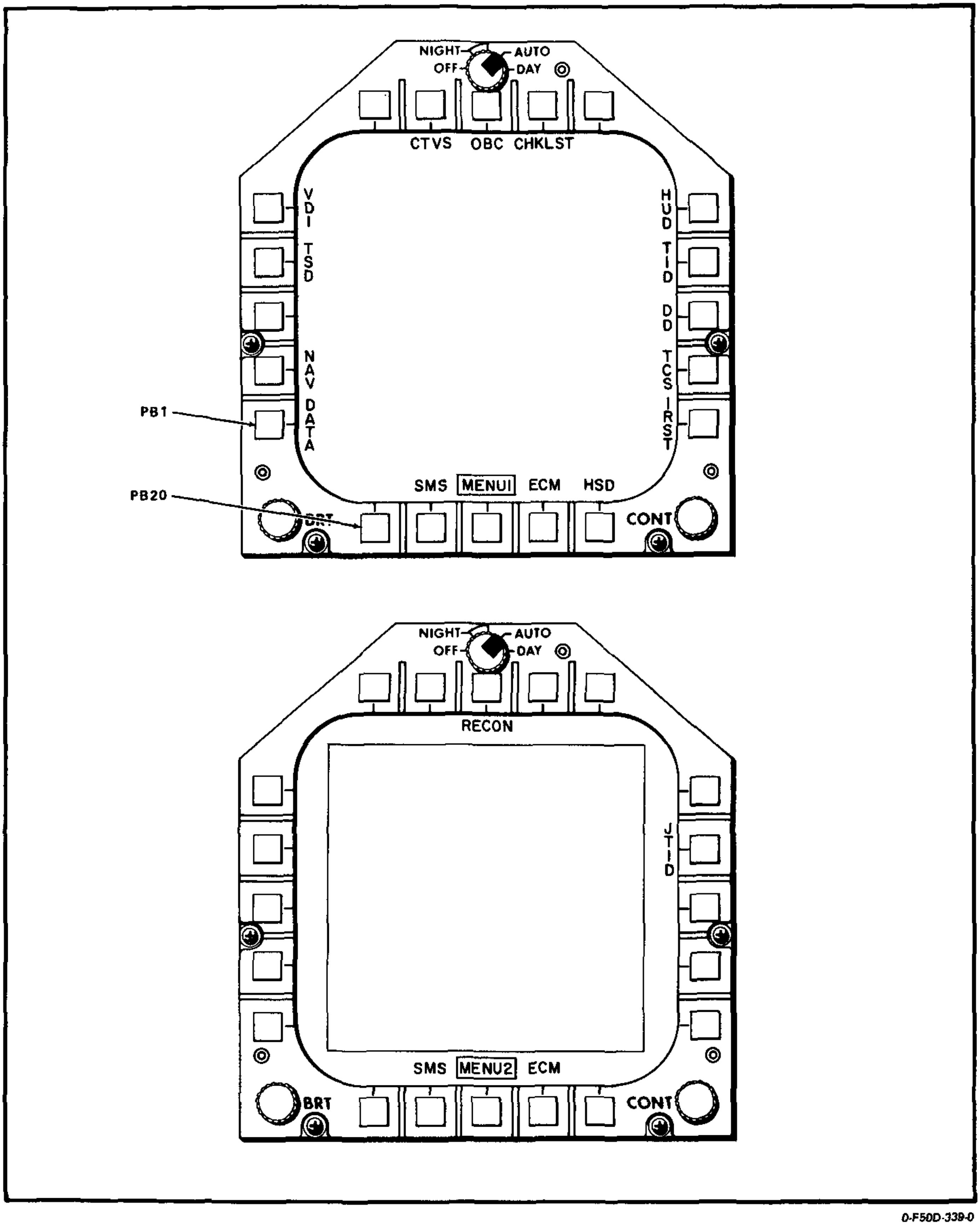

Figure 20-11. MFD MENU1 and MENU2 Displays

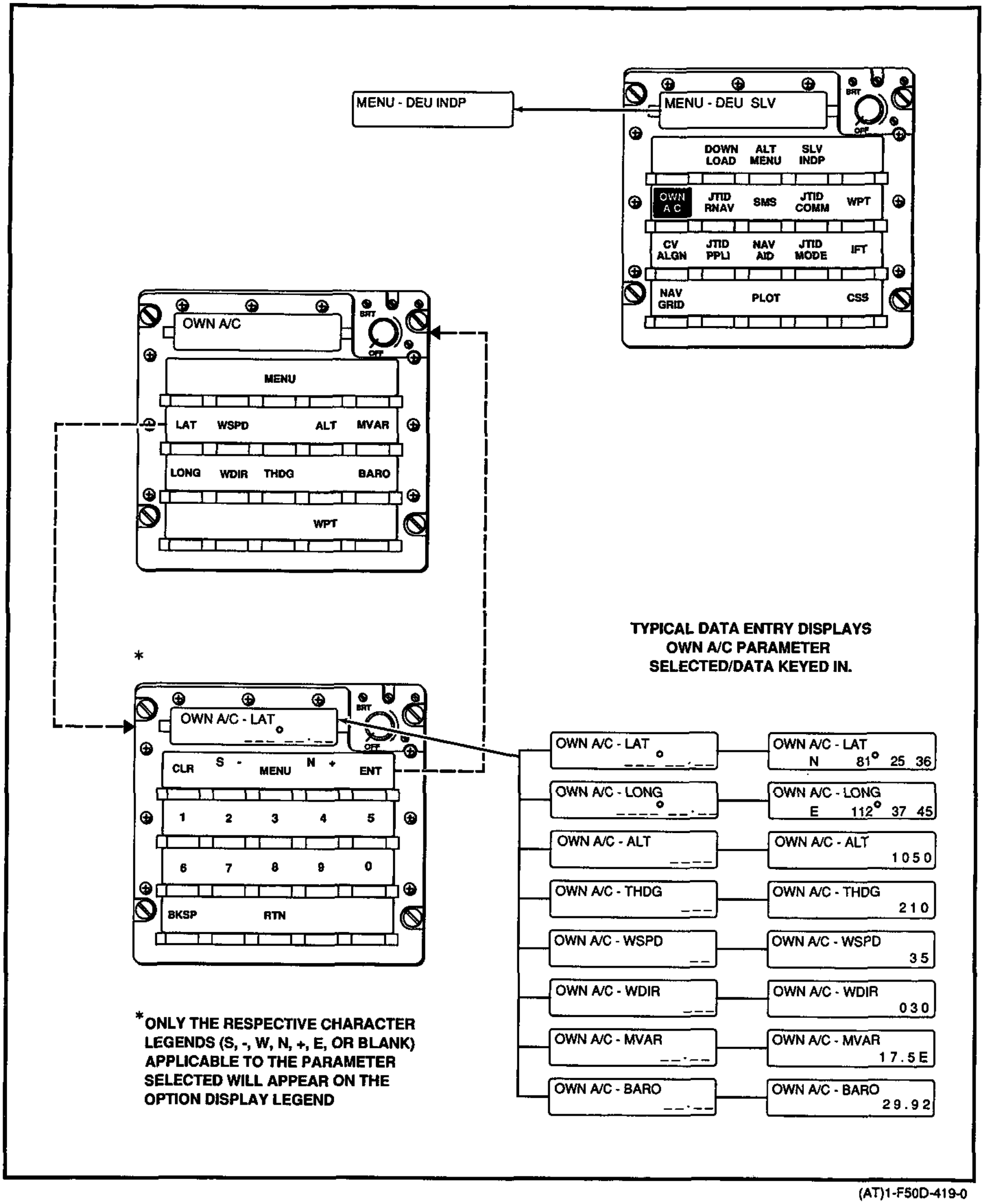

Figure 20-12. DEU Own-Aircraft Data Entry (Typical)

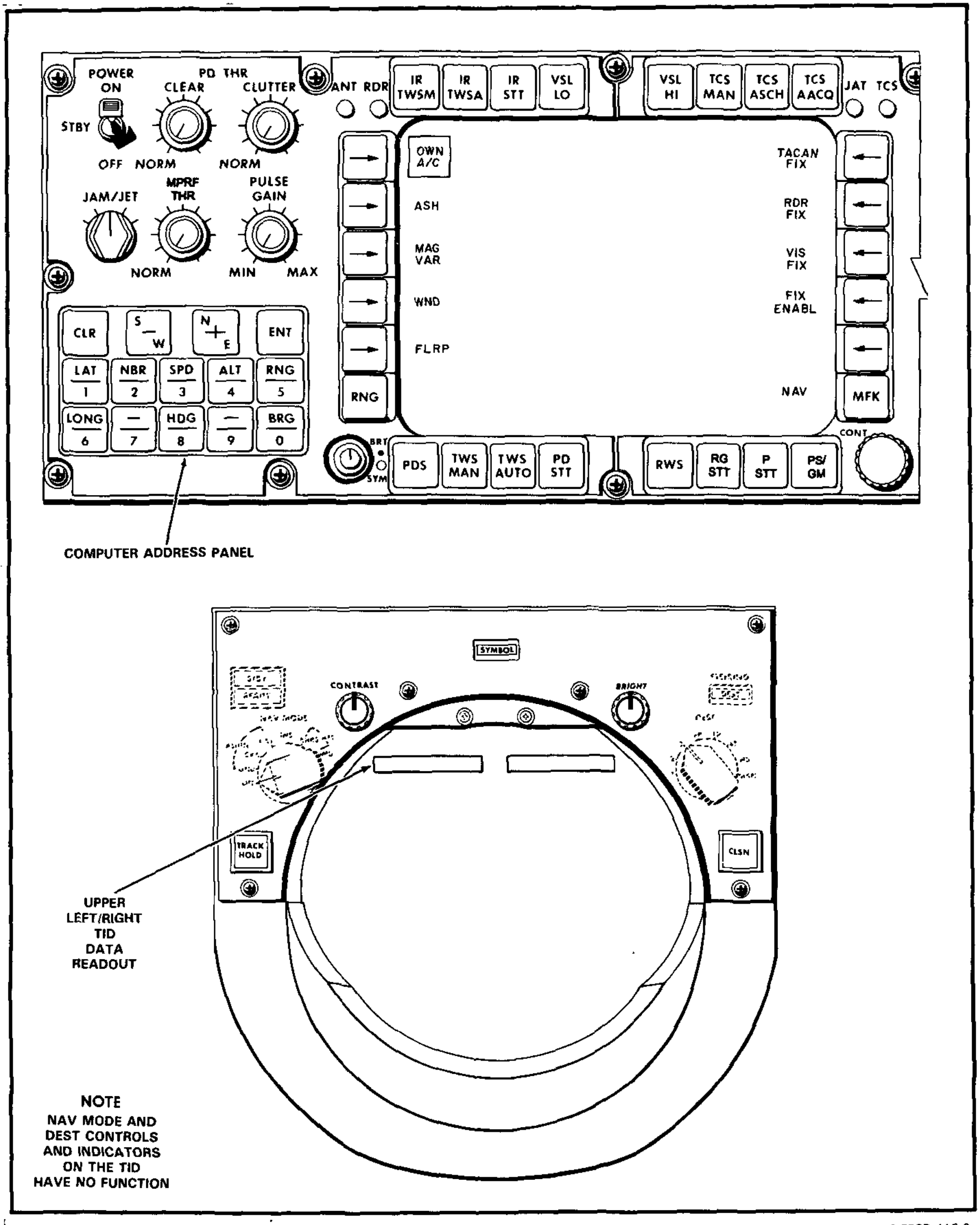

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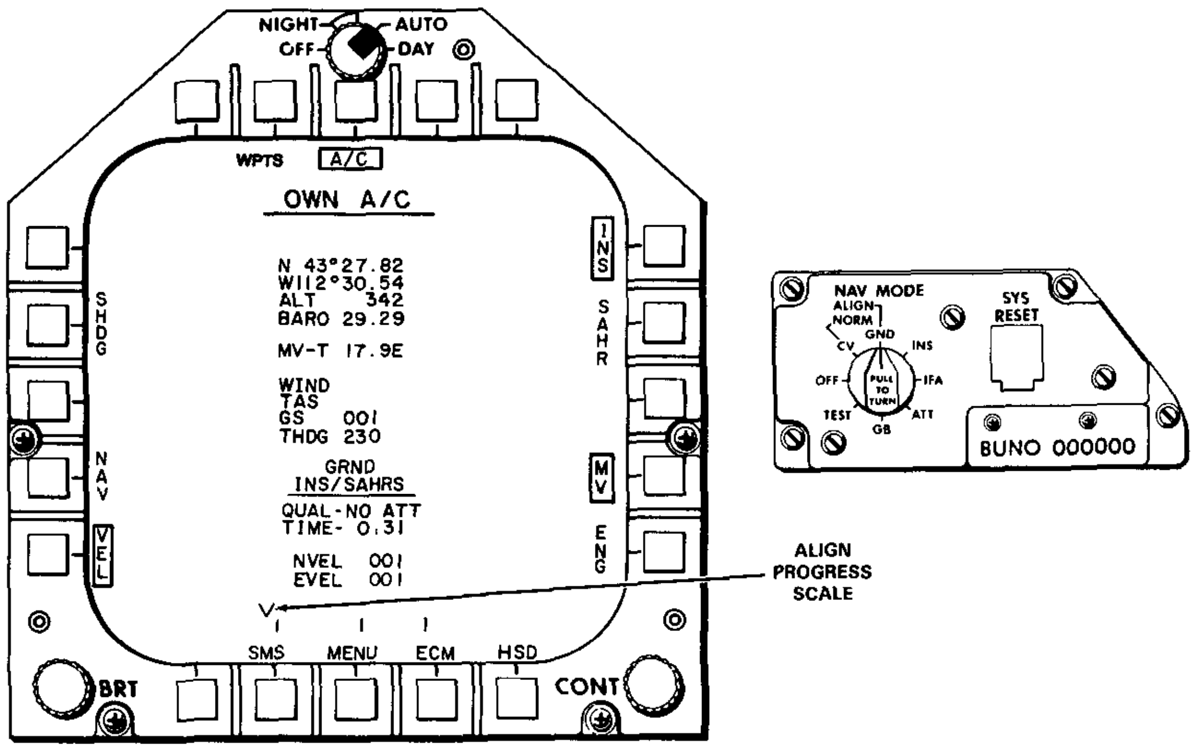
Figure 20-13. DD/TID Own-Aircraft Data Entry

GROUND ALIGNMENT



STORED HEADING GROUND ALIGNMENT

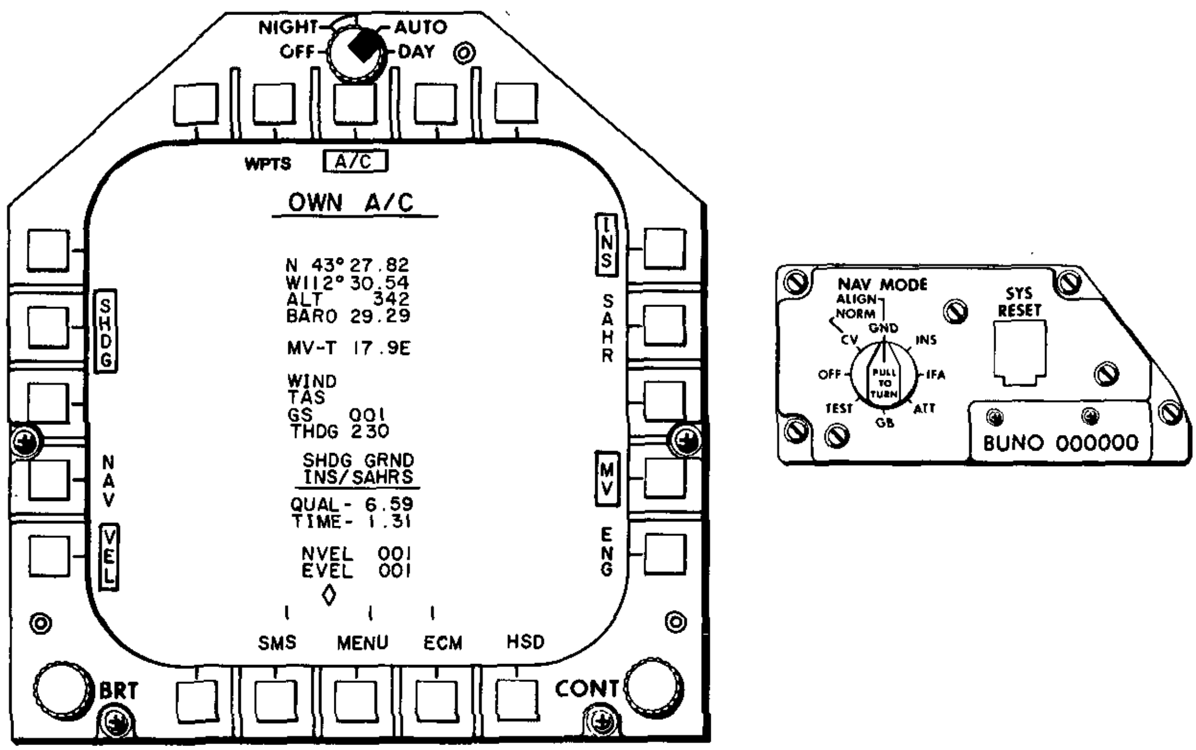


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Figure 20-14. MFD Ground Alignment Formats

5. Verify that SHDG is not boxed. If it is, press the SHDG pushbutton to unbox SHDG.

Note

Unboxing of SHDG must be performed within 17 seconds of selecting GND ALIGN on the NAV MODE switch or the boxed SHDG will be selected and unboxed by the system and deselection will not be available.

6. Verify latitude and longitude and enter correct values if necessary. If new entries are required at this time, the alignment time may be extended, depending on the differences between the newly entered values and those displayed when alignment was initiated.

7. Alignment progress can be monitored by observing the QUAL and TIME acronyms and the alignment scale on the MFD OWN A/C format. The indicator on the alignment progress scale changes from a "V" to a diamond symbol at the first tic mark. This represents an 8 nm per hour estimated navigation quality. The second tic mark represents an estimated 2 nm per hour quality and the third an estimated 0.8 nm per hour quality. At this point a dot appears in the diamond. An INS ALIGN COMPLETE message normally appears at the top of the MFD display in 4 minutes. At this time the QUAL acronym is near or slightly below 1 nm per hour and the pointer on the align scale should be near the last tic mark.

8. During concurrent alignment, it is advisable to monitor the SAHRS alignment progress by pressing the SAHR pushbutton on the MFD. The OWN A/C MFD format will show SAHR boxed; and the QUAL and TIME acronyms and the align scale now refer to the SAHR. A SAHRS ALIGN COMPLETE message normally appears in approximately 2.5 to 3 minutes from the time when the parking brake was set. The QUAL will be approximately 10 (nm per hour) at this time.

9. Alignment may be continued after the appearance of the INS ALIGN COMPLETE message if time permits. This will provide only slight improvement in alignment quality but will provide some gyro biasing and eliminate unnecessary drift in the INS mode. If the parking brake is released during alignment, the INS and SAHRS will go to a SUSPEND ALIGN state as indicated by the computer message on the OWN A/C MFD format. Alignment will be resumed upon application of the parking brake. The numerical alignment quality displayed will never be lower than 0.50. Actual INS/SAHRS drift rate is normally less than 0.50 nm per hour.

10. Advancing the NAV MODE switch to INS will command the INS to its inertial navigation mode. If the parking brake is still applied at this time, the SAHRS will continue aligning.

11. In order to improve INS performance, enhanced alignment may be obtained by performing the following procedure.

    a. Initiate a standard alignment.

    b. Allow alignment to continue until an INS ALIGN COMPLETE message appears on the MFD.

    c. Without changing the NAV MODE switch position, taxi the aircraft to a convenient location, changing the heading by at least 70°, with 180° heading change being optimal.

    d. Reapply the parking brake and allow the INS to continue alignment for a minimum of 1 minute (7 to 8 minutes desired).

Note

The latitude and longitude waypoint 1 will be updated to current aircraft position when the NAV MODE switch is placed to INS.

20.3.1.2 Stored Heading Concurrent INS/SAHRS Alignment. Stored heading alignment is performed when rapid system reaction is operationally required. Under normal conditions, stored heading alignment can reduce ground align time by 1 minute. This procedure requires that a previous reference alignment be performed and that the aircraft remain stationary until the subsequent stored heading alignment is completed.

Perform a reference alignment by following the normal ground align procedure in paragraph 20.3.1.1. When the INS ALIGN COMPLETE message appears on the HUD and/or VDI format, return the NAV MODE switch to OFF. The aircraft heading should now be stored in the INS and should be available for the next alignment as long as the aircraft has not been moved.

Note

Selecting the SAHR pushbutton on the OWN A/C or NAV DATA MFD formats before the diamond reaches the second tic mark will inhibit a subsequent stored heading alignment.

1. Repeat steps 1 through 4 for normal ground alignment.

2. Verify that SHDG is boxed on the OWN A/C MFD format (Figure 20-14). Do not depress the SHDG pushbutton.

3. Repeat steps 6 through 9 as in normal ground align procedure.

20.3.2 Concurrent Carrier Alignment. Carrier alignment of the INS and the SAHRS requires knowledge of the carrier motion and position. This information is best provided by the SINS. A stored heading carrier alignment is also available using SINS inputs, after a reference alignment has been performed. For SINS stored carrier alignment, the stored parameter is actually the aircraft's spotting angle on the carrier.

In the event that SINS data is unavailable, carrier alignment can take place by manual entry of ship's position, speed, and heading. This procedure is called manual carrier align. Because of the entry of fixed parameters, its real values may be changing and extended alignment time with lesser alignment quality can be expected for manual carrier alignment.

20.3.2.1 Concurrent SINS RF or Cable Carrier Alignment. Carrier alignment using SINS data from the ASW-27C D/L can be implemented by either cable or RF transmission, depending on whether the SINS cable from the deck-edge box to the nose wheelwell connector is plugged in. For either mode of data transmission, the following alignment procedure is used, after verifying proper operation of the MCS and MFD.

1. Ensure SAHRS AC/DC cb's (1A3, 1A5, 1A6, 9I3) pulled prior to application of electrical power.

2. DATA LINK power switch — ON.

3. DATA LINK MODE switch — CAINS/WPT.

4. Verify parking brake is set.

Note

Application of SAHRS power prior to selecting CV ALIGN will not allow SAHRS to properly align.

5. NAV MODE switch — CV ALIGN.

6. Reset SAHRS cb's.

7. Select OWN A/C MFD format by depressing DATA pushbutton on MFD MENU1 display. The CV SINS DATA format will appear (Figure 20-15).

8. Verify that SHDG is not boxed. If it is, depress the SHDG pushbutton to unbox it.

9. Monitor the progress of alignment by observing the QUAL and TIME acronyms and the align scale on the MFD OWN A/C format. The SINS (ship's) latitude, longitude, and INS north and east velocities can also be evaluated on the MFD OWN A/C format. An INS ALIGN COMPLETE message will normally occur in 7 minutes. At this time the align quality should be below 1 nm per hour.

Note

Do not select SAHR during CV ALIGN to check alignment progress. Wait until INS alignment is complete and INS has been selected on the NAV MODE switch before selecting SAHR.

10. SAHRS alignment progress may be monitored at this time by selecting the NAV page.

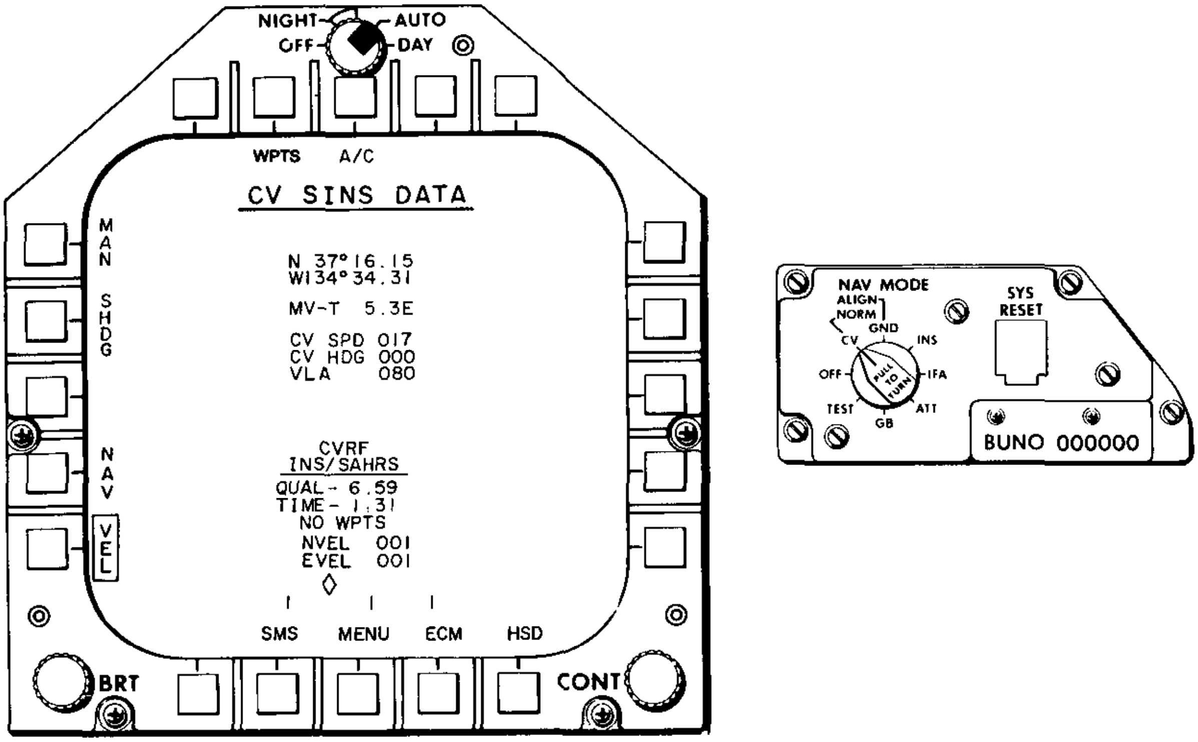
Note

- The SAHRS alignment process will initiate after the INS determines a valid true heading (approximately at INS quality value of 5). SAHRS quality value should reinitiate to approximately 31.2 at that time.

- If power has been applied to the aircraft for an extended period of time prior to INS CV align being initiated, the SAHRS may complete a ground align (NORM) and a SAHRS complete message appears on the MFD. After the INS CV align is initiated, the SAHRS will initiate a concurrent CV align normally, but another SAHRS align complete message may not appear.

11. It is advisable to continue alignment after appearance of the INS ALIGN COMPLETE message if time permits. When ready to take the alignment, the inertial navigation mode may be selected by setting the NAV MODE switch to INS.

CV ALIGNMENT



STORED HEADING CV ALIGNMENT

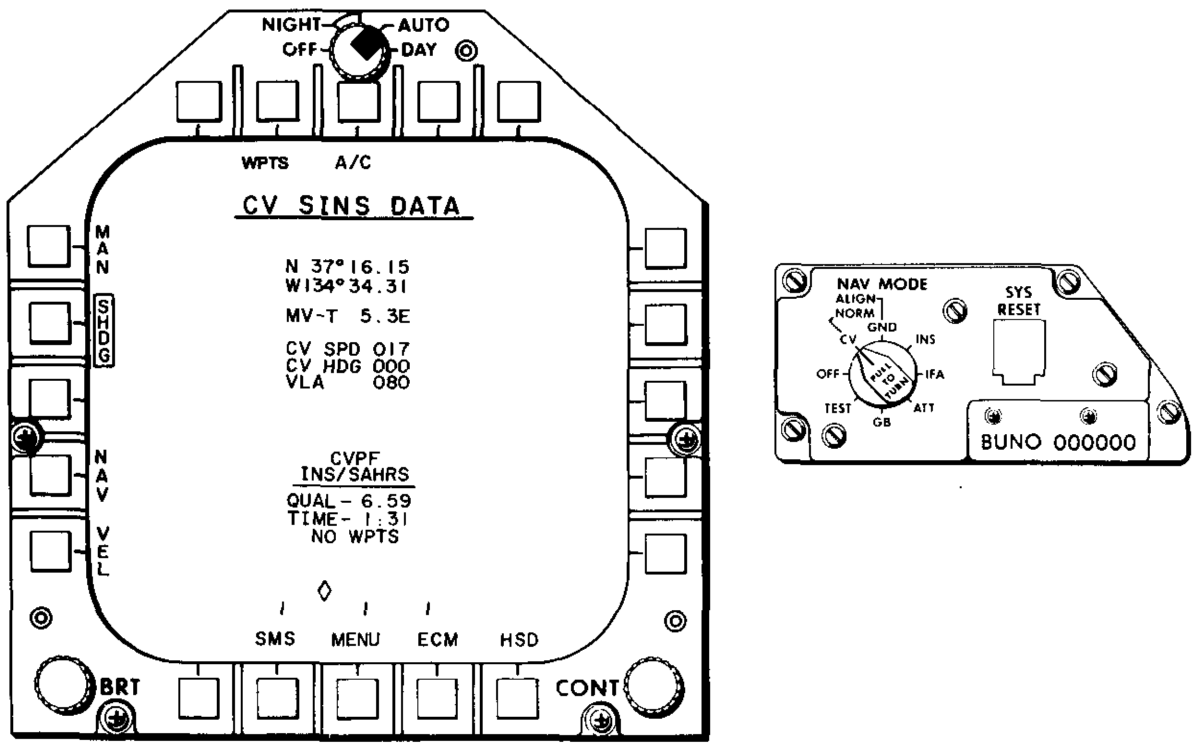


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Figure 20-15. CV Alignment Formats — SINS

Note

Although SINS carrier alignment normally requires no entry of data, if a SINS alignment takes place at any carrier location other than the flight deck, then it is advisable to enter the correct vertical lever arm via the DEU. This is the height in feet of the aircraft INS above the carrier's SINS location. This entry can be made only via the DEU by calling up the DEU CV ALIGN page and depressing the VLA pushtile shown in Figure 20-16.

20.3.2.2 Concurrent SINS Stored Heading Carrier Alignment. Carrier alignment time can be reduced by 1 minute by performing a stored heading carrier alignment. This procedure requires that a reference alignment be performed using SINS data and that the aircraft's position on the carrier remain stationary until the completion of the subsequent stored alignment.

Perform a reference alignment by following the SINS carrier align procedure in paragraph 20.3.4.2.1. When the INS ALIGN COMPLETE message appears on the HUD/VDI formats, return the NAV MODE switch to OFF.

Note

- Do not box SAHR on the DATA or NAV formats during the reference alignment. This will prevent the reference alignment and SHDG will not be boxed when alignment is initiated.

- Do not cycle the parking brake during the reference alignment. This will prevent the reference alignment and SHDG will not be boxed when alignment is initiated.

1. Repeat steps 1 through 7 of concurrent SINS carrier align.

2. Verify that SHDG is boxed on CV SINS DATA MFD format (Figure 20-15).

3. Repeat steps 9 and 10 of concurrent SINS carrier align.

20.3.2.3 Concurrent Manual Carrier Alignment. The INS and SAHRS will initiate ground alignments if there is no SINS data. The CV MANUAL format will be displayed after the ship's data is entered.

1. Repeat steps 1 through 8 of concurrent SINS carrier align.

Note

If the SINS or data link is not operating or if a manual carrier alignment is desired, skip steps 2 and 3.

2. Enter best knowledge of ship's latitude, longitude, speed, and heading via the DEU or DD. When the DATA pushbutton on the MFD is depressed, the CV MANUAL DATA format, shown on Figure 20-16 appears.

Note

- If SINS is restored, MAN must be unboxed on the CV DATA format in order to return to a CV RF alignment.

- Entry of VLA is never required for manual carrier alignment.

- When using the DEU, data entry is made via the DEU CV ALIGN format, using the LAT, LONG, CSPD and CHDG pushtiles, and the appropriate quadrant and numerals shown in Figure 20-16.

- Data entry using the DD requires selection of the NAV category from the MFK pushtile and the boxing of the OWN A/C acronym prior to entering the carrier latitude and longitude via the DD LAT, LONG, quadrant and numeral pushtiles, as shown in Figure 20-17. This is done in a similar manner as described in paragraph 20.3.1.1, and shown in Figure 20-13. Entry of carrier speed and heading via the DD requires the boxing of the WIND acronym prior to using the DD SPD, HDG and numeric pushtiles as shown in Figure 20-17.

3. Repeat steps 9 through 11 for concurrent SINS carrier align (paragraph 20.3.2.1).

Note

In concurrent manual carrier align, the INS ALIGN COMPLETE computer message may take 15 minutes or longer to appear. The navigation quality at this time may not be better than 3 nm per hour. Because of the extensive alignment time, it may be necessary to launch prior to the receipt of the INS ALIGN COMPLETE computer message.

MFD FORMAT

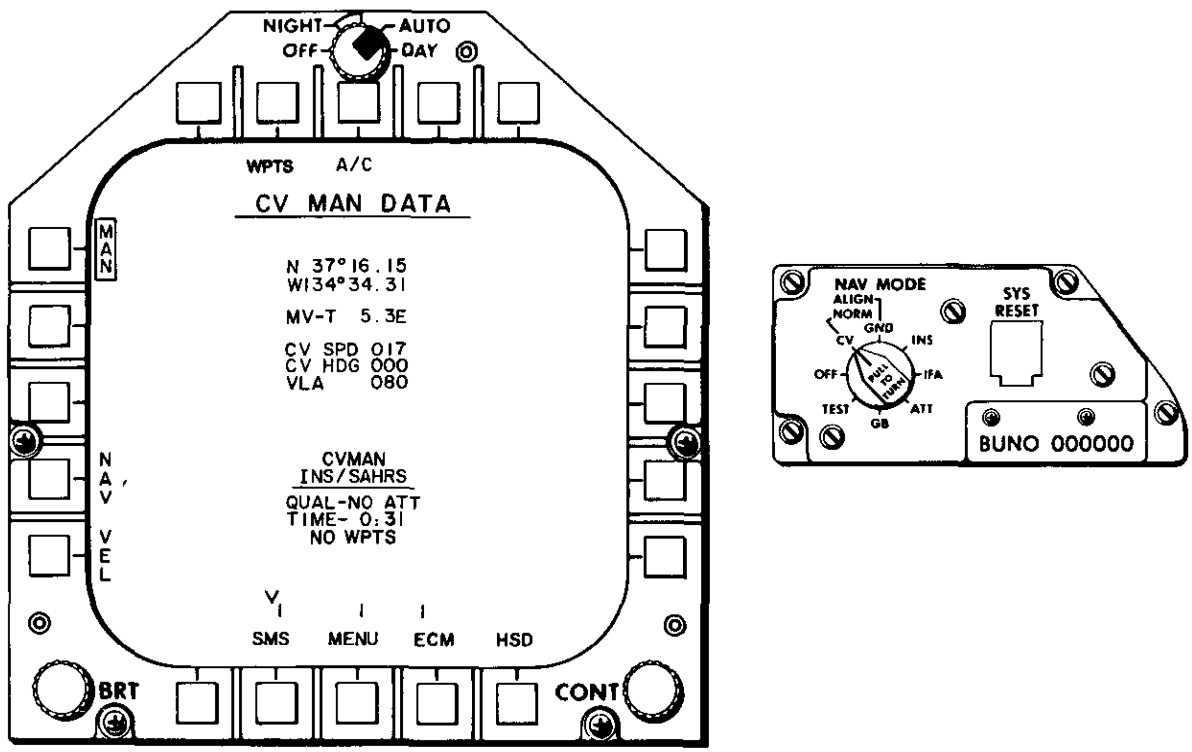

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Figure 20-16. CV Alignment Formats — Manual (Sheet 1 of 2)

20.3.3. Standalone Alignment

20.3.3.1 INS Standalone Alignment. When the SAHRS is not available or has failed, the alignment procedure for the INS is exactly the same as for concurrent alignment described above in paragraph 20.3.1. A SAHRS failure is indicated by the inability to box SAHRS on the MFD OWN A/C and align formats as well as its appearance in the failure history file and in the MFD OBC-NAV format as described in Chapter 27.

20.3.3.2 SAHRS Standalone Alignment. When the INS has failed or is not available or if a SAHRS alignment mode other than that of the INS is desired, then a SAHRS standalone alignment can be selected from the MFD SAHRS ALIGN format (Figure 20-18). This format will appear by depressing the NAV pushbutton on the OWN A/C MFD format. An INS failure is indicated by the inability to box INS on the MFD align or OWN A/C formats as well as its appearance in the failure history file and in the MFD OBC-NAV format as described in Chapter 27.

As shown in Figure 20-18, the possible SAHRS standalone alignment modes include normal ground align (NORM), stored heading ground align (SHDG), magnetic initiated ground align (MAG), and carrier align (CV). These are described below.

20.3.3.2.1 SAHRS Standalone Normal Ground Alignment. SAHRS normal ground alignment is the recommended mode for SAHRS standalone alignment and it will be automatically selected as the default mode when the INS is not available. This can be ascertained by selecting the SAHRS ground align MFD format and observing that the NORM legend is boxed. Verification of own-aircraft latitude and longitude should be made by observing the values displayed on the SAHRS ALIGN MFD format, and, if necessary, new values should be entered via the DEU or DD control panel as described in Normal Concurrent Ground Alignment procedures, paragraph 20.3.1.1. The SAHRS ALIGN COMPLETE message will usually appear in less than 3 minutes, with an align quality of less than 10 nm per hour.

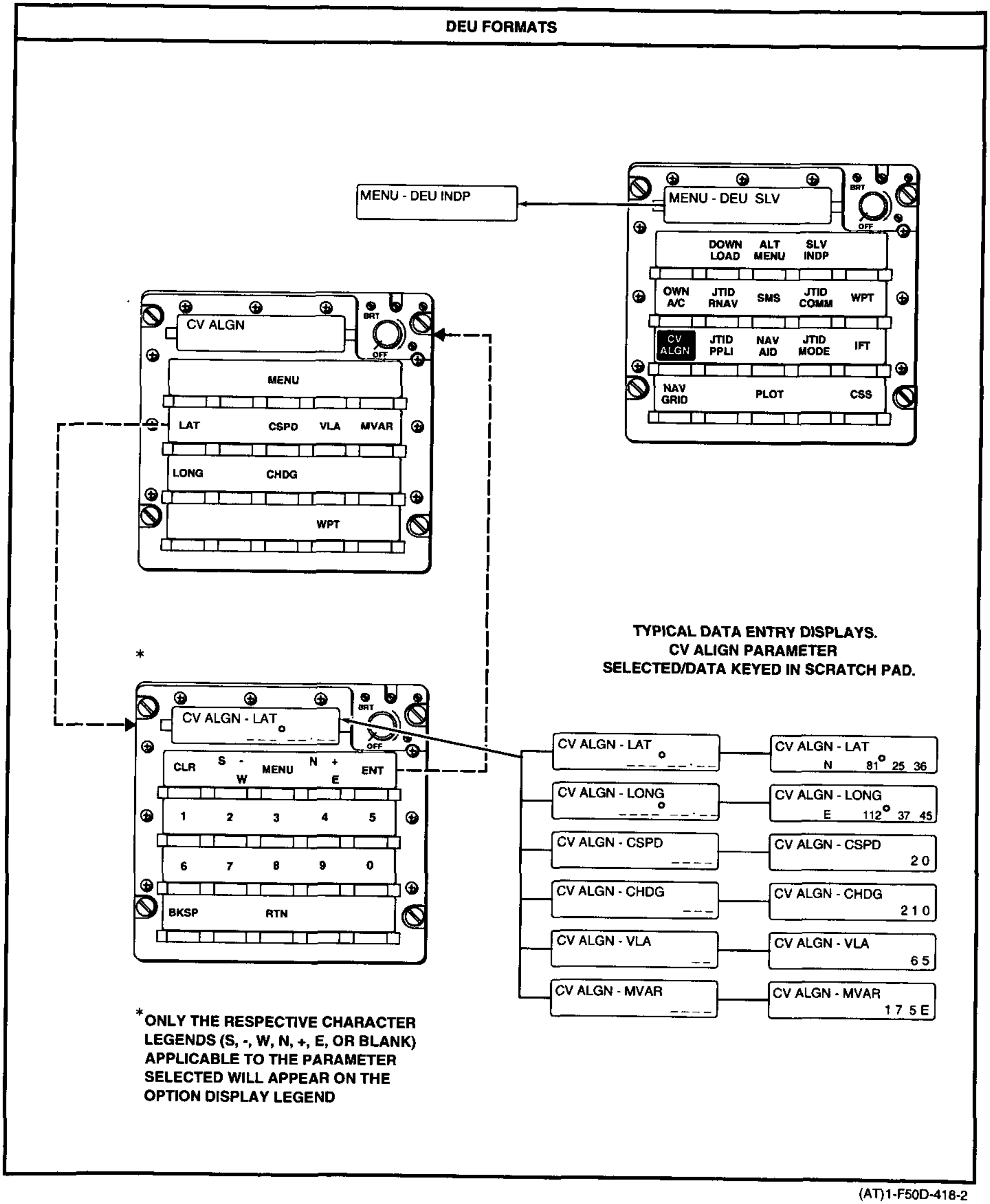

Figure 20-16. CV Alignment Formats — Manual (Sheet 2 of 2)

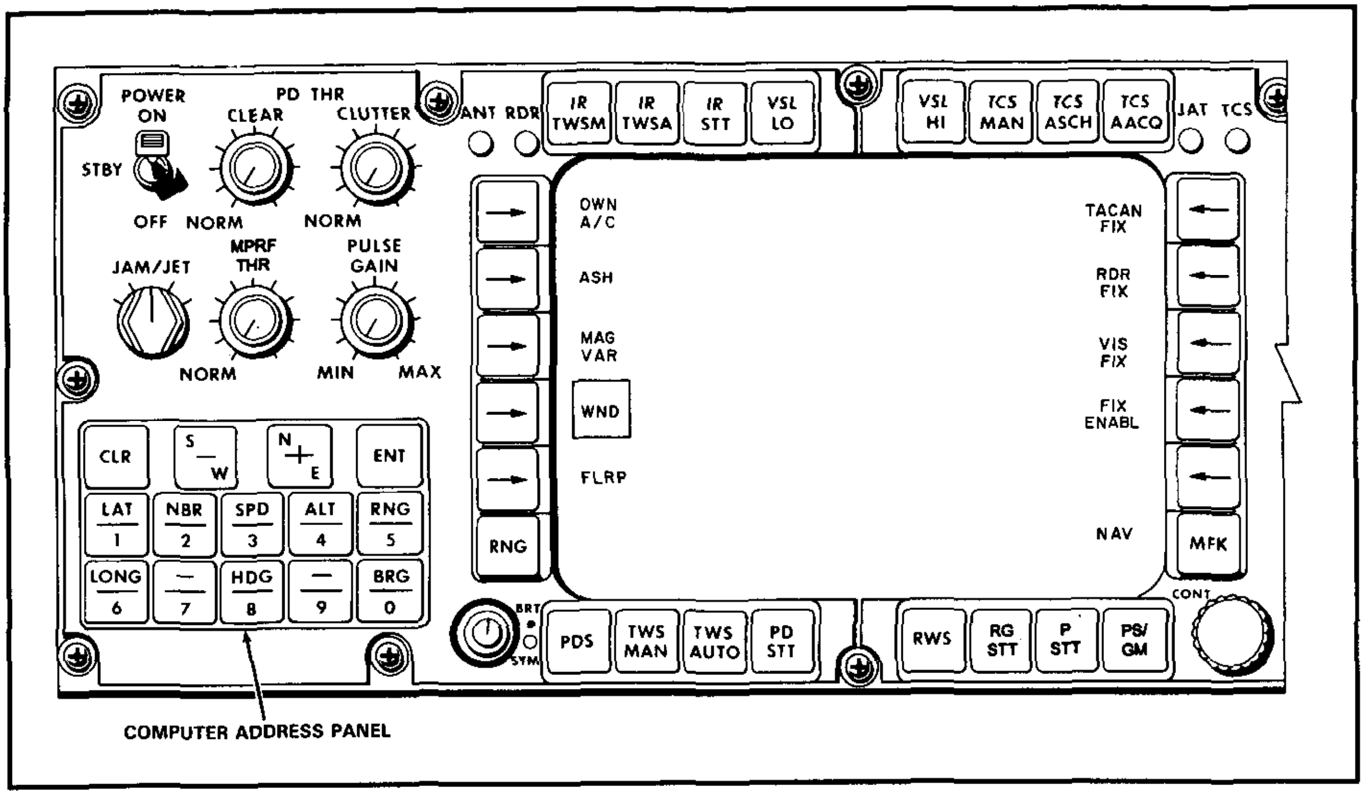

Figure 20-17. DD Align Data Entry

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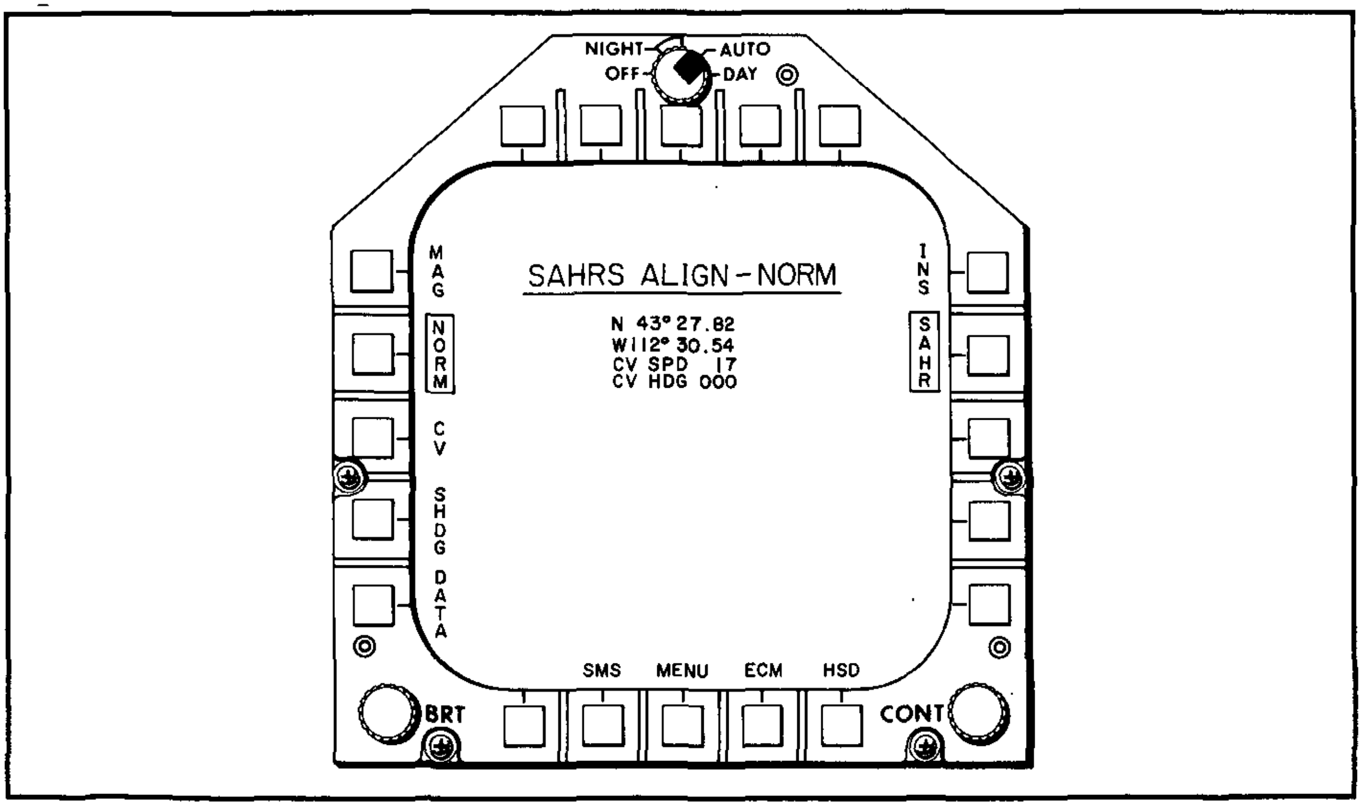

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Figure 20-18. SAHRS Standalone Align MFD Format

20.3.3.2.2 SAHRS Standalone Stored Heading Ground Alignment. The SAHRS stored heading align mode is always available subsequent to a previous alignment to a SAHRS ALIGN COMPLETE. However unlike an INS stored alignment, the SHDG pushbutton on the SAHRS ALIGN MFD format must be depressed to select this mode (Figure 20-18). As for all stored heading alignments, no data entries are required and the aircraft must not be moved subsequent to SAHRS power down. Since this alignment mode uses predetermined heading, the alignment process will be shortened. SAHRS stored heading alignment should normally provide a SAHRS ALIGN COMPLETE message in less than 1 minute. The navigation quality value at this time will exceed 10 nm per hour, and, if time permits, additional alignment is recommended and will take place as long as the parking brake is set.

20.3.3.2.3 SAHRS Standalone Magnetic Initiated Ground Alignment. The SAHRS magnetic initiated ground alignment mode is manually selected from the SAHRS ALIGN MFD format by depressing the MAG pushbutton shown in Figure 20-18. Verification of own-aircraft latitude and longitude on the above MFD format should be made, and, if necessary, correct values entered as described in SAHRS Standalone Normal Ground Alignment, paragraph 20.3.3.2.1. Since this alignment mode uses system magnetic heading to initialize heading, the alignment process will be shortened. A SAHRS ALIGN COMPLETE message should normally occur within 1 minute, although the navigation quality value at this time may exceed 10 nm per hour. If time permits, additional alignment is recommended and will take place as long as the parking brake is set. In this mode of alignment, magnetic heading inputs from the magnetic azimuth detector (flux valve) are used for initializing the SAHRS heading. It should be selected only in areas where no magnetic interference or anomalies exist.

20.3.3.2.4 SAHRS Standalone Carrier Alignment. The SAHRS standalone CV alignment mode is manually selected via the SAHRS ALIGN MFD format by depressing the SAHR and then CV pushbutton shown in Figure 20-18. There are two SAHRS standalone align modes. Which mode obtained depends on when CV is selected. If CV is selected prior to the INS determining true heading (approximately INS quality of 5) and initiating the SAHRS CV concurrent align, a SAHRS standalone align is commanded when the SAHRS has no heading information.

Note

Currently there is no indication on the MFD displays that the SAHRS has gone into the standalone mode except the SAHRS quality value will remain 10.0, the timer will be 00, SAHRS concurrent CV align will not initiate, and there will be no attitude information available from the SAHRS for up to 6 minutes or more. Reinitiating the INS alignment will allow a concurrent alignment to occur.

The SAHRS has no true standalone carrier align mode like the INS. During concurrent INS/SAHRS carrier align modes, the SAHRS depends on the INS to provide an initial input of true heading. Since this is not available in SAHRS standalone carrier alignment, when the SAHRS CV pushbutton is depressed in SAHRS standalone operation, it is commanded to a DG mode. Once the parking brake is released a DG heading can be entered via the DEU. When the aircraft is airborne, the slaved mode can be selected or if a system velocity source is present, in-flight restart can be selected to bring the SAHRS to a normal operational mode. This is described in SAHRS Backup Modes, paragraph 20.3.5.3.2.

If CV is selected after the INS has initiated the SAHRS CV concurrent alignment, the SAHRS alignment proceeds but is no longer receiving updated position and velocity information from the INS. The alignment will be considerably slower than concurrent alignment. The SAHRS is commanded to NORM mode. An in-flight restart may or may not be required depending on the SAHRS alignment quality.

SAHRS cannot be commanded to a CV mode unless the INS is in CV. If the INS is unavailable, the SAHRS will attempt a normal ground align.

20.3.4 Initially Entered Navigation Parameters. Prior to takeoff, either during or after alignment, it may be desirable to enter certain initial navigation-related parameters, in addition to those noted above that are required for alignment. It may also be possible to enter some of these parameters at any time during flight. They include the following and are discussed below:

1. Day barometric setting
2. Waypoint data
3. Wind speed and direction
4. Magnetic variation.

20.3.4.1 Barometric Setting. The barometric setting is normally made by the pilot using his 2-inch barometric altimeter setting knob. Although this setting is normally made prior to takeoff, it can be made anytime including during flight. The setting range is from 28.10 to 30.99 inches of Hg and the value set should be that reported by the control tower. This will provide system altitude corrections to within a maximum error of 16 feet. Verify that the entered value is displayed (Figure 20-6) on the HUD. A small difference between the HUD and instrument values may be expected. This will usually be less than 0.01 inch of Mercury but may on occasion be 0.02 inch. If any difference is present, adjust the altimeter so that the correct control tower value is displayed on the lower right side of the HUD. Barometric settings may also be made by the RIO via the DEU. To do this, the altimeter must be locked out by turning the setting knob to the minimum value (28.10 in Hg). The DEU OWN A/C page can now be used to enter the required value after depressing the BARO pushtile and the proper numeric values.

Entry of barometric settings can be made on the ground or in the air.

20.3.4.2 Waypoint Data Entry. Up to 100 waypoints can be stored in the waypoint file at any time. The primary parameters that may be entered for each waypoint are longitude, latitude, and altitude. These may be entered manually via the DEU by selecting the DEU WPT page (Figure 20-19) and depressing the desired waypoint number prior to entering the coordinates. Verification of correct entry can be made by examining the MFD WPT DATA format, selectable by depressing WPTS (PB7) on the MFD OWN A/C format and shown in Figure 20-20.

The DD control panel may also be used for entering these parameters for waypoints 1 to 20. When the DD control panel is used, on the main menu, press the WP 1-10 or WP 11-20 pushtile and then box the desired waypoint. The coordinates are entered using the quadrant and numeric pushtiles on the lower left portion of the DD control panel, as indicated on Figure 20-21.

The primary waypoint parameters and their ranges are as follows:

WPT Primary Parameter	Range
Longitude	E/W 180°
Latitude	N/S 90°
Altitude	-5000 to 99,996 feet

In addition to the above primary waypoint parameters, four other parameters relating to the reconnaissance steering function may also be entered when the specified waypoint is to be used as a reconnaissance target point. These parameters, however, can only be entered via the DEU using the DEU WPT page. They are as follows:

Reconnaissance Steering Parameter	Range
Command course	0 to 360°
Map lines	1 to 99
Target length	0 to 2048 nm
Map offset	±131,072 feet

During on-deck carrier operations, some waypoint data can be automatically provided from the D/L if provisions on the carrier have been made. This is called waypoint insertion. The D/L must be operating with the reply panel MODE switch in CAINS/WPT. The NAV MODE switch should be in any position other than CV. For these conditions, the latitude and longitude of up to the first 16 waypoints may be received.

20.3.4.2.1 Waypoint Data File Use. In general the 100 waypoints can be used in any manner described in paragraph 20.3.6, Tactical Navigation, for destination steering or for the one-fix updating functions. Usually, however, certain of these points are reserved for special functions.

Waypoint 1 is usually reserved for homebase coordinates. Its data is retained after use.

Waypoint 17 is used as a dynamic steering point when a reconnaissance steering mode is selected using the MFD RECON DATA format. At this time any previously stored data in waypoint 17 become invalid and must be reentered.

Waypoint 18 is used for the coordinates of an agreed point for data-link one-fix position update. Its data are still valid after update usage.

Waypoint 19 is used for the coordinates of the fighter link reference point, as described in the Supplemental NATOPS Flight Manual, NAVAIR 01-F14AAD-1A. Its data are still valid after usage for "FLRP."

Waypoint 20 is usually reserved for the approximate location and altitude of a hostile area. Its data are retained after use.

Waypoints 2 to 16 and 21 to 100 are general waypoints and are used as required by the mission. The data of these points are retained after use.

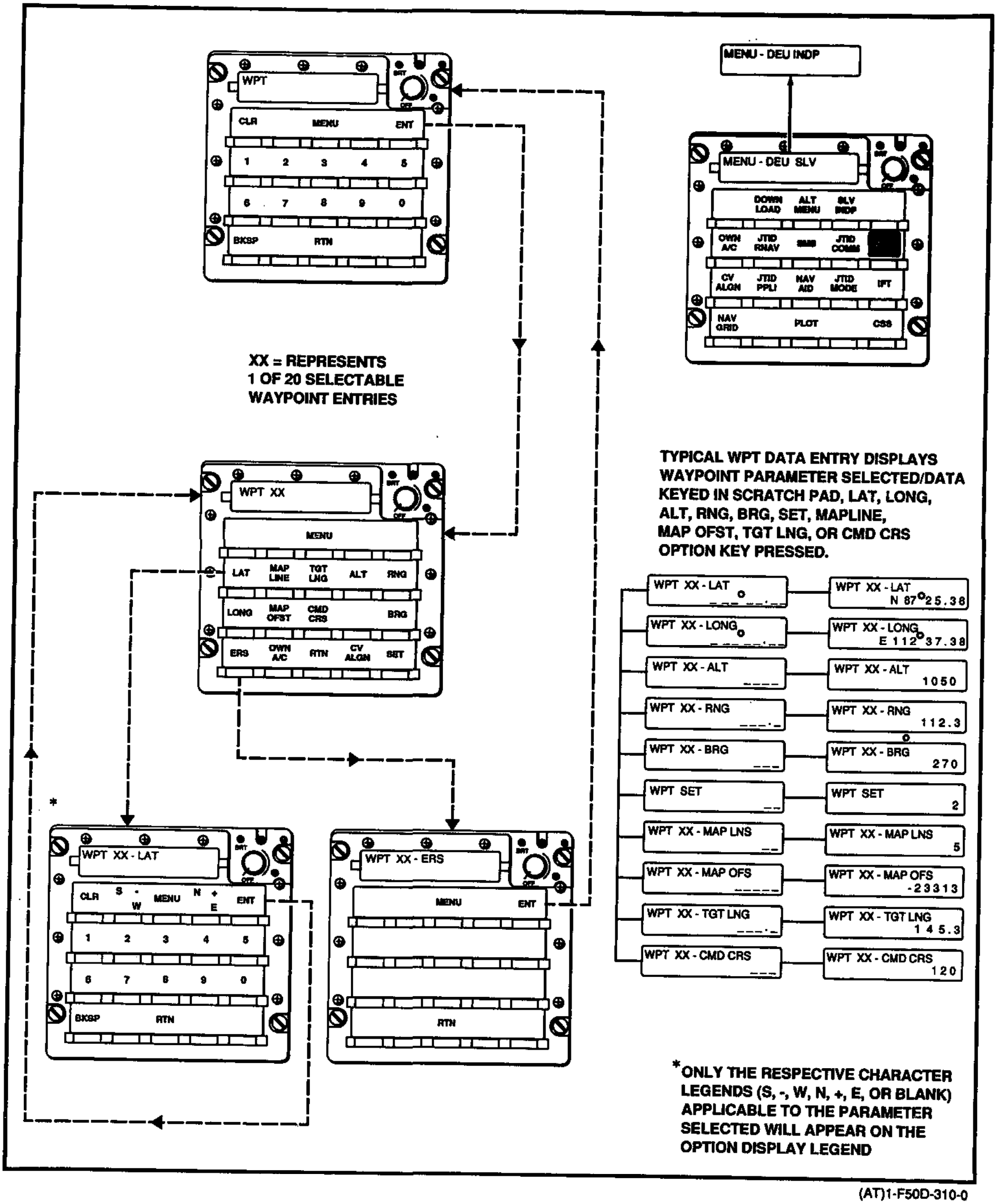

Figure 20-19. Data Entry Unit Waypoint Pages (Typical)

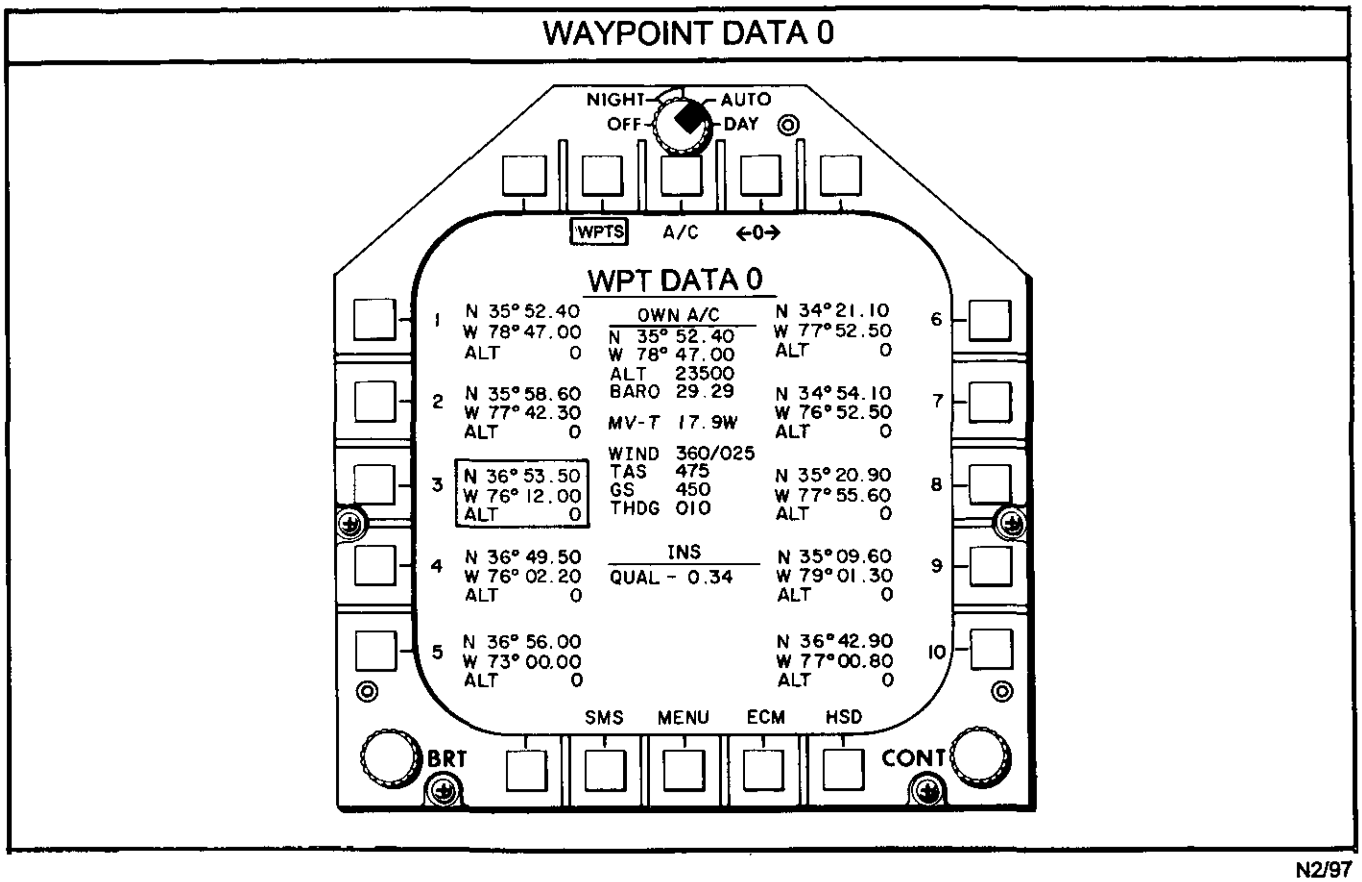

Figure 20-20. MFD Waypoint Data Format

20.3.4.3 Wind Speed and Direction. Wind parameters are normally generated by the navigation system using air data and INS or SAHRS velocities. When the navigation system cannot compute wind because of unavailability of the required velocity inputs, it will accept manual entries of wind from the DEU or the DD control panel. Entry of wind can be made prior to takeoff with no sensor failure since CADC true airspeed is not set valid until it reaches approximately 60 knots.

Wind is entered with the DEU (Figure 20-12) by selecting the OWN A/C DEU format and depressing the WSPD and WDIR pushtiles and then the proper numerics.

Wind is entered with the DD control panel (Figure 20-17) by selecting NAV and then boxing WIND and using the proper numeric pushtiles on the lower left portion of the DD control panel.

Note

For both DEU and DD entries, wind direction is the direction from which the wind is blowing.

20.3.4.4 Magnetic Variation. MAG VAR is available from the navigation system from a prestored table using aircraft coordinates. This value, when displayed on the MFD OWN A/C format, is labeled MV-T. It may also be computed using the difference between system true heading and magnetic heading from magnetic azimuth detector (labeled MV-C). In addition to this, the navigation system will accept and use a manually entered value of magnetic variation from either the DEU or the DD control panel (labeled MV-E).

Magnetic variation from the prestored table is the default value and will be automatically selected and displayed to the nearest degree. This is the recommended value and, unless aircraft position is unknown, will usually be the most accurate.

Selection of computed or entered magnetic variation is made by depressing the boxed MV pushbutton on the lower right side of the MFD OWN A/C format (Figure 20-22). When this is done the MV-T legend in the center of the format will cycle to MV-C, to MV-E, and back to MV-T, indicating the source and value of magnetic variation used by the navigation system.

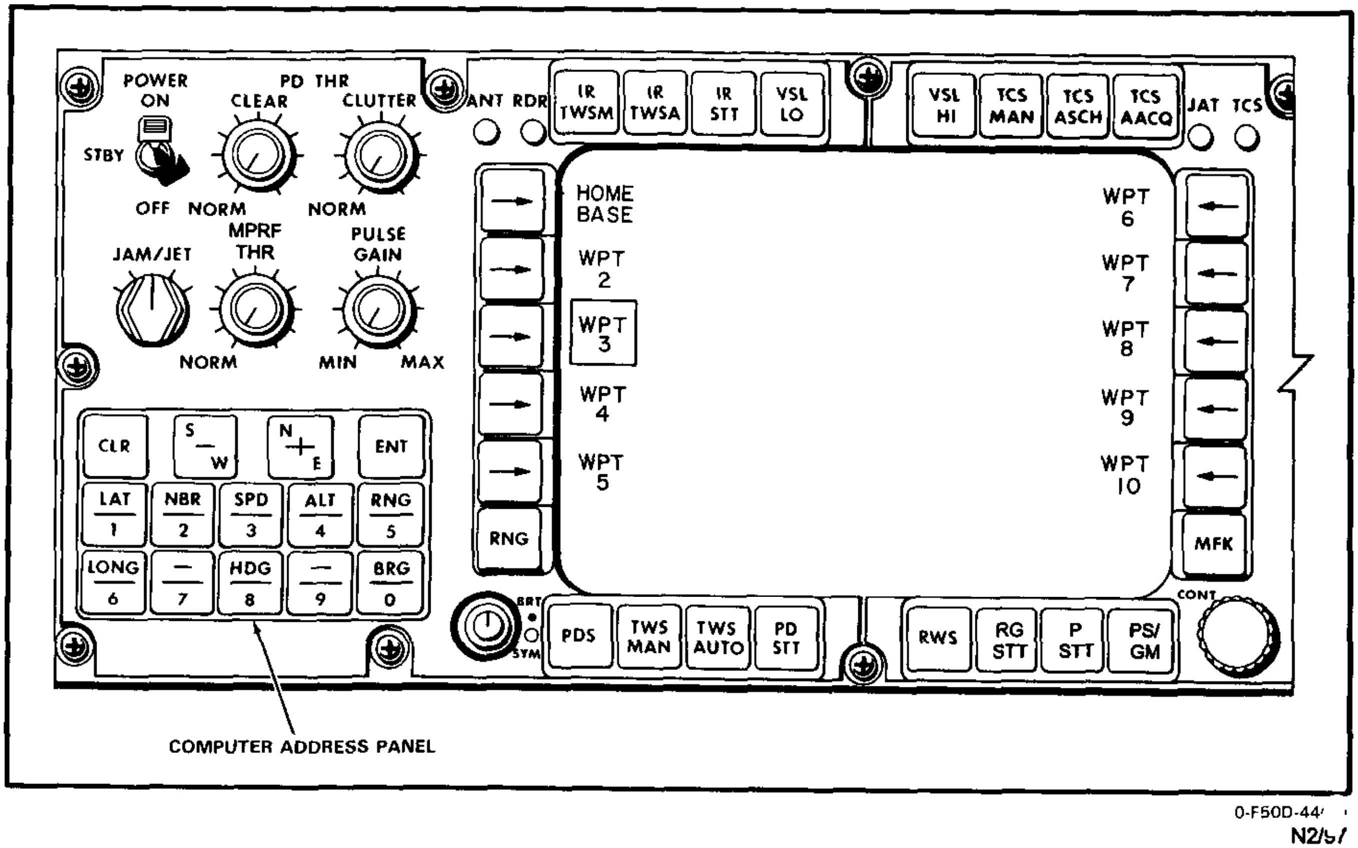

Figure 20-21. DD Waypoint Data Entry

Entered values of magnetic variation can be made using either the DEU or the DD control panel. When the DEU is used (Figure 20-12), the MVAR pushtile on the OWN A/C or CV ALGN format is selected and the value is entered to the nearest degree, preceded by an E or W for east or west, respectively. When the DD control panel is used (Figure 20-22), the NAV category is selected and the MAG VAR pushtile is depressed. Entry is made via the numerics on the computer address panel on the lower left portion of the DD by first depressing the HDG pushtile, followed by the appropriate E or W, and then the value also to the nearest degree.

20.3.5 In-Flight Operation. During flight, the navigation system can operate in several modes and submodes. These consist of the following in order of expected accuracy and completeness of information.

1. Primary
   a. In-flight align
2. Secondary
3. IMU backup
4. SAHRS backup
   a. SAHRS/slaved
   b. SAHRS DG
   c. SAHRS EC
   d. SAHRS in-flight restart.

Details on these modes, their capabilities, and the operational procedures are given in the following paragraphs.

Unless a manual selection is made, the navigation system will automatically select the best available mode in the decreasing order given above. When a manual selection is made an "M" will appear on the upper right portion of the OWN A/C MFD format. The disappearance of the "M" indicates automatic mode selection.

Manual selection of the navigation system mode can be made by either the pilot or the RIO using the applicable MFD format as described below. Navigation data entry and INS mode control is only a RIO function since the pilot does not have the required controls.

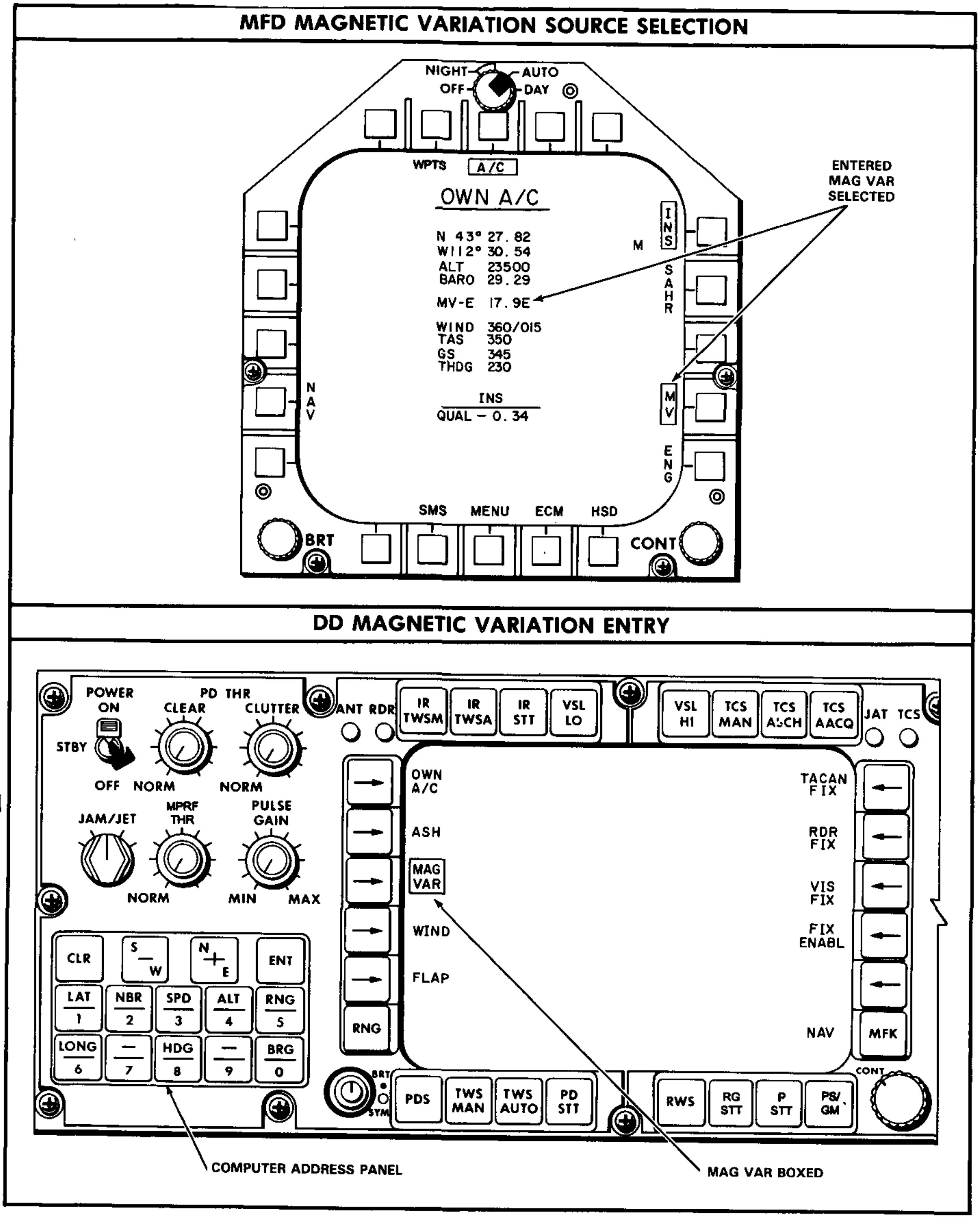

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Figure 20-22. Magnetic Variation Source Selection and DD Entry

20.3.5.1 Primary Navigation. The primary navigation mode uses INS-sensed dynamic inputs, with the INS in its inertial mode as inputs from the CADC and other aiding sources, when available and selected by the crew. This mode provides the most accurate information to all systems and is automatically selected at the completion of alignment when the NAV MODE switch is set to INS. It will also be automatically selected when the aircraft is airborne and the NAV MODE switch is still in the align position, if a reasonable quality of alignment has been obtained. The indication is that the INS legend on the upper right portion of the OWN A/C MFD format is boxed.

20.3.5.1.1 INS In-Flight Align. It is possible to align the INS during flight using an available velocity source and certain navigation system parameters. Presently the three sources of velocity data available for INS in-flight align are JTIDS, air data, and system velocity. Since an INS in-flight align using air data or system velocity may take as long as 25 minutes, this should only be attempted if serious INS degradation is suspected, JTIDS is not available, and a reasonable system velocity is available. The preferred source of INS in-flight alignment is JTIDS. A JTIDS in-flight align with good quality JTIDS velocity data should align in 12 to 15 minutes (display of an ALIGN COMPLETE message).

The quality of the air data velocity will depend upon the accuracy of entered or available wind information. System velocity is the computed optimum velocity using all available inputs. JTIDS velocity data is computed by the JTIDS system and is dependent on data received from the MCS and over the link.

Since an INS in-flight align uses current system position information, it is desirable to perform a one-fix position update prior to performing an INS in-flight align.

The procedure for in-flight align is as follows:

1. Verify a valid source of true heading is available, such as SAHRS by selecting SAHRS on the upper right portion of the OWN A/C MFD format. If a reasonable SAHRS true heading is not available, then enter the best estimated true heading via the DEU OWN A/C format (Figure 20-23).

2. Advance the NAV MODE switch to the IFA position. The IFA MFD format shown in Figure 20-23 will appear.

3. Select a velocity source by depressing a pushbutton on the right side of the IFA MFD format.

4. Observe the alignment progress on the IFA MFD format.

5. To ensure a good initial platform alignment, flight should be straight and level from 1 to 5 minutes.

Note

Because of the extensive time required for INS IFA, it is possible to select the INS mode via the NAV MODE switch prior to an INS align complete message. At this time the INS may advance to the inertial mode or may operate in the ATT mode, depending upon the alignment progress at the time.

20.3.5.2 Secondary Navigation. The secondary navigation mode uses SAHRS-sensed dynamic inputs, with the SAHRS in its normal operating mode, as well as inputs from the CADC and other aid sources, when selected and available. This mode will be automatically selected when the INS primary mode is not available because of either an INS failure or INS operation in a degraded mode (i.e., ATT mode). Indication of this condition can be observed on the MFD OWN A/C format, that will show SAHR boxed in the upper right portion and only SAHRS appearing as the legend in the center of the display (Figure 20-24).

Note

If the navigation mode reverts to secondary on deck during CV operations, the SAHRS will default to a CV standalone align mode (SAHRS continues to align as long as there is weight on wheels); if a system reset is initiated or occurs as a result of another failure, the SAHRS will revert to a NORM ground align mode. Attitude information will not be available for approximately 45 seconds when this occurs.

The secondary navigation mode can also be called anytime the SAHRS is operating in its normal mode, by depressing the SAHR pushbutton. For this condition, an "M" will appear on the upper right of the display indicating a manual selection has been made. Depressing the INS pushtile at this time will again return the system to the primary navigation mode with the "M" still appearing, indicating a manual selection has been made.

20.3.5.2.1 SAHRS Velocity Referencing. When SAHRS alignment is complete it will generate its own velocity outputs in a similar manner as the INS. Normally this parameter should be satisfactory for backup operation. In the event of an inadequate SAHRS alignment or degradation of SAHRS performance, it may be desirable to select a velocity source for SAHRS

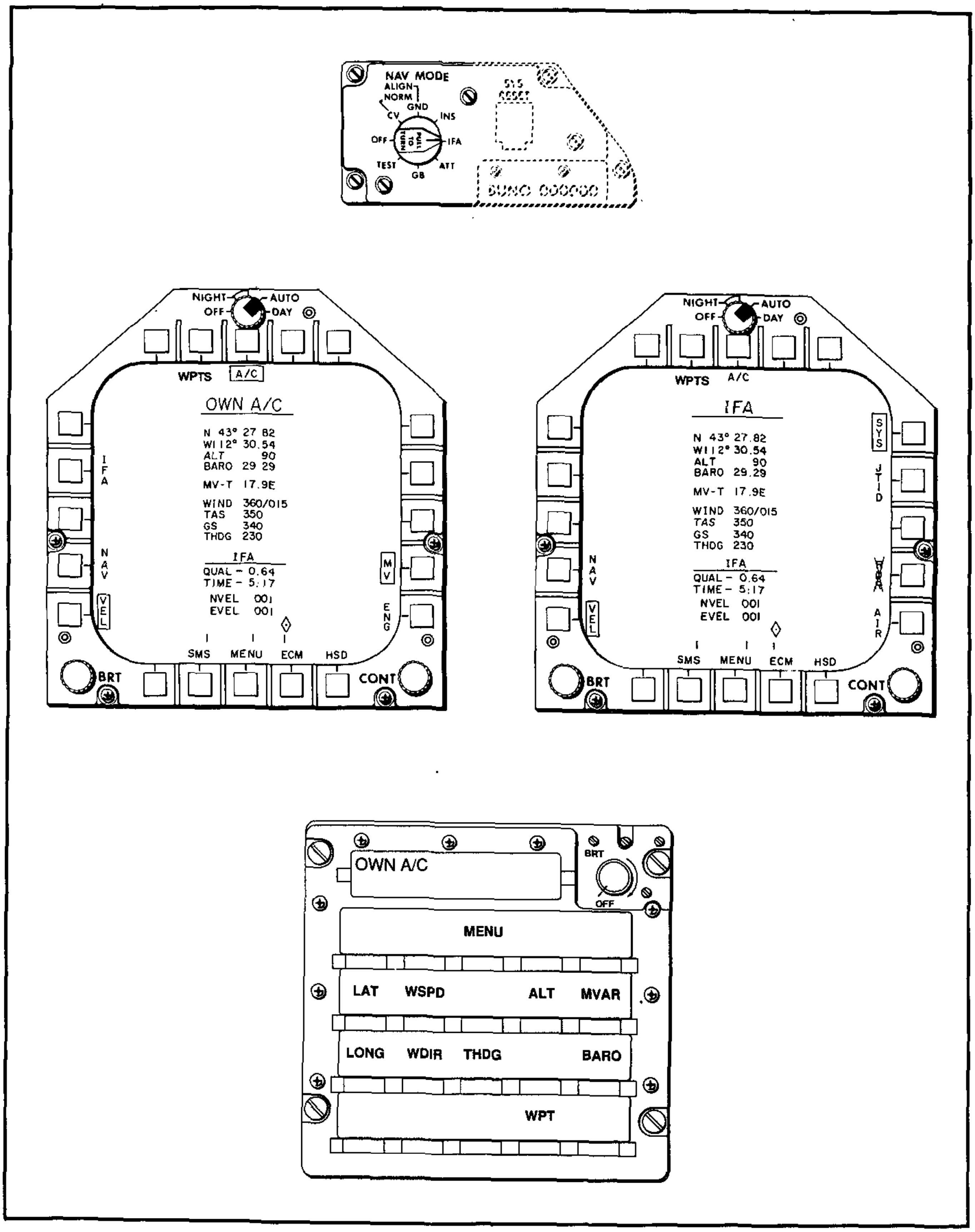

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Figure 20-23. INS In-Flight Align Formats

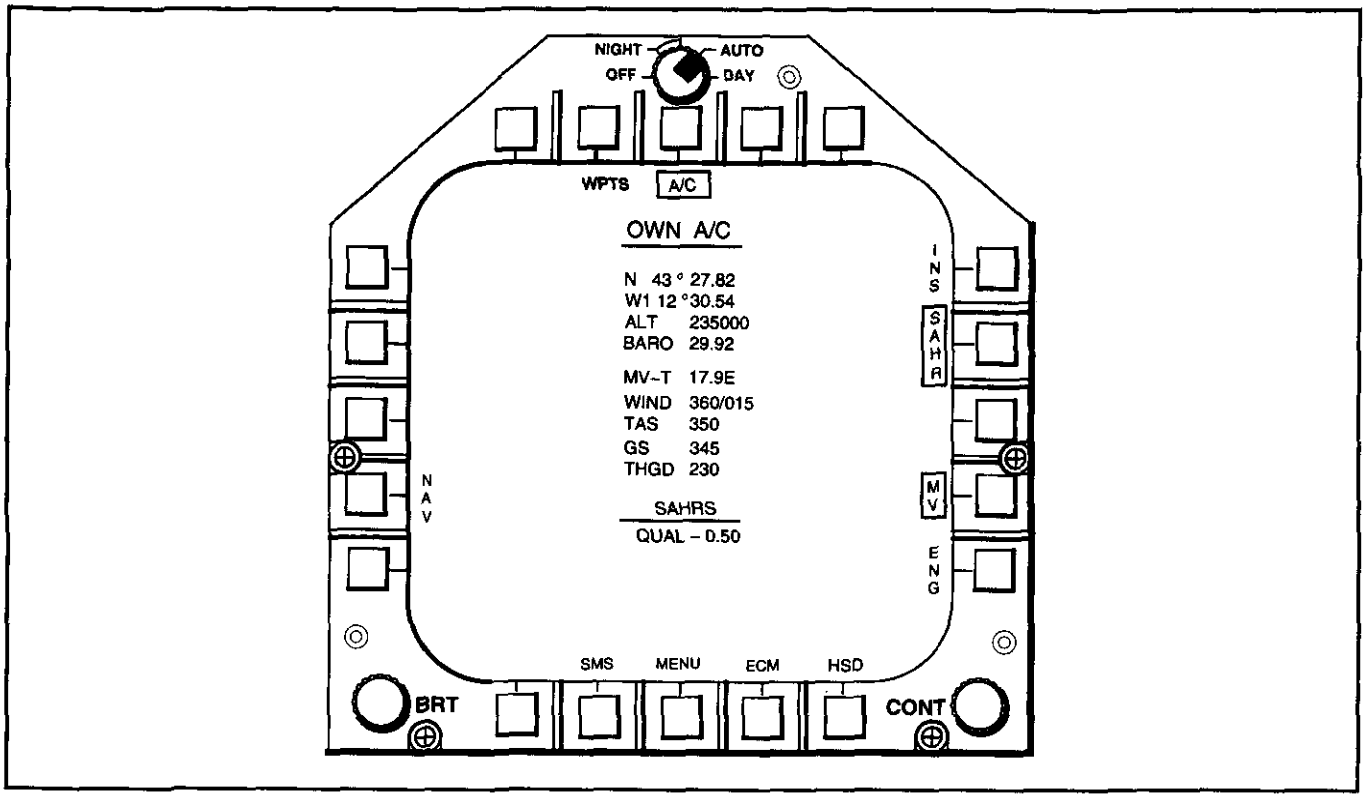

Figure 20-24. Secondary Navigation Mode Manually Selected

referencing. The sources available are shown on the lower right-hand portion of the NAV SYSTEM AID MFD format (Figure 20-25) and consist of the following:

1. SYS — System velocity is the computed optimum velocity using all valid velocity sources.

2. AIR — Air data computer true airspeed with wind compensation.

3. INS — INS-sensed velocity.

4. JTIDS — JTIDS-computed velocity.

When none of the above velocity sources is boxed, the SAHRS will use its own velocity. This is the default velocity mode.

20.3.5.3 Backup Navigation Modes. The backup navigation modes will provide most of the outputs available in the primary and secondary modes but with considerably degraded accuracy. Unlike the primary and secondary modes, the available navigation parameters are generated within the MCS, with the exception of attitude information, which is from the sensor selected. Best available system velocity is used to generate position information, and CADC inputs are used for vertical velocity. In backup navigation modes, certain data entries may be made and will be accepted as described below.

20.3.5.3.1 IMU Backup Mode. The IMU backup navigation mode will be automatically selected when both the primary (INS inertial) and the secondary (SAHRS normal) modes are not available, but the INS can still provide attitude and platform heading information and some form of system velocity is available. It may also be manually selected by positioning the NAV MODE switch to ATT with some form of system velocity available. The OWN A/C MFD format for this mode (Figure 20-26) will show a boxed INS legend in the upper right portion and an IMU or IMU/SAHRS legend will appear in the center, depending on SAHRS availability. If this mode was manually selected, an M will appear next to the boxed INS legend as shown in Figure 20-26. For this mode, the system will compute a best-available initial true heading. This parameter, however may not be accurate and it may be necessary to enter, at least one time, some estimate of the aircraft true heading via the DEU OWN A/C format.

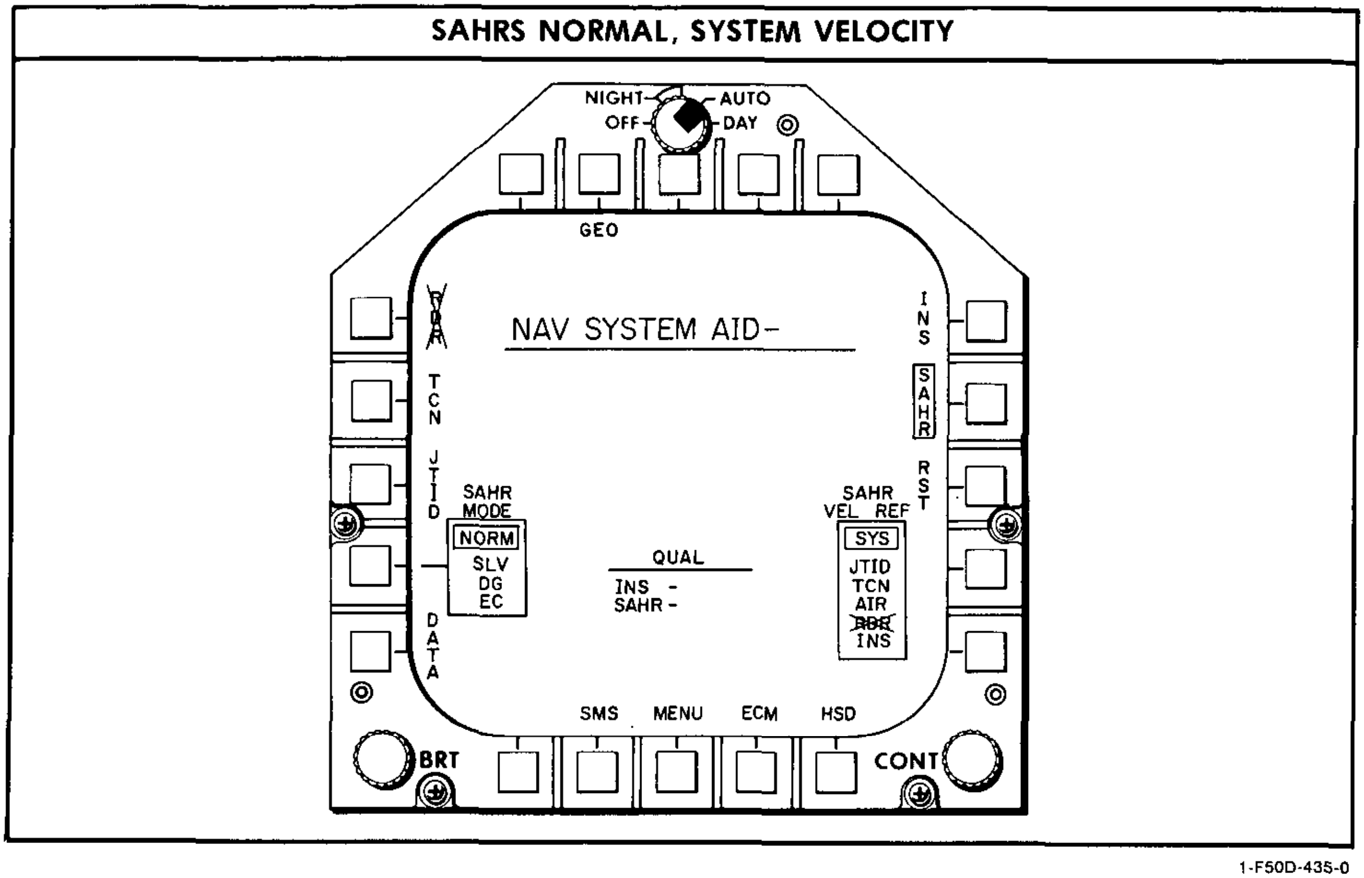

Figure 20-25. SAHRS Velocity Reference Selection

Note

Once ATT has been selected manually, the INS will degrade from an inertial mode to an attitude reference mode, and reversion to viable INS mode may be difficult or impossible.

20.3.5.3.2 SAHRS Backup Modes. A SAHRS backup mode will be automatically selected when the INS has failed or is not available, the SAHRS normal mode is not available, and some form of system velocity is available. The SAHRS backup modes include three submodes based on SAHRS operating as an attitude reference system. These include the following in the order of preference:

1. Slaved — Magnetic heading.
2. DG — Directional gyro.
3. EC — Emergency compass.

In the slaved and DG modes, the system will provide typical navigation outputs to the displays and other systems, as long as some form of system velocity is available. In addition to automatic selection, SAHRS submode operation may be manually selected via the NAV SYSTEM AID MFD format shown in Figure 20-27. This is done by first selecting SAHRS by depressing the SAHRS pushbutton on the upper right portion of the NAV SYSTEM AID MFD format and verifying that SAHRS is boxed. A SAHRS submode may be selected by depressing the SAHR MODE pushtile on the lower left of the same MFD format until the desired submode is boxed.

WARNING

Do not attempt this on deck. A weight-on-wheels interlock for the in-flight restart will freeze the SAHRS in the restart mode until weight off wheels. There will be no attitude information available from the SAHRS when this situation occurs.

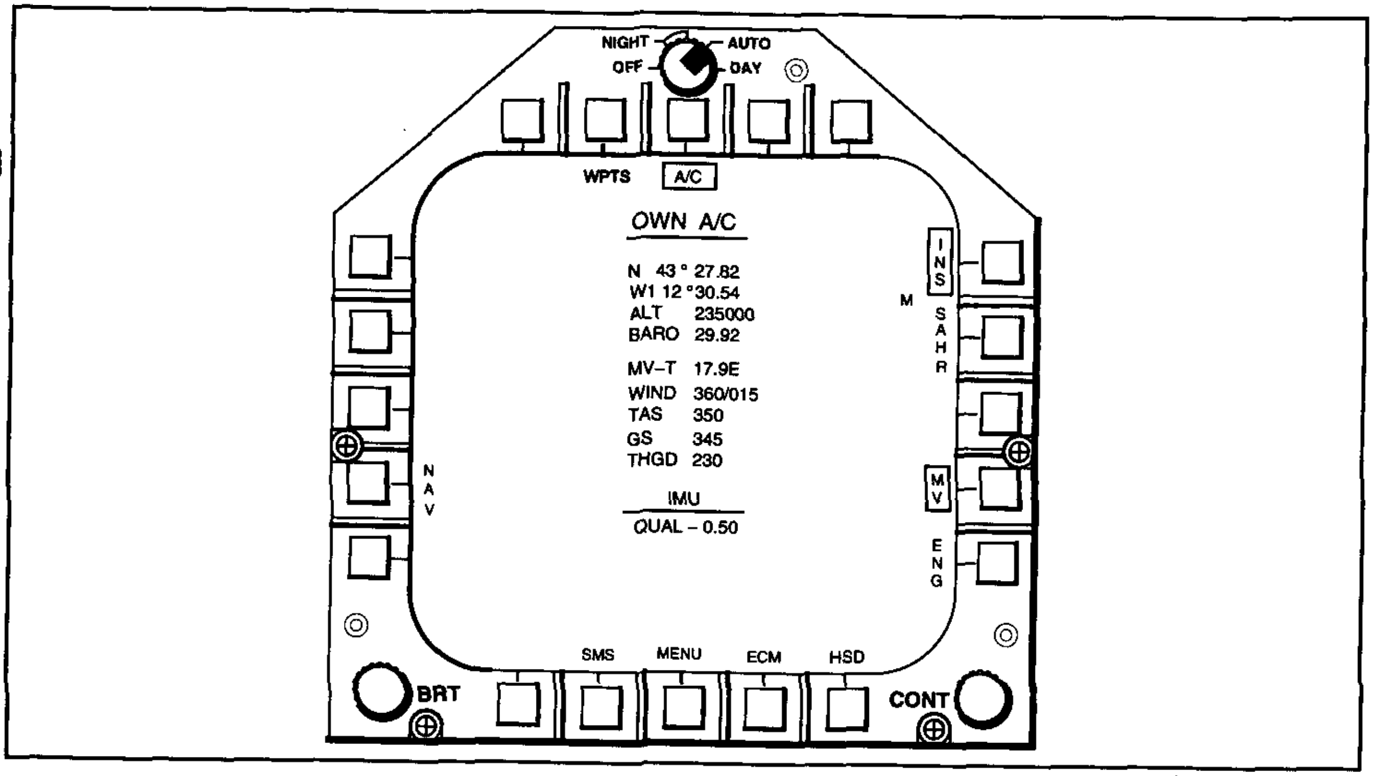

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Figure 20-26. IMU Backup Navigation Mode Selection

Note

> Although it is possible to cycle through the SLV, DG, EC submodes, reversion to NORM requires an in-flight restart. In-flight restart will automatically be initiated when the selection pushbutton is depressed to roll from EC to NORM or can be accomplished by depressing the in-flight RST pushbutton.

Considerable degradation in accuracy from the primary and secondary and even the IMU backup modes can be expected when the SLV and DG modes are selected. The SAHRS EC submode will not provide navigation parameters to the system although some air data parameters will be available.

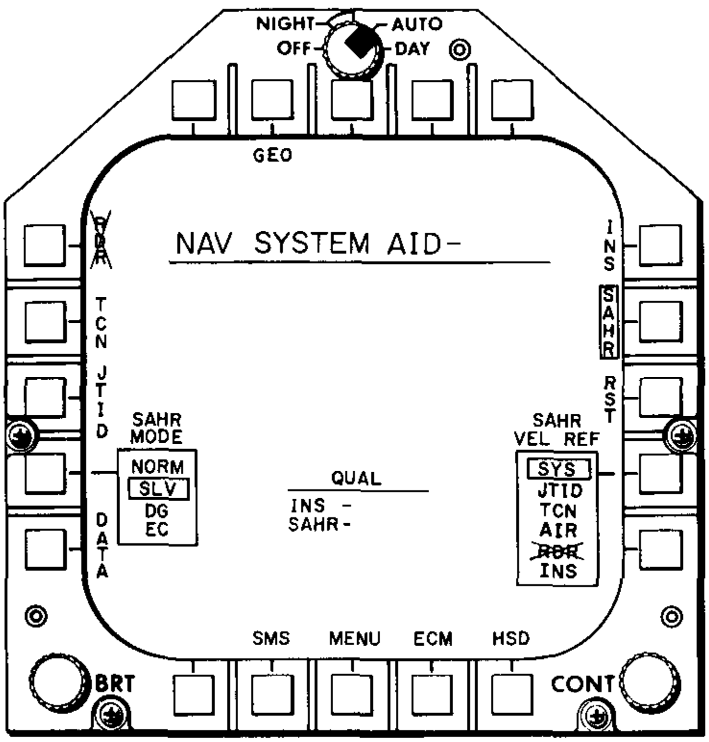
Selection of the slaved submode will result in magnetic heading information derived from the magnetic azimuth detector (flux valve) and true heading computed from this source plus magnetic variation. Attitude information is derived from SAHRS using first-order leveling and, therefore, may be subject to certain dynamic errors.

Selection of the DG submode will allow entry of a desired grid heading via the DEU, using the DEU NAV AID-DG HDG format (Figure 20-26). This entered parameter will be the initial heading reference until a new DG heading entry is made. In the system, it is treated as a magnetic-referenced parameter. Attitude information is derived from the SAHRS using first-order leveling and, like the SLV mode, is subject to dynamic errors.

The SAHRS EC submode provides only magnetic heading outputs using the magnetic azimuth detector as the input source. It is not a navigation mode, and only magnetic heading and certain air data parameters will be available when it is selected.

20.3.5.3.3 SAHRS In-Flight Restart. If the SAHRS is operating in a degraded submode, it may be possible to revert to the normal mode of operation via an in-flight restart. Prior to attempting an in-flight restart, the selection of SYS as the SAHRS velocity reference is recommended. In addition, aircraft position data should be evaluated and a position update should be performed if large position errors exist. An in-flight restart may now be initiated by selecting NORM as the SAHRS mode by depressing the indicated pushbutton on the lower left portion of the NAV SYS AID MFD format; or by depressing the RST pushbutton on the right center of the same MFD format (Figure 20-26). The subsequent boxing of the NORM legend in the SAHR MODE selector box on this format indicates a reinitialization of the SAHRS to its normal mode. The data to which the SAHRS is reinitialized is the current value of the navigation system position and velocity.

SAHRS BACKUP SLAVED MODE SELECTED



SAHRS BACKUP DG MODE SELECTED

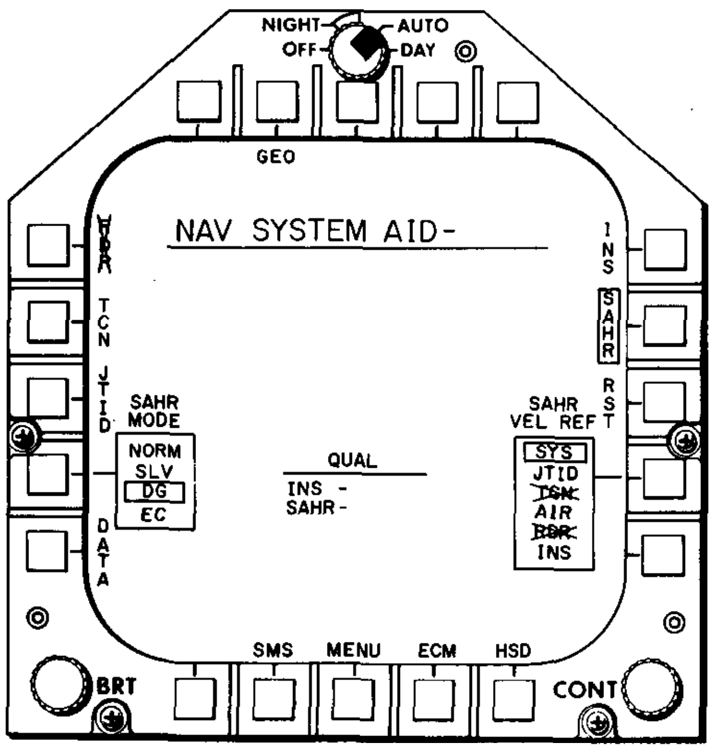


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Figure 20-27. SAHRS Backup SLV and DG Modes (Sheet 1 of 2)

DEU DG HEADING ENTRY FORMAT

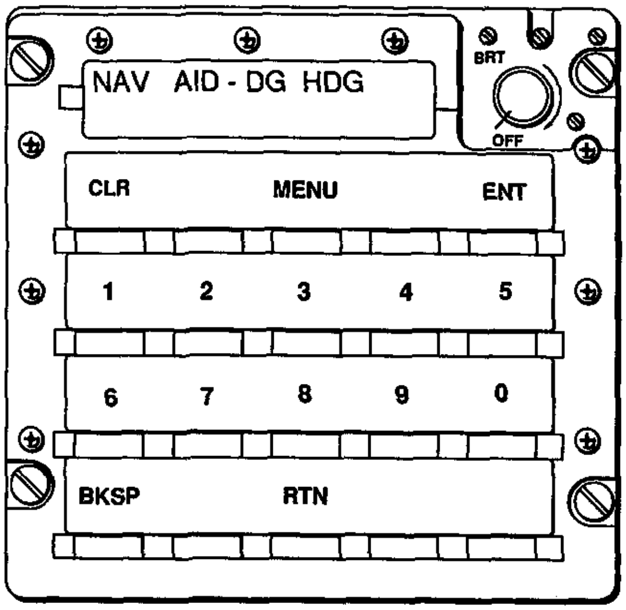

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Figure 20-27. SAHRS Backup SLV and DG Modes (Sheet 2 of 2)

It is also possible to perform an in-flight restart from the SAHRS normal mode. This should be done only if serious SAHRS degradation is suspected.

20.3.6 Tactical Navigation. The following paragraphs describe the procedures to be used for tactical navigation. This includes range, bearing, and time to go to waypoints and tacan stations; position updating; continuous position updating; surface waypoint determination position; display steering modes; autopilot steering; and all-weather landing.

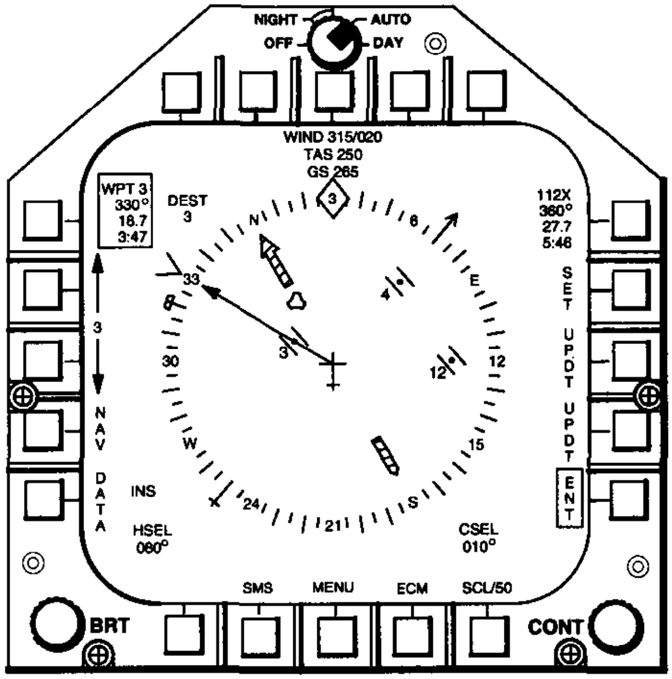
20.3.6.1 Range, Bearing, and Time To Go to Waypoints and Tacan Stations. The range, magnetic bearing, and time to go to any valid selected waypoint as well as the waypoint number itself are provided in alphanumerics on the upper left portion of the MFD HSD format (Figure 20-28). The desired waypoint number (1 to 100) is selected via the increase and decrease pushbuttons shown on the left side of the HSD format. Pressing the upper left WPT pushbutton will result in the boxing of the above data and entry into destination steering mode.

Range, magnetic bearing, and time-to-go information to a receiving/transmitting tacan station, also in alphanumerics, are provided on the same MFD HSD format but on the upper right-hand side. Included with this data is the tacan channel number. Depressing the upper right pushbutton on the MFD HSD format will cause this data to be boxed and will result in the selected course symbol being displayed through the tacan symbol, as shown in Figure 20-28. This will also unbox the waypoint data on the upper left of the HSD format.

Steering to a selected waypoint (destination steering), or to a tacan station (tacan steering), using the MFD HSD format is described in paragraph 20.3.6.5.

20.3.6.2 Update. All updates, except JTIDS, determine aircraft position one time by computing its location with respect to a known waypoint. JTIDS updates use the navigation correction data computed by the JTIDS. The difference in the computed position and the navigation system's present position are displayed on the MFD or the DD as differences (deltas) in latitude and longitude. If these differences are reasonable, the operator may elect to update the navigation system, including the INS and the SAHRS, by depressing the MFD FIX ENABLE pushbutton.

WAYPOINT DATA BOXED



TACAN DATA BOXED

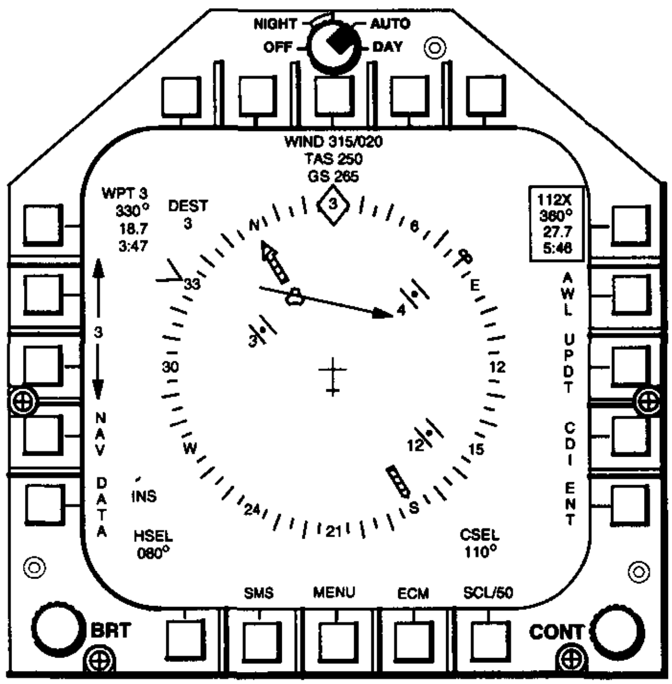


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Figure 20-28. Display of Waypoint and Tacan Data

A navigation update is performed by calling up the INS UPDATE MFD format shown in Figure 20-29 that will appear when the UPDT pushbutton is depressed on the HSD basic MFD format, shown in Figure 20-30. The available types of updates consist of visual, tacan, radar, HUD/designate, data link, and JTIDS. If a particular update type is not available, an "X" will appear over the acronym as shown in Figure 20-29. Since all updates except JTIDS use the coordinates of a selected prestored waypoint, the coordinates of the selected waypoint should be verified prior to performing all updates except JTIDS. This is done by calling up the WPT DATA 1 or 2 MFD format containing the point as shown in Figure 20-20 that is available from the OWN A/C basic format. The procedures for each of the types of updates are provided below.

20.3.6.2.1 Visual One-Fix Update. Visual one-fix update computes the aircraft's position using the coordinates of a point selected and stored in waypoint file and substituted for the aircraft's position at the instant of direct flyover. This requires that entry, selection, and verification of the waypoint be made prior to flying over the point and that the VIS pushbutton on the INS UPDATE MFD format be depressed at the time of flyover. When this is done, the INS UPDATE FORMAT shall display the computed latitude and longitude differences for evaluation. The procedure can be performed by either pilot or RIO as follows:

1. Verify the coordinates of the waypoint to be overflown by calling up the appropriate WPT DATA MFD format (Figure 20-20). If incorrect, enter the correct coordinates for the point via the DEU or the DD.

2. Call up the INS UPDATE MFD format, Figure 20-29. Select the correct waypoint corresponding to coordinates of the visual update point via the increase/decrease pushbuttons on the right side of the INS UPDATE MFD format.

3. At the instant of direct flyover of the visual point depress the VIS pushbutton. The VIS legend will be boxed at this time, and delta LAT and delta LONG will appear as shown in Figure 20-29. Optimum results will be obtained with low and slow flight conditions.

4. Verify that the delta LAT/LONG corrections are reasonable.

5. If the delta LAT/LONG corrections appear reasonable and a correction is required, press the FIX ENABLE pushbutton on the INS UPDATE MFD format. The corrections will be incorporated into the system and sensors and the correct latitude and longitude will be displayed on the OWN A/C MFD format.

20.3.6.2.2 Tacan One-Fix Update. Tacan one-fix update computes aircraft position using tacan measurements of range and bearing from a tacan station whose coordinates are known and stored in the waypoint file. The procedure requires that the tacan be operating and the station selected correspond to the waypoint that will be called up and whose coordinates will be used in the updating process. The procedure can be performed by either the pilot or RIO as follows:

1. With the tacan operating, select a tacan channel whose latitude and longitude coordinates correspond to the referenced tacan location stored in the waypoint file.

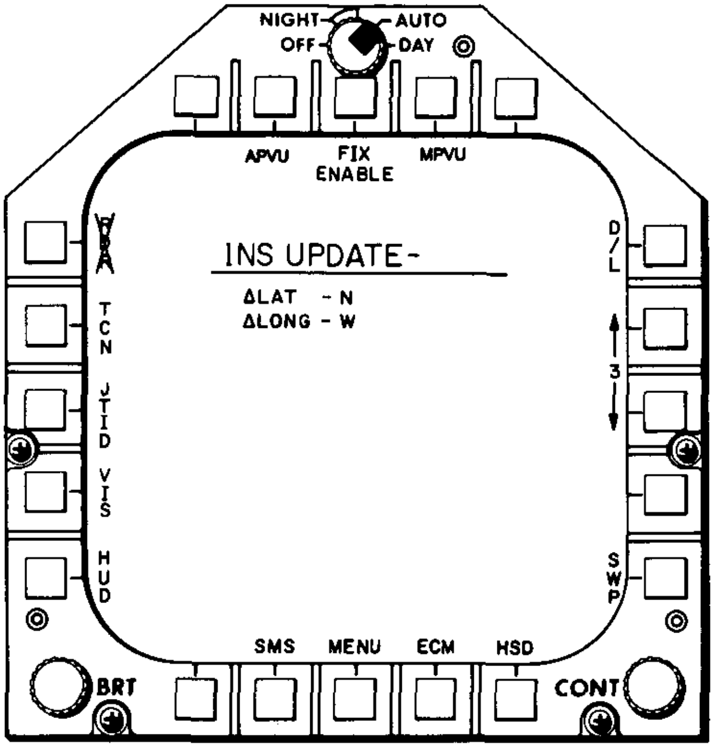
2. Verify that the coordinates of the tacan station are the same as those of the waypoint to be selected for updating by calling up the appropriate WPT DATA MFD format, Figure 20-20. If incorrect, enter the correct values via the DEU or DD.

3. Call up the INS UPDATE format, Figure 20-29. Select the correct waypoint corresponding to the coordinates of the tacan station using the increase/decrease pushbuttons on the right side of the INS UPDATE MFD format.

4. Depress the TCN pushbutton. The legend will be boxed and the computed delta LAT and delta LONG will appear, as shown in Figure 20-29.

5. Verify that the delta LAT/LONG corrections are reasonable.

6. If the delta LAT/LONG corrections appear reasonable and a correction is required, depress the FIX ENABLE pushtile on the INS UPDATE MFD format. The corrections will be incorporated into the system and sensors, and the correct latitude and longitude will be displayed on the OWN A/C MFD format.



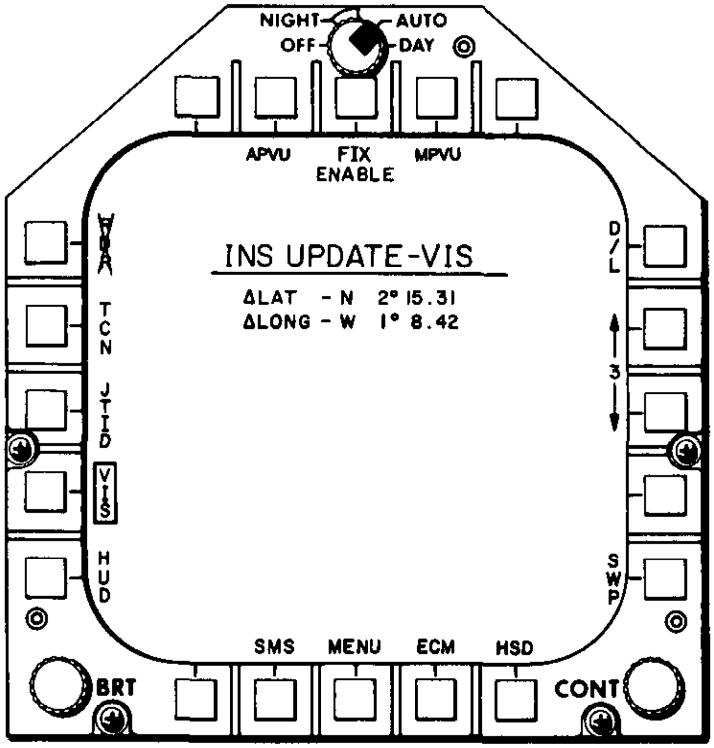


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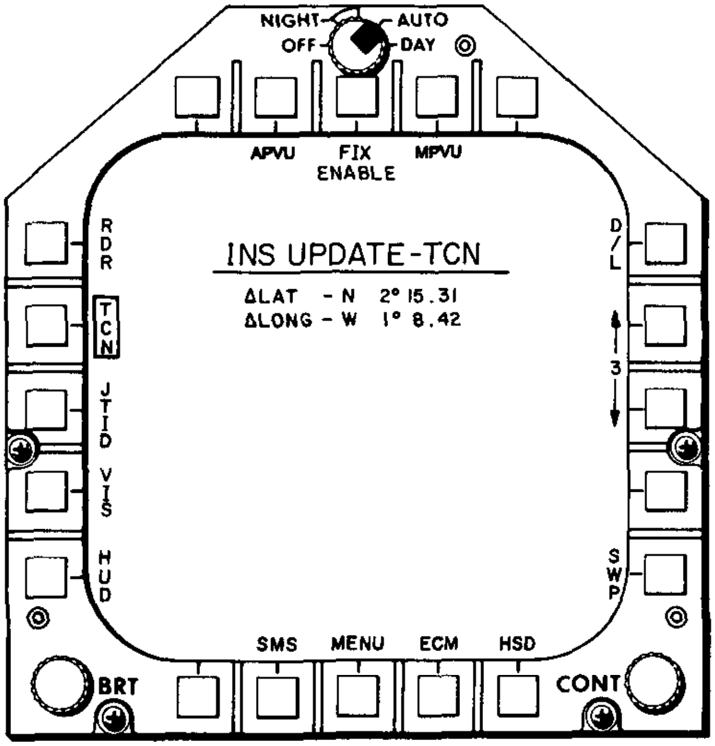
Figure 20-29. INS UPDATE MFD Formats (Sheet 1 of 4)



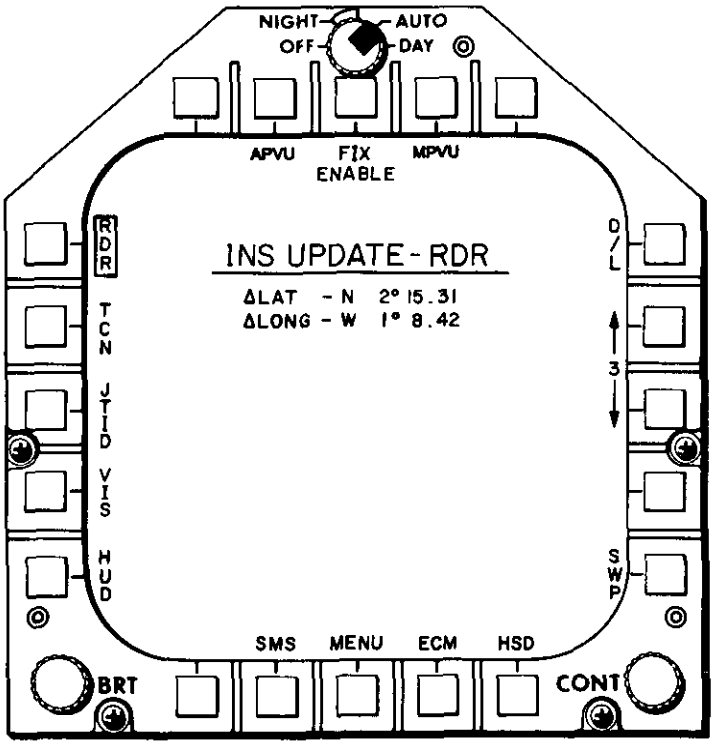


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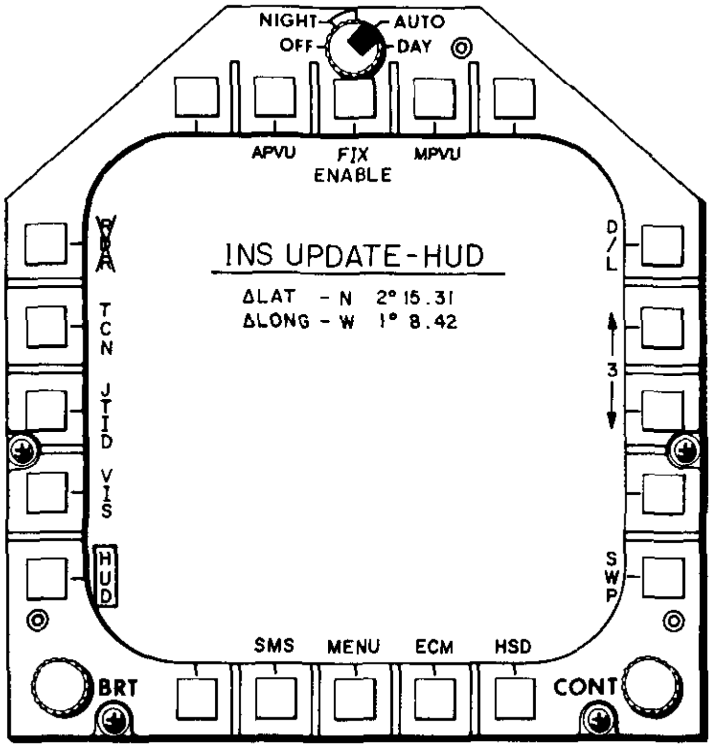
Figure 20-29. INS UPDATE MFD Formats (Sheet 2 of 4)



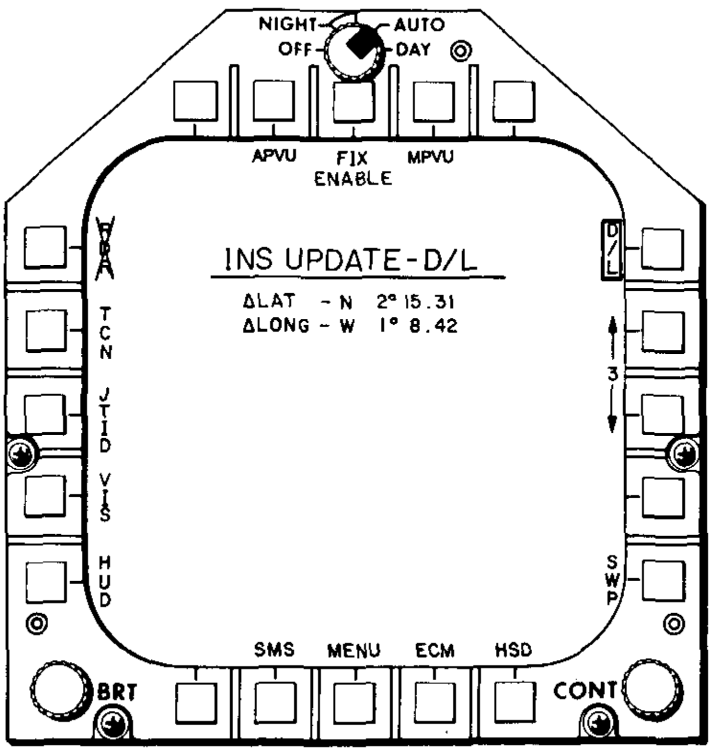


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Figure 20-29. INS UPDATE MFD Formats (Sheet 3 of 4)

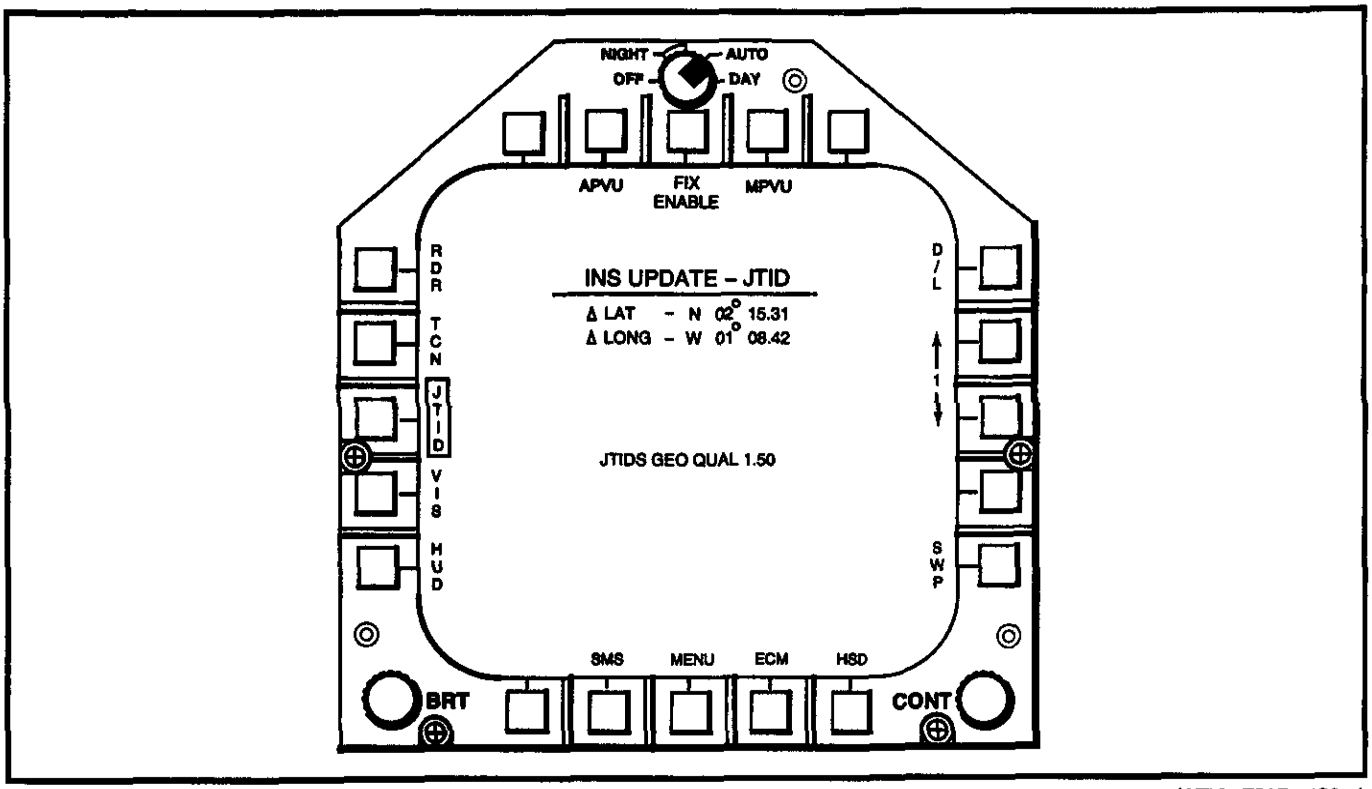

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Figure 20-29. INS UPDATE MFD Formats (Sheet 4 of 4)

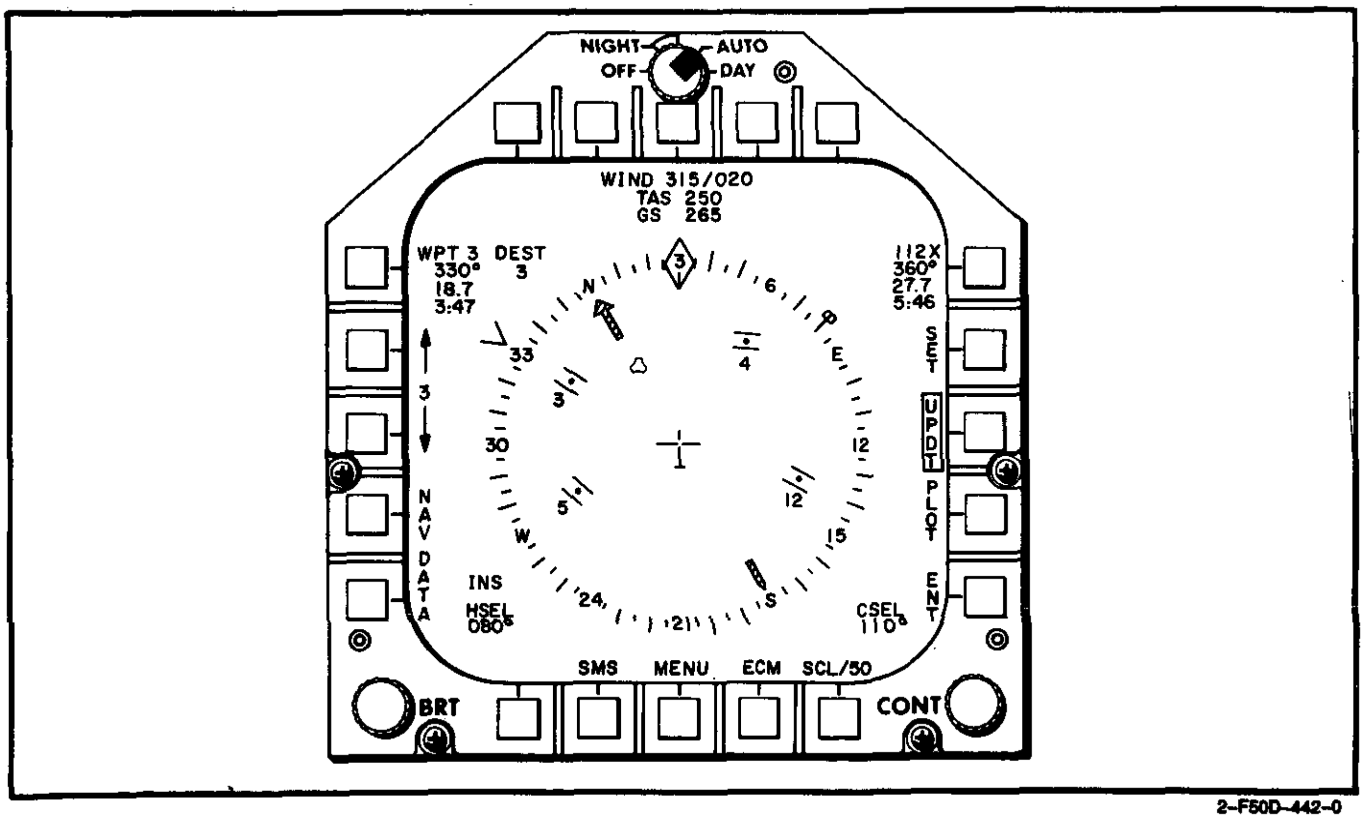

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Figure 20-30. HSD Basic MFD Format

20.3.6.2.3 Radar One-Fix Update. Radar one-fix update computes aircraft position using radar measurements of range, azimuth, and elevation angles from a radar-identifiable target whose coordinates are known and are stored in the waypoint file. This procedure requires that the radar is operating in the ground-map mode and that the DD cursor be positioned over the DD displayed target prior to designating via the sensor hand control as described below. Like other one-fix update modes it also requires that the waypoint corresponding to the radar target coordinates is selected for the update as described below. Since this procedure requires the use of the DD control panel, it can be performed only by the RIO. The procedure is as follows:

1. Select the radar ground-map mode via the GND MAP pushtile on the DD, shown in Figure 20-31.
2. Verify that the coordinates of the radar identifiable point are the same as those of the waypoint to be selected for updating by calling up the appropriate WPT DATA MFD format, Figure 20-20. If incorrect, enter the correct values via the DEU or DD.
3. Call up the INS UPDATE format, Figure 20-29. Select the correct waypoint corresponding to the coordinates of the radar-identifiable point via the increase/decrease pushbuttons on the right side of the INS UPDATE MFD format.
4. Select half-action mode by depressing the trigger on the RIO sensor hand control to the first detent position.
5. Place the DD cursor over the displayed radar target on the DD (Figure 20-31) using the sensor hand control and depress the trigger to the second detent (full action).
6. Depress the RDR pushbutton on the INS UPDATE MFD format. The RDR legend will become boxed and the computed delta LAT/delta LONG will appear as shown in Figure 20-29.
7. If the delta LAT/LONG corrections appear reasonable and a correction is required, depress the FIX ENABLE pushtile. The corrections will be incorporated into the system and the sensors and the correct latitude and longitude will be displayed on the OWN A/C MFD format, which will now appear.

20.3.6.2.4 Data-Link One-Fix Update. Data-link one-fix update computes aircraft position using inputs from an external platform that measures the aircraft position with respect to an agreed data-link target point whose coordinates are stored in a specific location in the waypoint file. The measured information consists of components of slant range to the waypoint that are transmitted to the aircraft via a specific data-link message. The procedure requires that the coordinates of the agreed data-link target point are stored as waypoint 18 in the waypoint file and that the data link is operating in the tactical mode. Verification and selection of the waypoint are performed similar to other one-fix update procedures but the tactical situation display on the MFD is used for location and designation of the data-link target point (Figure 20-32). Both the pilot and the RIO can perform this update procedure. The pilot uses the cursor control switch on the throttle, and the RIO uses the sensor hand control for designating and positioning the cursor. The procedure is as follows:

1. Verify data-link operation in the tactical mode (i.e., DATA LINK MODE switch is in TAC).
2. Verify the coordinates of waypoint 18 are the previously agreed values by calling up the WPT DATA 2 MFD format.
3. Call up the INS UPDATE MFD format (Figure 20-29) and select waypoint 18 via the increase/decrease pushbuttons.
4. Call up the TSD MFD format (Figure 20-32) available from the MENU1 MFD format. Using the pilot cursor control or the RIO sensor hand control, place the cursor over the data-link target point position and depress the switch.

Note

Both waypoint 18 from the waypoint file and the data-link reported location of this point appear on the TSD format. Since both symbols represent the same point, the difference in their location on the TSD MFD format is an indication of the aircraft position error. A check should be made to ascertain that this error is reasonable prior to performing the update.

5. Call up again the INS UPDATE MFD format. Depress the D/L pushbutton. A delay of several seconds may occur prior to the boxing of the D/L legend and the appearance of the delta LAT and LONG displays (Figure 20-29).
6. If the errors appear reasonable and an update is desired, depress the FIX ENABLE pushbutton. The corrections will be incorporated into the system and sensors and the correct latitude and longitude will be displayed on the INS UPDATE format and will also appear on the OWN A/C MFD format.

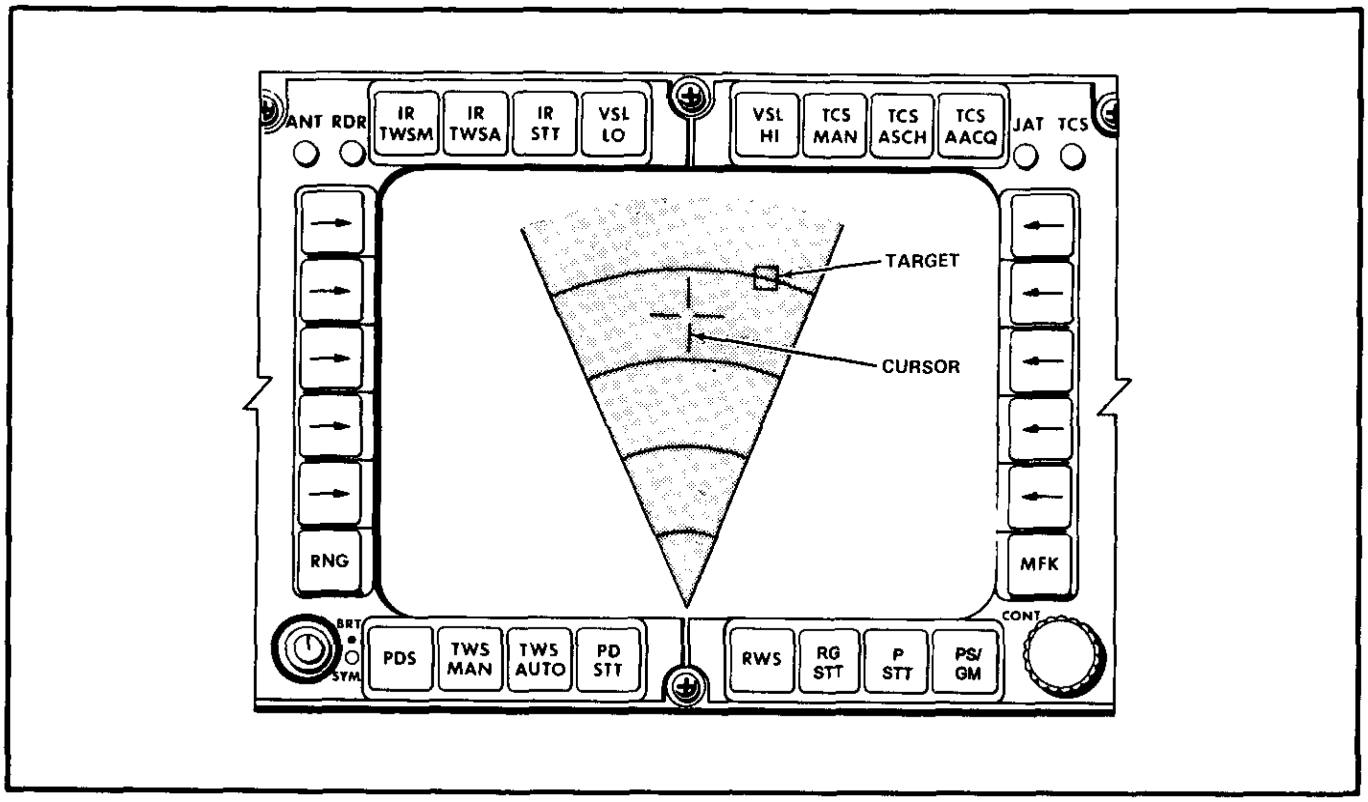

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Figure 20-31. DD Control Panel With GND MAP Selected

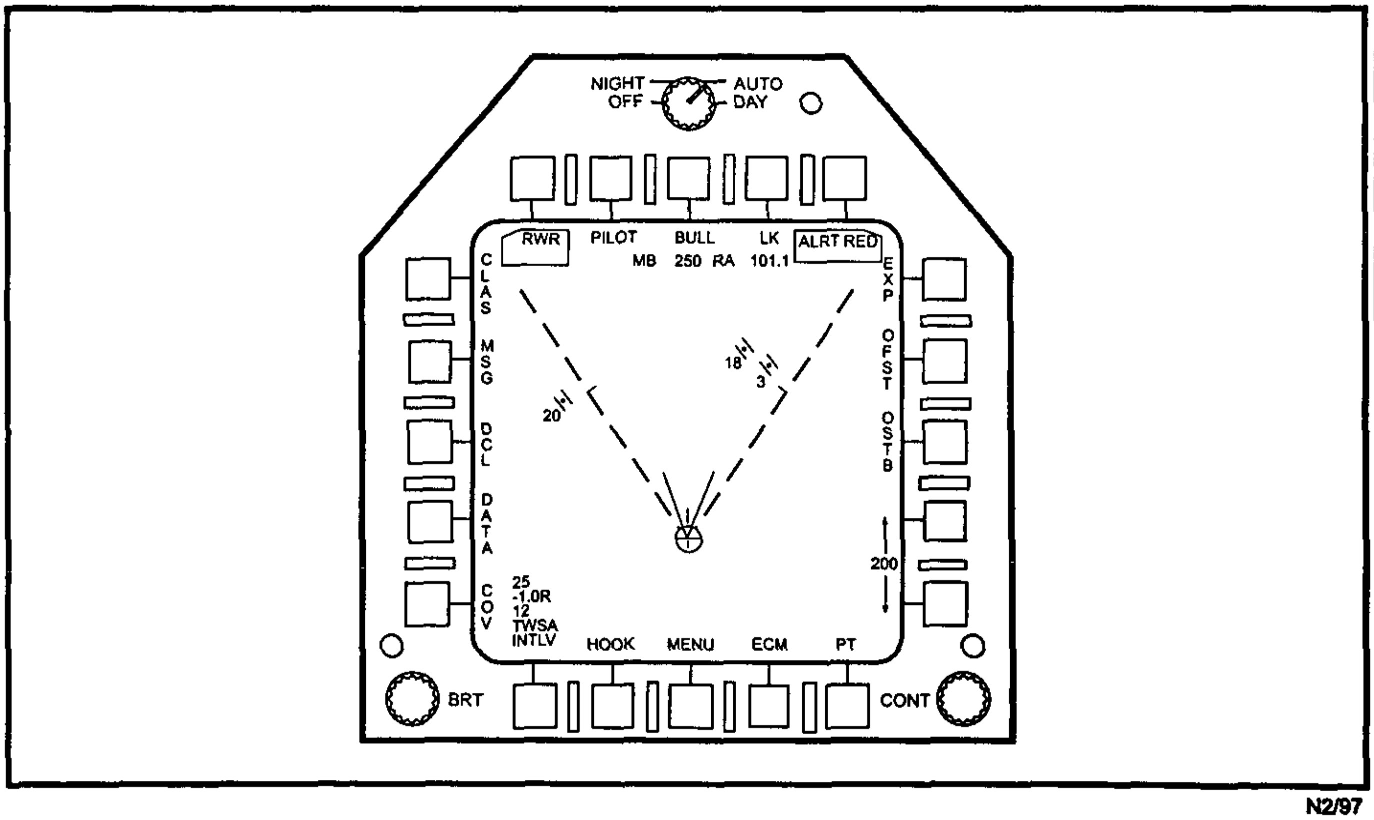

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Figure 20-32. MFD TSD Format

20.3.6.2.5 HUD/Designate One-Fix Update. HUD designate one-fix update computes aircraft position, using measurements of azimuth and elevation from the HUD center to a designated target point that is visible through the HUD and whose coordinates are known and stored in the waypoint file and system altitude. This procedure is performed only by the pilot using the cursor control switch on the throttle to position the HUD cursor over the visually sighted target and to designate. Like other one-fix update modes, it also requires that the waypoint corresponding to the visual target coordinates is selected for the update as described below.

1. Verify that the coordinates of the HUD visual target are the same as those of the waypoint to be selected for updating by calling up the appropriate WPT DATA MFD format (Figure 20-20).

2. Call up the INS UPDATE MFD format (Figure 20-29). Select the waypoint corresponding to the HUD visual target via the increase/decrease pushbuttons on the right side of the format.

3. Position the cursor over the visual target seen through the HUD using the cursor control switch and then depress the switch (Figure 20-33).

4. Depress the HUD pushbutton on the INS UPDATE MFD format. The HUD legend will become boxed and the computed delta LAT/delta LONG will appear as shown in Figure 20-29.

5. If the delta LAT/LONG corrections appear reasonable and a correction is required, depress the FIX ENABLE pushbutton on the INS UPDATE MFD format. The corrections will be incorporated into the system and sensors and the correct latitude and longitude will be displayed on the OWN A/C MFD format.

20.3.6.2.6 JTIDS One-Fix Update. JTIDS one-fix update uses the delta latitude and longitude information calculated by JTIDS to perform a one-time update of the system and sensors. This function will always use the JTIDS geodetic latitude and longitude correction data regardless of JTIDS NAV MODE. This procedure requires JTIDS operating in the net as an active participant (NORM selected on JTIDS control panel) with NET ENTR-OK. See Chapter 19 for JTIDS operating procedures. The JTIDS geodetic position quality must be ≤ 3 to display the data and allow the update. This procedure can be performed by either the pilot or RIO as follows:

1. Verify JTIDS operating and in sync.

2. Call up INS UPDATE MFD format (Figure 20-29) available from the MENU1 MFD format.

3. Depress the JTID pushbutton on the INS UPDATE MFD format.

   If the data from JTIDS is not valid or the quality is >3, the JTID pushbutton will be crossed out. The JTID pushbutton boxes and the JTIDS computed delta LAT and delta LONG will appear as shown in Figure 20-29.

4. If the delta LAT/LONG corrections appear reasonable and a correction is required, depress the FIX ENABLE pushbutton on the INS UPDATE MFD format. The corrections will be incorporated into the system and sensors and the corrected latitude and longitude will be displayed on the OWN A/C MFD format.

20.3.6.3 Continuous Position Updating. In addition to one-fix position updates, the navigation system has the capability to accept continuous navigation corrections from external sources when they exist and are valid. For the current configuration of the aircraft, the only two sources available for continuous position updating are tacan and JTIDS data. The tacan mode of continuous updating uses tacan measurements of range and bearing to a prestored selected waypoint that also is an active tacan station. Thus, as in one-fix updating, it is necessary to ensure that the selected waypoint corresponds to the tacan station that is being received. The JTIDS mode of continuous updating uses delta latitude, longitude, and altitude calculated by JTIDS to continuously update the navigation system. The JTIDS continuous update will update the navigation system with either geodetic latitude, longitude, and altitude corrections in the GEO mode or relative latitude, longitude, and geodetic altitude corrections in the REL mode. When the JTIDS altitude correction data quality is ≤ 10, this function will display and use only the latitude and longitude corrections.

Selection of JTIDS continuous position updating is made via the MFD NAV SYSTEM AID format (Figure 20-34) that will appear when the NAV pushbutton is depressed on the MFD HSD or OWN A/C format. The remaining procedures for JTIDS continuous update are the same as JTIDS one-fix update. Depress the JTID pushbutton on the NAV SYSTEM AID-JTID format. If the data from JTIDS is not valid or the quality is >3, the JTID pushbutton will be crossed out. The JTID pushbutton boxes and the JTIDS computed delta LAT, LONG, and ALT will appear as shown in Figure 20-34. Depression of the ENABLE pushbutton on the top center of the

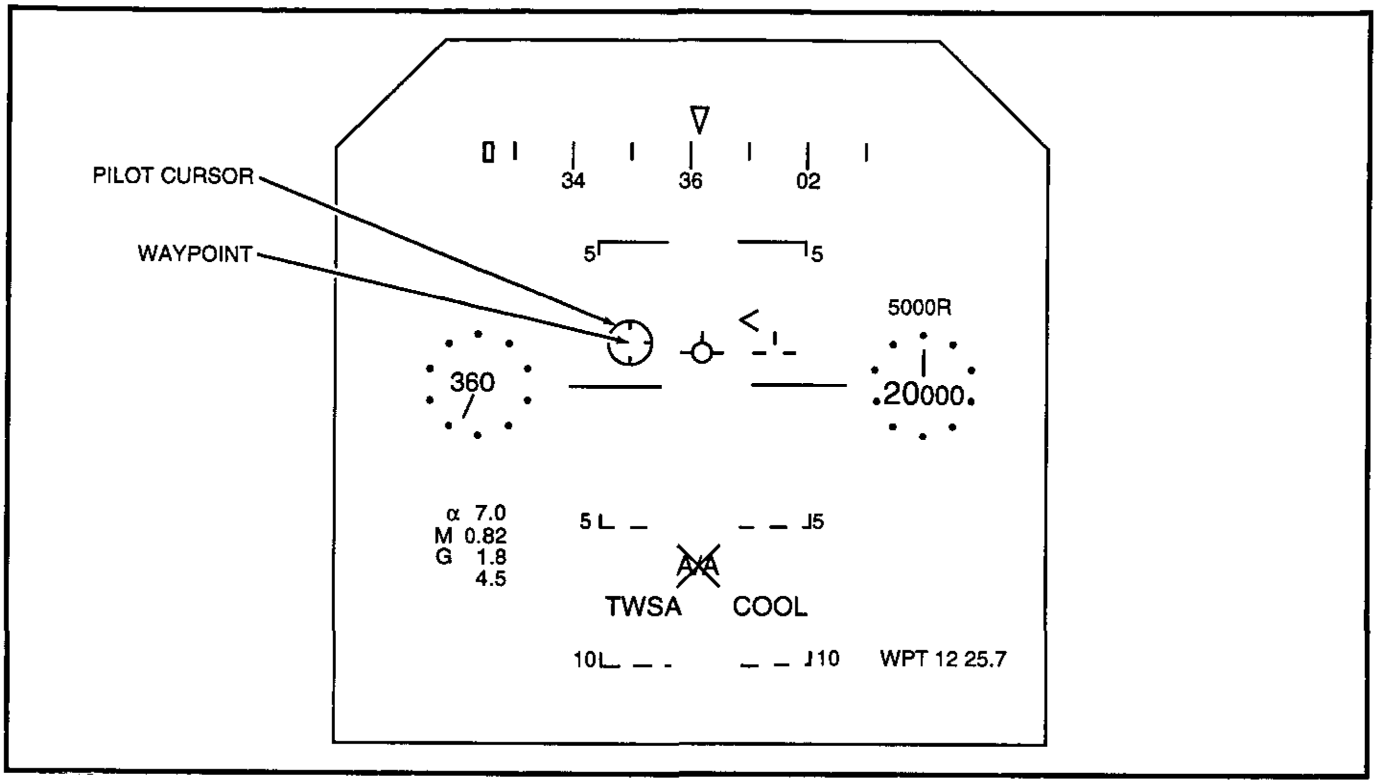

Figure 20-33. HUD/Designate Position Update

NAV SYSTEM AID format now allows the corrections, which are continuously computed, to update the system.

Selection of continuous position updating is made via the MFD NAV SYSTEM AID format (Figure 20-34) that will appear when the NAV pushbutton is depressed on the MFD HSD or OWN A/C format. If tacan data is being received from a transmitting station, the TCN legend will not be crossed out. The procedure for tacan operation is the same as for one-fix tacan position update described in paragraph 20.3.6.2.2. Select the correct waypoint using the up or down arrows on the HSD format, then depress the NAV pushbutton. Once this is done, depressing the TCN pushbutton on the resulting NAV SYSTEM AID format boxes the TCN legend and computed corrections for latitude and longitude are then displayed. Depression of the ENABLE pushbutton on the top center of the NAV SYSTEM AID format now allows the corrections, which are being continuously computed, to be provided to the system.

Note

For continuous position updating neither the INS nor the SAHRS are updated. Once this aiding mode is deselected or becomes invalid, the computed corrections will not be provided and a change in position may occur.

20.3.6.4 Surface Waypoint Position Determination. The position of a surface waypoint is determined by measuring its location with respect to the aircraft or with respect to some other known point. The following sensors and procedures can be used: visual, tacan, radar, HUD/designate, DEU, and TID. Selection is made from the SURFACE WPT POS format on the MFD. The computed latitude and longitude are displayed on the MFD or DD. The SURFACE WPT POS format is called by selecting the SWP pushbutton on the INS UPDATE format.

Note

The INS UPDATE format is called by selecting the UPDT legend on any of the HSD MFD formats.

On the SURFACE WPT POS MFD format (Figure 20-35), an "X" over the legend for a position determination mode indicates that the mode is not available. Until one of the available modes is selected, the format shown in Figure 20-35 displays only the mode legends, the boxed SWP legend, and the SURFACE WPT POS header.

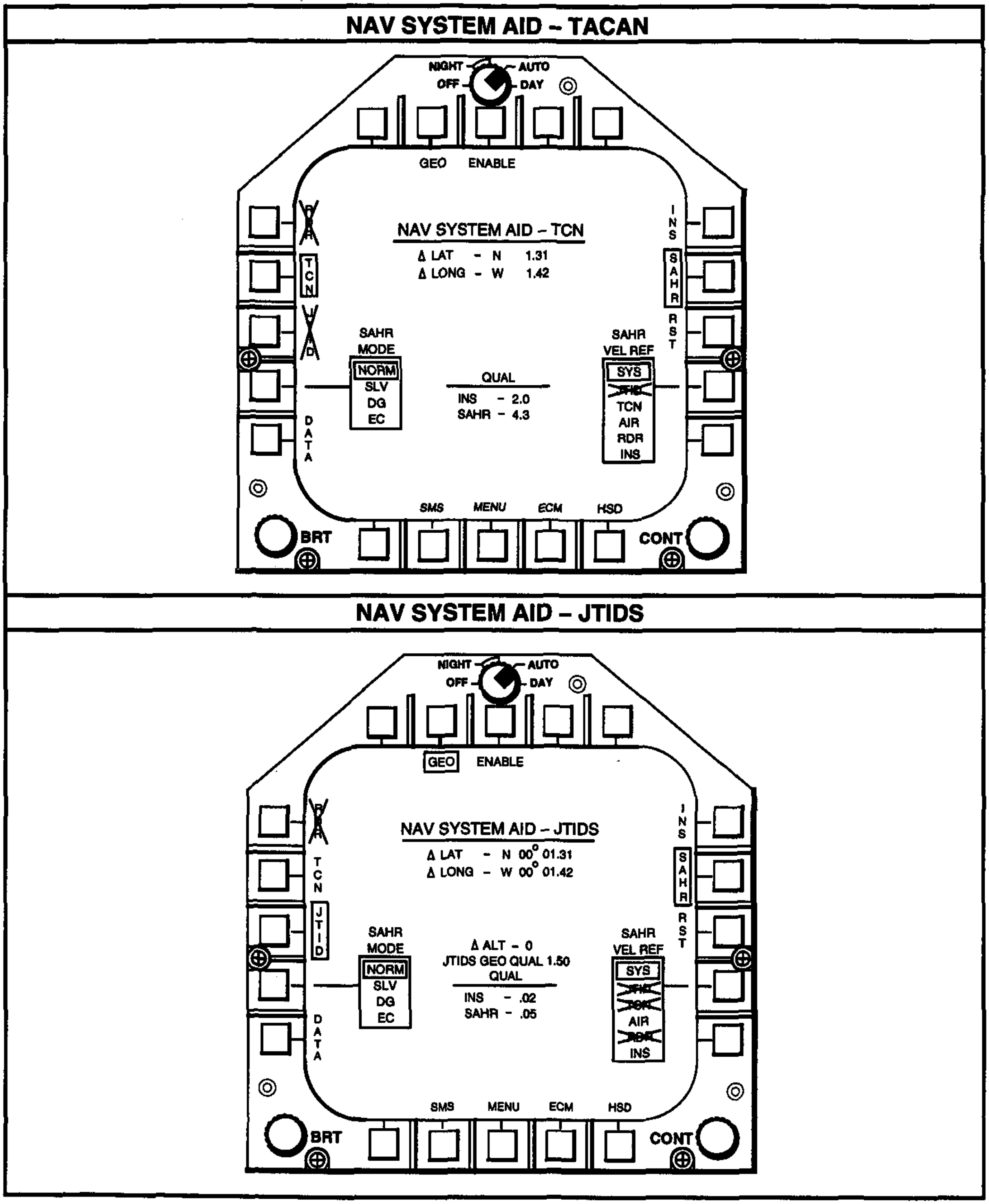

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Figure 20-34. Navigation System Continuous Update MFD Format

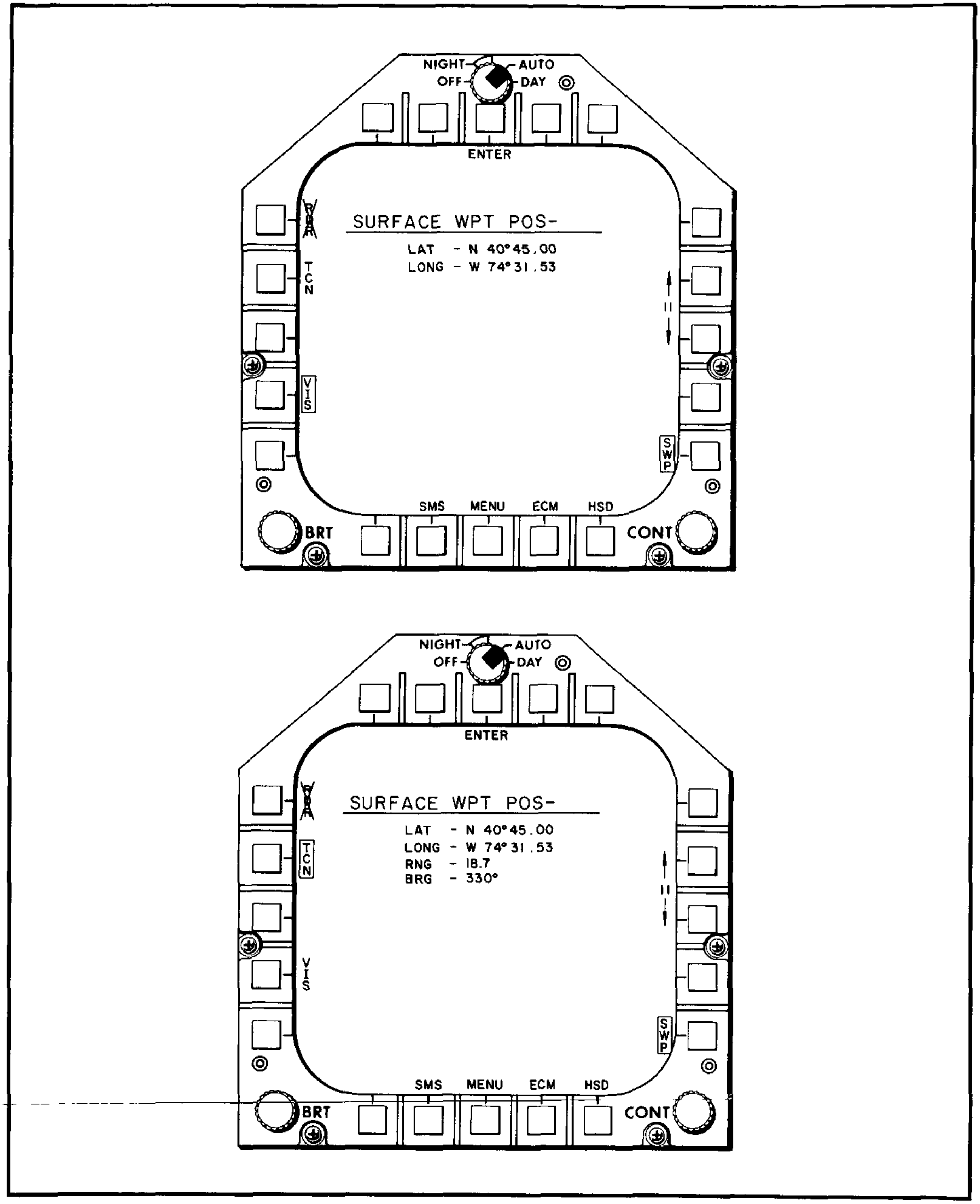

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Figure 20-35. Surface Waypoint Position MFD Formats (Sheet 1 of 2)

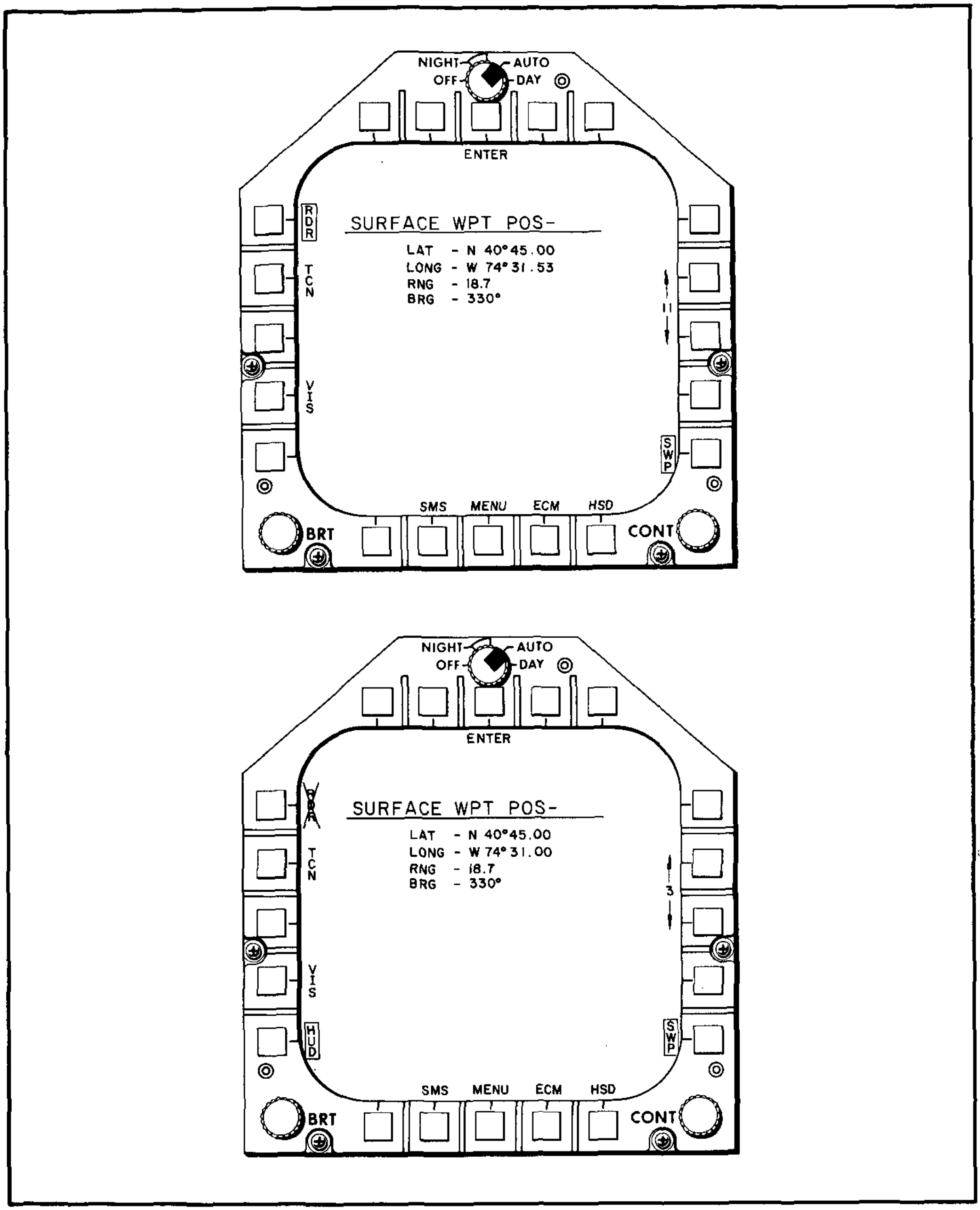

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Figure 20-35. Surface Waypoint Position MFD Formats (Sheet 2 of 2)

When using the visual, radar, or HUD/designate procedure, after the surface waypoint latitude and longitude have been computed and displayed on the MFD, pressing the ENTER pushbutton on the MFD format enters the coordinates into the waypoint file in an assigned waypoint number. For the DEU method, the coordinates are also displayed on the MFD, but are entered by pressing the DEU ENTER pushtile. When using the TID method, pressing the sensor hand control trigger enters the coordinates that are displayed on the MFD.

The paragraphs that follow describe the various methods and provide procedures.

20.3.6.4.1 Visual Mode. For a visual waypoint position determination, the aircraft present-position coordinates are assigned to the waypoint position at the instant of flyover. This requires that the VIS pushbutton be pressed at that time. The assigned coordinates are displayed when the VIS pushbutton is pressed. This procedure can be performed by either crewmember.

Note

For best results, the aircraft should be flown low and slow for this procedure.

1. Call up the MFD INS UPDATE format (Figure 20-29).

2. Depress the SWP pushbutton to display the MFD SURFACE WPT POS update format.

3. Depress the up or down arrow pushbutton until the desired waypoint number is displayed.

4. At the instant of overflight, depress the VIS pushbutton, boxing the VIS legend and displaying the latitude and longitude of the surface waypoint.

5. If the latitude and longitude appear reasonable, press the ENTER pushbutton on the SURFACE WPT POS format. This enters the coordinates into the waypoint file; they can be verified by selecting the WPT DATA format (Figure 20-20).

20.3.6.4.2 Tacan Surface Waypoint Position Determination. For tacan surface waypoint position determination, the position of the tacan station is computed using tacan measurements of range and bearing from aircraft present position. This procedure can be performed by either crewmember and requires that the tacan be operating.

1. With the tacan operating, select the channel for the station location to be determined.

2. Call up the INS UPDATE format (Figure 20-29).

3. Depress the SWP pushbutton to display the MFD SURFACE WPT POS format.

4. Depress the up or down arrow pushbutton until the desired waypoint number is displayed.

5. Depress the TCN pushbutton on the MFD SURFACE WPT POS format. This boxes the TCN legend and displays the tacan station latitude and longitude.

6. If the coordinates appear reasonable, press the ENTER pushbutton to place the surface waypoint coordinates into the proper waypoint file. They can be verified by selecting the WPT DATA format (Figure 20-20).

20.3.6.4.3 Radar Mode. For a radar surface waypoint position determination, the position of a radar surface target is computed using radar measurements of range, bearing, and elevation angle to the target from the known aircraft present position. The radar must be in the GND MAP mode. This procedure can only be performed by the RIO.

1. On the DD control panel, select GND MAP.

2. Call up the INS UPDATE format (Figure 20-29).

3. Depress the SWP pushbutton, which results in the display of the SURFACE WPT POS format with SWP boxed.

4. Depress the up or down arrow pushbutton until the desired waypoint number is displayed.

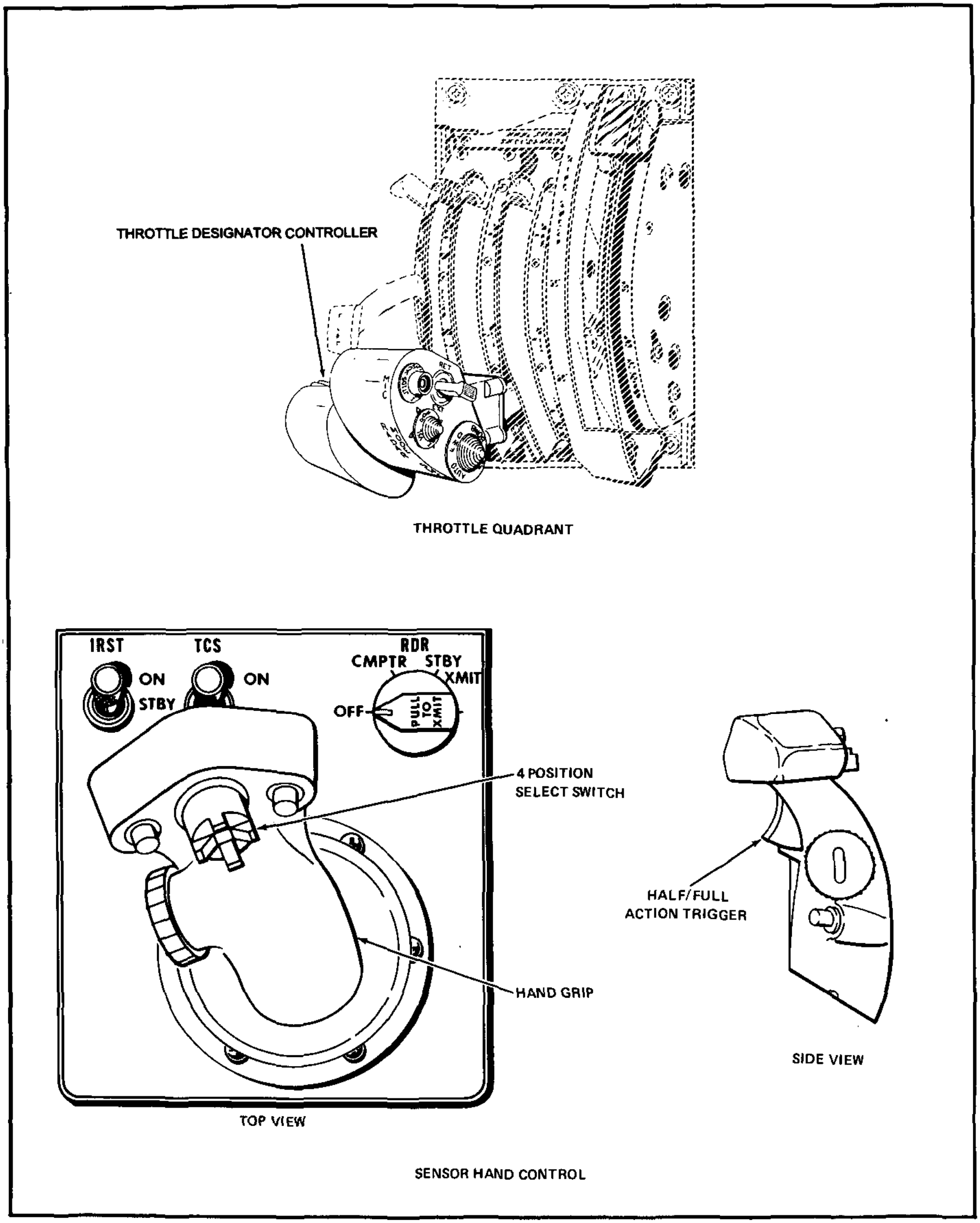
5. Set the sensor hand control cursor switch to the up position (Figure 20-36).

6. Select the half-action mode by depressing the trigger on the RIO sensor hand control to the first detent position.

7. Using the RIO sensor hand control, place the DD cursor over the radar target and depress the trigger to the second detent position (full action).

8. Depress the RDR pushbutton on the SURFACE WPT POS format to display the waypoint latitude and longitude and box the RDR legend.

9. If the coordinates appear reasonable, press the ENTER pushbutton to place the surface waypoint coordinates into the proper waypoint file; they can be verified by selecting the WPT DATA format.



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N2/97

Figure 20-36. Cursor Controls

20.3.6.4.4 HUD/Designate Mode. Using the HUD/designate mode, the pilot uses the HUD cursor to designate a visual target and the target position is computed using aircraft present position and azimuth/elevation measured from the HUD center to the designated target.

1. Call up the INS UPDATE format (Figure 20-29).
2. Depress the SWP pushbutton to display the SURFACE WPT POS format and box the SWP legend.
3. Depress the up or down arrow pushbutton until the desired waypoint number is displayed.
4. Using the pilot cursor control switch (Figure 20-36), place the HUD cursor over the visual target and depress the switch to designate the waypoint.
5. Depress the HUD pushbutton on the SURFACE WPT POS format to display waypoint latitude and longitude and box the HUD legend.
6. If the coordinates appear reasonable, depress ENTER pushbutton to place the surface waypoint coordinates into the waypoint file; they can be verified by selecting the WPT DATA format.

20.3.6.4.5 DEU Mode. In the DEU mode, the position of a new waypoint is computed based on its range and bearing from an existing waypoint already in the waypoint file. The range and bearing values are entered by the RIO via the DEU (Figure 20-19).

1. On the DEU, select the number of the known waypoint to be used as a reference.
2. On the DEU, enter the range and bearing from the reference waypoint to the new waypoint.
3. On the DEU, press the SET pushtile and select a waypoint number for the new waypoint.
4. Press the ENTER pushtile on the DEU. This causes the coordinates of the new waypoint to be computed and entered into the waypoint file.
5. The latitude and longitude of the new waypoint may be verified by calling the WPT DATA format on the MFD.

20.3.6.4.6 TID Spot Hook Mode. In the spot hook mode, coordinates are computed for a point designated by the RIO by spot hooking on the TID based on aircraft present position.

1. Set the sensor hand control cursor select switch to the down (TID cursor) position.
2. On the TID control panel (FO-4), depress the NON ATTK and SYM ELEM pushbuttons.
3. Set the azimuth scan to ±20° on the sensor control panel (FO-4) and adjust the antenna scan center to zero.
4. Call the WPT DATA MFD format and depress the desired waypoint number to box the waypoint legend.
5. On the TID control panel, set the RANGE switch as required and the MODE switch to A/C STAB.
6. Place the sensor hand control trigger to the half-action position.
7. Place the TID cursor on the desired screen location and hook by selecting full action. This causes the latitude and longitude of the hooked position to be computed and entered in the waypoint file.
8. The coordinates of the hooked position can be verified by calling the WPT DATA format.

20.3.6.5 Display Steering Modes. Selecting a display steering mode presents the pilot with command steering indications on the MFD and HUD. The display steering modes include manual, data link, destination, and tacan. The following paragraphs describe the procedures for selecting these modes and the indications provided. For all steering modes, the HUD should be in the TLN mode.

20.3.6.5.1 Manual Display Steering. In the manual display steering mode, the pilot maintains a command magnetic course by steering the aircraft to the command heading marker on the HUD or MFD VDI format.

Initially the pilot selects a command course for manual display steering with the course select control (FO-3); this results in the display of command course and a course line pointer on the horizontal situation display MFD format. The manual display steering mode is initiated when the MAN pushbutton on the MFD VDI display format is depressed. When this is done, the mission computer calculates command heading by offsetting command course for any wind drift that may be present.

Figure 20-37 shows the display formats used for manual steering. Manual steering mode can be selected as follows:

1. Call the VDI MFD format.

2. Using the pilot's CRS select knob on the course/heading panel (FO-3), select a course.

3. Verify the selected course value under CSEL on the VDI MFD format.

4. Depress the MAN pushbutton on the VDI format.

5. Steer aircraft to the command heading marker on the HUD or VDI.

20.3.6.5.2 Data-Link Display Steering. In the data-link display steering mode (Figure 20-38), the pilot maintains a command course, commanded by external inputs from the ASW-27C data link or AN/URC-107 JTIDS data link, by steering the aircraft to the command heading marker on the HUD, VDI, or HSD format. The pilot also adjusts aircraft altitude and speed in accordance with commanded values appearing on the VDI D/L MFD format. The ASW-27C must be in its tactical mode (TAC selected on the DATA LINK panel) or JTIDS must be in AIC and its tactical mode (JTIDS on the DATA LINK panel).

The data-link steering mode is selected by depressing the D/L pushbutton on the MFD VDI display format. When this is done, the mission computer then calculates command heading to be flown to make good the D/L supplied command course by correcting for any wind drift. The resulting command heading marker appears on the MFD VDI D/L, MFD HSD D/L, and HUD D/L formats. The D/L also supplies command altitude and command speed that are displayed on the MFD VDI D/L format. Command course is displayed on the MFD HSD D/L format as a course line pointer. Figure 20-37 shows the display formats used for data-link display steering.

Data-link steering using the ASW-27C or URC-107 JTIDS can be performed as follows:

1. Call the VDI and HSD display formats on the pilot center and right MFDs, respectively.

2. Depress the D/L pushbutton on the center MFD VDI format.

3. Maintain the command altitude indicated on the right side of the center MFD VDI format.

4. Maintain the command speed indicated on the left side of the center MFD VDI format.

5. Steer the aircraft to the command heading marker on the HUD or center MFD VDI format.

6. A comparison between the command course received from the data link and the drift-compensated command heading can be observed on the right-hand MFD HSD D/L format. Command course is in the form of a course line pointer, and the command heading to be flown is indicated by captain's bars.

20.3.6.5.3 Destination Display Steering. In the destination steering mode, the pilot maintains a great circle route from the aircraft present position to a designated waypoint by steering to the command heading marker on the HUD and VDI.

The pilot selects the destination waypoint for steering by depressing the up or down arrow pushbuttons on the HSD basic format and then pressing the ENTER pushbutton. This results in the HSD format in Figure 20-39. The mission computer calculates range, bearing, and time to go from the aircraft position. This data is shown in the upper left data block on the HSD format. The destination display steering mode may then be initiated by depressing the DEST pushbutton on the MFD VDI display format or by boxing WPT on HSD. The mission computer then calculates the command great circle course to the selected waypoint and the command heading to fly to make it good by considering drift angle.

The destination command course, destination command and heading, range to destination, time to go, and waypoint number are displayed as shown in Figure 20-39.

For the destination steering mode proceed as follows:

1. Call the VDI and HSD formats on the pilot center and right MFDs, respectively.

2. On the HSD basic format, depress the up or down arrow pushbuttons until desired destination waypoint number appears between the arrows.

3. On the HSD basic format, depress the ENT pushbutton. The selected waypoint will then appear under the DEST waypoint symbol on all HSD displays and under the selected WPT symbol of the HSD display used to enter the waypoint.

4. On the VDI basic format, depress the DEST pushbutton or box WPT on the HSD format. Destination steering will now be provided and DEST will be boxed.

5. Steer aircraft to command heading marker on HUD or VDI.

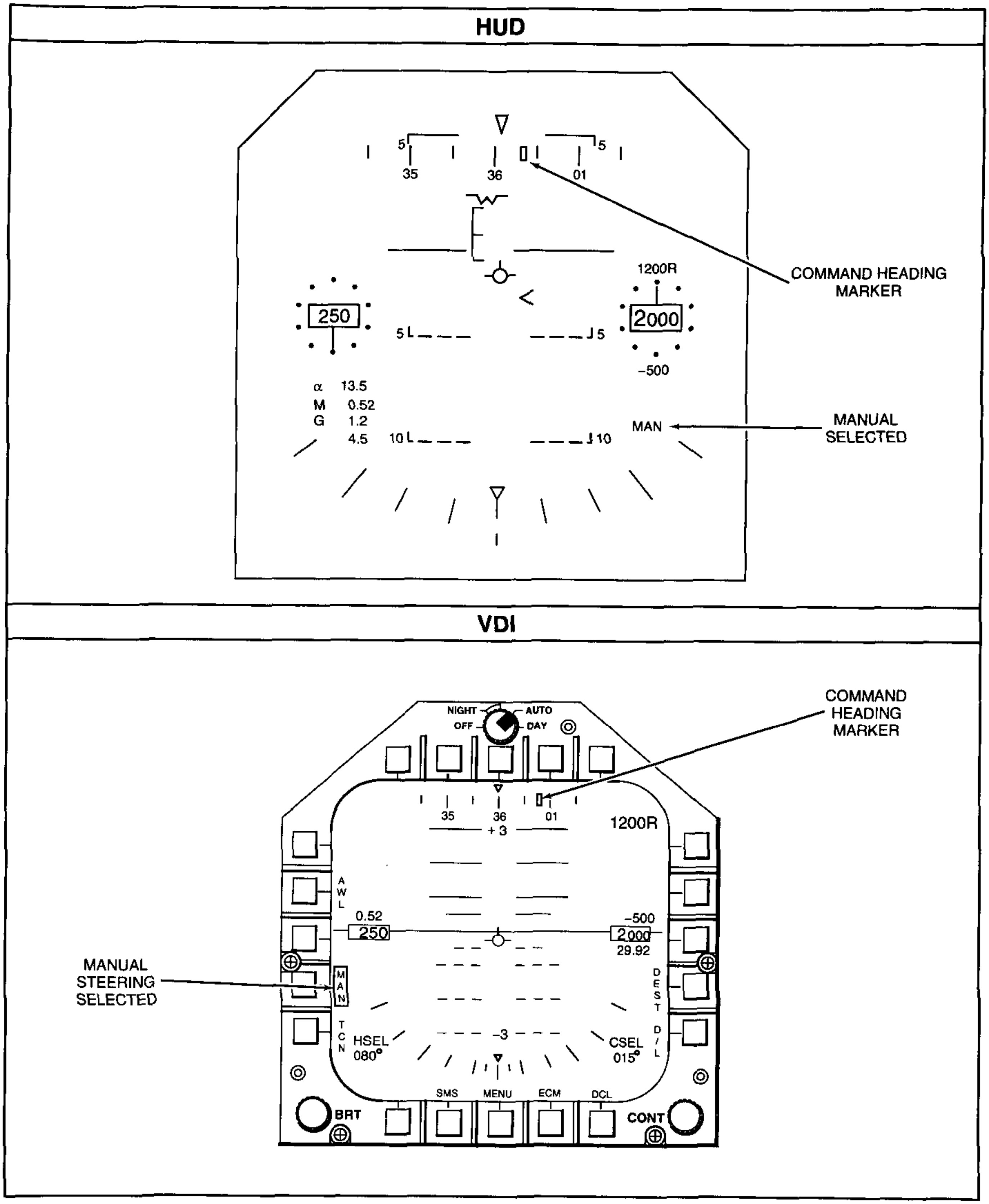

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Figure 20-37. Manual Steering Mode Formats (Sheet 1 of 2)

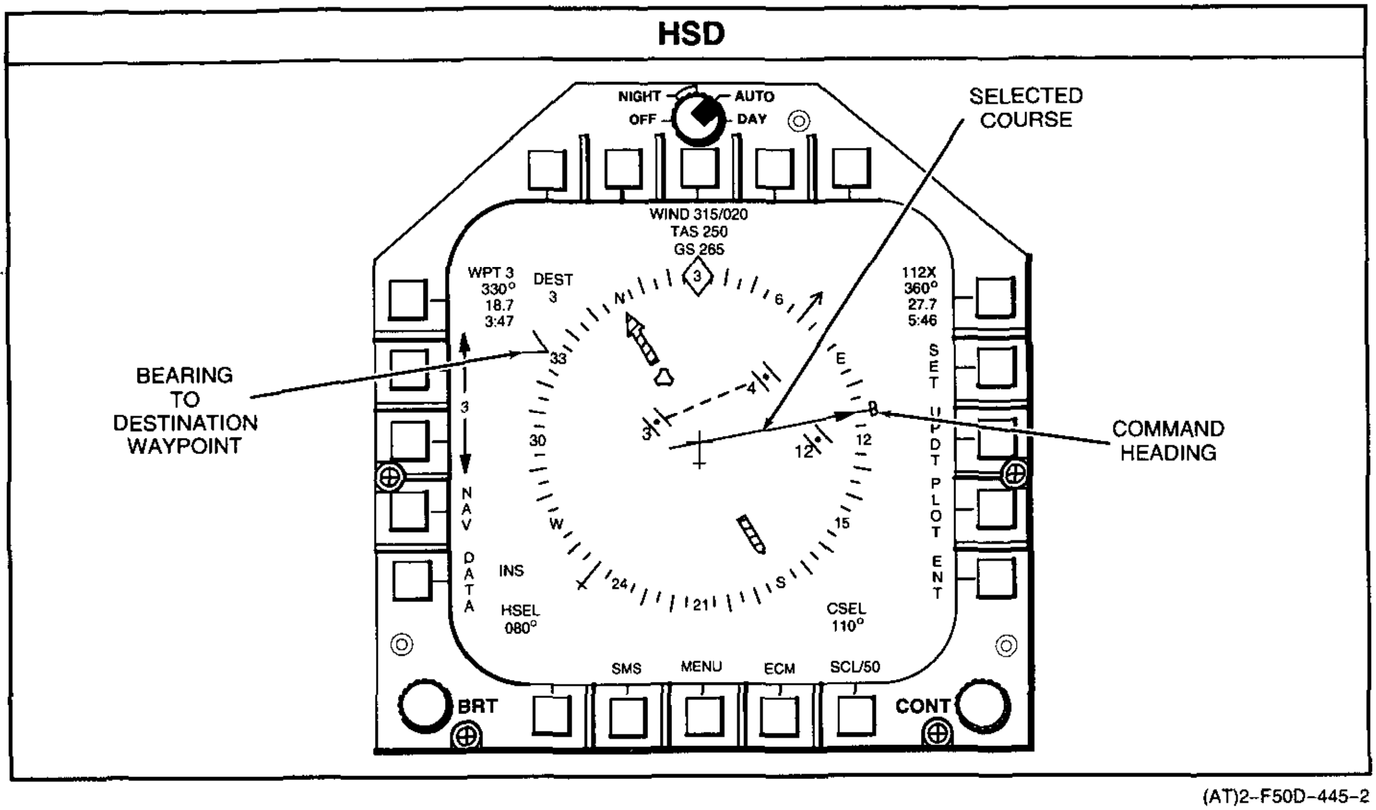


Figure 20-37. Manual Steering Mode Formats (Sheet 2 of 2)

20.3.6.5.4 Tacan Steering. In the tacan steering mode (Figure 20-40), the pilot may steer to a selected tacan radial using the various course deviation displays on the HUD and MFD. The tacan deviation is the angular difference between the bearing to the tacan station (tacan radial) and the command course (tacan course) selected by the pilot on the course/heading control panel.

To enter the tacan steering mode, the pilot depresses the TCN pushbutton on the MFD VDI display format or boxes TACAN on the HSD format. After selection of a tacan course, the tacan deviation symbols are displayed on the HUD, MFD VDI tacan, and two possible HSD tacan formats. On the HSD tacan format, the CDI display mode may be selected by depressing the CDI pushbutton. With CDI selected, the tacan deviation is displayed in the form of a deviation bar whose offset is scaled along a row of deviation tics. The arrow head on the bar is changed on the displays to indicate whether the tacan course is toward or away from the tacan station. If the tacan deviation is less than 90°, a to indication is shown and, if greater than 90°, a from indication. The tacan deviation bars on the HUD, MFD VDI tacan display format and MFD HSD tacan display format are solid bars when going to and dashed bars when coming from. The separation between deviation tics is 4°.

If the CDI display is not selected, then the second HSD format in Figure 20-40 is displayed. On this format, the tacan radial is still displayed passing through the aircraft symbol but instead of the deviation indication, the command course pointer is shown passing through the station symbol.

The tacan ID, command course, tacan range, tacan bearing, time to go to the tacan station, and tacan deviation are all shown on the MFD HSD tacan display format. The tacan range and tacan deviation are shown on the HUD and MFD VDI tacan display format. Figure 20-40 shows the display formats used for tacan display steering.

The tacan steering mode is performed as follows:

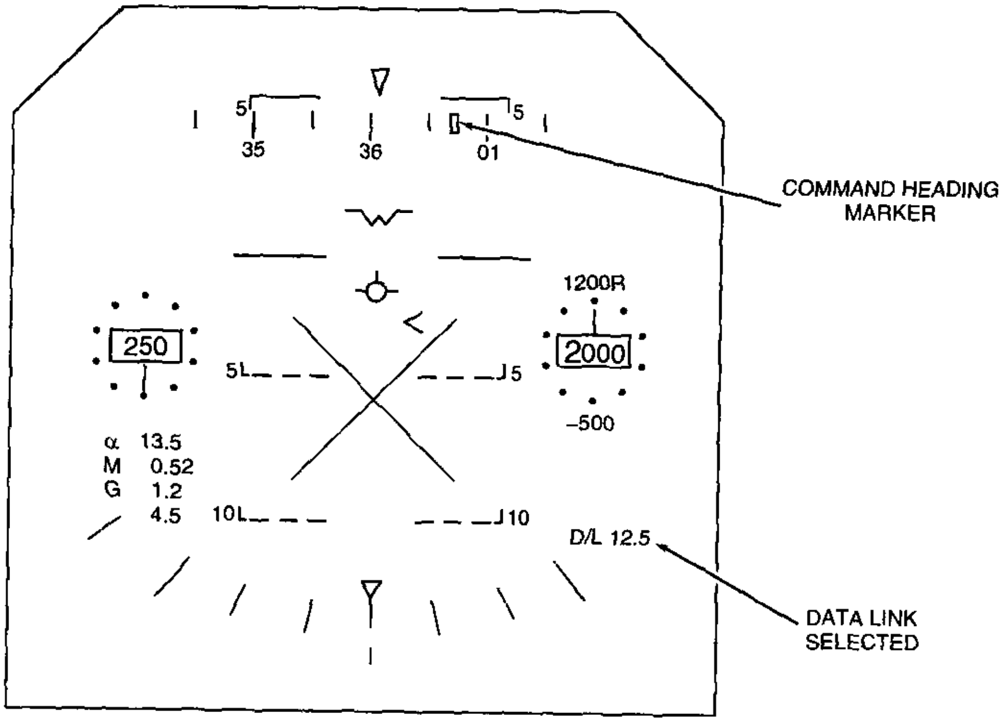
1. Select the desired tacan channel.

2. Call the VDI or HSD formats on any MFD.

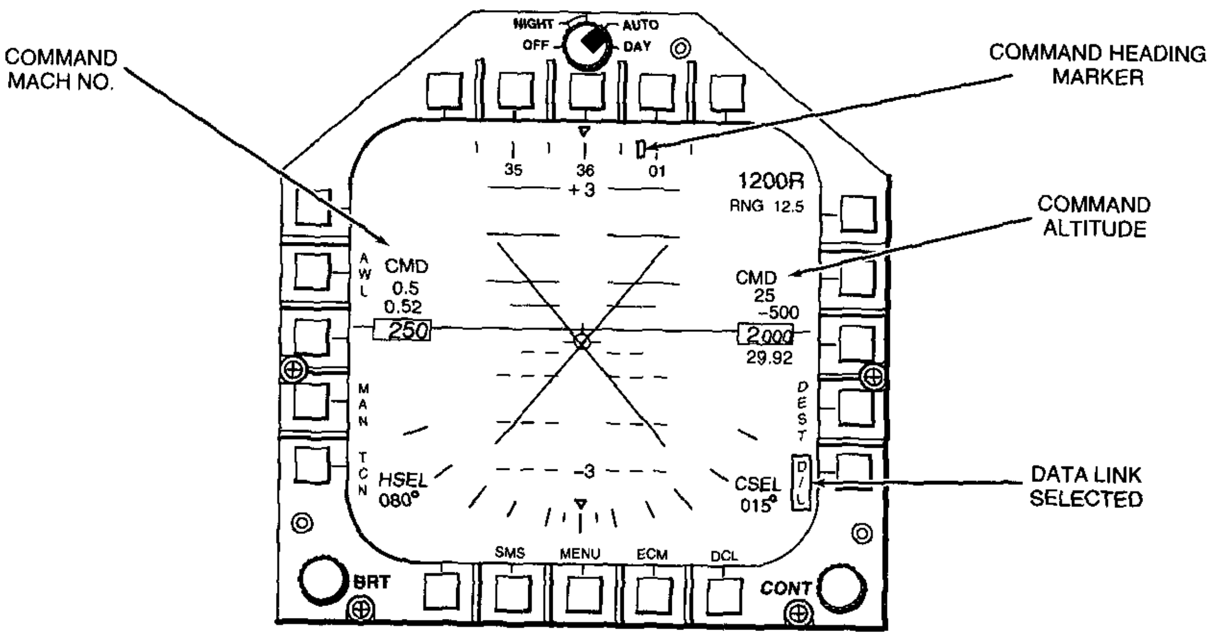
3. Depress TCN pushbutton on VDI format or box tacan information on HSD format to enable tacan steering.

4. Depress CDI pushbutton on HSD format to bring up course deviation indication format.

HUD



VDI



(AT)2-F50D-446-1

Figure 20-38. Data-Link Steering Mode Formats (Sheet 1 of 2)

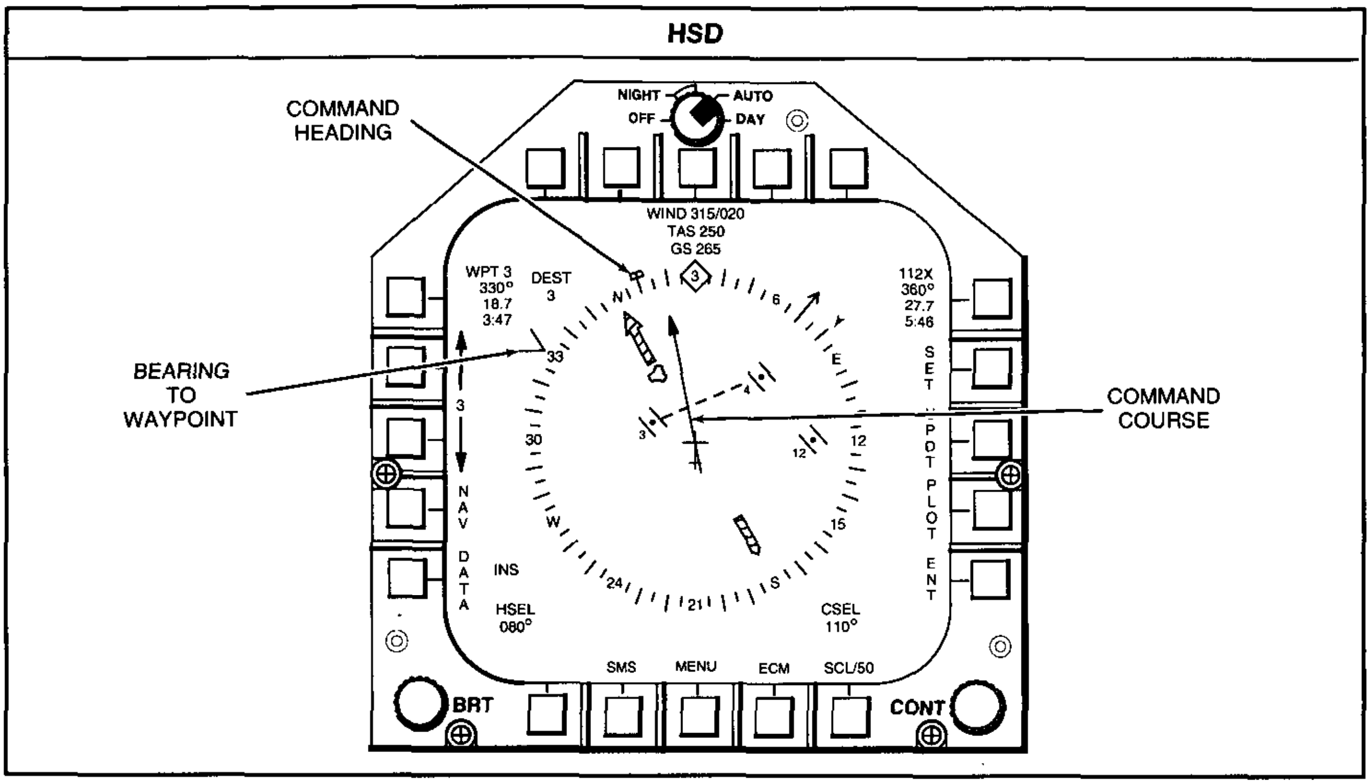


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Figure 20-38. Data-Link Steering Mode Formats (Sheet 2 of 2)

5. On pilot course/heading display control panel, command course is selected. This is verified under CSEL on pilot center and right MFD.

6. Pilot steers to move tacan deviation pointer to center of MFD HSD tacan display format until it becomes coincident to command course (tacan course) line.

20.3.6.6 Autopilot Steering. The mission computer provides the AFCS autopilot with a set of steering validity discretes and a computed steering error for its engaged steering mode. The available autopilot steering modes are: heading hold, ground track hold/destination hold, and data-link vector hold. Refer to Chapter 2 for a description of these AFCS functions.

Note

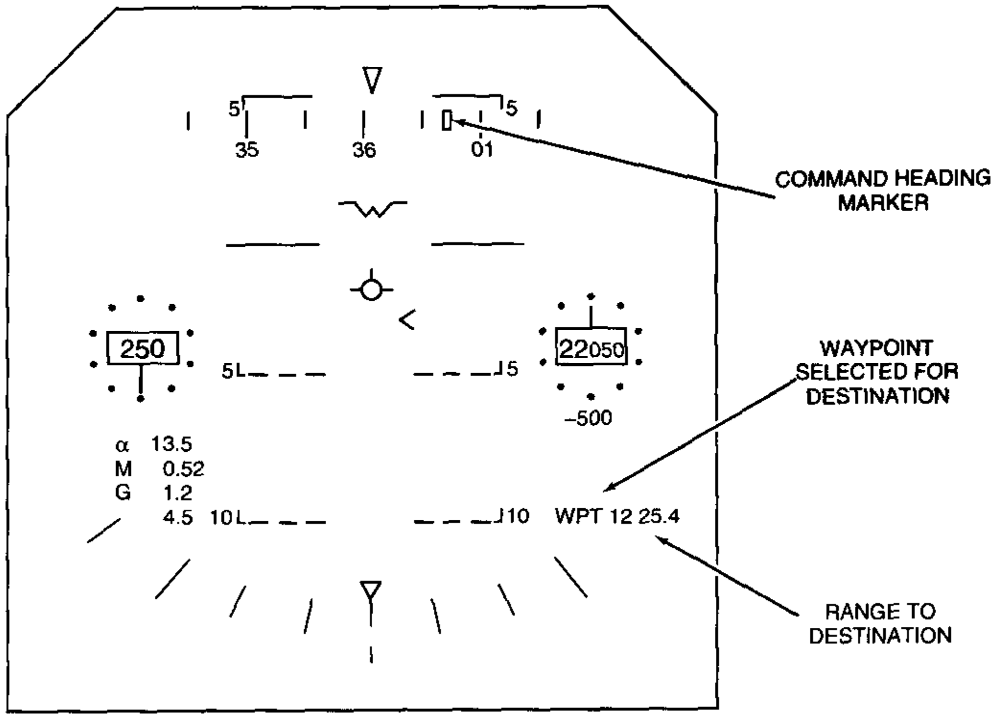
The autopilot data-link vector hold steering mode is not supported using JTIDS vector steering data.

20.3.6.7 All-Weather Landing. The mission computer provides the appropriate steering information to the aircraft displays for a requested AWL mode. This is derived from data supplied by the ILS and ACLS. AWL information is available from either the data link (AN/ASW-27C (ACL)) or the ILS receiver (AN/ARA-63) or both. The AWL steering modes operate continuously in the A/C landing phase to monitor and respond to pilot AWL requests. The pilot steers to glidepath situation displays (both ACL and ILS) and flight director displays during the approach and descent phases of the landing phase. Chapter 2 describes the AFCS ACL function, and Chapter 17 provides ACLS description and procedures.

Note

The AWL function is not supported by the JTIDS.

HUD



VDI

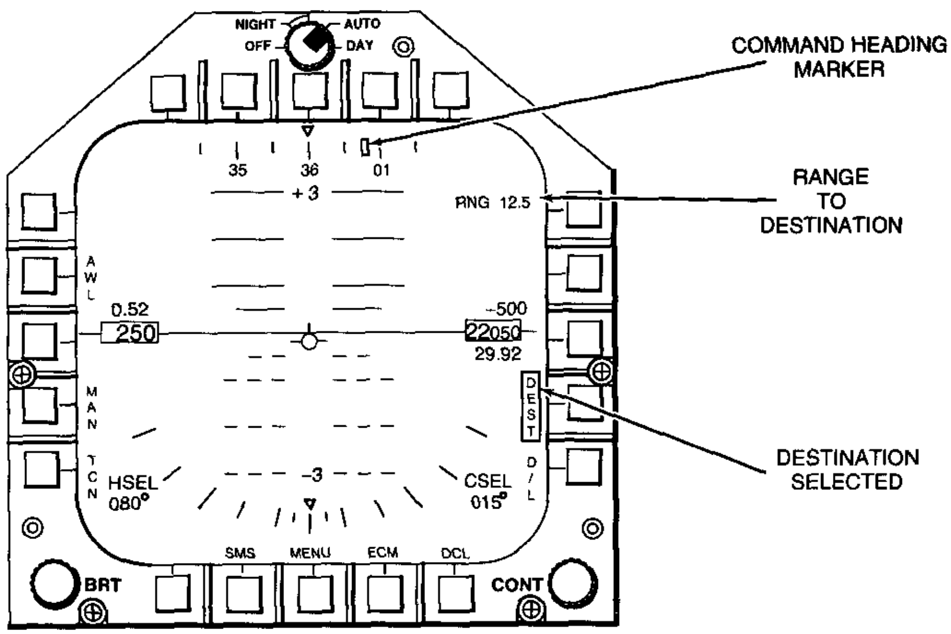


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Figure 20-39. Destination Steering Mode Formats (Sheet 1 of 2)

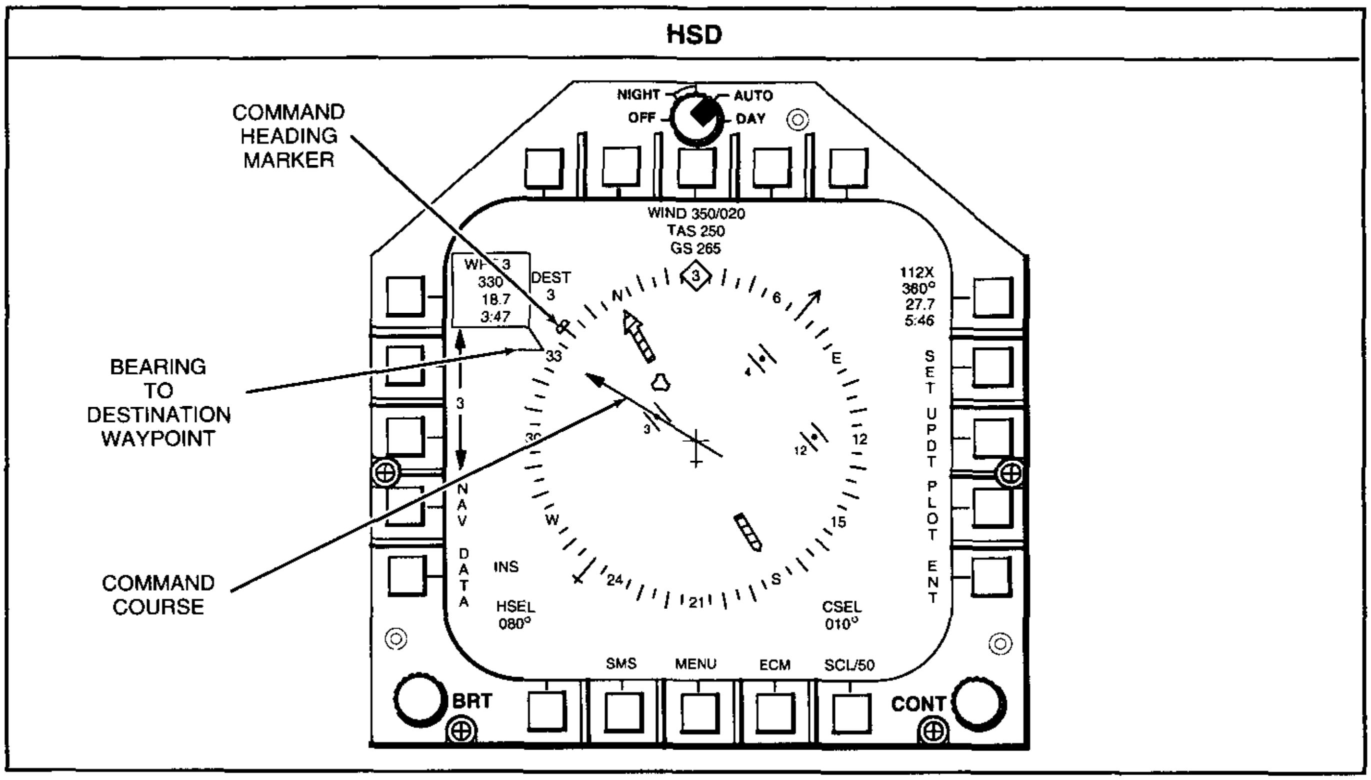
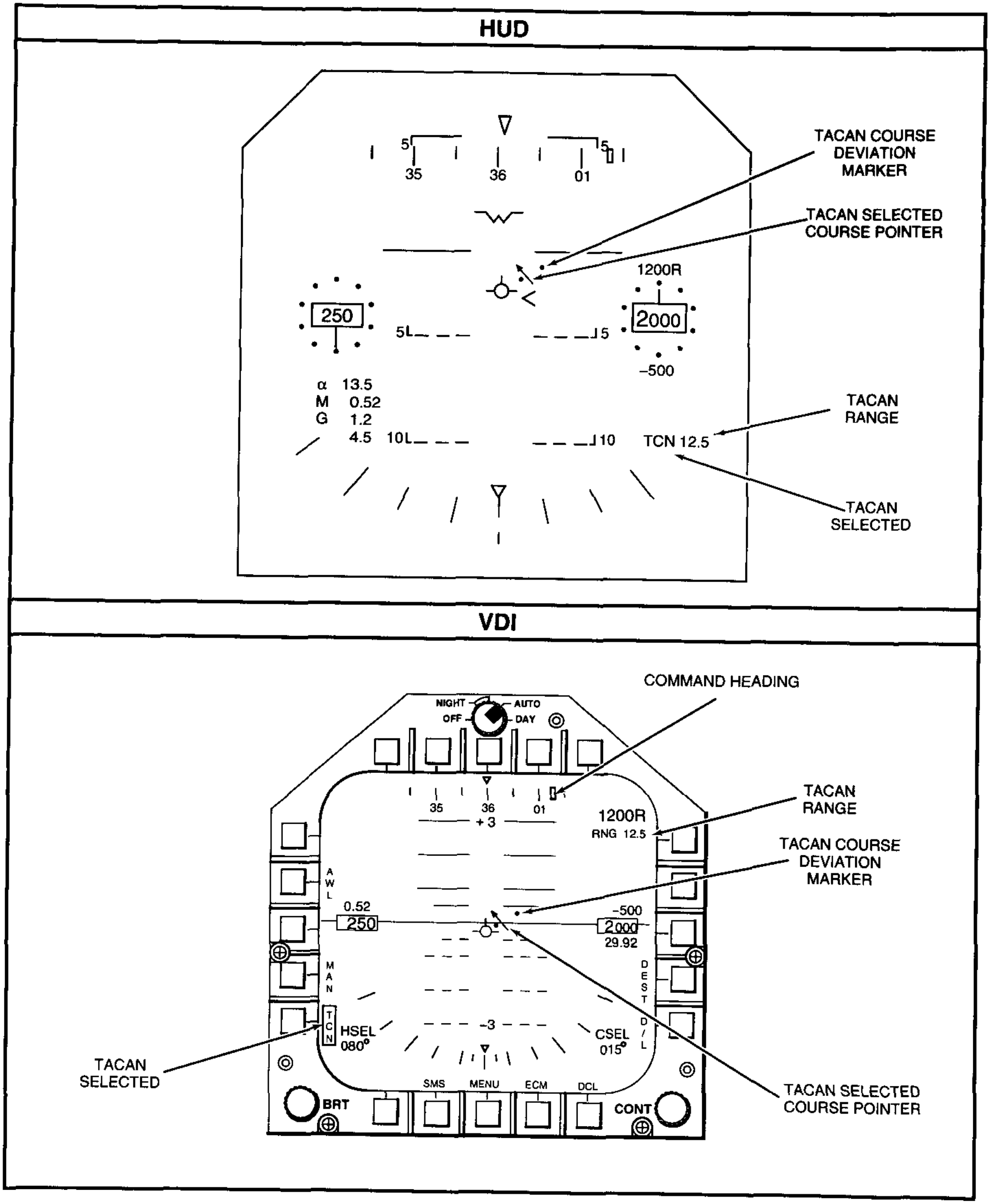
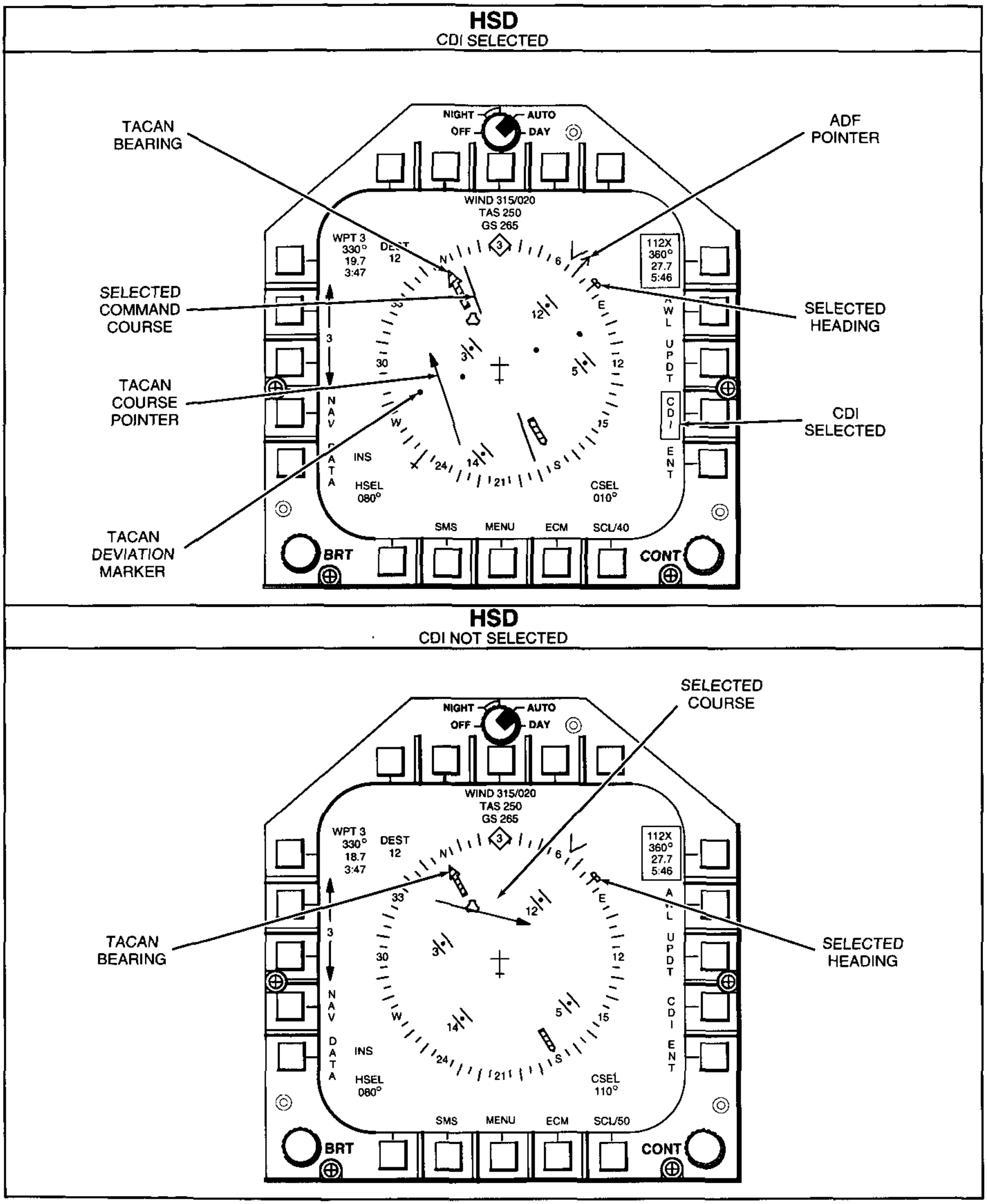


Figure 20-39. Destination Steering Mode Formats (Sheet 2 of 2)



(AT)2-F50D-448-1

Figure 20-40. Tacan Steering Mode Formats (Sheet 1 of 2)



(AT)2-F50D-448-2

Figure 20-40. Tacan Steering Mode Formats (Sheet 2 of 2)

CHAPTER 21

Identification

21.1 IDENTIFICATION TRANSPONDER (AN/APX-100)

21.1.1 IFF Transponder. The APX-100 IFF transponder system is capable of automatically reporting coded identification and altitude signals in response to interrogations from surface (or airborne) stations so that the stations can establish aircraft identification, control air traffic, and maintain vertical separation. The system has five operating modes (1, 2, 3/A, C, and 4). Modes 1 and 2 are IFF modes, mode 3 (civil mode A) and mode C (automatic altitude reporting) are primarily air traffic control modes, and mode 4 is the secure (encrypted) IFF mode. The IFF control panel is in the rear cockpit (Figure 21-1).

21.1.1.1 Master Switch. The MASTER switch applies power to all the transponder system components except the altimeter components. It is a four-position rotary switch placarded OFF, STBY, NORM, and EMER. The switch must be lifted over a detent to switch to EMER or to OFF. STBY should be selected for 2 minutes prior to switching to LOW or NORM to allow the transponder to warm up. In NORM, the transponder system is operational at normal receiver sensitivity. In EMER, the transponder transmits emergency replies to mode 1, 2, or 3/A interrogations. The mode 3/A emergency reply includes code 7700. When EMER is selected, all modes are enabled regardless of the position of the selector switches. When the front seat ejects, a switch is tripped that automatically selects the emergency mode if the MASTER switch is in any position other than OFF.

21.1.1.2 Antenna Select Switch. The position of the antenna select switch determines APX-100 antenna reply logic. Although the system is designed to receive an interrogation on either antenna at all times regardless of switch position, with TOP or BOT selected, it will only reply on the selected antenna, and only if the strongest interrogation signal was received on that antenna. For example, if BOT were selected and the interrogation signal was stronger from the top antenna, no reply would be transmitted. In the DIV (diversity) position, an antenna diversity comparator identifies which antenna received the strongest interrogation signal and automatically selects that antenna to transmit the reply. It is therefore recommended that the antenna select switch be left in DIV at all times.

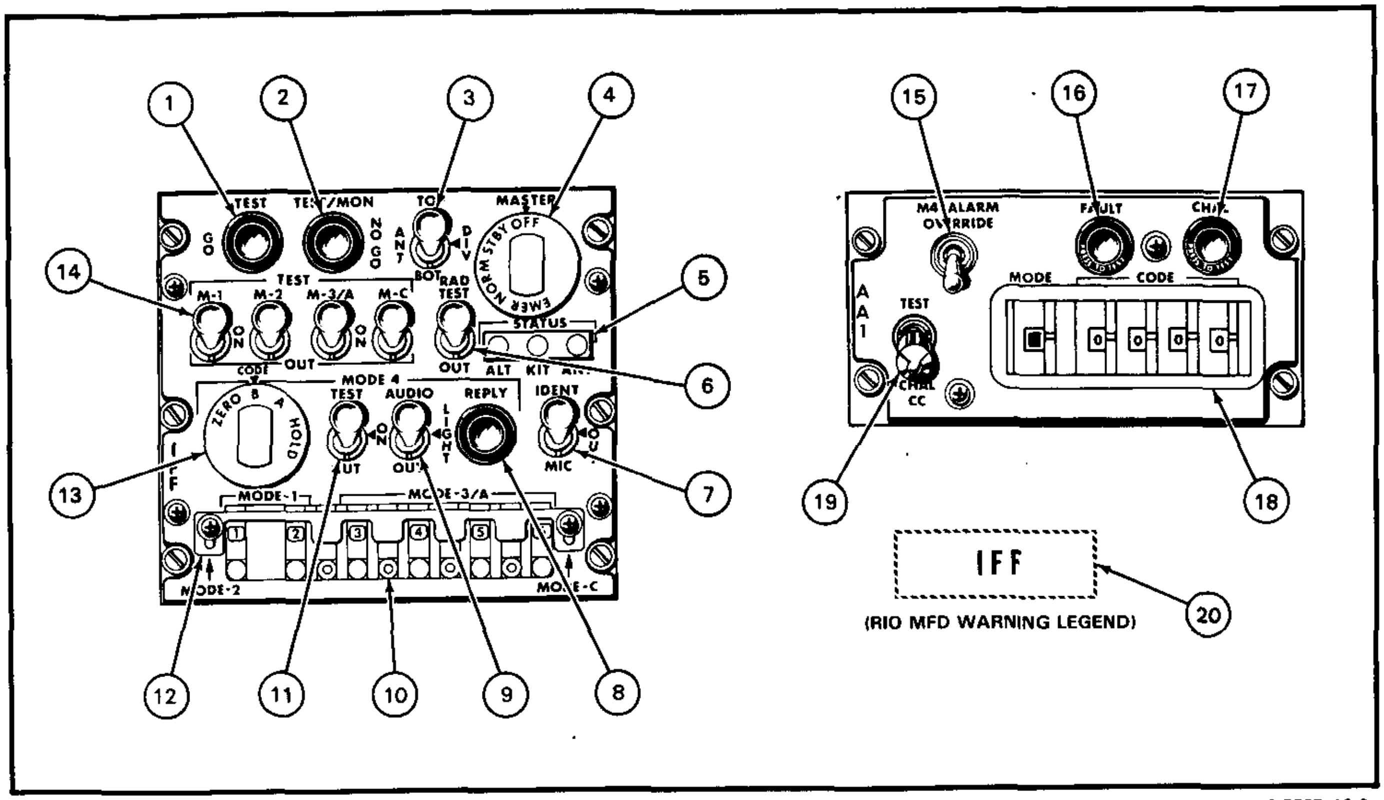
CAUTION

If either TOP or BOT is selected on the APX-100 antenna select switch, a Mode IV reply will be transmitted only if the Mode IV interrogation signal is strongest on the antenna selected. If the stronger of the two antennas was not selected at the time of interrogation, the aircrew will not have any indication that their aircraft was interrogated or that no reply was made.

21.1.1.3 IDENT-OUT-MIC Switch. The IDENT-OUT-MIC switch is a three-position toggle switch. The spring-loaded IDENT adds an identification of position pulse to mode 1, 2, and 3/A replies for a period of 15 to 30 seconds. In MIC, the identification of position function is activated for 15 to 30 seconds each time the UHF microphone switch is pressed.

21.1.1.4 Mode 1, 2, and 3/A Code Selectors. The two mode-1 thumbwheel selector switches allow selection of 32 mode-1 codes and the four mode-3/A thumbwheel selectors allow selection of 4096 mode-3/A codes. The mode-2 code that is set on the four MODE 2 selector switches may be read by moving the sliding cover. The code may be reset by inserting a pointed object like a pen tip or a paper clip to rotate the thumbwheel. Mode 2 codes are not normally changed in flight.

21.1.1.5 Mode Switches. The four mode switches (M-1, M-2, M-3/A, and M-C) each have OUT, ON, and spring-loaded TEST positions. The center position ON of each switch enables that mode. To test the transponder, press the mode switch of each mode to TEST.



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NOMENCLATURE	FUNCTION
1. TEST light (GO)	Illuminates when respective MODE switch TEST position is actuated; indicates proper (GO) operation of modes 1, 2, 3/A, and C. Master switch must be set to NORM.
2. TEST/MON light (NO GO)	The light has two functions. Illuminates when respective MODE switch TEST position is actuated; indicates failure (NO GO) of modes 1, 2, 3/A and C. Master switch must be set to NORM.
3. ANT switch	Selects upper (TOP), lower (BOT), or both (DIV) antennas. DIV (diversity) permits the IFF to switch automatically for transmission to the antenna that received the strongest interrogation signal.
4. MASTER switch	OFF — Deenergizes set. STBY — Energizes receiver-transmitter for immediate operation upon switching to an operating position. NORM — Allows receiver-transmitter response to interrogations. EMER — Energizes receiver-transmitter and generates emergency replies to mode 1, 2 (thumbwheel settings), and 3/A (code 7700) and a normal reply to mode C, when interrogated, whether mode switches are at ON or OUT.

Figure 21-1. IFF Control Panels (Sheet 1 of 3)

NOMENCLATURE	FUNCTION	
5. STATUS lights (red)	ALT —	Illumination indicates altitude encoder circuit failure during MODE C test.
	KIT —	Illumination indicates KIT/KIR TSEC failure during MODE 4 test.
	ANT —	Illumination indicates excessive voltage standard wave ratio (VSWR) to antenna during MODE C or MODE 4 tests.
6. RAD switch	TEST —	When selected, transponder replies to mode 3/A or 4 TEST mode interrogations from a ramp test set during ground maintenance testing.
	OUT —	Deenergized position.
7. IDENT—OUT—MIC switch	IDENT —	Momentary position provides IDENT reply for 15 to 30 seconds after releasing switch; replies to interrogation in modes 1, 2, 3/A.
	OUT —	Deenergizes circuit.
	MIC —	Transfers IDENT reply activation switch from IDENT to radio microphone switch
8. MODE 4 REPLY light	Illuminates when system has successfully replied to a mode 4 interrogation provided the AUDIO/LIGHT/OUT switch is not in the OUT position.	
9. MODE 4 AUDIO/LIGHT/OUT switch	AUDIO —	Enables (1) An ICS tone indicating either incomplete signal reception or that the received interrogation code does not match the installed code, (2) no go and IFF caution lights indicating no reply to a valid mode 4 interrogation, and (3) MODE 4 REPLY light indicating a valid mode 4 interrogation reply.
	LIGHT —	Enables (1) no go and IFF caution lights indicating no reply to a valid mode 4 interrogation, and (2) MODE 4 REPLY light indicating a valid mode 4 interrogation reply. Disables ICS audio tone monitoring.
	OUT —	Disables all ICS tone and light monitoring of mode 4 interrogations, replies, and nonreplies.
10. CODE selectors (MODE 1 and 3/A	Code selectors are rotatable drums with imprinted numbers that appear in code selector windows, permitting selection of codes for mode 1 and 3/A.	
11. MODE 4 switches	ON —	Enables mode 4.
	OUT —	Disables mode 4. See Figure 21-2 for mode 4 caution/reply light logic.
	TEST —	Activates KIT mode 4 computer self-test. TEST GO light illuminates if system if functional, NO GO if it is not. If KIT computer is at fault, STATUS KIT light illuminates red. If KIT/KIR is not installed, NO GO and STATUS KIT lights illuminate.

Figure 21-1. IFF Control Panels (Sheet 2 of 3)

NOMENCLATURE	FUNCTION	
12. MODE 2	Code selectors are rotatable drums with imprinted numbers that can be seen when sliding cover is moved out of view. Changing requires pointed object. Not normally changed in flight.	
13. MODE 4 CODE switch	ZERO —	Erases code 4 from KIR-1A and KIT-1A computers. IFF ZERO advisory legend appears on upper left of RIO's MFD.
	B —	Selects KIT-1A computer B code.
	A	Selects KIT-1A computer A code.
	HOLD —	Retains code in KIR-1A computers when landing gear is down or when system is turned off.
14. MODE switches (1,2, 3/A, and C)	TEST —	GO TEST light illuminates if system is functioning properly; NO GO TEST light illuminates if system failure.
	ON —	Permits selection of interrogating modes to which the transponder will reply.
	OUT —	Deenergized position.
15. M4 ALARM OVERRIDE switch	Disables the mode 4 tone alarm to the RIO's ICS.	
16. FAULT light	Indicates a malfunction of APX-76 receiver-transmitter, caused by receiver, video, or transmitter signals.	
17. CHAL light	Remains illuminated for the duration of a challenge period indicating correct operation.	
18. CODE selectors	First thumbwheel selects mode, 1, 2, 3A, 4A, or 4B. Last four thumbwheel rotatable drums with imprinted numbers appearing in code selector windows, permit selection of desired interrogation code.	
19. TEST-CHAL CC switch	Momentary two-position center-return switch.	
	TEST —	Onboard transponder is triggered by onboard interrogator. Both sets must have same code setting. IFF solid lines are displayed on DD at 3 and 4 miles.
	CHAL CC —	A selective identification feature (SIF) interrogation cycle starts the 5- to 10-second challenge period. Only correct modes and code replies are displayed (two brackets only on DD).
20. IFF warning legend	Indicates mode 4 interrogation was received, but system has not generated reply; mode 4 KIT/KIR computers have been zeroized; KIT/KIR has failed self-test.	

Figure 21-1. IFF Control Panels (Sheet 3 of 3)

TRANSPONDER (APX-100)	INTERROGATOR (APX-76)	CAUTION	REPLY (APX-100)
4 OUT (A) STBY	A	ON	OFF
4 ON (A) STBY	A	ON	OFF
4 ON (A) NORM	A	OFF	ON
4 ON (A) NORM	B	OFF	OFF
4 ON (B) NORM	A	OFF	OFF
4 ON (B) NORM	B	OFF	ON
4 ON (B) STBY	B	ON	OFF
4 ON (B) STBY	B	ON	OFF
4 ON (A) NORM RAD TEST	VERIFY BIT 1 (A)	OFF	ON
4 ON (A) NORM	VERIFY BIT 1 (A)	ON	OFF
4 ON (A) STBY	VERIFY BIT 1 (A)	ON	OFF
KIT ZERO	A OR B	ON	OFF

Figure 21-2. Mode 4 Caution and Reply Light Logic

Illumination of the GO TEST light indicates proper operation of that mode. Illumination of the NO GO TEST light indicates failure of the selected mode. The MASTER switch must be set to NORM for the test function to operate. The modes not being tested should be OUT when testing on the ground to prevent unnecessary interference with nearby ground stations. If a malfunction exists during these self-tests, an IFX acronym will appear on the tactical information display (TID). The IFF transponder is also continuously checked by aircraft self-test. Failure causes the IFX acronym to be shown on the TID. Calling up the failure history file or the CNI OBC display on any MFD will show whether the failure is in the transponder computer (IFA), the transponder (IFXPN), or the entire system (IFX).

21.1.1.6 RAD TEST-OUT Switch. The spring-loaded RAD TEST is used for testing. It enables a mode-3/A code reply to a TEST mode interrogation from a ramp test set. It also enables a mode 4 reply to a VERIFY 1 interrogation from a surface station or a ramp test set. A VERIFY 1 interrogation is a modified mode 4 interrogation used for testing.

21.1.1.7 Mode 4 Operation. Mode 4 operation is selected by setting the MODE 4 toggle switch ON, provided that the MASTER switch is NORM. Setting the MODE 4 switch to OUT disables mode 4.

The MODE 4 CODE switch is placarded ZERO, B, A, and HOLD. The switch must be lifted over a detent to switch to ZERO. It is spring-loaded to return from HOLD to position A. Position A selects the mode 4 code for the present code period and position B selects the mode 4 code for the succeeding code period. Both codes are mechanically inserted into the transponder by maintenance personnel. The codes are mechanically held in the IFF, regardless of the position of the MASTER switch or the status of aircraft power, until the first time the landing gear is raised. Thereafter, the mode 4 codes will automatically zeroize anytime the MASTER switch or the aircraft electrical power is turned off. The code settings can be mechanically retained after the aircraft has landed (landing gear must be down and locked) by turning the CODE switch to HOLD and releasing it at least 15 seconds before the MASTER switch or aircraft electrical power is turned off. The codes again will be held, regardless of the status of aircraft power or the MASTER switch, until the next time the landing gear is raised.

The mode 4 codes can be zeroized anytime the aircraft power is on and the MASTER switch not OFF by turning the CODE switch to ZERO.

An audio signal, the REPLY light, and the IFF caution light are used to monitor mode 4 operation. The AUDIO/LIGHT/OUT switch controls these mode 4 indicators. When the IFF MASTER switch is in NORM and the MODE 4 TEST/ON/OUT switch is on, selecting AUDIO on the MODE 4 AUDIO/LIGHT/OUT switch provides two types of mode 4 caution indications: (1) an ICS audio tone indicating either incomplete signal reception or the received interrogation code does not match the installed code, and (2) a no go light and IFF caution light indicating the system is not responding to a valid mode 4 interrogation. Selecting the light position disables the ICS audio tone and provides only the IFF caution light and no go light. Selecting the OUT position disables the ICS tone, no go light, and IFF caution light indications and disables the REPLY light indication of a valid reply. (Caution and REPLY light logic is shown in Figure 21-2.)

Note

When flying in a tactical environment, the MODE 4 AUDIO/LIGHT/OUT switch should remain in the AUDIO position at all times. Use of a switch position other than audio will deny the aircrew mode 4 caution indications.

21.1.1.8 IFF Caution Light. The IFF caution light on the RIO's ladder lights comes on to indicate that mode 4 is not operative. The light is operative whenever aircraft power is on and the MASTER switch is not OFF. However, the light will not operate if the mode 4 computer is not physically installed in the aircraft. Illumination of the IFF caution light indicates that: (1) the mode 4 codes have zeroized, (2) the self-test function of the KIT-1A/TSEC computer has detected a faulty computer, or (3) the transponder is not replying to proper mode 4 interrogations.

If the IFF caution light illuminates, switch the MASTER switch to NORM (if in STBY) and ensure that the MODE 4 toggle switch is ON. If illumination continues, employ operationally-directed flight procedures for an inoperative mode 4 condition.

21.1.1.9 IFF ZERO CAW. An IFF ZERO CAW is displayed in the MFD CAW window when a KIT computer is installed and the mode 4 codes have been zeroized. The IFF ZERO CAW is only valid if the APX-100 MASTER switch is not OFF. If the MASTER switch is OFF, the IFF ZERO CAW is displayed regardless of whether the IFF codes are zeroized or not.

21.1.2 Altitude Computations. Altitude computations are performed by the CADC.

The computer outputs are altitude information corrected for static position error. The synchro output is supplied to the altimeter providing the crew with a corrected altitude indication. The digital output from the computer is applied to the transponder for transmission on mode C, coded in increments of 100 feet, and referenced to 29.92 inches of mercury.

21.2 IFF INTERROGATOR (AN/APX-76)

The AN/APX-76 provides radar identification of airborne and surface Mark 10 IFF systems. It operates in conjunction with the radar and is automatically turned on whenever the RDR power switch is placed to any position except OFF. A minimum warmup time of 3 minutes is required before successful operation or BIT can be performed. The system requires 115-Vac from the main ac bus through the IFF A/A ac circuit breaker (1J7) and 28-Vdc from the main dc bus through the IFF A/A dc circuit breaker (9F6). It is capable of interrogation and display of modes 1, 2, 3A and 4, and of displaying EMERG AND IDENT on the DD. Refer to NAVAIR 01-F14AAD-1A.

The APX-76 interrogator consists of an antenna array that is part of the radar antenna, a control panel, receiver-transmitter, switch amplifier, and for mode 4 operation, an interrogator computer.

The IFF antenna consists of six dipole antennas mounted on the surface of the radar planar array antenna. The antenna azimuth and vertical coverage is the same as that of the radar antenna except that the beam width of the APX-76 is 13°. The transmitter operates at a fixed frequency of 1,030 MHz and the receiver operates at a fixed frequency of 1,090 MHz.

Except for the display of IFF video, the APX-76 is the same in all modes of radar operation. The radar analog signal converter provides an IFF pretrigger for the purpose of synchronizing the IFF and radar. On receiving the pretrigger from the radar, the IFF synchronizer generates triggers that establish the timing of transmission of challenges and decoded reply video for display on the DD. With the radar in low PRF, IFF video is mixed with radar video and displayed in the radar format. In high PRF, the IFF video isdisplayed in a B-scan format without radar video.

The synchronizer also sends a mode 4 pretrigger to the interrogator computer.

The interrogator computer generates mode 4 interrogations and interpolates mode 4 replies. Display of mode 4 is the same as all other modes. The mode 4 codes are prevented from zeroing when the RDR power switch is cycled.

21.2.1 IFF Self-Test. Prior to APX-76 operation, self-test of the unit should be performed. The APX-76 contains a self-test function that provides closed loop testing in conjunction with the on-board APX-100 (IFF Transponder). To perform the self-test, the RIO must set the mode and code switches on the control panel to correspond with the mode and code switches of the APX-100. The APX-100 must be in NORM or EMER before performing the test. The RIO may now initiate self-test by holding the TEST/CHAL CC switch in TEST for 5 to 10 seconds. Provided both the IFF and the APX-76 are functioning properly, two horizontal bars will be displayed across the DD at approximately 4 and 5 miles illumination of the green CHAL light on the control panel while the switch is being held in the test position, also indicates that the APX-76 made a valid interrogation. The bottom line on the DD indicates that the APX-100 responded in mode and the top line indicates it responded in code. Both lines together indicate that the APX-76 is decoding properly. Biasing of the mode and code lines enables them to be spread out on the DD during test. If the first attempt to test the APX-76 fails because of lack of video on the DD, or the amber fault light on the control panel illuminates, the RIO should initiate a valid challenge by momentarily holding the CHAL CC/TEST switch in CHAL CC in order to reset the BIT flags associated with the APX-76. The APX-76 normally powers up with the BIT flags in the fault position. The system will continuously fault until the flags are reset. The APX-76 antenna is checked during the test by receiving actual video from the APX-100 antenna. Failure of any part of the APX-76 closed loop test will cause IFI to be displayed in continuous monitor. A further breakdown as to what portion of the system has failed can be verified by calling up the maintenance file. Testing of all modes of the APX-76 should be performed independently. Failure of one mode does not necessarily mean that all modes are malfunctioning.

The APX-76 receiver-transmitter, switch amplifier, interrogator (KIR) computer, and synchronizer are checked during CNI OBC. Results can be called up on any MFD. These units are also subject to continuous monitoring. Status can be read by calling up the failure history file. In addition, the TID displays the IFI acronym if the receiver-transmitter or switch transponder fails continuous monitoring. During OBC, CHALLENGE IFF is displayed on MFD 3 in order to remind the RIO to reset the BIT flags by making a valid challenge.

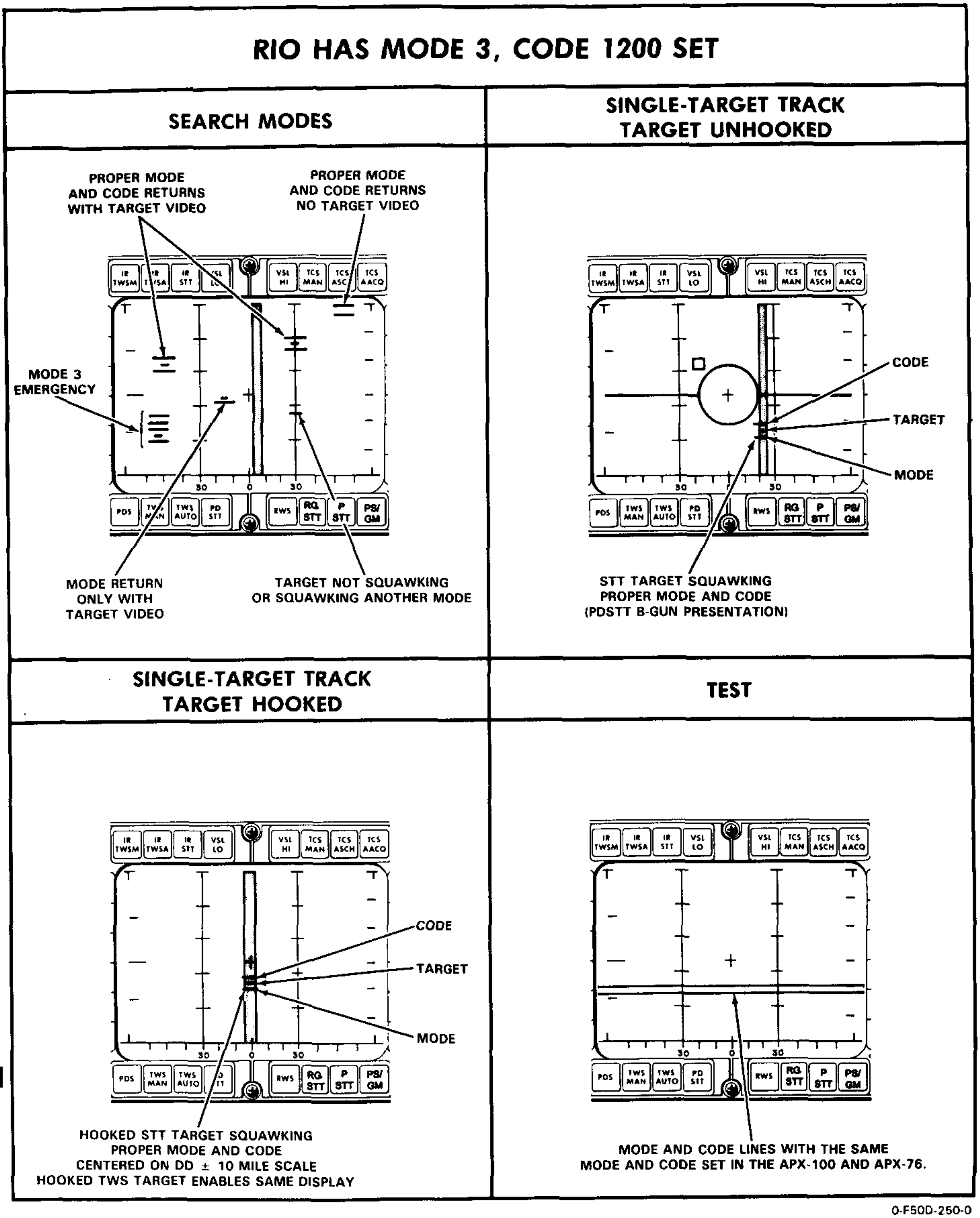


Figure 21-3. IFF Display Formats

PART VIII

Weapon Systems

Chapter 22 — TARPS Subsystem

Chapter 23 — Navigation Command and Control Grid

Chapter 24 — Reserved for LANTIRN Targeting System

The following chapters are to be found in NAVAIR 01-F14AAD-1A:

Chapter 25 — F-14D Weapon System

Chapter 26 — Weapon System Controls and Displays

Chapter 27 — AN/APG-71 Radar System

Chapter 28 — AN/AAS-42 Infrared Search and Track System

Chapter 29 — AN/AXX-1 Television Camera Set

Chapter 30 — Integrated Sensor Operation

Chapter 31 — Stores Management System

Chapter 32 — Air-to-Air Weapons

Chapter 33 — Air-to-Ground Weapons

Chapter 34 — Electronic Warfare Systems

Chapter 35 — Data-Link Systems

Chapter 36 — Weapon System Degraded Operation

CHAPTER 22

TARPS Subsystem

22.1 RECONNAISSANCE SYSTEM

The reconnaissance system establishes the aircraft as a multisensor reconnaissance aircraft with the flexibility for a wide range of reconnaissance missions. Specific missions include order-of-battle generation, prestrike/ poststrike photography, and maritime surveillance.

The sensors and associated equipment are contained in the pod's four compartments (Figure 22-1). The sensors are serial frame camera (KS-87D), low- to medium-altitude panoramic camera (KA-99), or long-range standoff frame camera (KS-153A with 24-inch lens), and AN/AAD-5A infrared reconnaissance set.

This capability is compatible with the F-14 tactical air reconnaissance pod system and includes target designation and steering command functions and reconnaissance sensor control as well as specific reconnaissance displays to crew and in-flight annotation of reconnaissance data.

The TARPS consists of the following components (as shown in Figure 22-1):

1. TARPS pod

2. Serial frame camera

3. Panoramic camera

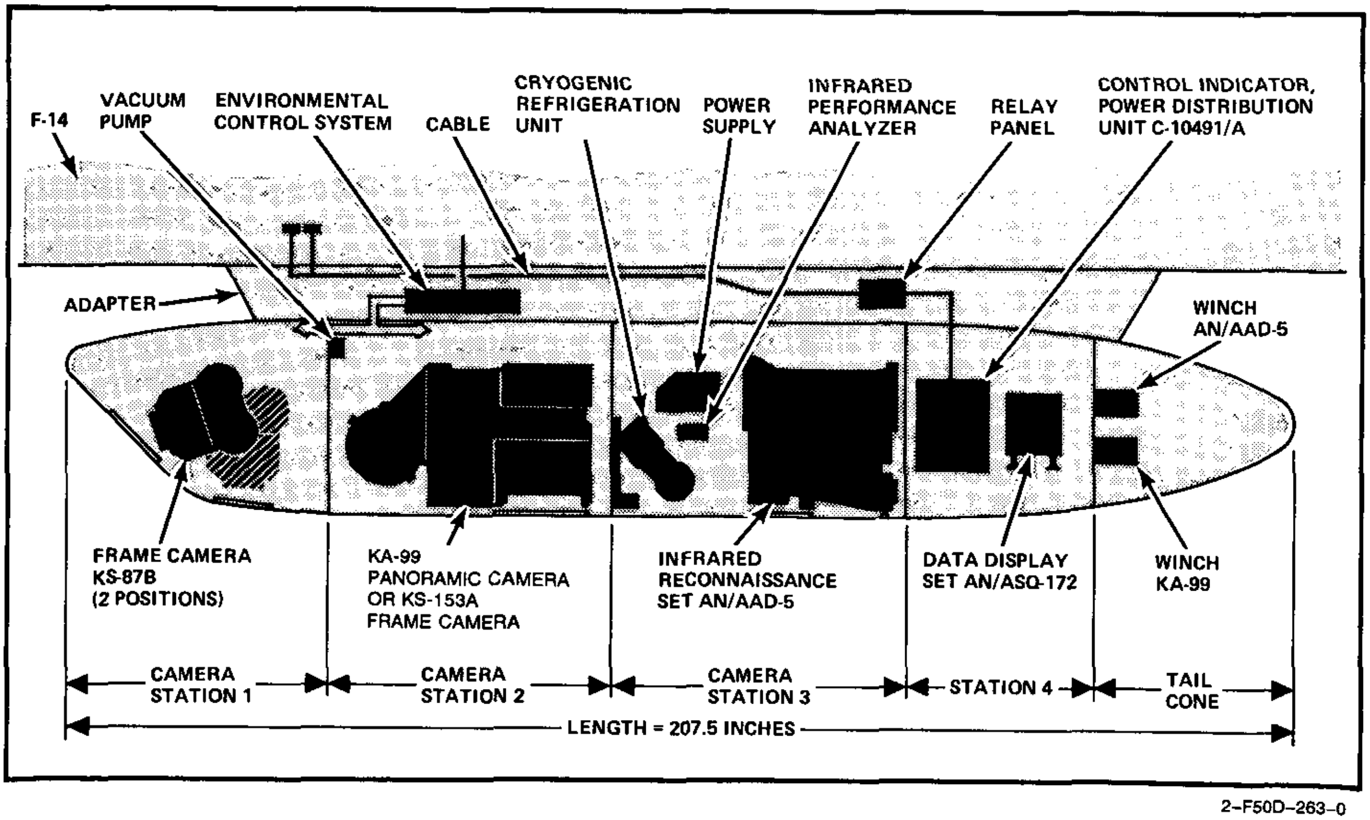


Figure 22-1. Tactical Air Reconnaissance Pod System

4. Infrared line scanner set

5. Data display system

6. TARPS environmental control system

7. Control indicator power distribution unit

8. Controller processor signal unit

The TARPS location on the aircraft is shown in Figure 22-2.

22.1.1 TARPS Pod. The TARPS pod (Figure 22-2) is 207.5 inches long and weighs approximately 1,625 pounds including sensor equipment. The pod is nonjettisonable and is mounted to the aircraft on weapon station 5 with an integral pylon adapter. The adapter provides the pod with sensor control signals, data annotation signals, electrical power, and ECS support from the aircraft. Circuit breaker protection is provided through the ac left and right main circuit breaker panel. The pod is designed for carriage throughout the flight envelope.

22.1.2 Serial Frame Camera. The serial frame camera can be directed in flight either to the forward oblique position to obtain photographs of the area as seen by the pilot, or to a vertical position for use as a backup sensor in the event the panoramic camera fails or for mapping missions.

The serial camera mount assembly holds the camera and provides the capability to move the camera in flight from the vertical position to the forward position. Controls for the camera positioning are on the CPS.

22.1.3 Panoramic Camera. The panoramic camera offers full horizon-to-horizon panoramic imagery over a broad velocity/above ground level mission envelope.

22.1.4 Infrared Line Scanner Set. The IRLS provides a film record of terrain being traversed by the aircraft. Scanning optics receive IR energy from the area under surveillance. Electrical signals, representing the scanned area, are recorded on black and white film. The IRLS is roll stabilized to ±20° in NFOV and ±4° in WFOV. If normal INS and SAHRS modes are not available, IR imagery may be degraded because of poor roll stabilization.

22.1.5 Data Display System. The DDS performs two basic TARPS functions. It provides coded annotation on the sensor film for future interpretation of the recorded intelligence data and supplies necessary control signals to the individual sensors.

22.1.6 TARPS Environmental Control System. The ECS supplies conditioned air for pod cooling and heating and for defogging the camera windows.

22.1.7 Control Indicator Power Distribution Unit. The CIPDU provides power and signal distribution as well as fail indicators for each of the various pod sensors and major pod equipment to guide maintenance personnel in the identification of faulty WRAs. The CIPDU also provides the verification of proper operation following corrective maintenance for preflight checkout purposes.

22.1.8 Controller Processor Signal Unit. The CPS (Figure 22-3) and cockpit displays provide the controls and information required by the RIO and pilot for operation and checkout of TARPS. The CPS is in the aft cockpit left console and contains the primary TARPS controls and indicators. Using the CPS with the multifunction displays, the RIO has full control of TARPS. A description of the CPS controls and their functions are provided in Figure 22-3.

22.2 DISPLAY SYSTEM

As described in Chapter 2, the display system provides the following:

1. Selection of waypoint to be reconnoitered and steering mode (point-to-point, command course, or mapping) to be employed.

2. Display of reconnaissance steering cues and camera status to the HUD when valid steering is selected and the aircraft is not in A/A with a weapon selected.

3. Display of reconnaissance steering cues on the VDI when the VDI is selected.

4. Command steering displays using the reconnaissance steering symbol and reconnaissance command heading marker.

5. Displays of reconnaissance TARPS sensor status and camera solution cues to crew on the MFD RECON DATA status format.

6. Display of target waypoint (reference point) data on the MFD RECON DATA status format.

7. Display of waypoint reconnaissance parameters (command crossing angle, target length, map lines, map separation distance (map offset)) on two formats.

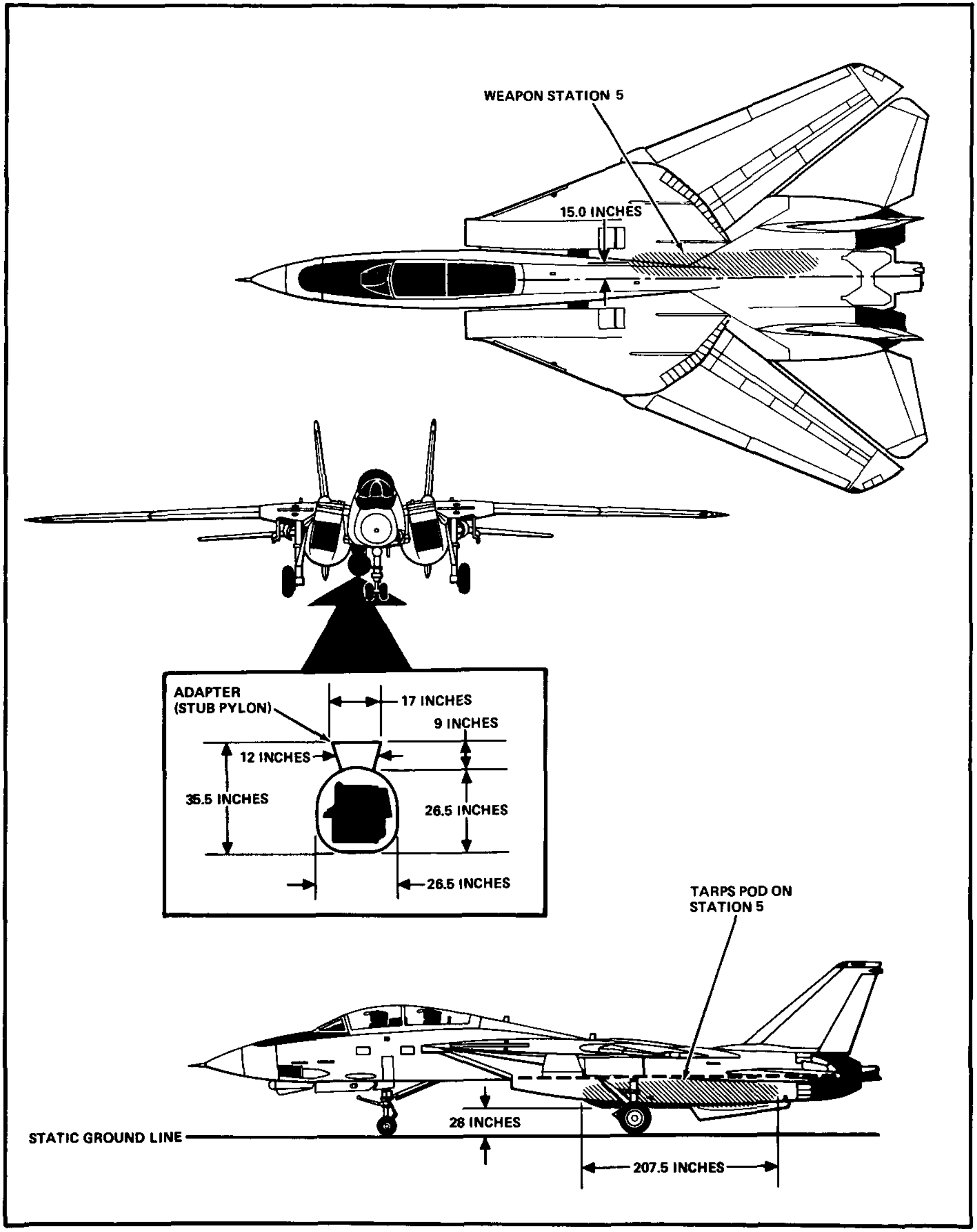


Figure 22-2. TARPS Component Locations

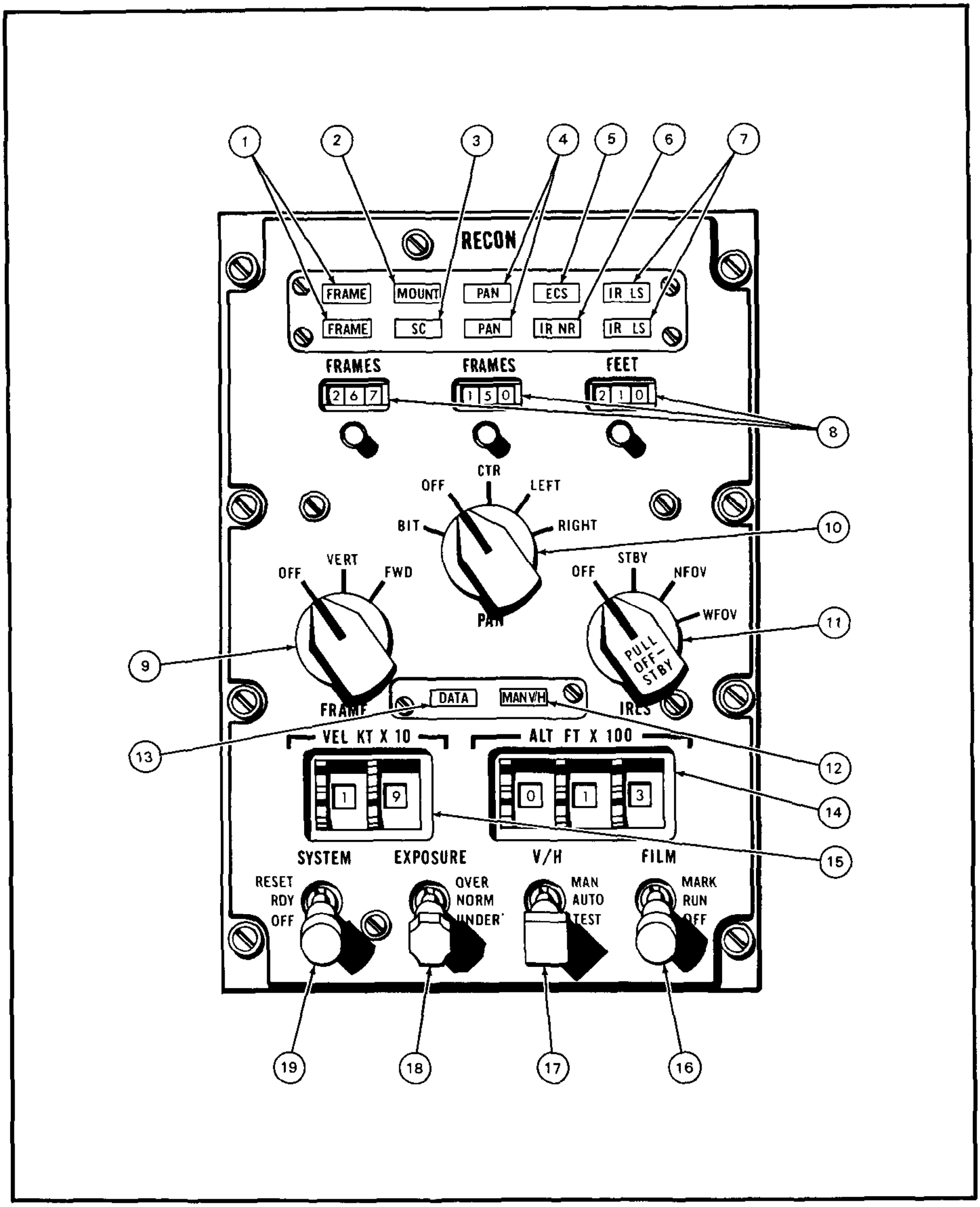


Figure 22-3. Controller Processor Signal Unit (Sheet 1 of 6)

NOMENCLATURE	FUNCTION
(1) FRAME lights • Amber • Green	Green FRAME light flashes once per camera cycle when serial frame camera is activated and no failure exists. Amber FRAME light illuminates if failure exists in serial frame camera and green FRAME light goes off.
(2) MOUNT light • Amber	Illuminates indicating mount failure. This occurs when serial frame camera fails to achieve directed position within 23 seconds. (It may be firmly locked in position opposite to directed one.) CIPDU internal failure can also give mount failure indication.
(3) SC (Sensor Control) light • Amber	Illuminates when SC/DDS has failed to furnish Film Motion Compensation (FMC) or cycle commands to sensors. Failure to deliver formatted data on command to sensors will not show SC failure. Consequently, SC GO indication can result in good sensor imagery operation but without data annotation.
(4) PAN lights • Amber • Green	Green PAN light flashes once per camera cycle when the panoramic camera has been activated and no failure exists. Amber PAN light illuminates and green light goes out if failure occurs.
(5) ECS (Environmental Control System) light • Amber	Illuminates only under failure condition (compartment temperature below 0°C or above 51°C). ECS is automatically activated on takeoff by weight-on-wheels switch.
(6) IR NR (IR not ready) light • Amber	Illuminates when sensor is not sufficiently cooled. Cool down period is a maximum of 17 minutes. After cool down is completed the IR NR light goes out for 120 seconds, then on for 80 seconds during BIT testing, then extinguishes indicating sensor is ready.
(7) IR LS (IR Line Scanner) light • Green • Amber	Green IR LS light flashes once per foot of film exposed. Green IR LS indicator goes out and amber IR LS light illuminates if failure occurs in infrared sensor.
(8) Frames and feet (indicators)	Display number of frames remaining in frame and pan cameras, and number of feet of film remaining in infrared sensor. Indicators are set initially as part of sensor servicing via reset knobs directly under indicators. Each frame or pan camera cycle decreases indication by 1. Each foot of film cycles through IR sensor decreases feet indication by 1.
(9) FRAME camera switch	OFF – Frame camera is shut off. VERT – SYSTEM switch is RDY. Power applied to frame camera. Mount placed in vertical position. When FILM switch in RUN, camera is cycling. FWD – SYSTEM switch in RDY; power is applied to frame camera.Mount placed in forward position (depressed 16° from horizon). When FILM switch in RUN, camera is cycling.

Figure 22-3. Controller Processor Signal Unit (Sheet 2 of 6)

NOMENCLATURE	FUNCTION	
		Note Requires approximately 15 seconds to transition between FWD and VERT. (The amber mount light illuminates if transition not completed in 23 seconds.)
(10) PAN camera switch	BIT –	(momentary position) SYSTEM switch must be in RDY to get BIT. Applies power to pan camera. Initiates 12 second BIT. With FILM switch to RUN, BIT will not function. **CAUTION** Do not run PAN BIT check. (May cause the film to jam)
	OFF –	Pan camera is shut off.
	CTR –	SYSTEM switch in RDY. Pan camera enabled. Awaiting operate command. FILM switch to RUN; pan camera cycling. Exposure, average of left and right light sensors. Camera set for 55% overlap at NADIR. KS–153A/24 inch: selects 21.4 degree scan centered on NADIR.
	LEFT –	SYSTEM switch in RDY. Pan camera enabled. Awaiting operate command. FILM switch to RUN; pan camera cycling. Exposure controlled by left light sensor. Camera set for 55% overlap at 30° below left horizon. KS–153A/24 inch: selects 21.4 degree scan centered on one of the preset depression angles. To prevent interference in coverage by the external fuel tanks the following preset value is recommended: 27° depression angle.
	RIGHT –	SYSTEM switch in RDY. Pan camera enabled. Awaiting operate command. FILM switch in RUN; pan camera cycling. Exposure controlled by right light sensor. Camera set for 55% overlap at 30° below right horizon. KS–153A/24 inch: selects 21.4 degree scan centered on one of the preset depression angles. To prevent interference in coverage by the external fuel tanks the following preset value is recommended: 31° depression angle.

Figure 22-3. Controller Processor Signal Unit (Sheet 3 of 6)

NOMENCLATURE	FUNCTION	
		Note LEFT or RIGHT positions should only be selected for high altitude standoff, or low angle photography. With LEFT or RIGHT selected, blurring of imagery at nadir will occur at lower altitudes because focus is set 30 degrees below horizon slant range.
(11) IRLS switch	OFF –	Sensor is shut off.
	STBY –	SYSTEM switch in RDY. Continuous monitor mode (CMM) mode is activated. Sensor begins cooldown. (If cooldown is not achieved within 17.6 minutes, the IRLS fail light (amber) will illuminate.) The IR door will remain closed during cooldown. After cooldown is achieved mirror spin motor is energized and IR door will open unless landing gear handle is down.
	NFOV/ – WFOV	SYSTEM switch in RDY. Sensor in ready mode. Sensor selects narrow (or wide) field of view in response to switch position. Sensor is ready to cycle if cool down has occurred. IR door will open if gear handle is UP. **Note** FILM switch in RUN. IR LS flashes green (one flash/foot of film travel). If cooldown is incomplete, the IR NR will be illuminated amber and the sensor will not respond.
(12) MAN V/H light • Amber	OFF –	Vg/H from aircraft computer within acceptable limits.
	ON –	Illuminated amber: V/H switch in TEST. With VEL set at 90 (900 kts) and ALT set at 005 (500 ft), or any equivalent of 1.8 ratio, the thumbwheel circuitry has failed if the light stays on. V/H switch in AUTO. Computer failed or computer fail discrete is received with or without TARPS pod on aircraft. Manual Vg/H being used. Set correct values to Vg/H in thumbwheels. Set V/H switch to MAN. If negative AGL or computed Vg/H = 0, MAN Vg/H is being used. Set corrected values of Vg/H in thumbwheels.

Figure 22-3. Controller Processor Signal Unit (Sheet 4 of 6)

NOMENCLATURE	FUNCTION	
		V/H switch in MAN. Manual V/H intentionally selected. Values set in thumbwheels being used. Set correct values in thumbwheels. **Note** • A TARPS advisory will appear on the Reconnaissance MFD CAWS window when MAN V/H is selected (figure 24-6). In addition, a TARP1 is generated on the OBC Basic Display and Maintenance Failure Format (figure 24-7). • If negative AGL or Vg/H = 0, and the TARPS pod is not on the aircraft, there is no MAN Vg/H advisory.
(13) DATA light	OFF –	Data received from computer. ON –Data from aircraft computer failed (via CPS DATA FAIL discrete). **Note** A TARPS advisory will appear on the Reconnaissance MFD CAWS window (figure 24-6) when MAN V/H is selected. In addition, a TARP1 and TARP2 are generated on the OBC Basic Display and Maintenance Format. (Figure 24-7).
(14) ALT FT X 100	Used to set manual altitude inputs to pod. Counter range is from 000 to 999, read in multiples of 100 feet.	
(15) VEL KT X 10 thumbwheels	Use to set manual ground speed inputs to pod. Counter range is from 00 to 99, read in multiples of 10 knots.	
(16) FILM switch	MARK –	(momentary position) Allows RIO to mark special interest frame with * in data block.
	RUN –	Activates selected sensor when SYSTEM switch is set to RDY.
	OFF –	Terminates TARPS sensor operation

Figure 22-3. Controller Processor Signal Unit (Sheet 5 of 6)

NOMENCLATURE	FUNCTION	
(17) V/H selector switch	MAN -	Selects manual thumbwheel inputs. (TARPS advisory appears on MFD CAWS figure 24-6. TARP1 appears on OBC Basic Display and Maintenance Failure Format figure 24-7).
	AUTO -	Selects aircraft computer value of Motion Compensation Factor (MCF).
	TEST -	(Momentary position) Tests proper functioning of thumbwheels Vg/H circuitry. With a 1.8 ratio set in the thumbwheels, a good test is indicated by the MAN V/H light extinguishing.
(18) EXPOSURE selector switch	UNDER -	-1 f-stop exposure for doubled S/C film setting.
	NORM -	Normal exposure for doubled S/C film setting.
	OVER -	+1 f-stop for doubled S/C film setting.
(19) SYSTEM switch	OFF -	Aircraft power denied to TARPS. No sensors can be operated.
	RDY -	Aircraft power available at sensor connectors. If respective sensor moved from OFF position, sensor is placed in standby or ready mode.
	RESET -	Clears TARPS failure signal. If failure is other than transient, TARPS advisory remains.

Figure 22-3. Controller Processor Signal Unit (Sheet 6 of 6)

8. Provide selection of TARPS air-to-ground ranging for altitude above ground level determination.

22.3 TARPS EQUIPMENT CIRCUIT BREAKERS

The main power circuit breakers that control TARPS equipment are in the aft cockpit. FO-8 and FO-9 show their location. The circuit breakers are numbered and labeled as follows:

NOMENCLATURE	CIRCUIT CARD
RECON POD	1E2
RECON POD CONT	8E2
RECON POD DC PWR NO. 1	8E4
RECON POD DC PWR NO. 2	8E3

NOMENCLATURE	CIRCUIT CARD
RECON HTR PWR PHA	2B1
RECON HTR PWR PHB	2D1
RECON HTR PWR PHC	2F1
RECON ECS CONT AC	2G4
RECON ECS CONT DC	8E1

Refer to Chapter 2 for an alphanumeric listing of circuit breakers.

22.4 RECONNAISSANCE DISPLAYS AND FORMATS

The reconnaissance display symbology provides sensor status/ reconnaissance steering selection (via the MFD RECON DATA status page) and the steering cues (via HUD/VDI displays) to the flightcrew. In addition, the position of the dynamic steering point can be displayed on the horizontal situation display or tactical information display/repeat on the MFD.

The MFD RECON DATA status format is selected from the MFD MENU2 format (Figure 22-4) by depressing the RECON pushbutton.

22.4.1 MFD RECON DATA Status Format. This MFD format (Figure 22-5) provides the following functions:

1. Selection of waypoint to be reconnoitered (via increment/decrement pushtile on the upper left corner of the MFD RECON DATA status format) and steering mode (point-to-point, command course, or mapping) to be employed.

2. Displays TARPS sensor status, advisories (TARPS and NFOV), and camera solution cues to crew.

3. Displays target waypoint (reference point) data.

4. Provides selection of TARPS air-to-ground ranging for AGL determination and AGL data display.

22.4.2 Reconnaissance Fault/Problem Reporting. The reconnaissance system will report the TARPs faults/problems via the MFD warning, caution, and advisory window and store the faults in the OBC file and failure history file.

22.4.2.1 MFD Warning/Caution/Advisory Window. The mission computer will report the following advisories on the MFD (Figure 22-6):

1. TARPS — Reports a general failure (crew alert) from the CPS. Monitor CPS to determine whether or not this is a catastrophic failure (sensor(s) fail). A TARPS advisory need not scrub the reconnaissance mission.

2. NFOV — Reports to the RIO that the IRLS is required to be placed in the WFOV position.

Note

A crew alert is generated from the CPS when any of the following conditions occur:

a. Sensor failure (includes serial frame camera mount position).

b. ECS failure.

c. SC/DDS failure.

d. Manual Vg/H in use.

e. CPS data fail (a TARP2 will be simultaneously stored in OBC/failure history file).

f. Manual Vg/H test fail.

22.4.2.2 OBC/Failure History File. The following faults will be simultaneously stored in the OBC and failure history file (Figure 22-7) when the TARPS advisory is displayed on the MFD:

1. TARP1 — Reports a general failure (crew alert) from the CPS.

2. TARP2 — Reports a data communication failure between the mission computer and the CPS. This means that the annotation data and control signals are no longer being transmitted to TARPS.

22.4.3 Reconnaissance Steering Selection. There are three reconnaissance steering modes available: PTP, CCRS, and mapping. They are selected via the MFD RECON DATA status format in either TLN, A/G, or A/A. The steering function is initiated when a TARPS steering mode is selected. Steering cues will always be computed when a steering mode is selected and will be displayed on the HUD except in A/A with a weapon selected. The VDI will always display steering cues.

Before a steering mode can be selected, the waypoint must be selected. In order to do so, the up-down arrow on the MFD RECON DATA status format is used to select the desired waypoint number. Next, by hitting ENT, the desired waypoint parameters will be displayed. Waypoint 17 is inhibited for reconnaissance steering since this waypoint contains the position of the DSPT.

22.4.3.1 Point-to-Point Steering. PTP is selected when the navigation system is properly operating. Selecting PTP on the reconnaissance MFD RECON DATA status format immediately computes the wings-level position for the initial placement of the DSPT and computes a heading to command the pilot to fly to that position.

Note

The wings-level distance is approximately 4 to 8 nm from target (depends on velocity and altitude).

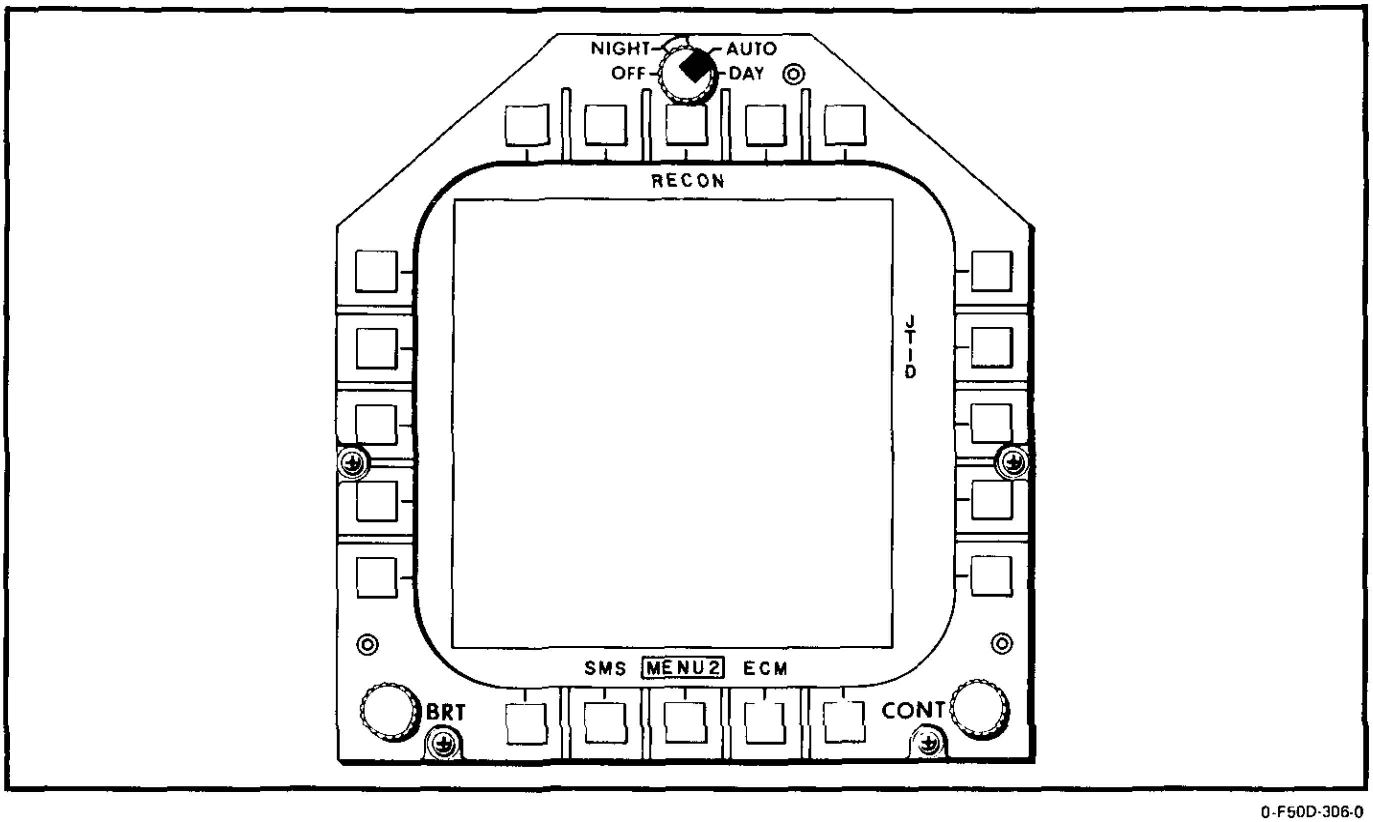


Figure 22-4. MFD MENU2 Format

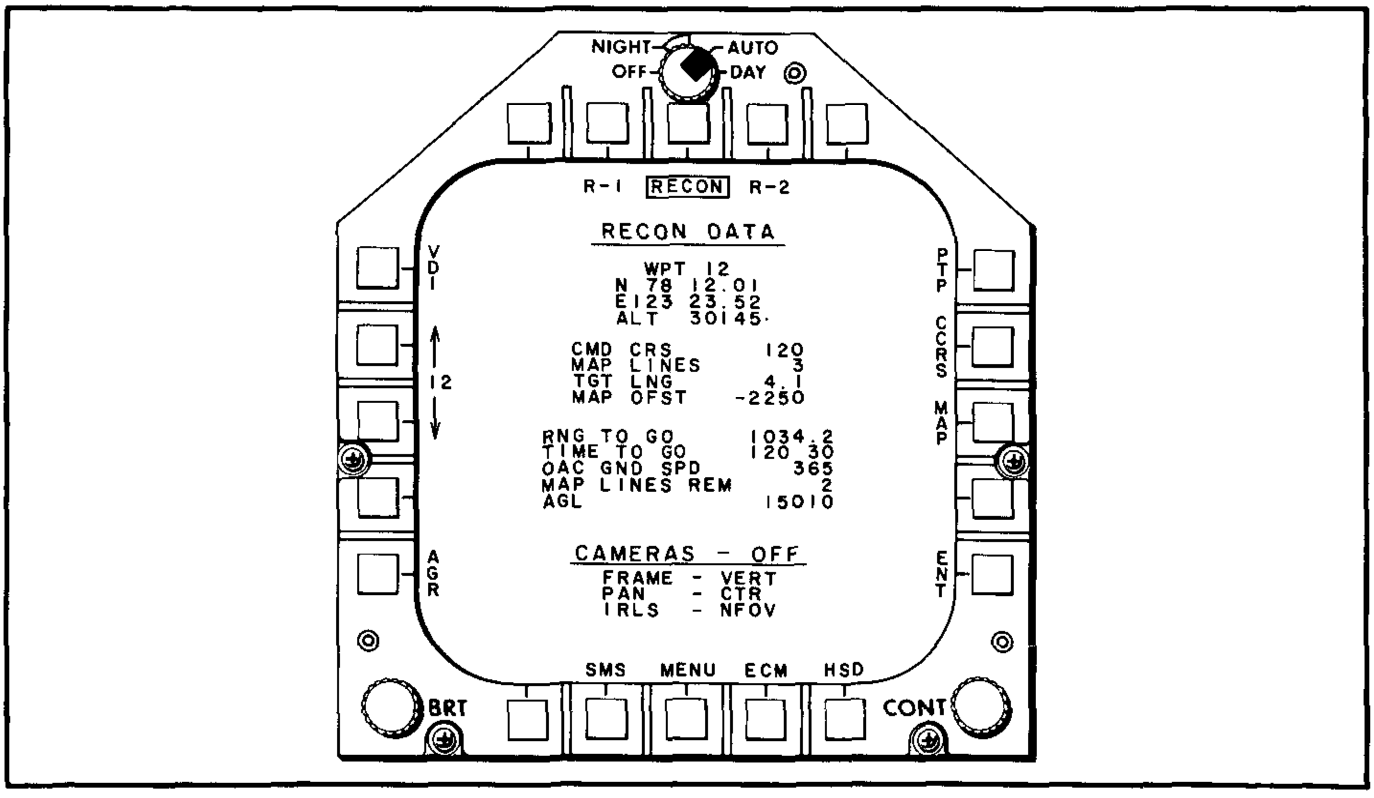
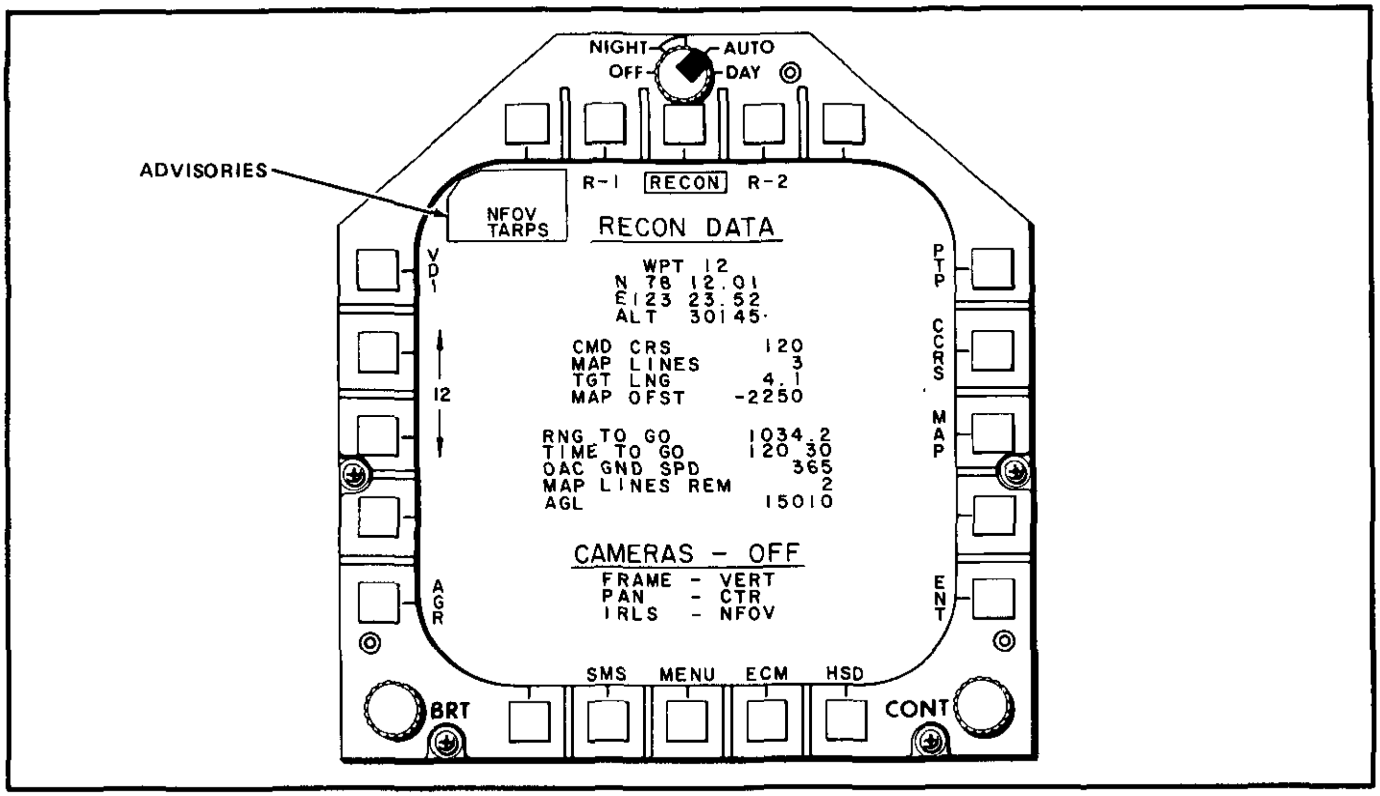


Figure 22-5. MFD RECON DATA Status Format



0-F50D-453-0

Figure 22-6. TARPS Advisories

In addition, the algorithm will put the reconnaissance target designator over the target on the HUD. The PTP steering will transition into CCRS for final approach over the target.

Note

PTP remains boxed on the MFD RECON DATA status format. The reconnaissance steering symbol and command ground-track line assist the pilot in a wings-level flight over the target.

PTP steering is deselected when the aircraft has flown 0.5 nm past the target or the crew manually deselects PTP on the reconnaissance MFD RECON DATA status format. At this time, all steering cues are removed from the HUD and VDI. In addition, the DSPT (waypoint 17) is removed from the HUD.

22.4.3.2 Command Course Steering. CCRS is selectable if the navigation system is properly operating and the selected waypoint to be reconnoitered has a nonzero value for target length. When the above conditions are satisfied, the selection of CCRS on the MFD RECON DATA status format will box CCRS. Immediately following that, TARPS will compute the DSPT, which is displayed on the HSD format, and the complete set of steering cues (the reconnaissance steering symbol, CGTL, reconnaissance target designator, and reconnaissance command heading marker) to guide the aircraft to fly over the target at a command crossing angle (stored in the waypoint file). When the aircraft approaches the wings-level position (indicated when the DSPT initiates movement to the target), the CGTL will appear to provide additional visual cues for proper target crossing.

Note

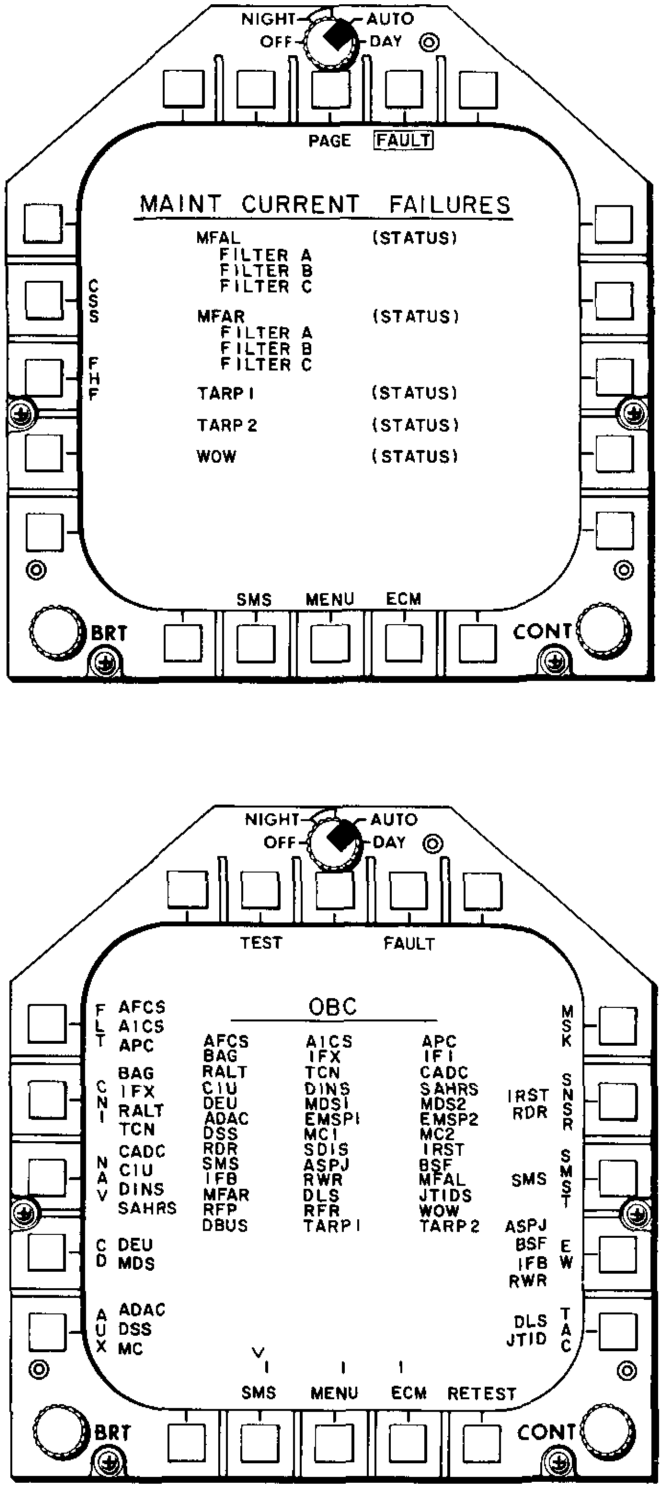
PTP would be selected (instead of CCRS) if the target length is zero.

CCRS steering is deselected when the aircraft has flown the target length (stored in the waypoint file) past the target or when the crew manually deselects CCRS on the MFD RECON DATA status format. As in PTP, all steering cues are removed from the HUD and VDI. In addition, the DSPT (waypoint 17) is removed from the HSD.

22.4.3.3 Mapping Steering. MAP is selectable under the following conditions:

1. Navigation system is properly operating.

2. The selected waypoint to be reconnoitered has a nonzero value for target length.



0-F50D-454-0

Figure 22-7. MFD OBC/Maintenance Failure Formats

3. The two map parameters, map offset (separation distance between adjacent map legs) and map lines, are nonzero values.

When the above conditions are satisfied, the selection of MAP on the MFD RECON DATA status format will box MAP. TARPS will then compute the DSPT (displayed on the HSD) and the complete set of steering cues (the reconnaissance steering symbol, CGTL, reconnaissance target designator, and reconnaissance command heading marker).

MAP steering includes guidance through the required 90° to 270° turn maneuvers, using command heading and steering symbology, for the necessary return legs of the reconnaissance missions.

Note

- PTP would be selected if only condition 1 was valid. Insufficient parameters are available for mapping.
- CCRS would be selected if only conditions 1 and 2 were valid.

MAP is deselected at the completion of the last map leg or when manually deselected by the crew on the MFD RECON DATA status format. When MAP is deselected, the following will occur: removal of the reconnaissance overlay symbols (CGTL, reconnaissance command heading marker, reconnaissance target designator, and reconnaissance steering symbol) from the HUD and VDI; removal of the DSPT from the HSD; and MAP LINES REM (on the MFD RECON DATA status format) will be zero.

22.4.4 HUD/VDI Symbology. The HUD/VDI symbology is available when there is a valid selection of reconnaissance steering. This symbology consists of the following functions:

1. Displays reconnaissance steering cues and sensor status to the HUD when valid steering is selected and the aircraft is not in A/A with a weapon selected (Figures 22-8 and 22-9).
2. Displays reconnaissance steering cues on the VDI when the VDI is selected (Figure 22-8).

The HUD/VDI symbols are listed and displayed in Figures 22-8, 22-9, and 22-10.

22.5 RECONNAISSANCE SYSTEM OPERATION

The RIO is primarily responsible for the entry of reconnaissance parameters for waypoints and selection/operation of TARPS sensors. In addition, the RIO may assist in updating the INS just prior to flying over the target and plotting the target leg (in CCRS and MAP modes) on the HSD.

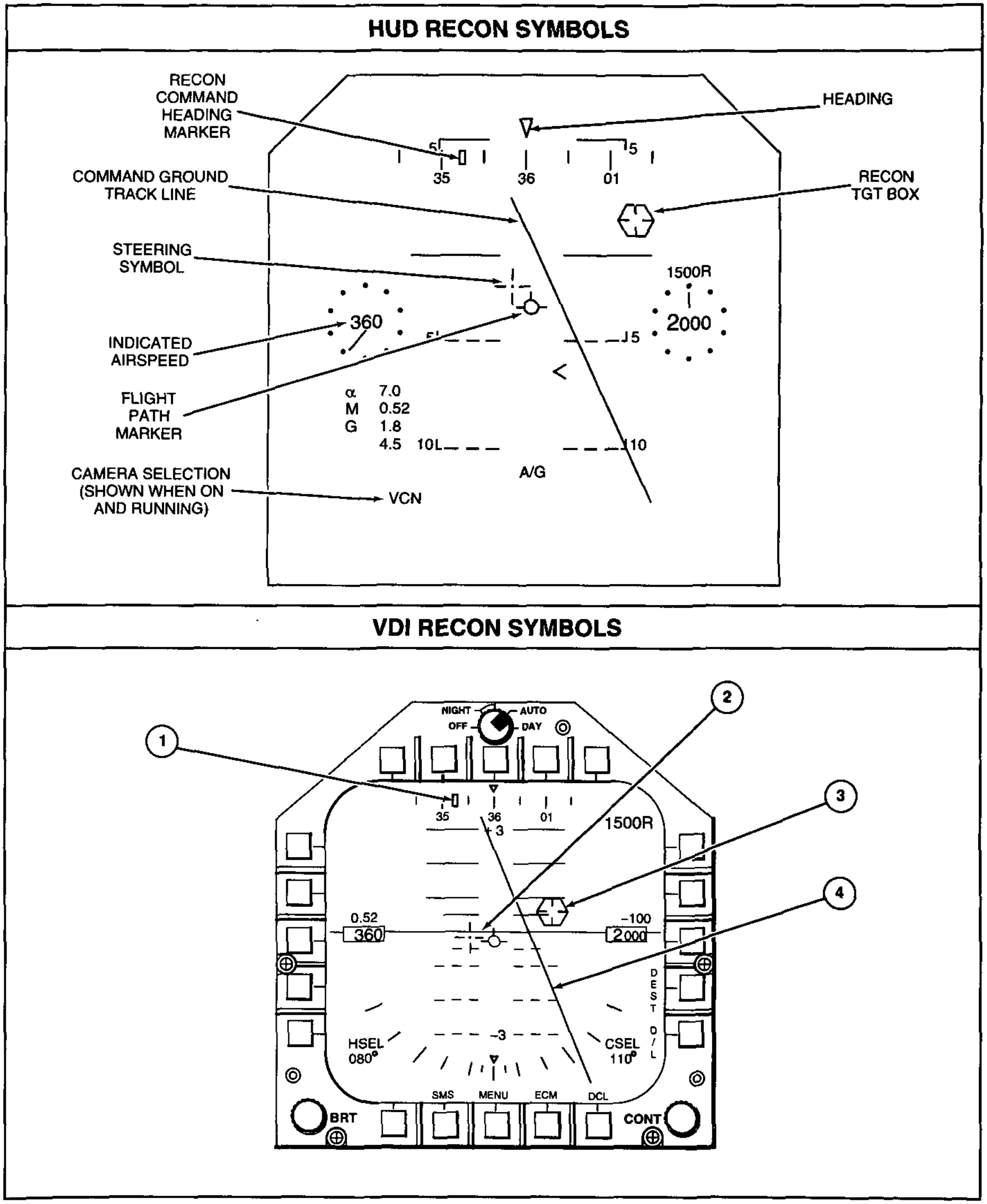
22.5.1 Reconnaissance Parameter Entry. Reconnaissance parameters are entered into the waypoint file (Figures 22-11 and 22-12) by the RIO via the DEU. The maximum number of waypoints available for reconnaissance is 19. (Waypoint 17 is reserved for the dynamic steering point. Waypoints 18 to 20 have dual functions as recce files or as hostile area, FLRP, and data link.) In addition to the standard waypoint entry (target latitude, longitude, and altitude), the following reconnaissance parameters are entered: command crossing angle, target length, map lines, and map offset (separation distance between adjacent map legs). The altitude entered is the target MSL altitude. The target length is entered via the DEU. Figure 22-13 shows TARPS DEU entry matrix.

Note

- *A target altitude of 0 is considered invalid.* In the event that the radar altimeter and radar altitude from APG-71 is not available, then the AGL altitude will be the difference between the system altitude and hostile area altitude (and not the waypoint altitude).
- Entries of odd tenths will be rounded to the next lowest even digit.

22.5.1.1 Reconnaissance Parameter Display. Reconnaissance parameters are displayed on the MFD RECON WPT DATA 1 (Figure 22-11) and MFD RECON WPT DATA 2 formats (Figure 22-12). MFD RECON WPT DATA 1 format contains the reconnaissance parameters for the first ten waypoints. This page is selected by depressing the R-1 pushbutton on the MFD RECON DATA status format. The RECON WPT DATA 2 format contains the remaining ten waypoint reconnaissance parameters. These parameters are accessed by depressing the R-2 pushbutton on the MFD RECON DATA status format.

The reconnaissance parameters consist of command crossing angle, target length, map lines, and map separation distance (map offset).



(AT)3-F50D-312-0

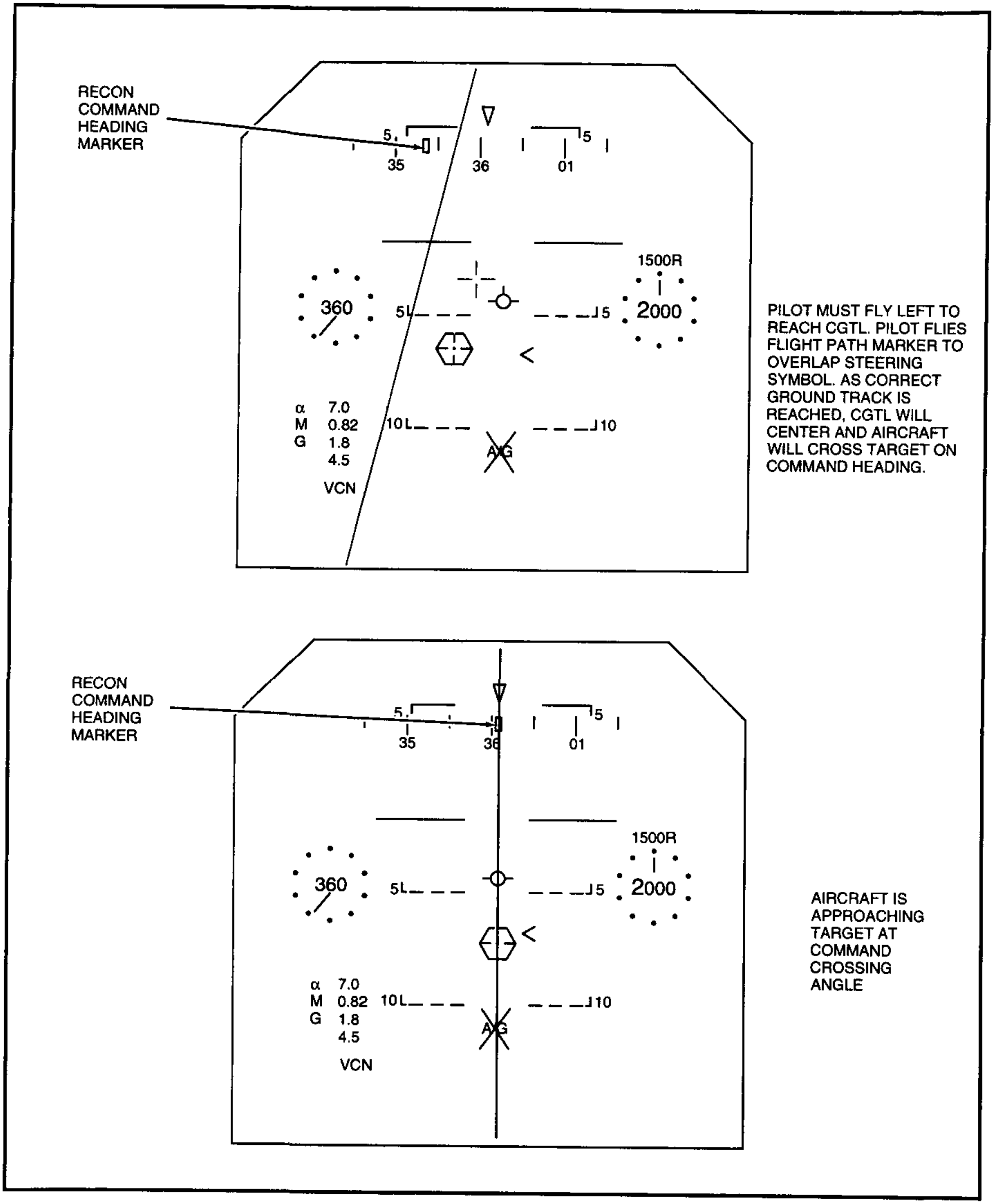
Figure 22-8. HUD/VDI Reconnaissance Symbology (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
(1) Recon Command Heading Marker	Indicates the magnetic heading for Recon steering. – Primary steering cue for initial phase of PTP steering. – Indicates intended magnetic heading to DSPT (as commanded by the Recon Steering Symbol).
(2) Recon Steering Symbol	Provides command bank information via azimuth displacement from velocity vector.
(3) Target Designator, Hexagon	Displays target position referenced to the aircraft navigation system.
(4) Command Ground Track Line (CGTL)	Displays the path of the command ground track. Indicates cross track displacement error.
Camera Selection Legend	Displays the camera operational mode. First letter indicates frame position: V=vertical, F=forward, blank=not selected. Second letter indicates pan position: C=center, R=right, L=left, or blank=not selected. Third letter indicates IRLS position: N=narrow field of view; W=wide field of view; S=Standby; or blank=not selected. (Note – This is only available on the HUD)

Note

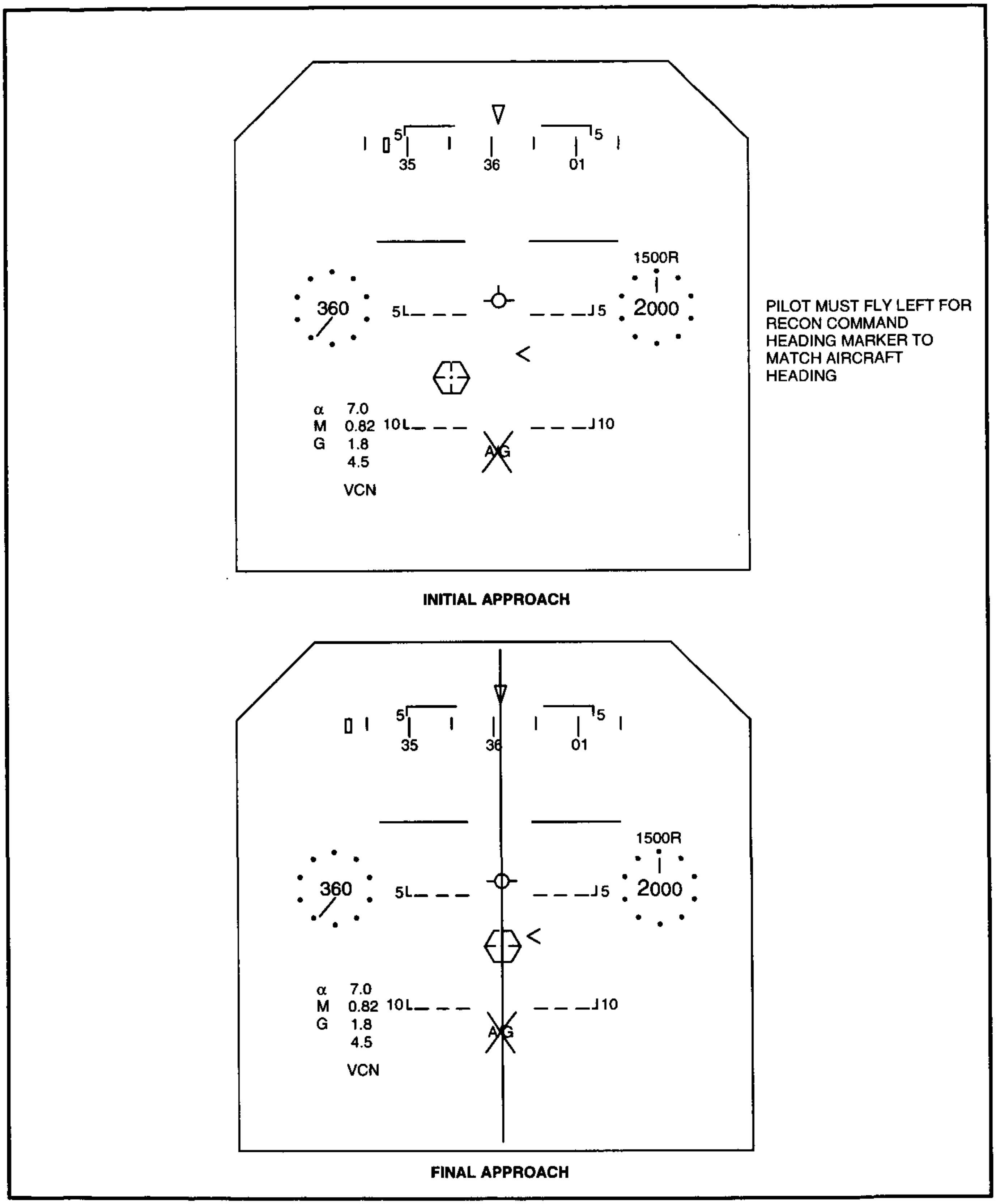
When weapon is selected in A/A, the Recon Steering Symbol set (which includes the Recon Steering Symbol; GCTL; Recon Target Designator, and Recon Command Heading Marker) will be displayed on the VDI

Figure 22-8. HUD/VDI Reconnaissance Symbology (Sheet 2 of 2)



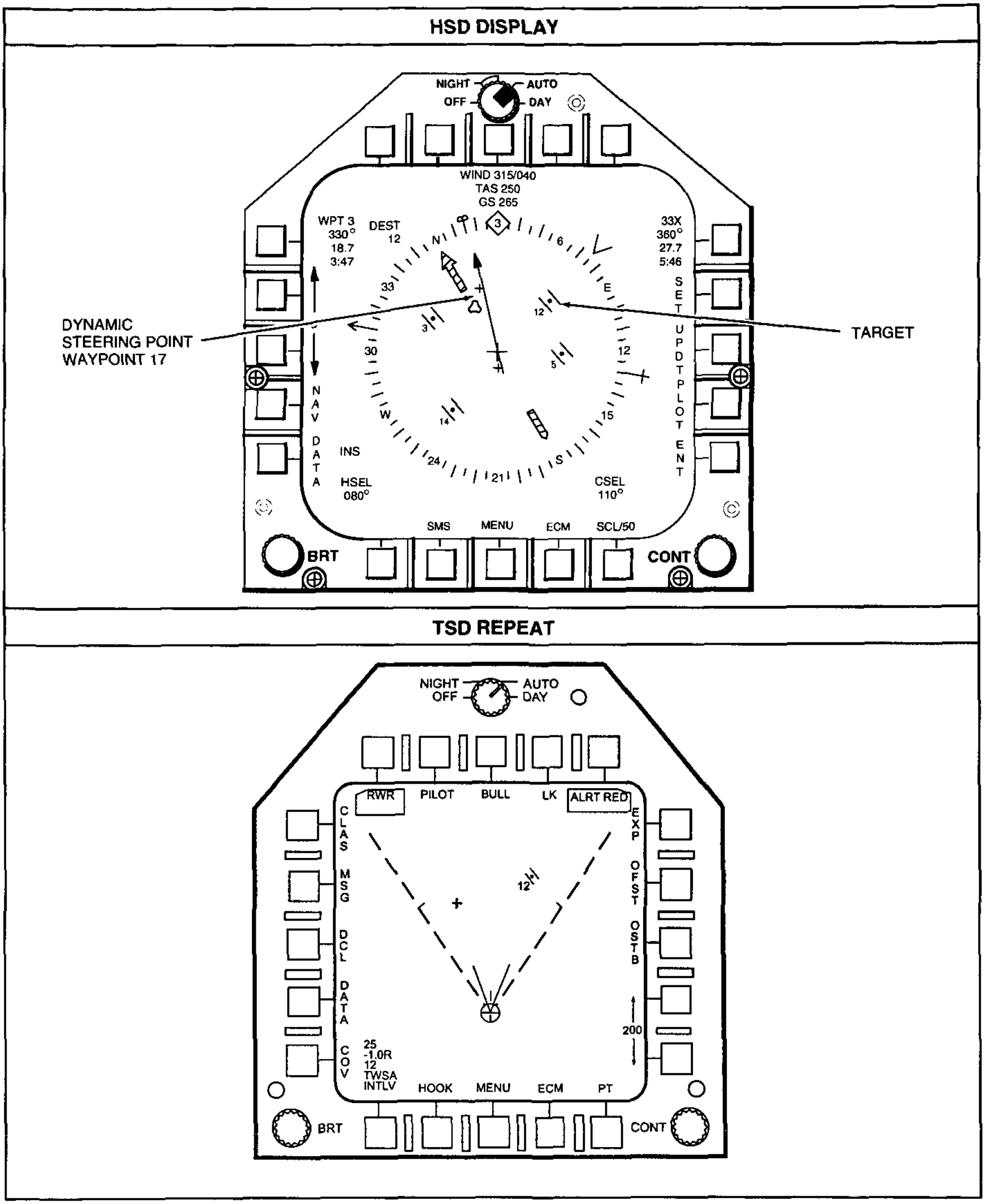
(AT)3-F50D-313-1

Figure 22-9. HUD Reconnaissance Display (Command Course Steering) (Sheet 1 of 2)



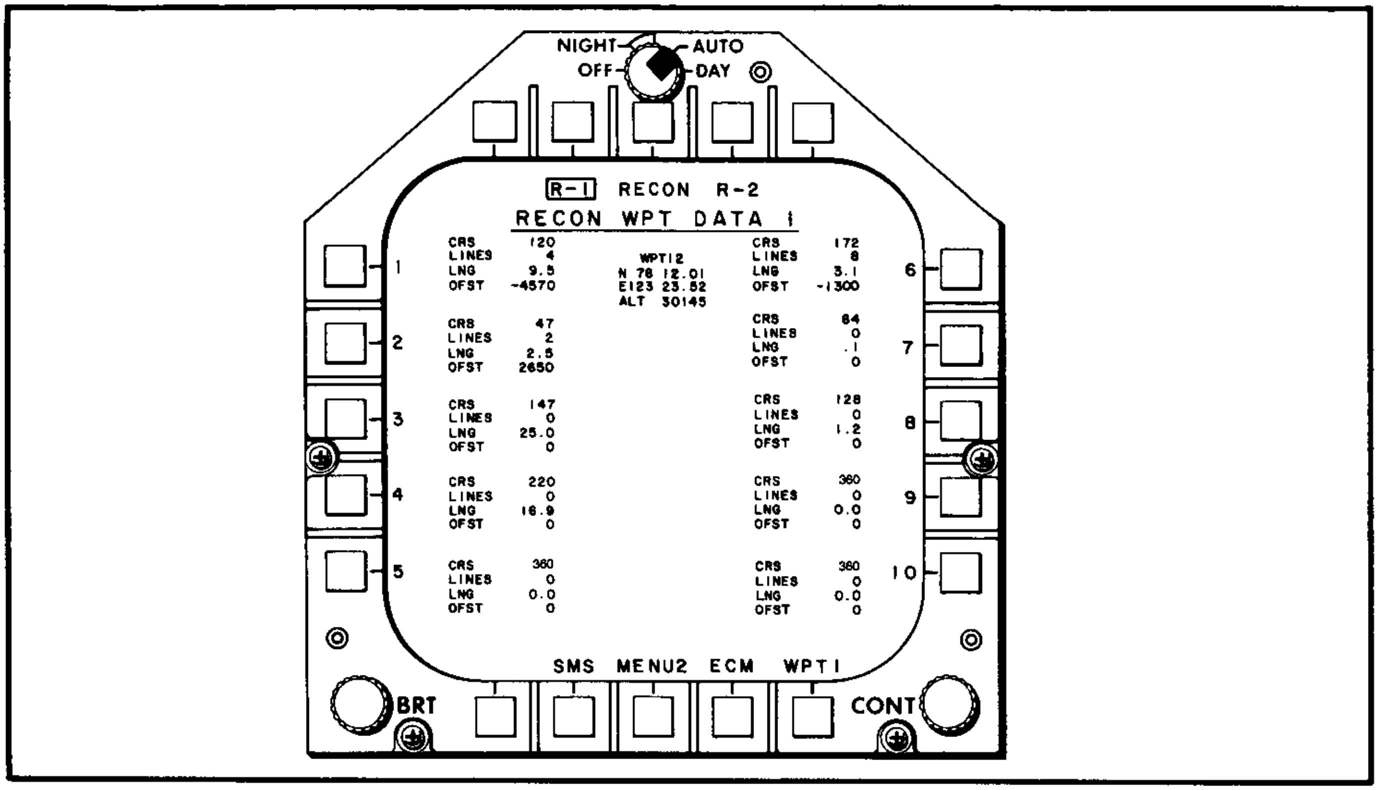
(AT)3-F50D-313-2

Figure 22-9. HUD Reconnaissance Display (Command Course Steering) (Sheet 2 of 2)



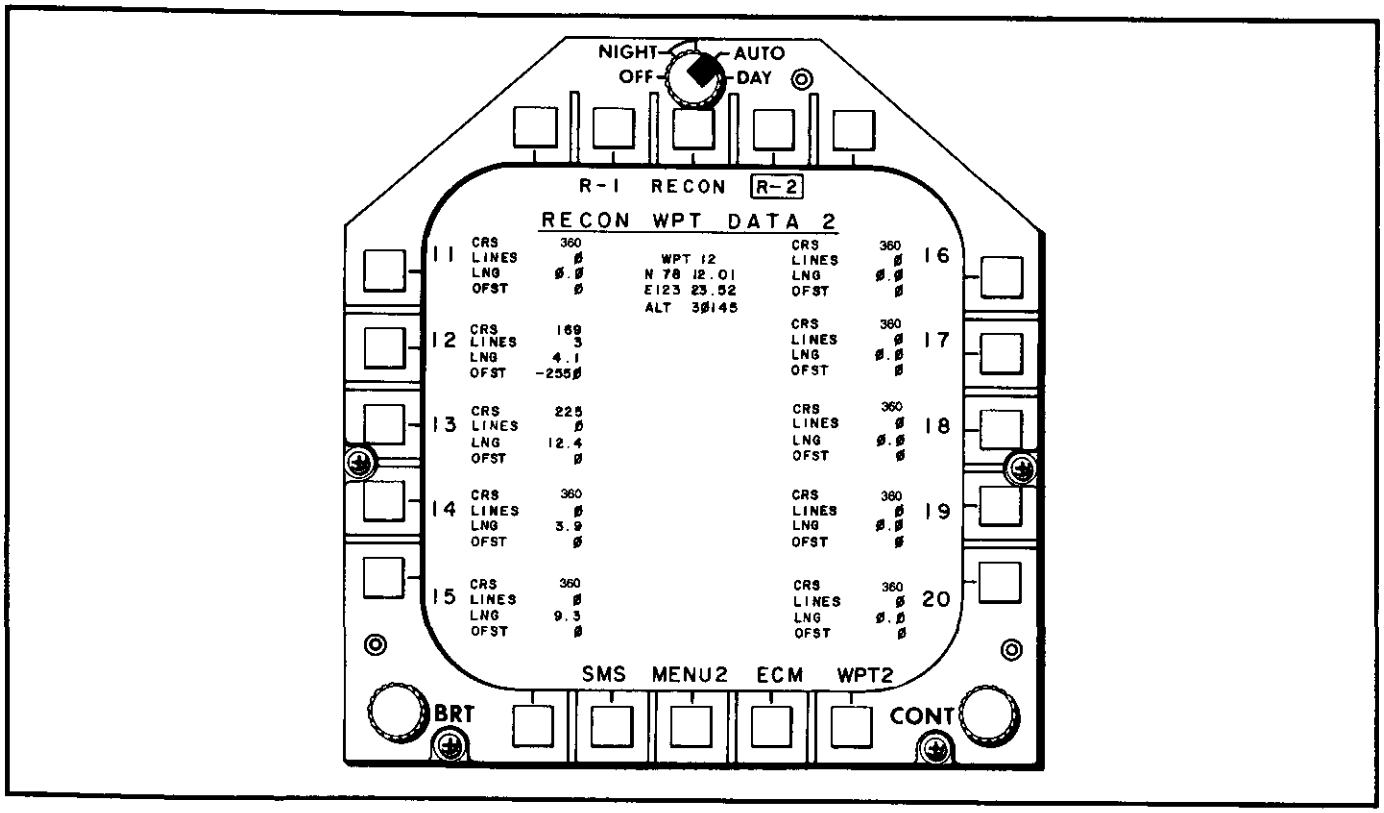
(AT)3-F50D-455-0
N2/97

Figure 22-10. Dynamic Steering Point Display



1-F50D-308-0

Figure 22-11. MFD RECON WPT DATA 1 Format



1-F50D-309-0

Figure 22-12. MFD RECON WPT DATA 2 Format

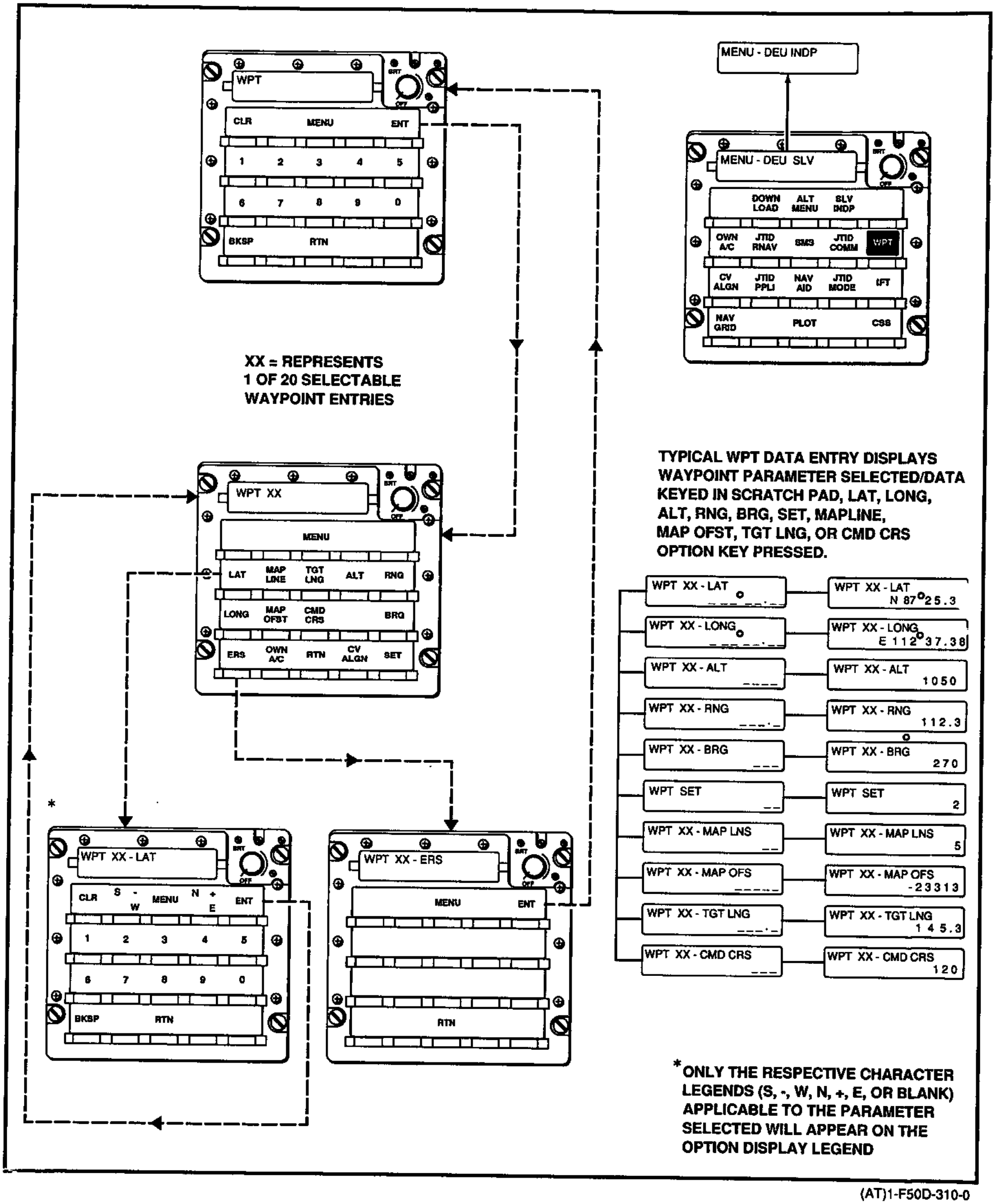


Figure 22-13. DEU Reconnaissance Selection

22.5.2 In-Flight Entry of Reconnaissance Waypoint Parameters. The RIO may update the waypoint file at any time when a reconnaissance steering mode is engaged, without affecting the current steering. In order for the pilot to use the updated reconnaissance parameters, he must reselect the steering mode.

22.5.3 One-Fix Update. Unless the aircraft is flying in a JTIDS net, it is recommended that one-fix position update be performed just prior to flying over the intended target to minimize miss distance. Refer to Chapter 20 for the procedures for one-fix position updates.

22.5.4 Plotting Command Course/Map Target Leg. This optional procedure provides the flightcrew with additional steering cue/information on the HSD. If a file waypoint is available, the RIO may use this waypoint to mark the end of a target leg by performing the following steps:

1. On the DEU, select WPT and enter the designated waypoint for reconnaissance.
2. Select RNG and enter the target length of the reconnoitered target.
3. Select BRG and enter the command course of the reconnoitered target.
4. Press SET and enter the number of the available (or free) waypoint.
5. Select MENU.
6. Select PLOT.
7. Select DRAW. The DEU will respond "Plot from . . ." Enter waypoint number to which aircraft is flying. When DEU responds "Plot to . . .," enter the waypoint number used in step 4.

22.5.5 Cycling Sensors. The RIO will put the FILM switch on the CPS in the RUN position when the RANGE-TO-GO goes to zero or transitions to RANGE REMAINING. The RIO will turn off the selected sensors when RANGE REMAINING goes to zero.

22.6 PILOT RECONNAISSANCE OPERATION

A sensor operating button is provided on the pilot control stick. With the SYSTEM switch on the controller processor signal unit set to RDY and any or all sensor selector switches in the ready position, the activated sensor can be cycled by the pilot pressing the BOMB button on the control stick. This is the only TARPS control capability provided to the pilot. Each camera will cycle at its proper rate for velocity/height ratio (V/H) and the IRLS will run continuously at the proper speed until the pilot releases the BOMB button.

Note

The BOMB button will not initiate camera operation with the expanded chaff adapter installed.

22.6.1 Navigation Visual Surface Waypoint Update. Unless the aircraft is flying in a JTIDS net, it is recommended that the one-fix position update be performed just prior to flying over the intended target to minimize miss distance. Refer to one-fix position update in Chapter 20 for INS update operations.

22.6.2 Pilot TARPS Steering. TARPS aircraft steering is displayed on the VDI and on the HUD in A/G and A/A (weapon not selected). The VDI is selected via the MFD RECON DATA status format.

HUD TARPS steering using TARPS symbology (Figure 22-9) is obtained by selecting a reconnaissance steering mode (PTP, CCRS, or MAP) on the reconnaissance MFD RECON DATA status format.

Note

In addition to the steering cues, the reconnaissance target designator will be positioned on the HUD/VDI to indicate actual target position. (It is recommended to perform a surface waypoint update to the navigation system to ensure that the reconnaissance target designator will overlay the expected target site.) Steering is accomplished by noting the direction that the reconnaissance steering symbol is displaced from the velocity vector. Banking the aircraft in the same direction to achieve and maintain alignment of the two symbols will produce the desired flightpath. If in PTP steering, match aircraft heading with reconnaissance command heading marker.

At the completion of a PTP, CCRS, or MAP mission, the TARPS symbology will be removed from the HUD/VDI. In addition, the steering mode will become unboxed on the MFD RECON DATA status format. There is no sequencing of waypoints. To steer to the next waypoint, the desired waypoint number must be selected.

WARNING

Following steering too closely can result in pilot fixation to the exclusion of safe altitude control.

22.6.3 Identification of Targets Using Television Camera Set. The aircrew can enhance their ability to identify ground targets by using the TCS. The TCS is slaved to the reconnaissance target line of sight when RADAR is selected as MASTER on the SSP, MAN ACQ is selected on the DD, and wide field of view is selected.

22.6.4 Altitude (AGL) Mechanization. AGL information for F-14D/TARPS software calculation of Vg/H uses the following sources in the order given:

1. APN-194 radar altimeter — This altitude source is used under the following conditions (when the APN-194 is operating properly):

   a. System altitude is less than 2,500 feet.

   b. System altitude is between 2,500 and 5,000 feet and radar altimeter is selected on the PDCP.

   When the radar altimeter is being used, an "R" is placed by the altitude reading on the HUD/VDI. (Figure 22-8)

2. APG-71 radar altitude — Altitude will be calculated using a 55° lookdown angle, earth stabilized antenna (TARPS AGR mode). This source will be used if above 5,000 feet or the APN-194 is inoperative. AGR must be selected on the MFD RECON DATA status format. The radar altitude is being used to compute the AGL when AGR is boxed (Figure 22-5).

3. Own-ship system altitude (selected waypoint) — Used whenever the APN-194 and APG-71 derived altitude are not available. AGL is calculated as system altitude minus selected waypoint altitude.

Note

Valid target altitude is nonzero. An altitude of zero is considered invalid.

4. Own-ship system altitude (hostile area) — Used when the APN-194 and APG-71 derived altitude are not available and the target altitude is invalid (waypoint contains zero altitude). The AGL is calculated as the navigation system altitude minus the hostile area altitude. The hostile area altitude is chosen that represents the average terrain in the area of interest and inserted into the hostile area waypoint prior to flight.

In the event of data transmission failure or navigation system failure, as indicated by the DATA light on the CPS, which is addressed by the TARPS advisory on the MFD, the RIO must manually enter the velocity and AGL. This entry of velocity (groundspeed) and AGL is facilitated via the velocity and altitude thumbwheels on the CPS. Manual Vg/H (AGL) may be selected at any time by the RIO and should be used instead of steps 3 or 4 above when doubt exists as to the quality of the inputs.

22.7 SENSOR CAPABILITIES AND LIMITATIONS

22.7.1 Lineal Coverage. Total lineal coverage available for specific sensors depends on film load and altitude. Complete lineal coverage data for all sensors will be provided in the F-14 Tactical Manual (NWP 3-22.5-F14A/B, NAVAIR 01-F14AAA-1T) and Tactical Pocket Guide (NWP 3-22.5-F14A/B PG, NAVAIR 01-F14AAA-1T-3).

22.7.2 Serial Frame Camera. The KS-87D serial frame camera has a fixed-focus, 6-inch focal length lens, weighs about 79 pounds, and can hold up to 1,000 feet of 2.5 mil thick, 5-inch film.

The fixed focus is set at a hyperfocal distance of 1,339 feet, which gives excellent imagery from about 750 feet to medium altitudes. Below 750 feet, the imagery is less sharp but is still good down to about 500 feet. The KS-87D provides a 41° field of view with a 4.5 X 4.5-inch negative. A full 1,000-foot roll allows 2,400 exposures.

The RHA exposes a data block on each frame. The data is encoded BCD, A/N, or alternate BCD and A/N. The data block provides time, date, latitude, longitude, altitude, drift, heading, pitch, roll, classification (if known in advance), and a mission code. The BCD also provides Vg/H, which allows the aircraft velocity to be calculated.

The KS-87D two-position mount allows the RIO to select vertical (VERT) or forward (FWD). In the vertical position, the KS-87 backs up the pan camera and is also used for bomb damage assessment, route reconnaissance, and is the primary camera for mapping missions. The forward position looks 16° down from the horizon and is very useful for pilot's view flightpath tracing and ship surveillance photography. Changing the mount position requires about 16 seconds and a mount fail indication will result if the transition is not complete within 23 seconds. Frequent FWD-VERT switching can cause the mechanical drive to overheat and seize, resulting in a mount fail. The mount will automatically move to vertical when the SYSTEM switch is at RDY and the FRAME switch is turned OFF, or if the landing gear handle is moved to DN.

The KS-87D can be reloaded or replaced in approximately 10 minutes and with the aircraft's engines turning, if necessary.

Figure 22-14 summarizes some specific characteristics and information on the KS-87D serial frame camera.

22.7.3 Panoramic Camera. The KA-99A is a 9-inch focal length, f/4.0 lens panoramic camera that provides high-quality, medium- to low-altitude imagery. Located in bay 2, the KA-99A offers full horizon-to-horizon imagery with 55-percent overlap up to a maximum of 1.06 Vg/H (8 cps). When external fuel tanks are installed, the field of view is reduced about 25° on the right and 17° on the left. The film cassette will hold a maximum of 2,000 feet of film. A single exposure measures 4.5 X 28 inches, and a data code block appears between each frame. The camera will indicate FAIL when the film load is down to approximately 40 exposures, preventing the film bitter end from going through the high-speed drive gears and causing camera damage. The KA-99A will automatically focus down to approximately 500 feet but will revert to a focus altitude of 6,000 feet if the TARPS program fails to input and there is no manual input of V/H from the CPS.

The RIO may select CTR, LEFT, or RIGHT for the KA-99A on the CPS. When LEFT or RIGHT is selected, the camera uses only the light sensor on the side selected instead of averaging the two as it does when CTR is selected; in addition, the cycle rate and FMC are based on the slant range distance from aircraft to the ground at a 30° depression angle. To avoid degraded imagery, do not use LEFT or RIGHT settings below 1,500-foot altitude. The KA-99A can be set for air to air (focus on

Focal length	6 inches
Diaphragm range	f 2.8 to 6.7
Field of view	41° x 41°
Negative Format	4.5 x 4.5 inches
Vg/H Range*	0.01 to 1.18
Maximum Cycle Rate	6 cycles per second
Effective Shutter Speeds	1/60 to 1/3,000
Filters	Yellow, red, or none
Angle of View	Vertical or Forward (16° below horizon)
Hyperfocal Distance**	1339 feet (fixed focus)

*Vg/H is listed as a knots per foot of altitude ratio (computed for vertical camera position only). The DDS is capable of generating a maximum of 1.42 Vg/H.

**The hyperfocal distance is the distance from the optical center of the lens to the nearest point of acceptable sharp focus, when focused at infinity. The sensor may be effectively used well below the hyperfocal distance, but will render increasingly soft imagery at lower altitudes.

The automatic exposure control (AEC) system uses an external light meter. The AEC can be overridden (plus-or-minus one F-stop) on the CPS.

The mount requires approximately 16 seconds to move the camera from vertical to forward, or back to vertical. The Cps will display a mount fail light if the transition is not completed within 23 seconds.

Optional 3 inch focal length lens available.

Figure 22-14. KS-87D Serial Frame Camera Characteristics infinity, no FMC, and 1 cycle per second) on the CIPDU. There is no cockpit indication that air-to-air settings have been selected. The KA-99 is favored by flightcrews on combat missions because its horizon-to-horizon lateral coverage allows it to be used with a considerable offset. This capability increases the flightcrew's probability of successfully completing the mission in defended areas where evasive combat maneuvering will be necessary. Although it is not necessary for the aircraft to be flown wings level when photographing a target with the KA-99 camera, the lack of roll-rate stabilization dictates that an established angle of bank be maintained while the target is within the camera's FOV.

Figure 22-15 summarizes some specific characteristics and information on the KA-99A panoramic camera.

22.7.4 Long-Range Oblique Photography Camera (KS-153A With 610-Mm Lens). The KS-153A still picture camera set is a modular, pulse-operated, sequential-frame camera designed for oblique or vertical reconnaissance photography at medium to high altitude. Two configurations are available:

1. Low-altitude, high-speed photography (80 mm focal length tri-lens configuration)

2. Medium-altitude standoff (610 mm/24-inch focal length standoff configuration)

The 24-inch standoff configuration will be utilized to replace the KA-93C LOROP sensor and will be mounted in bay 2 of the TARPS pod in lieu of the KA-99.

Focal Length	9 inches
Maximum Aperture	f/4.0
Field Of View	28° x 180°
Negative Format	4.5 x 28 inches
Vg/H Range	0.5 to 1.06
Maximum Cycle Rate	8 cycles per second
Effective Shutter Speeds	1/43 to 1/22,600
Filters	Yellow, red, or clear
Forward Overlap	CTR 55% at NADIR; L/R 55% at 30° below side horizon
Film Load	2,000 feet (2.5 mil); 800 exposures (750 usable)

Note

- The Automatic Exposure Control (AEC) system uses internally mounted light meters which average the scanned field. AEC can be overridden (± 1 Fstop) in–flight with the CPS.
- Sensor does not have roll stabilization, thus aircraft rolling will alter angle of view and may blur imagery.
- Maximum listed Vg/H can be exceeded, but the imagery will be degraded by incorrect FMC and reduced overlap.

Figure 22-15. KA-99A Panoramic Camera Characteristics

The KS-153A features true angle corrected FMC across the entire film format for any oblique angle; automatic range focus from 1,000 feet to infinity, and self-contained automatic temperature/pressure focus compensation; shutter priority automatic exposure control using preflight setting of aerial film speed and aircraft V/H signal; 12- or 56-percent preflight-selectable overlap; roll compensation; and data annotation. The 4.5-inch X 9-inch film format provides sequential frames 10.7° along-track and 21.4° across-track coverage on 9.5-inch wide film. This image format reduces processing time and allows direct stereo viewing without cutting the film.

The KS-153A can be programmed for any desired depression angle from horizon to horizon, limited in coverage only by the aircraft fuel tanks (17° left, 25° right). Typically, the KS-153A will be preprogrammed for the following three depression angles: 27° left oblique, vertical, and 31° right oblique. These are selected using the LEFT, CTR, and RIGHT positions on the CPS PAN camera control switch. When selected, a 21.4° scan will be used, centered about the preset oblique angle. Depression angles cannot be changed in flight.

Figure 22-16 summarizes some specific characteristics and information on the KS-153A standoff camera.

22.7.5 Photographic Film. Film can be separated by general type as follows:

1. Black and white film:

    a. Aerial film speed

    b. Resolution

    c. Spectral sensitivity

2. Color film:

    a. Aerial film speed

    b. Negative/reversal

    c. Camouflage detection infrared.

Film speed is a value assigned to a specific film to enable you to determine the correct exposure in various light conditions. High-speed films are required for low-available-light missions and for high-speed, low-level missions where very fast shutter speeds are required. High-resolution films provide greater detail but require more light. A film's spectral sensitivity means some colors will reproduce on the film better than other colors. Most of the common black and white films are panchromatic: sensitive to all three primary colors (red, green, and blue) that are found in normal daylight. Since the red light does not scatter in haze as much as blue, contrast filters are used to reduce the blue light. A yellow filter will pass the green and red light, eliminating the scattered blue light. A red filter will pass only the red light, eliminating the scattered blue and also the green (which scatters less than the blue). However, the yellow filter will normally require one additional f/stop of exposure and the dark red filter will normally require two additional f/stops of exposure. Some black and white films have extra sensitivity to infrared light. This film is most helpful in producing contrast detail between some objects that would tend to blend with normal films. Most notable would be the difference between water and vegetation. Color films produce greater shadow detail than black and white films and show color separation in some objects that would reproduce at the same density on black and white film. However, color film has less fine resolution to show very intricate detail in a target. Some color films are reversed in the processing, so that they reproduce the colors in the original scene without printing. These films are termed reversal or transparency film. CDIR color film is used to show contrasts between live vegetation and camouflage material. This greatly increases the chances of locating difficult targets. Aerial color films require expensive, complex processing that is not generally available at sea.

22.7.6 Infrared Reconnaissance Set. The AAD-5 infrared line scanning detector is a passive detector of energy in the far infrared region. The most striking characteristic of the AAD-5 is its ability to detect thermal activity, such as the hot-water discharge of a power plant, the heat from the boiler of a ship, or the thermal shadow left on a runway or ramp by a departed aircraft. This characteristic can be used for many purposes, such as determining the state of readiness of ships in a harbor, judging the traffic load of an airfield, determining the quantity of P-O-L in storage tanks, determining whether buildings are occupied, and separating recent bomb craters from old ones. Since the AAD-5 IR detector cannot determine the difference between the radiated energy generated by activity and infrared (IR) energy reflected from the sun, some types of activity cannot be reliably detected during the day.

The natural phenomenon of crossover will cause land and water bodies to have identical IR signatures about 1 hour after sunrise and 1 hour after sunset. Missions flown to detect land and water contrast (such as bomb damage assessment on bridges) should avoid these times by at least 2 to 3 hours.

Focal Length	24 inches/610mm
Angular Field Of View	21.4 across track, 10.7 along track
Film Format	4.5 x 9.5 inches
Image Frame Format	9.06 inches across track, 4.53 inches along track
Frame overlap (preflight selected)	12% or 56%
Film Capacity	200 feet of 2.5 mil /2.47 frames per foot (500 feet optional)
Aperture Range	f/4 to f/16 continuously
Maximum Cycle Rate	4 frames per second
Average Resolution	75 Lp/mm, EK 3412
Shutter Speed Range	1/150 to 1/2,000 sec
Film Speed (preflight setting)	AFS 0 to AFS 999
Linear Coverage (200 feet film @ 30K, 12 nmi standoff @ 56% overlap)	467 nm
Weight (500 foot cassettes without film)	233 pounds
V/R Rate	0 – 0.196 knots/foot @ 56% 0 – 0.39 knots/foot @ 12% 1.25 knots/foot maximum
Camera Oblique Rotation (24 inch)	+/– 86° of vertical
Angle of View (preflight adjustable)	Vertical and left/right (at selected depression angles)

Note

- Optional yellow, red, orange, or clear filters.
- Shutter priority automatic exposure control by preflight film speed setting and aircraft V/H signal, accuracy 1/2 f/stop.
- Sensor will automatically compensate for altitude pressure (sea level to 5,000 feet) and temperature (25 °C to 45 °C stable within +/– 2°C).
- Sensor produces a LED matrix array data block with a 3 millisecond write time.

Figure 22-16. KS-153A Still Picture Camera Characteristics (610-Mm Standoff Configuration)

The AAD-5 IR detector is not an all-weather sensor. It cannot collect imagery through clouds or extremely heavy haze. It is relatively unaffected by smoke.

At low altitudes, the AAD-5 IR detector is a relatively good identification sensor. At higher altitudes, it may be adequate only for detection or general identification, depending on the type of target. A special ground resolution chart is included in Tactical Manual NWP-3-22.5-F14A/B (NAVAIR 01-F14AAA-1T).

The AAD-5 IR detector is fully roll and roll-rate stabilized from a 0° to 20° angle of bank in NFOV and 0° to 4° angle of bank in WFOV. Beyond angle-of-bank limits, a steady bank angle will not seriously degrade IR imagery. This feature makes it a highly practical sensor for combat maneuvering situations. Because of varying scale at the outer edges, the target should be placed within the center 90° of the format.

The AAD-5 IR detector can be reloaded in approximately 10 minutes and with the aircraft engines turning. The system is made up of several modular sections that can be replaced rapidly (in about 15 minutes). Replacement of the entire system requires in excess of 45 minutes.

22.7.7 Digital Data System. The reconnaissance pod carries a digital data system that interfaces with the aircraft inertial navigational system, altimeters, computers, and standard heading reference system to automatically control and integrate the reconnaissance system.

Reconnaissance system control is accomplished by the data converter. Sensor stabilization signals and operating rate voltages are generated and routed to the sensors. Stabilization signals are provided from the inertial navigation system, or, if it fails, from the SAHRS. Operating rate signals are determined from inertial navigation and radar altimeter inputs. A semiautomatic backup method of generating Vg/H signals is available if the inertial navigation system fails. A fully manual option is available through the CPS if other components (including the data converter) fail. Maximum automatic Vg/H is 1.42 knots per foot.

If the aircraft is carrying a TARPS pod, negative AGL causes the MAN Vg/H light on the CPS panel to be lit. This light goes out when AGL becomes positive. Without a TARPS pod on the aircraft, negative AGL does not light the MAN Vg/H light. CADC or computer failure, however, causes the light to be lit with or without a pod aboard.

Reconnaissance system integration is accomplished through digital information from the data converter, which is translated into binary or alphanumeric form and added to preset information and real time, which is adjusted prior to flight. Code matrix boxes are printed on all imagery in either binary or alphanumeric form. Integration information includes data, squadron and detachment, sortie, sensor identification, system altitude, heading, roll, pitch, latitude, longitude, radar altitude, time, inertial navigation system status, relative drift to ground track, and Vg/H.

CHAPTER 23

Navigation Command and Control Grid

23.1 NAVIGATION COMMAND AND CONTROL GRID

NAV GRID enhances fleet air defense by providing navigation command and control information during combat air patrol operations and for fleet defense of a specific fixed position. NAV GRID provides aircraft position relative to a geographic reference point (grid origin) that is common to all fleet defense units. This eliminates dependence on navigation aids such as tacan for position reference during AAW operations. Combat air patrols using NAV GRID can report target contacts using grid coordinates or range and bearing relative to grid origin (TID only) in addition to normal reports referenced to own-aircraft position.

23.1.1 NAV GRID Data Entry. In order to display a NAV GRID, the RIO must first define the following parameters:

1. Grid origin, either in latitude and longitude coordinates or as a range and bearing from own-aircraft.

2. Grid heading (threat axis), in degrees, from 0 to 359° (magnetic).

3. Grid coverage angle (threat sector, in degrees, from 0° to 180°). Grid heading will always define the center of the total grid coverage.

4. Number of grid sectors, from 1 to 6. Total grid coverage angle divided by the number of sectors yields the angular coverage of each sector.

Grid parameters can be entered via the DEU or the DD computer address panel. The DEU NAV GRID parameters are used for NAV GRID entries and are the primary entry device with the DD as the backup.

23.1.1.1 DEU Data Entry Procedures. (See Figure 23-1.)

1. From the DEU menu page, select NAV GRID.

2. Using the NAV GRID page, enter the following parameters:

   a. Latitude and longitude (LAT, LONG) of grid origin, or range and bearing (RNG, BRG) from own-aircraft to grid origin.

   b. Threat axis heading (HDG) (°0 to 359°).

   c. Grid coverage angle (COVR) (0° to 180°).

   d. Number of grid sectors (SECT) (1 to 6).

23.1.1.2 DD Data Entry Procedures

1. On the DD, press the MFK pushtile to bring up the MFK menu on the display.

2. On the MFK menu, select the SPL legend to bring up the SPL menu on the display.

3. Select NAV GRID legend on the SPL menu (Figure 23-2).

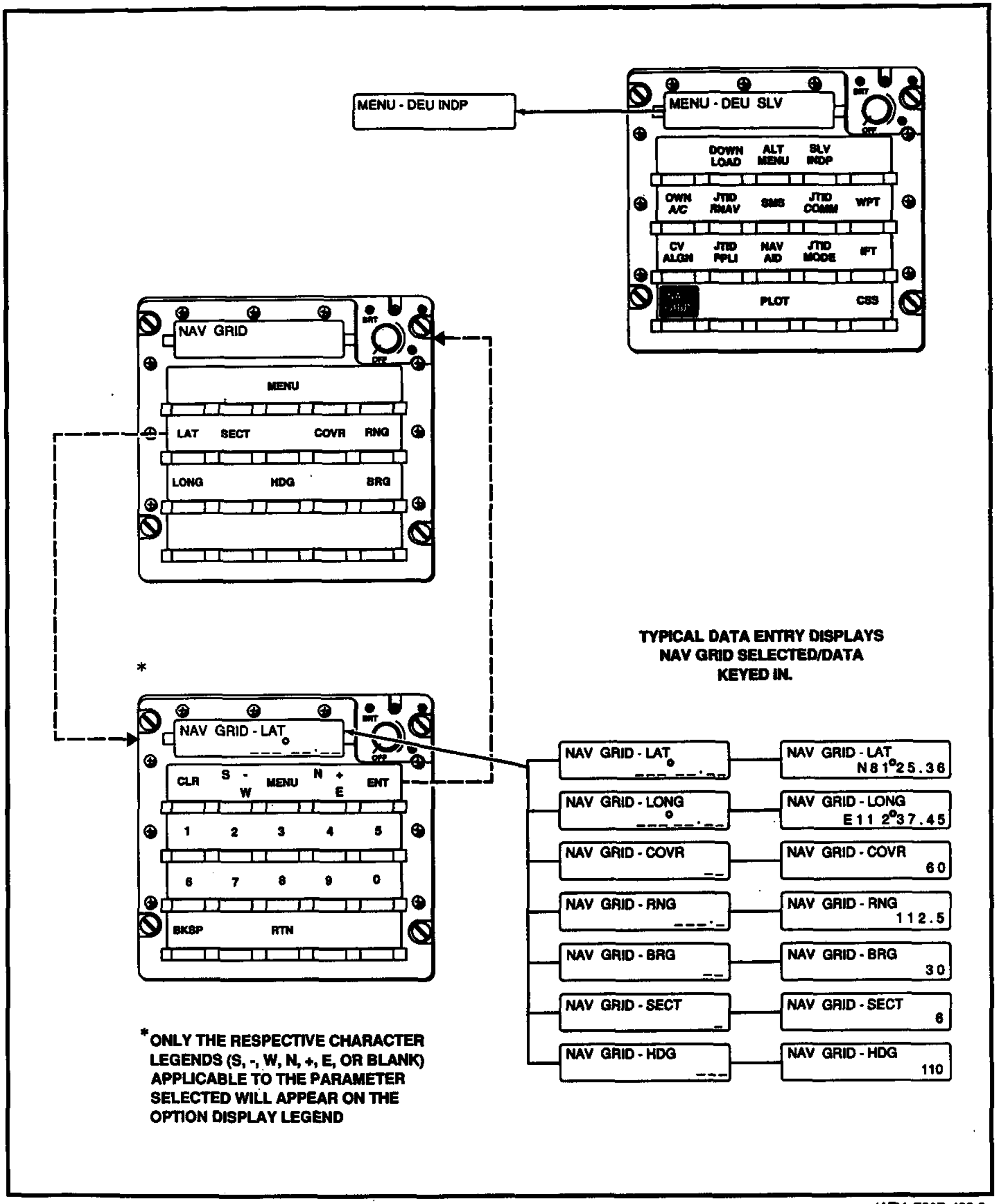
4. On the DD keyboard, enter:

   a. Latitude and longitude (LAT, LONG) of grid origin, or range and bearing (RNG, BRG) from own-aircraft to grid origin.

   b. Azimuth scan coverage (grid coverage angle) (ALT) (0° to 180°).

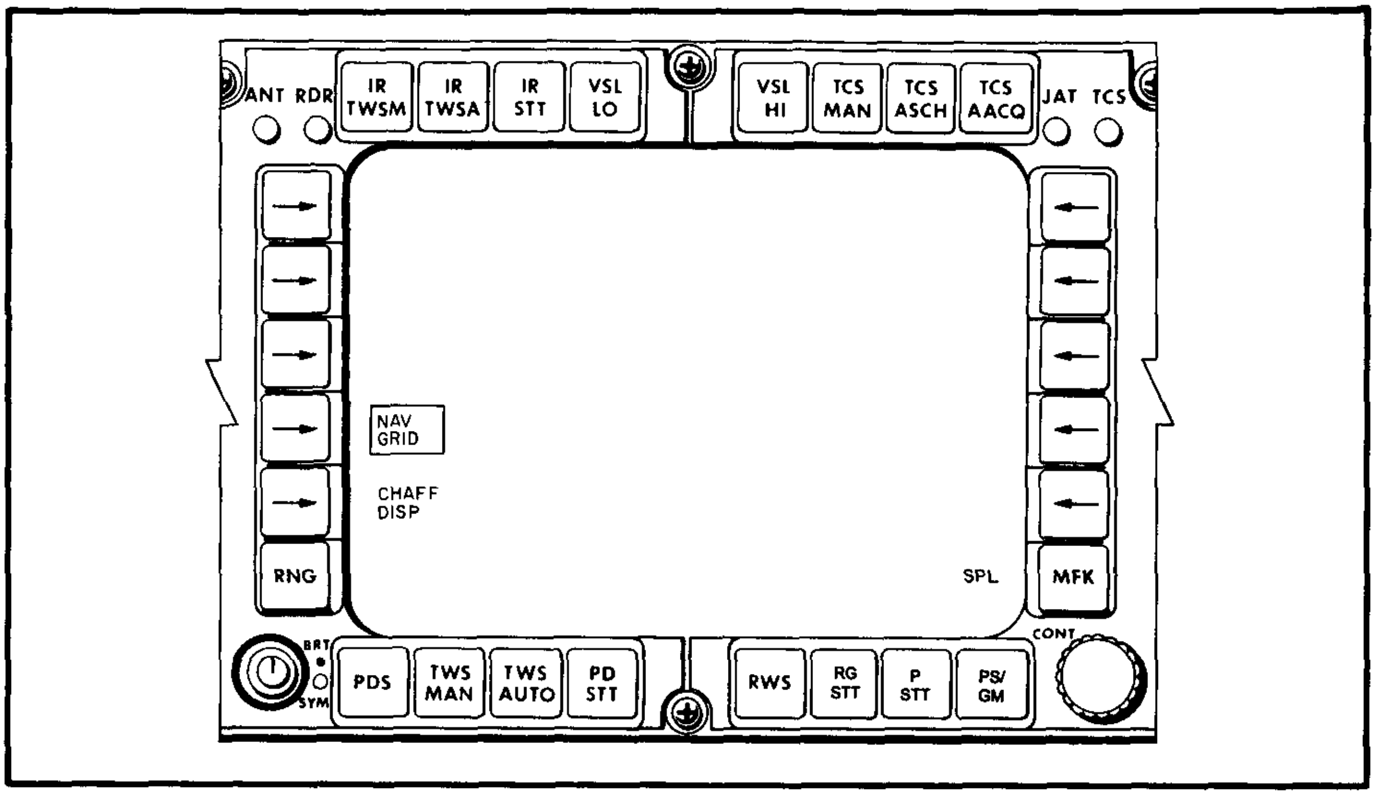
   c. Azimuth scan center (threat axis heading) (HDG) (0° to 359°).

   d. Number of grid sectors (NBR) (1 to 6).



(AT)1-F50D-408-0

Figure 23-1. DEU NAV GRID Data Entry — Typical



1-F50D-406-0
N2/97

Figure 23-2. DD NAV GRID Data Entry

23.1.2 NAV GRID Displays. NAV GRID can be displayed independently on both the TSD and TID in either a ground-stabilized or aircraft-stabilized format.

23.1.2.1 Tactical Information Display. The TID NAV GRID display is enabled by selecting the A/C STAB position of the TID mode switch. Selecting this position directly from ATTK results in an aircraft-stabilized NAV GRID. Own aircraft is fixed at the bottom center of the TID with the top of the display oriented to own-aircraft magnetic heading (Figure 23-3, detail A).

A ground-stabilized NAV GRID display on the TID is achieved by moving the TID MODE switch to GND STAB then to A/C STAB. Own aircraft is initially displayed at the center of the TID. The top of the TID is oriented to magnetic north. Own-aircraft and sensor tracks transit the display in the direction of magnetic heading at own-aircraft groundspeed while the grid and any waypoint positions remain fixed (Figure 23-3, detail B).

The grid itself is represented by grid strobes emanating from grid origin. Grid center is oriented to grid heading (threat axis) with each sector bounded by two strobes. Short tic marks on the strobes represent 50-mile increments from grid origin; longer tic marks represent 100-mile increments. A maximum of seven range tics (350 miles) is displayed. When the grid contains six sectors, no range tics are displayed on the center strobe.

Selectable range scales are 25, 50, 100, 200, and 400 in either stabilized mode. A TID offset can be utilized to reposition own-aircraft anywhere on the display. The grid is repositioned accordingly and may only be partially displayed (Figure 23-3, details B and C). Offset positioning is canceled by momentarily cycling out of the selected STAB mode.

Tactical use of the NAV GRID often makes it desirable to reference tracks, waypoints, or own-aircraft position as a range and bearing from grid origin rather than from own-aircraft. This is accomplished by RIO selection of NAV GRID on the DD (SPL category) as shown in Figure 23-2.

23.1.2.2 Tactical Situation Display. The TSD format can be selected on any MFD. NAV GRID can be selected for display via the GRID pushtile on the TSD DCL format (Figure 23-4). Like the TID, the TSD can

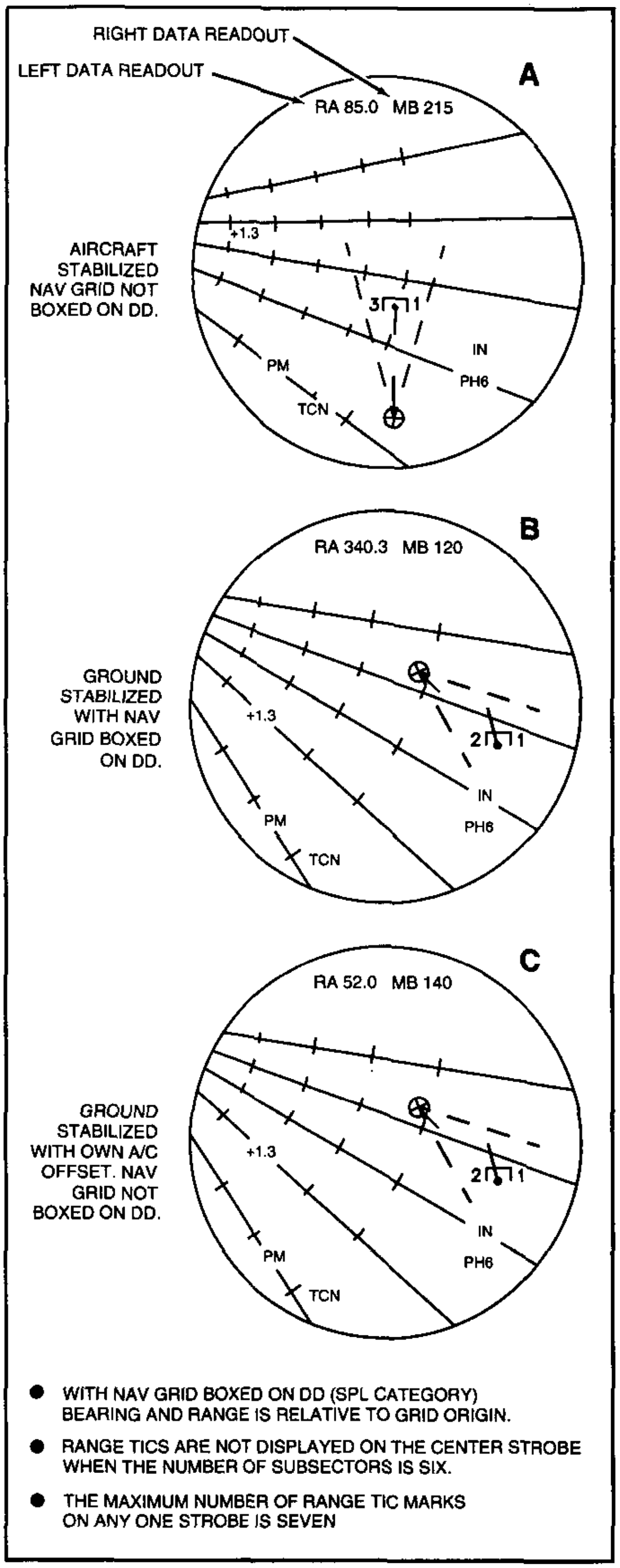


Figure 23-3. TID NAV GRID Displays

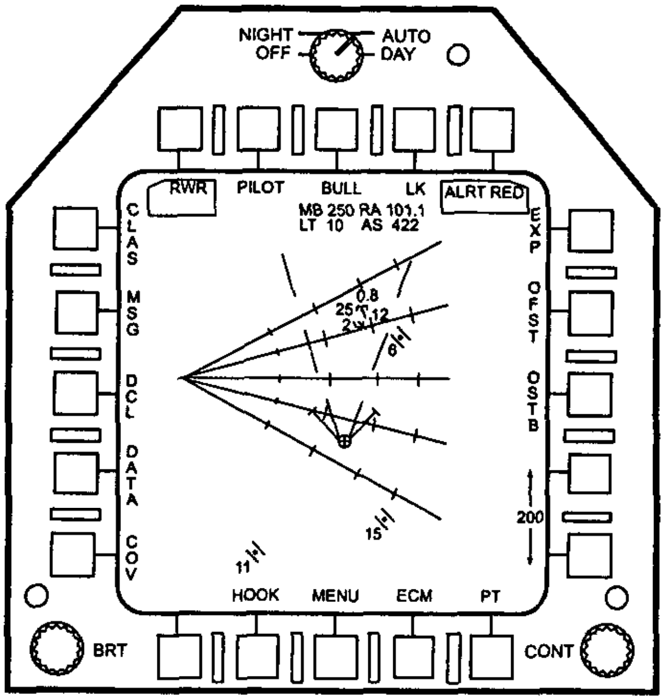


Figure 23-4. TSD NAV GRID Display

display the NAV GRID in either ground- or aircraft-stabilized formats as selected by the GSTAB or ASTAB pushtiles. The ASTAB display has own-aircraft position fixed on the lower third of the display with the top of the display representing own-aircraft magnetic heading. The GSTAB display initializes with own-aircraft at the center of the display. The top of the display represents magnetic north. Own-aircraft and sensor tracks transit the display based on magnetic heading and groundspeed while the grid and any waypoint positions remain fixed.

The grid itself is displayed as on the TID, with up to six sectors defined by strobes emanating from grid origin and centered on grid heading (threat axis). Short and long tic marks represent 50- and 100-mile increments, respectively. Any TSD range scale (25, 50, 100, 200, or 400) is selectable. Future software will include an OFFSET and EXPAND capability for all TSD formats. Unlike the TID, bearing and range data hooked tracks or waypoints cannot be referenced to grid origin.

CHAPTER 24

LANTIRN Targeting System

Reserved.

PART IX

Flightcrew Coordination

Chapter 37 — Flightcrew Coordination

Chapter 38 — Aircraft Self-Test

CHAPTER 37

Flightcrew Coordination

37.1 INTRODUCTION

The duties of the pilot/RIO team are necessarily integrated and contribute to the performance of the other. Successful crew interaction can provide cockpit synergy that significantly improves mission success. However, a pilot/RIO team that does not interact successfully can be a major detriment to mission success. In this chapter, specific responsibilities are delineated for each phase of flight. Specific mission flightcrew responsibilities are also delineated.

37.2 PILOT AND RIO RESPONSIBILITIES

37.2.1 Aircrew Coordination. Aircrew coordination is the flightcrew's use and integration of all available skills and resources in order to collectively achieve and maintain crew efficiency, situation awareness, and mission effectiveness. Integration of the flightcrew's activities will provide error protection through human redundancy. Crew coordination is one of the most significant factors toward mission success.

37.2.2 Pilot Responsibilities. The pilot is the aircraft commander and responsible for the safe and orderly flight of the aircraft and the well-being of the crew. In the absence of direct orders from higher authority cognizant of the mission, responsibility for starting or continuing a mission with respect to the weather, mission environment, or any other condition affecting the safety of the aircraft rests with the pilot.

37.2.3 Radar Intercept Officer Responsibilities. The RIO constitutes an extension of the pilot's observation facilities. By intercommunication, the RIO should anticipate rather than await developments in flight. The RIO will be a safety backup for the pilot. In this capacity, the RIO shall offer constructive comments and recommendations, as necessary, throughout the mission in order to maintain the safest and most effective flight environment. The RIO will be responsible for the reading of the checklists utilizing a challenge and reply system. The RIO will normally be responsible for all communications except in tactical situations.

37.2.4 Mission Commander. The mission commander may be either a pilot or a RIO. He shall be qualified in all phases of the assigned mission and be designated by the unit commanding officer. When the assigned mission commander is a RIO, he shall be responsible for all phases of the assigned mission except those aspects of safety of flight that are directly related to the physical control of the aircraft. The mission commander shall direct a coordinated plan of action and shall be responsible for the effective execution of that plan.

37.2.5 Specific Responsibilities

37.2.5.1 Flight Planning

37.2.5.1.1 Pilot. The pilot is responsible for the preparation of required charts, flight logs, and navigation computations including fuel planning, checking weather and NOTAMS, and for filing required flight plans.

37.2.5.1.2 RIO. The RIO is responsible for the preparation of charts, flight logs, navigation computations including fuel planning, checking NOTAMs, obtaining weather for filing purposes, and completing required flight plans.

37.2.5.2 Briefing. Accomplish those tasks delineated in the preceding paragraph.

37.2.5.2.1 Mission Commander. The mission commander, pilot or RIO, is responsible for briefing all crewmembers on all aspects of the mission to be flown. Refer to Chapter 6 of this manual for specific items.

37.2.5.3 Preflight

37.2.5.3.1 Pilot. The pilot is responsible for accepting and preflighting the assigned aircraft and coordinating preflight operational checks in accordance with this manual and appropriate preflight checks contained in NAVAIR 01-F14AAD-1B.

37.2.5.3.2 RIO. The RIO will be capable of, and proficient in, performing a complete aircraft preflight, including armament, in accordance with this manual and appropriate preflight checklists contained in NAVAIR 01-F14AAD-1B.

37.2.5.4 Prestart

37.2.5.4.1 Pilot. The pilot will execute prestart checks prescribed in NAVAIR 01-F14AAD-1B and, when external power is applied and checks requiring external power are completed, will inform the RIO "Prestart checks completed. Ready to start."

37.2.5.4.2 RIO. The RIO will execute prestart checks prescribed in NAVAIR 01-F14AAD-1B and, when external power is applied, will inform the pilot "Prestart checks completed."

37.2.5.5 Starting

37.2.5.5.1 Pilot. The pilot will start engines as prescribed in paragraph 7.4.3 and will keep the RIO informed of any unusual occurrences.

37.2.5.5.2 RIO. The RIO will remain alert for any emergency signal from the groundcrew and will inform the pilot if such signals are observed.

37.2.5.6 Poststart

37.2.5.6.1 Pilot. At completion of the emergency generator check, the pilot will inform the RIO "Emergency generator check complete." The pilot will complete all poststart checks prescribed in NAVAIR 01-F14AAD-1B and coordinate with the RIO the initiation of OBC.

37.2.5.6.2 RIO. At completion of the emergency generator check, the RIO will perform the poststart checks prescribed in NAVAIR 01-F14AAD-1B. When OBC is completed and the inertial navigation system aligned, the RIO informs the pilot, "Ready to taxi."

37.2.5.7 Pretakeoff

37.2.5.7.1 Pilot. The pilot will execute Pretakeoff, Instrument, and Takeoff Checklists prescribed in NAVAIR 01-F14AAD-1B and as posted in the aircraft. The pilot will report to the RIO Takeoff Checklist items, using the challenge-reply method. The pilot will receive the "Ready for takeoff" report from the RIO and advise him of type and configuration takeoff planned, prior to rolling or catapulting. The pilot will report "Rolling" or "Saluting," as appropriate, to the RIO.

37.2.5.7.2 RIO. The RIO will execute Pretakeoff Checklists prescribed in NAVAIR 01-F14AAD-1B; will initiate, using the challenge-reply method, the posted Takeoff Checklist in the aircraft; and, at completion of the Takeoff Checklist, RIO informs the pilot "Ready for takeoff."

37.2.5.8 Takeoff and Departure

37.2.5.8.1 Pilot. The pilot shall ensure that the intercom remains in HOT MIKE for normal flight operations and will report "Gear up" and "Flaps up" to the RIO insofar as safety permits. The RIO should be advised of any unusual occurrences during takeoff that may affect safety of flight. The pilot or RIO will request, copy, and acknowledge all clearances.

37.2.5.8.2 RIO. Where departures are made in actual instrument conditions, the RIO will monitor the published clearance departure procedures and inform the pilot of any deviation from the prescribed flightpath. The RIO will copy all clearances received and at all times be prepared to provide the pilot with clearance information of navigational information derived from these instruments. Built-in-test checks will not be conducted during instrument climbouts.

37.2.5.9 In Flight (General)

37.2.5.9.1 Pilot. The pilot will inform the RIO of any unusual occurrences and will ensure that the aircraft is operated within prescribed operating limitations at all times. The pilot or RIO will normally request, copy, and acknowledge all clearances.

37.2.5.9.2 RIO. The RIO will assist the pilot in normal or emergency situations, including navigation, communication, and visual lookout. The RIO will inform the pilot of the weapon system status. During ascent or descent, the RIO will inform the pilot 1,000 feet prior to the intended level-off altitude.

37.2.5.10 Intercept

37.2.5.10.1 Pilot. The pilot will maneuver or coordinate aircraft maneuvers with, or as directed by, the RIO, observing normal operating limitations. The pilot will inform the RIO of weapons status, weapons selected and armed, and when the target is sighted visually. The pilot will monitor aircraft position from initial vector through breakaway by pigeons information or navigational display.

37.2.5.10.2 RIO. The RIO will handle all communications from initial vector through breakaway, excluding missile-away transmissions; provide the pilot with descriptive commentary, including weapon status and target aspect, if available; and direct and coordinate aircraft maneuvers with the pilot, as necessary, to complete the intercept.

37.2.5.11 Instrument Approaches

37.2.5.11.1 Pilot. The pilot is responsible for the safe control of the aircraft, the decision to commence the approach with the existing weather, and the selection of the type of approach to be made. The pilot, before commencing any penetration, will report to the RIO the completion of each item of the Instrument Checklist. In addition, the pilot will challenge the RIO Instrument Penetration Checklist, as to approach plate availability and corrected altimeter setting.

37.2.5.11.2 RIO. The RIO will monitor aircraft instruments and appropriate approach plate during holding, penetration, and approach and shall be ready to provide the pilot with any required information. He shall be particularly alert to advise the pilot of deviations from the course of minimum altitudes prescribed on the approach plate. Built-in-test checks will not be conducted in actual instrument conditions. The RIO will inform the pilot of the status of the radar and will do nothing to cause the display to be lost. During penetrations and/or descents (VFR or IFR), the RIO will report to the pilot the aircraft descent through each 5,000 feet of altitude above 5,000 feet and each 1,000 feet of altitude loss below 5,000 feet, until, on reaching the desired altitude, the RIO will report when altitude error exceeds 10 percent of actual altitude or ±300 feet.

37.2.5.12 Landing

37.2.5.12.1 Pilot. The pilot will utilize the Landing checklist and will report each item to the RIO prior to reporting "Gear down, hook down" to the final controller, tower, or Pri-Fly. The pilot will receive a "Ready to land" report from the RIO.

37.2.5.12.2 RIO. In the landing pattern, the pilot shall read and the RIO acknowledge the posted Landing Checklist. The RIO shall visually check the flap position and landing gear position by looking through the opening on the left side of the instrument panel. The RIO will report "Ready to land" to the pilot. Built-in-test checks shall not be conducted while in the landing pattern.

37.2.5.13 Postflight

37.2.5.13.1 Pilot. The pilot will inform the RIO of any unusual occurrences on the landing roll or arrestment. The pilot will report flap and wing position to the RIO when clear of the runway or landing area and will report when the wing is actuated. The pilot will inform the RIO when shutting down engines. The pilot will conduct a postflight inspection of the aircraft.

37.2.5.13.2 RIO. The RIO will challenge the pilot on flap position if the report is not received. When informed by the pilot that the wing has been actuated, the RIO will visually verify wing and spoiler positioning. The RIO will complete the built-in-test checks remaining and secure that rear cockpit for shutdown, then notify the pilot "Ready for shutdown." The RIO will assist the pilot in conducting a postflight inspection of the aircraft.

Note

> The RIO will vacate the aircraft first and after the aircraft is on the ground, flight deck, or hangar deck, the pilot will exit. This is particularly important during shipboard operations.

37.2.5.14 Debriefing. The pilot and RIO will complete the yellow sheet and all required debriefing forms.

37.2.5.14.1 Maintenance. The pilot and RIO will complete the yellow sheet, BER card, and all other required maintenance debrief forms. The crew will ensure a complete debrief is provided for all maintenance discrepancies.

37.2.5.14.2 Mission. The mission commander will be responsible for conducting a thorough mission debrief to include the accomplishment of mission goals, adherence to SOP/ROE/NATOPS, intercockpit and flight communication, and conflict resolution.

37.3 SPECIAL CONSIDERATIONS

37.3.1 Functional Checkflights. The pilot and RIO shall brief with maintenance to determine the discrepancies that were corrected and the intentions of the functional checkflight.

37.3.1.1 Pilot. The pilot is responsible for adherence to all FCF procedures as described in NAVAIR 01-F14AAD-1F.

37.3.1.2 RIO. The RIO is responsible for monitoring the FCF procedures and the completion of specific tasking outlined in NAVAIR 01-F14AAD-1F.

37.3.2 Formation Flights

37.3.2.1 Formation Leader. A pilot will be designated the formation leader. The status of each member of the formation shall be briefed and clearly understood prior to takeoff. As a minimum, formation brief items shall include loss of sight, lost communication, inadvertent IMC, and formation integrity. The formation leader is responsible for the safe and orderly conduct of the formation. This includes visual lookout, the separation between aircraft within the formation and during transition periods, breakups, and rendezvous.

37.3.2.2 Pilot. The pilot is responsible for the safe separation of his aircraft and the other aircraft in the formation. Lead changes will include a positive acknowledgment by both pilots.

37.3.2.3 RIO. The RIO will monitor formation separation and closure during joinup and advise the pilot when an unsafe situation exists.

37.3.3 Training

37.3.3.1 Instructors. All instructors will be designated in formal directives by unit commanding officers. In FRS the instructor will be charged with authority and responsibility to provide proper direction to pilot and RIO replacements to ensure safe and successful completion of each training mission. On training missions where a pilot under instruction is the pilot in command, the instructor's guidance shall be advisory in nature and under no circumstance shall the pilot in command be relieved of his authority and responsibility as aircraft commander. Termination of the training or evaluation portions of the flight for reasons of safety, unsatisfactory performance, or material discrepancy shall be the instructor's prerogative.

37.3.4 SAR. The mission commander or senior member of the flight, should the mission commander be unavailable, shall assume responsibility for the rescue operation until relieved on scene or fuel dictates a return to base. The primary responsibility of the on-scene commander will be communication of the downed crew's position and condition to potential rescue aircraft or vessels. Additionally, the on-scene commander will ensure search coordination, traffic control on the scene, and provide communication with the downed crews if feasible.

37.4 PROCEDURES, TECHNIQUES, AND CHECKLISTS

37.4.1 General. Even though some of the procedures, techniques, and checklists are specifically designed for the pilot and RIO, the entire contents of the flight manual and pocket checklist should be thoroughly read, understood, discussed, and agreed upon collectively by the pilot-RIO team. Discrepancies in procedures or the need for additional procedures should be brought to the attention of the NATOPS evaluator and/or instructor. Most of the procedures (individual and coordinated) are covered in this manual and are grouped under flight phases and/or categories. Aircraft systems descriptions, with their individual operating criteria, are covered in Chapter 2. Classified systems descriptions and procedures, and some limitations information, are covered in the classified supplement (NAVAIR 01-F14AAD-1A). The pocket checklist (NAVAIR 01-F14AAD-1B) contains the pilot and RIO checklist items for preflight, prestart, start, poststart, takeoff, built-in test, instrument and descent, and postflight procedures. Improper crew coordination is usually an attributable factor to improper emergency procedures.

37.4.2 Pilot. The pilot should relate to the RIO all indications relevant to the ongoing emergency. The pilot should assess the situation, set emergency priority, and direct the RIO to effectively assist him.

37.4.3 RIO. The RIO should monitor all critical flight parameters and read all applicable checklists in a challenge and reply system. He should assist in navigation, communication, and coordinate with outside agencies and aircraft, but not to the detriment of the resolution of the emergency.

CHAPTER 38

Aircraft Self-Test

38.1 AIRCRAFT SELF-TEST OVERVIEW

Aircraft self-test allows testing of the operational status of all major avionics and radar subsystems and display of the results. This capability is also referred to as OBC throughout this section. Figure 38-1 identifies the major components associated with this function. Most of the status information is derived from BIT implemented within the avionics and radar subsystems. All operational aspects of aircraft self-test are fully supported by the MCS if one of the mission computers has failed.

There are two categories of test: (1) tests that are performed by the system automatically; (2) those that require initiation by the flightcrew. Testing should be initiated by the flightcrew as part of the normal preflight checkout to obtain the overall status of each system. Figure 38-2 is a summary description for the various test types, including origin and purpose. Avionics testing is controlled by the pilot and the RIO primarily through the MFDs and cockpit control panels. Radar testing is controlled by the RIO via the DD and TID. The majority of the displayed information is the result of each subsystem performing a particular mode of BIT or the MCS performing data bus or software configuration tests. On an automatic (i.e., periodically by the MCS) basis, subsystems are polled by the MCS in order to determine their operational status. Operational status is displayed at a subsystem and WRA level through a series of OBC formats on the MFDs. Both current and historical equipment status is displayable. Warning/caution/advisory cues are displayed on the MFDs for critical equipment failures and overtemperature conditions. Details of radar subsystem failures are available only on the DD and TID. Avionics and radar failure acronyms are displayed on the TID during normal tactical operation.

Aircraft self-test also allows examination of memory contents for WRAs that support a CSS capability. CSS is controlled with the DEU and the results are displayed on the MFDs. The radar subsystem provides a similar but limited capability that is controlled via the DD. These features are available in all system modes and are used for troubleshooting and maintenance purposes.

38.2 MASTER TEST PANEL CHECKS

Master test checks are initiated by the pilot through the MASTER TEST panel (Figure 38-3) on the right outboard console. These tests check the operational status of specific aircraft systems basic to safety of flight and mission success. The OBC, WG SWP, FLT GR UP, and FLT GR DN positions are used on the deck only and are prevented from inadvertent use in flight by the weight-on-wheels safety switches. The remaining tests, except for emergency generator, which also requires combined hydraulic pressure, can be done whenever electrical power and cooling air are available. For details of specific aircraft systems tests, refer to the applicable system description.

WARNING

During ground operations, once the OBC position is selected, do not deselect OBC until the program has completed the entire cycle. When the disable signal, which inhibits throttle movement, is removed, the APC will run through its BIT and advance the throttles to greater than 80 percent.

Note

- Before starting the test, depress the MASTER RESET button on the left vertical console to turn off any caution or advisory lights associated with the air data computer.
- In LTS, the MASTER CAUTION light will flash unless there is a circuit failure within the caution advisory indicator, in which case the light will be steady.

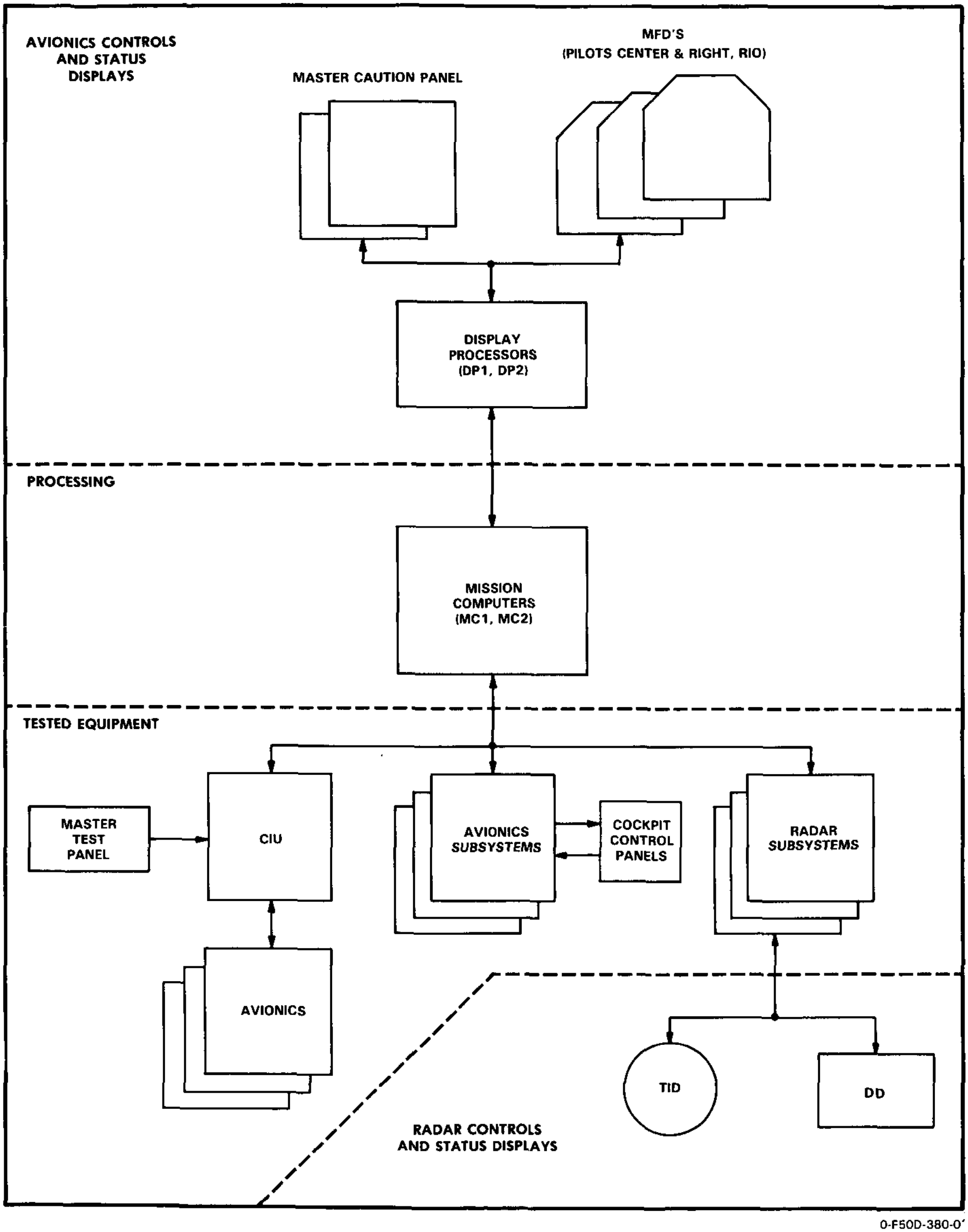


Figure 38-1. On-Board Checkout

NAME	ORIGINATOR	PURPOSE
Master Test Checks	PILOT	Selectable tests of instruments, fuel system, warning system (lights), wingsweep, AOA
Onboard Checkout (OBC) Sequences	PILOT and RIO	Tests various avionics, flight controls, actuators, AICS, and computers
Continuous Monitor	AUTOMATIC	Monitors majority of avionics and radar functions for in−flight or on−deck failures. Typically performed every 2 seconds
Unit/Subsystem Self−test	PILOT and RIO	Independent testing of individual, or groups of functionally related subsystems
Data Bus Tests	AUTOMATIC	Tests each data bus channel for each bussed subsystem
Software Configuration Test	AUTOMATIC	Tests the compatibility of subsystem software program loads

Figure 38-2. Test Types

38.2.1 MASTER TEST Switch Operation. The master test check is made by pulling the knob up, rotating to the desired position, and depressing it. After the test is completed, the MASTER TEST switch must be pulled up and deselected to deenergize the system.

WARNING

Cycling the CIU circuit breakers (3E7, 4E1, and 4E2) with the MASTER TEST switch in or above the OBC position will cause the AFCS BIT sequence to initiate. AFCS BIT sequence tests and deflects various aircraft control surfaces, which could be a hazard to unsuspecting ground personnel.

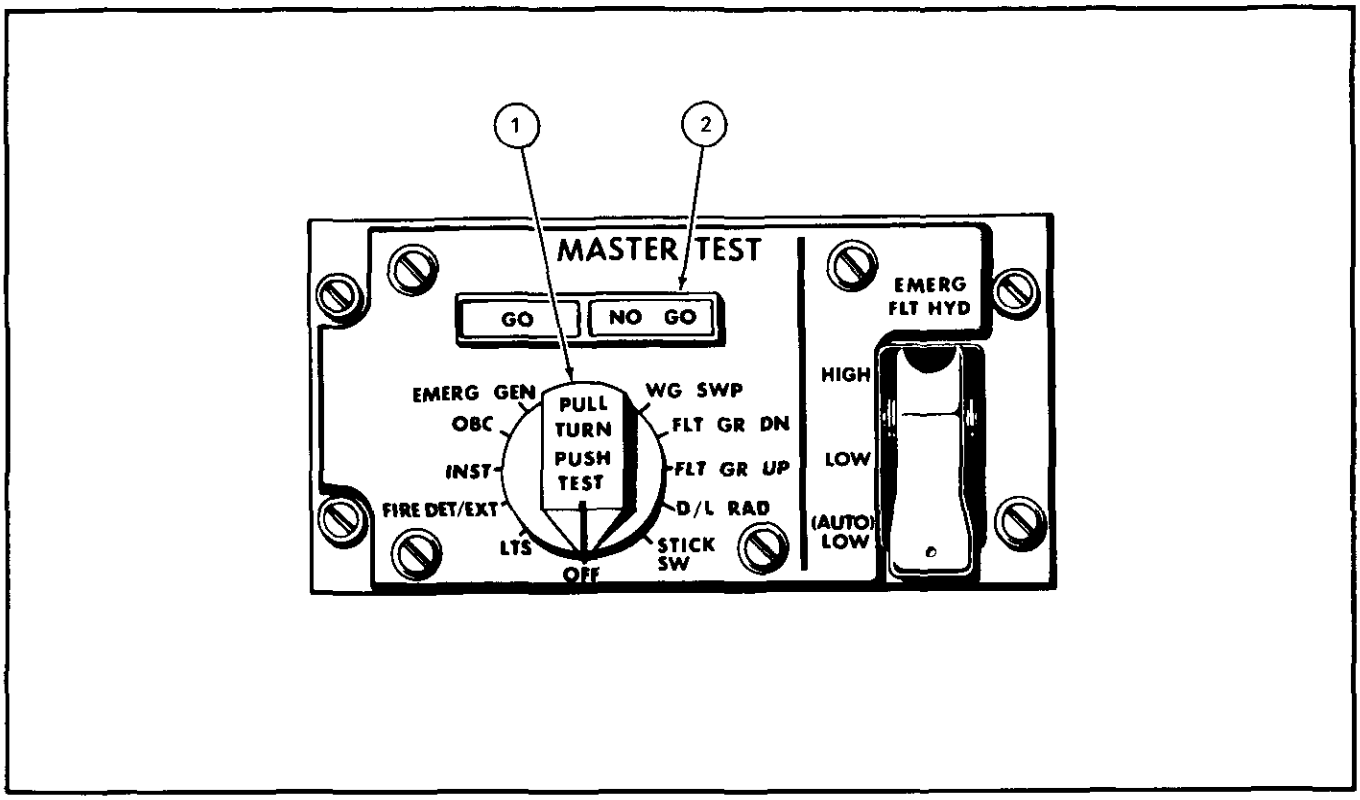
System status and test results are indicated on the cockpit instruments: GO-NO GO lights on the master test panel; warning, caution, and advisory lights in both cockpits; and displays including MFDs and TID.

The GO-NO GO indicator lights on the MASTER TEST panel will illuminate only in LTS, FIRE DET/EXT, EMERG GEN, and FLT GR UP. In the LTS test position, only the bulbs in the GO-NO GO indicators are checked. In EMERG GEN, FIRE DET/EXT, and FLT GR UP, a GO light indicates a valid test and a NO GO light indicates an unsatisfactory test. The STICK SW utilizes only the GO light; therefore, a valid test in STICK SW is indicated by a GO light but the lack of a light indicates an unsatisfactory test.

Electrical power for the master test panel comes from the left main dc bus through the MASTER TEST circuit breaker (9H4) on the DC MAIN circuit breaker panel. When operating on aircraft power or when external electrical power is connected to the aircraft, cooling air must be supplied to all avionic equipment before a test is initiated.

38.3 ON-BOARD CHECKOUT

OBC checks the operational status of the equipment listed in Figure 38-4. It provides fault isolation to the WRA level without the use of ground support equipment. The system automatically monitors all equipment providing an initial, periodic, or operator-initiated mode of BIT in order to detect failures or command subsystems into test as a result of selections made with the MFD OBC display formats. When a test is completed, the tested equipment responds with either a GO (when all tests have passed) or NO GO (when at least one test has failed) for each WRA tested. Detected failures are processed by the MCS in order to maintain current status and a historical record of failure information. Test status is also used to control the operation of the system and is displayable on the MFDs. OBC formats present failure acronyms for failed equipments only (i.e., the absence of a failure acronym implies that the equipment is operational). A historical record of failures is maintained during the course of a flight and is displayable at any time on the FHF format including during postflight operations by maintenance personnel. The historical record of failures should be cleared (erased from the FHF) prior to a mission by the flightcrew so that only failures relevant to the current mission are retained by the system.



NOMENCLATURE	FUNCTION	
(1) MASTER TEST switch	OFF -	Disables test functions.
	LTS -	Turns on caution, warning, and advisory lights; emergency stores jettison button; GO and NO GO lights; landing gear and hook transition lights; approach indexer; FIRE warning lights.
	FIRE DET/EXT -	L and R FIRE warning lights illuminate. If a circuit problem exists, the corresponding FIRE light will not illuminate. Simultaneously, the fire extinguishing system initiates a self-test. If tests pass, the GO light illuminates. If the NO-GO light illuminates or if both or neither GO or NO-GO lights illuminate, a failure exists in the system.

Figure 38-3. Master Test Panel (Sheet 1 of 2)

<table>
<tr><th>NOMENCLATURE</th><th colspan="2">FUNCTION</th></tr>
<tr><td>Note
• The 10 second audio alarm goes on.
• If EIG fails self test, the BIT segment to the left of the EGT legend remains illuminated.</td><td>INST –</td><td>Decreases the RIO's fuel counter to 2000 pounds, illuminates the FUEL LOW, MASTER CAUTION, and BINGO (if the pilot bingo counter set >2000 pounds) lights. Displays the following pilot cockpit indications.
RPM 96%
EGT .... 960°C (initiates engine over temperature alarm)
FF .... 10,500 pounds per hour
FUEL QTY .... 2,000 ± 200 pounds (both cockpits)
WING SWEEP .... 45° ± 2.5°
AOA .... 18 ± .5° units
BINGO .... ON (if Bingo set > 2,000)
FEED/WING/EXT
FUEL QTY .... 2,000 pounds</td></tr>
<tr><td></td><td>OBC –</td><td>Enables preflight testing when selected prior to selecting a subsystem for test via the MFDs. Failure acronyms are displayed on the MFDs.</td></tr>
<tr><td></td><td>EMERG GEN –</td><td>Activates automatic transfer feature of generator and checks tie contactors. GO lights indicate satisfactory check. If the NO GO light remains illuminated, a malfunction is indicated.</td></tr>
<tr><td></td><td>WG SWP –</td><td>Air data computer simulates that circuit to the wing sweep system (wings do not move). Requires wings in oversweep, and wing sweep button in AUTO.</td></tr>
<tr><td></td><td>FLT GR DN –</td><td>Initiates ground check of auto throttle interlocks. Requires throttles in AUTO throttle region and enables ground selection of AUTO throttles. Engines will respond to stick movement and nozzles remain closed.</td></tr>
<tr><td></td><td>FLT GR UP –</td><td>Permits checking external fuel tank pressurization. GO light indicates required pressure. WING/EXT TRANS switch must be in AUTO and DUMP switch set to OFF.</td></tr>
<tr><td></td><td>D/L RAD –</td><td>Tests the data link converter. Test results are available on the MFDs. Inhibits tactical control messages during test sequence. Symbology displayed is determined by the display mode selected.</td></tr>
<tr><td></td><td>STICK SW –</td><td>Checks left and right spoiler symmetry switches and 1-inch stick switches (left and right).</td></tr>
<tr><td>(2) GO–NO GO lights</td><td>GO –</td><td>Indicates valid test.</td></tr>
<tr><td>Note
Functional only in LTS, FIRE DET/EXT, INST, EMERG GEN, FLT GR UP, and STICK SW.</td><td>NO GO –</td><td>Indicates unsatisfactory test.</td></tr>
</table>

Figure 38-3. Master Test Panel (Sheet 2 of 2)

SUBSYSTEM/DESIGNATION	INITIAL	COMMANDED	CONTINUOUS MONITOR	COCKPIT
ADAC CP−1770	30.	20.	2.	N/A
AFCS AN/ASW−43	N/A	53.	2.	N/A
AICR C−8684	N/A	63.	2.	N/A
AILR C−8684	N/A	63.	2.	N/A
APC AN/ASW−105	N/A	83.	2.	83.
ASPJ AN/ALQ−165	N/A	110.	30.	110.
BAG AN/APN−154	N/A	3.	N/A	N/A
BSF	N/A	3.	2.	N/A
CADC CP−1035	N/A	4.	2.	N/A
CIU	2.	2.	10.	N/A
DEU	N/A	20.	2.	N/A
DP1	N/A	40.	5.	N/A
DP2	N/A	40.	5.	N/A
DLS AN/ASW−27C	N/A	15.	N/A	(Note 2)
DSS	N/A	(Note 3)	1.	N/A
EMSP1	N/A	N/A	2.	N/A
EMSP2	N/A	N/A	2.	N/A
IFB	N/A	3.	2.	N/A
IFI AN/APX−76	N/A	2.	N/A	N/A
IFX AN/APX−100	N/A	2.	2.	N/A
INS AN/ASN−130	N/A	55. Mins	1.	N/A
IRSTS	N/A	30.	2.	N/A
JTIDS AN/URC−107	10.	15.	12.	N/A
MC1 AN/AYK−14	.2	12.	10.	N/A
MC2 AN/AYK−14	.2	12.	10.	N/A
MFA LEFT	N/A	2.	N/A	N/A
MFA RIGHT	N/A	2.	N/A	N/A
RADAR AN/APG−71	210.	150.	2.	N/A
RALT AN/APN−194	N/A	3.	N/A	(Note 4)
RFP AN/ARC−182	N/A	N/A	2.	N/A
RFR AN/ARC−182	N/A	N/A	2.	N/A
RWR AN/ALR−67	N/A	N/A	1.	(Note 5)
SAHRS AN/USN−2	16.	5.	5.	N/A
SDIS	2.	6.	2.	N/A
SMS AN/AYQ−15	2.	10.	1.	N/A
TACAN AN/ARN−118 or AN/URC−107	(Note 6)	(Note 6)	(Note 6)	(Note 6)
TARPS	N/A	N/A	2.	N/A

Figure 38-4. *Subsystem BIT Mode Test Times (Sheet 1 of 2)*

SUBSYSTEM/DESIGNATION	INITIAL	COMMANDED	CONTINUOUS MONITOR	COCKPIT

Notes:

1. All test times are in seconds unless otherwise noted.
2. This test is the Data Link RAD (D/L RAD) test initiated by the RIO or Pilot. This test remains in effect for as long as the MASTER TEST panel switch is in D/L RAD. Refer to Operator Initiated BIT section for more information.
3. DSS Commanded BIT times of 5.0 and 65.0 seconds correspond to the Data Storage Set (DSS) test, and the DSS test including the Bulk Memory Checksum test, respectively.
4. This test remains in effect for as long as the PUSH TO TEST knob on the RADAR ALTITUDE indicator is held depressed.
5. This test remains in effect for as long as the TEST switch on the RADAR WARNING RCVR panel is held to BIT. Once released, the test completes in approximately 13 seconds.
6. JTIDS initial BIT will cause a 4–second loss of tacan lock. A tacan self–test is performed during JTIDS OBC. See Chapter 20 for additional details.

Figure 38-4. Subsystem BIT Mode Test Times (Sheet 2 of 2)

Current failure information is also displayed on the TID in the OBCCM window (refer to paragraph 38.5), and on the MFDs in the warning/caution/advisory window for certain equipment failures.

38.3.1 Built-in-Test Description. Several types of BIT are supported by each subsystem and are performed internally. These modes include: power-up (or initial), periodic (continuous or automatic), and commanded (includes both MFD and cockpit control panel initiated) BIT. Refer to Figure 38-4 for approximate BIT times for each subsystem. Regardless of the BIT type, detected failures are retained for the affected subsystem by the MCS. Each mode of BIT contains a series of tests that differ from mode to mode. Because of these differences, a priority for each subsystem determines when a subsystem failure no longer exists. Other tests performed by the MCS include data-bus channel tests, and a test to determine the compatibility of each subsystem's software load with the MCS OFP.

38.3.1.1 BIT Modes. The following is a brief description of each BIT mode. Refer to Figure 38-4 for subsystem applicability.

Initial BIT is performed by each subsystem upon the application of electrical power. This mode of BIT is only performed after power has been off for a specific length of time (i.e., cold start) and then restored. For shorter power interruptions (i.e., warm start), this mode of BIT is not performed. The MCS monitors each subsystem for a response (GO or NO GO) at the completion of this mode.

Continuous-monitor BIT is performed by each subsystem on a continuous and noninterfering basis (i.e., subsystem continues to perform normal operational mode as well). The BIT time is usually 2 seconds. The MCS monitors each subsystem at a 1-second rate in order to establish current status (GO or NO GO).

Commanded BIT is performed by each subsystem when commanded through the MFDs or by a cockpit control panel (when available). This mode is typically the most comprehensive and provides the highest degree of fault isolation. When used, this mode interrupts normal operation of the selected subsystem. The MCS monitors the subsystem while it is in test and the response (GO or NO GO) at the completion of test.

Data bus test is performed by the MCS in order to detect data bus (mission bus No. 1 and No. 2, and intercomputer bus) channel failures. Computer bus channel failures are detected and reported by the RDP to the MCS. Each channel is tested on MCS cold start, and when a subsystem first responds on the data bus. The test consists of transmitting several test patterns of data across each channel to a subsystem, and then reading back the data. A disagreement in the data establishes a NO GO for the data bus channel at fault. Since most bussed subsystems are dual redundant on the data bus, a single-channel failure will not affect the operation of the applicable subsystem. In the event that both channels have failed, the subsystem will be maintained as NOT READY, making the subsystem unavailable to the rest of the system.

STATUS	DEFINITION
NOT READY	Subsystem is not responding on a data bus as determined by the MCS, due to one of the following conditions: power-down, not installed, remote terminal failure, bus message error, excessively busy, or failure of all data bus channels to a particular subsystem. In addition, any bus subsystem that does not complete commanded BIT within a specified period of time will be set to this status type.
NO GO	Subsystem has at least one WRA fault detected as a result of performing one of its BIT modes. These failures are reported to the MCS only after an appropriate failure threshold has been reached. Depending on the extent of the failure, the subsystem may not be operationally usable by the system, causing a degraded mode to be entered where available. Subsystems that are not on a data bus and are not responding due to being powered down or not installed are reported as NO GO.
CONFIG ERROR	Subsystem has an inconsistent software program, or firmware load as determined by the MCS. This type of failure does not preclude the system from operationally using the affected subsystem. The subsystem can be powered down at the flightcrew's discretion to prevent the subsystem from being used by the system.

Figure 38-5. Definition of Status Types

Software compatibility test is performed by the MCS in order to detect incompatible software program loads as compared to the configuration for the rest of the system. In addition, a subsystem will test and report the internal compatibility between its main program load and firmware. Each subsystem is tested by the MCS on MCS cold start and when a subsystem first responds on the data bus. When an incompatibility is detected with a subsystem, the subsystem status will be maintained as CONFIG ERROR, and a computer message will be displayed indicating the WRA at fault.

38.3.1.2 BIT Status/Priorities. OBC display formats provide the flightcrew with continuous status of avionics and radar subsystems. Note that weapon and stores status are displayed on the SMS format, which is selectable from the menu format. Failure acronyms are displayed on the OBC formats for every failed item. These acronyms identify failures at the subsystem and WRA level on various OBC formats. Equipment BIT status is displayed as either NO GO, NOT READY, or CONFIG ERROR. Refer to Figure 38-5 for status-type definitions. Note that absence of a failure acronym indicates that the equipment is GO. Refer to Figure 38-6 for a list of subsystems versus types of status. Note that when the MCS cold-starts as a result of a power-transient or a system reset, BIT status for equipment that is NOT READY will not be displayed as such for 1 minute. After this time has elapsed, only equipment that is currently NOT READY will be considered failed. This allows subsystems that need time to warm up or perform initial BIT to do so without being prematurely reported as NO GO.

Each mode of subsystem BIT is weighted according to the amount of fault isolation that it provides. Subsystem failures can be removed from the system (i.e., will clear any equipment failure maintained by the MCS) only by one of the following:

1. Selecting system reset.

2. Cycling power to the MCS.

3. Cycling power to subsystem (only pertains to equipment on data bus). During power-off, equipment BIT status reverts to NOT READY.

4. CONFIG ERROR is overridden by NO GO or NOT READY.

5. Equipment status of NO GO will remain unless same or higher weight of BIT reports GO condition.

SUBSYSTEMS	NOT READY	NO GO	CONFIG ERROR
ADAC	X	X	X
AFCS	X(1)	X	
AICL	X(1)	X	
AICR	X(1)	X	
APC	X(1)	X	
ASPJ	X	X	X
BAG	X(1)	X	
BSF	X(1)	X	
CADC	X(1)	X	
CIU	X	X	X
DEU	X	X	X
DP1	X	X	X
DP2	X	X	X
DLS	X(1)	X	
DSS	X	X	
EMSP1	X	X	
EMSP2	X	X	
IFB	X(1)	X	
IFI	X		
IFX	X(1)	X	
INS	X	X	X
IRSTS	X	X	X
JTIDS	X	X	
MC1	X	X	X
MC2	X	X	X
MFA LEFT		X	
MFA RIGHT		X	
RADAR	X		X
RALT	X(1)	X	
RFP		X	
RFR		X	
RWR	X	X	X
SAHRS	X	X	X
SDIS	X	X	X
SMS	X	X	X
TACAN		X	
TARPS		X	
WOW		X	

NOTE: (1) Subordinate to the converter interface unit (CIU), and equipment status is displayable as NO GO as a result of a subsystem not completing commanded BIT within a set time.

Figure 38-6. Status Types

38.3.1.3 MFD Commanded BIT. In addition to displaying equipment BIT status, the MFD OBC formats are the primary means for generating command-initiated BIT. Testing can be controlled from any MFD on which an OBC format is displayed. The only other available method of testing (for equipment listed in Figure 38-4) is to use a dedicated cockpit panel to control test on an individual equipment basis. Test controls allow tests of the selected subsystem(s) to be initiated or terminated. The OBC display formats allow testing at several different levels, including sequence testing, functional group testing, and individual (or unit) testing. Sequence testing allows several items to be tested at the same time, with the MCS automatically testing (i.e., in parallel or in sequence) the appropriate equipment. Functional group testing allows functionally related equipment to be tested at the same time in a similar manner to the sequence tests. Each OBC format generally contains a series of pushbutton legends representing systems that have command-initiated BIT capability. Commanded BIT can be initiated one at a time, or in any combination, as long as the prerequisites for testing are satisfied. Refer to paragraph 38.3.2 for commanded BIT test prerequisites.

OBC display formats also serve to provide feedback or the progress of testing (i.e., in test, test complete, and awaiting test) through MFD acronym status. Computer messages are generated and displayed on the MFDs in response to invalid test selections.

38.3.1.4 Control Panel-Initiated BIT. Control panel-initiated BIT is an alternate mode of BIT initiated from a cockpit control panel. Refer to Figure 38-4 for applicability. Control panel initiated BIT is described with the applicable subsystem.

38.3.2 Test Prerequisites/Restrictions. Commanded BIT testing requires that certain conditions be satisfied prior to the test command from the MCS, for safety-of-flight purposes. These conditions govern the control of all commanded BIT initiated through the MFDs and depend on the type of test. In addition, there are some restrictions that disable tests because of equipment or operational mode conflicts. (Initial and continuous BIT are not subject to these conditions.)

38.3.2.1 BIT Interlocks/Test Restrictions. Preflight tests are enabled by the pilot selecting OBC on the MASTER TEST panel with weight on wheels, TAS < 76 knots, and handbrake set. These tests are designated preflight and it is recommended that they be performed at this time since a failure may constitute a flight safety hazard. All interlocks are constantly checked for change in status to ensure the safety of the aircraft. In-flight tests are performed only when the aircraft is airborne with weight off wheels and TAS > 76 knots. Refer to Figure 38-7.

38.3.3 Avionic BIT Operation. Avionic BIT operation is controlled through MFD OBC display formats. For some systems, dedicated control panels serve as a redundant and alternate means for controlling BIT. All OBC formats display equipment status, equipment failure acronyms for detected WRA failures, and the progress of testing. These formats provide the capability to manually initiate/terminate command BIT and to mask/unmask current failures on the displays. These formats are accessible on any MFD including the pilot center (MFD1), pilot right (MFD2), and RIO (MFD3) displays.

When the system is powered up from a cold-start condition (i.e., power to MCS off for greater than 300 milliseconds) or when system reset is ordered, the mission computers perform initial BIT. All other equipment takes varying amounts of time to warm up or to complete initial BIT. At the completion of mission computer initial BIT, MFD2 will display the OBC BASIC format. At all other times, the OBC BASIC format can be accessed on any MFD by selecting the MENU1 pushbutton followed by the OBC pushbutton. The OBC BASIC format allows initiation of various test sequences, and also serves as the menu for access to all other OBC formats. Tests can also be commanded through OBC functional group formats. OBC computer messages provide feedback to the flightcrew and are displayed when testing is completed or in response to test selections that are not acceptable because of invalid interlocks and operational conflicts.

When the system is in a backup mode of operation (only one mission computer operational), it will support all the OBC functions that are normally provided in a full-up mode (i.e., both mission computers operational).

38.3.3.1 MFD OBC Formats. There are several different types of OBC formats: basic, functional group, fail data, maintenance, and failure history file. Figure 38-8 identifies the equipment that can be commanded to test, or masked, from each of the format types.

Figure 38-9 identifies all possible OBC failure acronyms and failure history file acronyms that are displayed on OBC formats. It also provides an explanation and possible action that the aircrew can take in response to the fault.

38.3.3.1.1 OBC Basic. The OBC basic format displays failures at the subsystem level and provides the capability to initiate the OBC sequence tests. Additional information for a subsystem failure can be found on the corresponding functional group format. Each acronym that appears on the OBC basic format indicates that the subsystem is not currently operational. Each acronym appears in a dedicated location as shown in Figure 38-10.

38.3.3.1.2 Functional Group Formats/Fail Data Format. The OBC functional group format display failures are at the WRA level. Additional information for a WRA failure can be found on the corresponding fail data format for that functional group. Subsystem failure status is indicated as either NO GO, NOT READY, or CONFIG for each subsystem in the functional group. Refer to Figure 38-5 for failure status types. When the status is NOT READY for a subsystem on the bus, the WRA corresponding to the remote terminal (i.e., the WRA that directly communicates on the bus with the MCS) is displayed subordinate to the subsystem.

A prompt (* NEXT PAGE *) on the bottom of an OBC functional group format (or a fail data format) appears if there are additional failure acronyms for the group or additional fail data pages. Pressing the PAGE pushbutton in response to the prompt will cause the next page of information to be displayed. Paging past the last page will cause the first page to be displayed again.

Fail data information is only displayed on a fail data format after at least one commanded BIT has been performed for the applicable subsystem.

Note

Fail data is available for display continuously for CADC, EMSP1, and EMSP2.

Otherwise, if commanded bit has not been performed, a prompt will be displayed on the first line of the fail data format as FAIL DATA NOT AVAILABLE for the applicable WRA or system.

38.3.3.1.3 Failure Acronym Masking. Masking removes or inhibits display of OBC equipment failure acronyms for known WRA faults. Failure acronyms will be removed from the OBC formats (basic and functional group) and from the TID OBCCM window regardless of the mode of BIT that detected the failure. Failure acronyms are maskable at the OBC basic level, where all currently failed equipment is affected, and also at the functional group/unit level, where only equipment in the functional group is affected. Failure acronyms may also be unmasked in order to cause their redisplay after having been previously masked. Unmasking is initiated with OBC formats or by the system as a result of performing commanded BIT. Whichever level of masking/unmasking is selected, all the corresponding equipment appearing on the OBC basic, OBC functional group, and

FLIGHT STATUS	TEST SELECTS	EQUIPMENT TESTED
PREFLIGHT (weight−on−wheels, TAS<76 KTS, MTP set to OBC. Parking brake set)	Preflight test	(1) CIU, CADC, APC, AFCS, AICS, RALT, IFB, ADAC, DSS, SMS, (1) DLS, BSF, (2) SDIS, IRST, JTIDS
	Retest test	(1) CIU, ADAC, DSS, DEU, SMS, (3) ASPJ, (NON−RADIATE), SDIS, IRST
	Individual/group test	(1) CIU, CADC, APC, AFCS, AICS
(Weight−on−wheels, parking brake set)	Individual/group test	(3) INS, SAHRS, JTIDS
(Weight−on−wheels, TAS<76 KTS)	Individual/group test	RALT
	Retest test	ADAC, DSS, DEU, SMS, (2) ASPJ (NON−RADIATE), SDIS, IRST
INFLIGHT (weight−off−wheels, TAS>=76 KTS)	Inflight test	IFB, DEU, IFX, BAG, SMS, (1) DLS, (2) ASPJ (RADIATE), MFA LEFT/RIGHT, SDIS, IRST
	Individual/group test	BAG, IFX, (3) ASPJ (RADIATE)
	Retest test	ADAC, DSS, DEU, SMS, (2) ASPJ (RADIATE), SDIS, IRST
Preflight/Inflight	Individual/group test	(4) DP1, (4) DP2, DEU, IFB, (5) MC1, (5) MC2, ADAC, (6) DSS, SMS, (1) DLS, SDIS, IRST
	Retest test	ADAC, DSS, DEU, SMS, SDIS, IRST

NOTES:

(1) CIU/DLS:

When the CIU or DLS is selected for test through the MFD's, the system will reject the selection(s) if a CV SINS mode of alignment is in progress. This allows the SINS alignment to continue to completion without interruption.

(2) ASPJ:

In addition to the interlock conditions indicated above, the following switch settings must be made on the ASPJ control panel in order to initiate test:

—When the ASPJ is selected for test with the MFD's, the ASPJ will perform BIT and radiate (i.e., transmit RF) only if XMIT switch is selected. If RCV is selected, the ASPJ will perform BIT without radiating.

—When the ASPJ is selected for test with the MFDs, the ASPJ will not perform BIT if STBY or OFF is selected.

Figure 38-7. Interlock Test Restrictions (Sheet 1 of 2)

(3) INS:

Prior to selecting INS for test with the OBC NAV format, TEST on the NAV MODE panel must be selected.

(4) DP1/DP2:

When DP1 or DP2 is selected for test through the OBC CD formats, the following restrictions apply:

ALLOWABLE TEST SELECTION	FLIGHT STATUS
DP1 or DP2	In–flight (Weight off wheels), both DP's must be operationally GO OR Preflight (Weight on wheels)
NONE	In–flight (Weight off Wheels), one DP not operationally GO

(5) MC1/MC2:

When MC1 or MC2 is selected for test with the OBC AUX formats, the following restrictions apply:

ALLOWABLE TEST SELECTION	FLIGHT STATUS
MC1 or MC2	In–flight (Weight off wheels), both MC's must be operationally GO OR Preflight (Weight on wheels)
NONE	In–flight (Weight off wheels), one MC not operationally GO

(6) DSS:

Prior to selecting the DSS for test through the MFD's, the data storage unit must be inserted into the Data Storage Unit Receptacle (DSUR). DSS BIT will be limited (i.e., less bulk memory checksum test) when the DSS is tested as part of a preflight or retest sequence. Otherwise, if the test selection is an individual or functional group type made through the OBC AUX format, DSS BIT will include the performance of the bulk memory checksum test. The bulk memory checksum test adds approximately 1 minute to the overall test time.

Figure 38-7. Interlock Test Restrictions (Sheet 2 of 2)

OBC DISPLAY FORMAT	TEST SELECTION TYPE
BASIC	SEQUENCES:
	Prelight
	Inflight
	Retest
Functional group	Group or individual:
FLT (flight)	AFCS, AICS, APC
CNI (communication, navigation, identification)	RFP, RFR, BAG, IFX, IFI, RALT, TCN
NAV (navigation)	CADC, CIU, DINS, SAHR
CD (controls and displays)	DEU, DP1, DP2
AUX (auxiliary)	MC1, MC2, EMSP1, EMSP2, ADAC, DSS, DBUS
SMST (stores management system)	SMS
TAC (tactical)	DLC, JTIDS
EW (electronic warfare)	ASPJ, BSF, IFB, RWR, MFA
SNSR (sensors)	IRST, RDR, SDIS, TARPS
FAIL DATA	
CNI	
NAV	
CD	
AUX	
JTIDS	
SMST	
SMST SWITCHES	
EW	
SNSR	
MAINTENANCE CURRENT FAILURES	
FAILURE HISTORY FILE	

Figure 38-8. OBC Display Format Types

TID OBCCM window will be affected. Format examples are shown in Figure 38-11. Note that the OBC maintenance formats are unaffected by any masking operation. Masking and unmasking is controlled via OBC basic, any OBC functional group, or any fail data format as follows:

1. OBC basic masking is performed by selecting the MSK function on the OBC basic format, at which time the MSK pushbutton legend will be boxed. This allows all the equipment failure acronyms currently appearing on the OBC basic format to be removed. Unmasking is performed by pressing the MSK pushbutton while it is boxed. As a result, failure acronyms are displayed for equipment currently failed and the MSK pushbutton legend is unboxed to indicate that no failures are masked. The MSK pushbutton appears boxed on the OBC BASIC format if there is at least one WRA failure masked in the system.

2. Functional group masking is performed by selecting the ALL and MSK pushbuttons on the respective OBC functional group format. The ALL pushbutton legend is boxed to indicate its selection and unboxed if deselected. Group masking is only performed if the ALL pushbutton is boxed prior to making the selection of the MSK pushbutton. Group masking will only remove failure acronyms associated with equipment on the corresponding functional group format. Group unmasking is performed by deselecting the ALL/MSK pushbutton when the MSK pushbutton legend is boxed. The MSK pushbutton legend appears boxed if there is at least one equipment that is masked on the corresponding functional group format.

3. Unit masking is performed by selecting equipment and MSK pushbuttons. Any number of WRAs may be selected prior to selecting the MSK pushbutton in order to mask more than one failure at the same time. Each equipment pushbutton legend is boxed to indicate its selection and is unboxed if reselected. Only those items that remain selected (i.e., boxed) before selecting the MSK pushbutton will be masked. Unit unmasking is performed by selecting the equipment and MSK pushbuttons when the MSK pushbutton legend is boxed.

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
ADAC	ADAC	Airborne Data Acquisition Computer	ADAC failure, Fatigue and Engine Monitoring data records will no longer be recorded on the DSS
AFCS	AFCS	Automatic Flight Control System	Failure of a system WRA as shown below
ACCELEROMETER	AFCAM		Yaw accelerometer failure
PITCH ACTUATOR	AFCPA		Pitch actuator position does not agree with command
PITCH COMPUTER	AFCPC		Pitch computer failure (Valid only with corresponding CAUTION-ADVISORY lights on. Autopilot caution light and indicated failure is not valid)
PITCH SENSOR	AFCPS		Pitch sensor failure
ROLL ACTUATOR	AFCRA		Roll actuator position does not agree with command
ROLL COMPUTER	AFCRC		Roll computer failure
ROLL SENSOR	AFCRS		Roll sensor data failure
YAW ACTUATOR	AFCYA		Yaw series servo actuator failure
YAW COMPUTER	AFCYC		Yaw computer failure (Check that ALPHA COMP/PEDAL shaker circuit breaker (RB1) is engaged)
YAW SENSOR	AFCYS		Yaw sensor failure
AICS	AICS	Air Inlet Control System	Failure of AICL or AICR (See below)
AICS-L or AICS-R		Air Inlet Control (Left or Right)	Indicates which AICS has failed. Used in conjunction with INLET/ RAMPS caution lights.
PROGRAMMER	AILP AIRP		Programmer failure, without INLET light, computer uses normal values Operational mode, no flight restriction

Figure 38-9. OBC Failure Acronyms (Sheet 1 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
NO. 1 RAMP ACTUATOR	AILA1 AIRA1		NO. 1 actuator position does not agree with command
NO. 2 RAMP ACTUATOR	AILA2 AIRA2		NO. 2 actuator position does not agree with command
NO. 3 RAMP ACTUATOR	AILA3 AIRA3		NO. 3 actuator position does not agree with command
STATIC PRESSURE	AILS1 AIRS1		Static pressure sensor. With INLET light, SENSOR fail safe mode. Without INLET light, failure operational. No flight restriction
TOTAL PRESSURE	AILS2 AIRS2		Total pressure sensor. With INLET light, SENSOR fail safe mode
ANGLE OF ATTACK	AILS4 AIRS4		Angle-of-Attack (AOA) or engine fan speed. (AFTC may be in secondary mode.) Without INLET light, fail operational. No flight restriction
ID/MCB	AILID AIRID		Identifier conflict
APC	APC	Approach Power Compensator	Auto throttle inspection. System will default to BOOST automatically. A REV 4 AIC programmer is installed in lieu of correct REV 5 programmer.
ACCELEROMETER	APCAM		APC accelerometer fail No associated light Auto throttle inoperative APC not authorized for landing
COMPUTER	APCPU		APC computer fail Auto throttle inoperative
ASPJ	ASPJ	Airborne Self-Protection Jammer	ASPJ failure. ECM may not be available. Run commanded BIT
PROCESSOR	SPJPR		Possible processor failure. Run commanded BIT to provide fault isolation to WRA level
RECEIVER LOW	SPJRL		Low-band receiver failure

Figure 38-9. OBC Failure Acronyms (Sheet 2 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
RECEIVER HIGH	SPJRH		High-band receiver failure
RECEIVER AUG	SPJRA		Augmentation receiver failure
TRANSMITTER LOW	SPJTL		Low-band transmitter failure
TRANSMITTER HIGH	SPJTH		High-band transmitter failure
TRANSMITTER AUG	SPJTA		High-band augmentation transmitter failure
RWR INTERFACE	SPJRI		Interface failure between ASPJ and RWR
BAG	BAG	Beacon Augmentor	BAG not powered on Run commanded BIT Degraded position approach on automatic carrier landing (ACL) and/or ground vectoring
BSF	BSF	Band Suppression Filters	BSF failure
FILTER 1-RWR 315	BSF1		BSF filter FWD 315 deg
FILTER 2-RWR 45	BSF2		BSF filter FWD 45 deg
FILTER 3-ASPJ	BSF3		BSF filter -ASPJ
CADC	CADC	Central Air Data Computer	Check caution/advisory lights. Examine CADC Fail Data Format
CIU	CIU	Converter Interface Unit	CIU fail
DBUS		Data Bus	MIL-STD-1553 data bus channel failure (See below)
ADAC MBUS 2 CHAN A	AAC2A		Mission Bus NO. 2 channel A fail
ADAC MBUS 2 CHAN B	AAC2B		Mission Bus NO. 2 channel B fail
ARDP MBUS 1 CHAN A	RDP1A		Mission Bus NO. 1 channel A fail

Figure 38-9. OBC Failure Acronyms (Sheet 3 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
ARDP MBUS 1 CHAN B	RDP1B		Mission Bus NO. 1 channel B fail
ARDP MBUS 2 CHAN A	RDP2A		Mission Bus NO. 2 channel A fail
ARDP MBUS 2 CHAN B	RDP2B		Mission Bus NO. 2 channel B fail
	RM1C		Computer Bus (Radar/MC1) channel fail
	RM2C		Computer Bus (Radar/MC2) channel fail
	RCIUC		Computer Bus (Radar/CIU) channel fail
ASPJ MBUS 1 CHAN A	SPJ1A		Mission Bus NO. 1 channel A fail
ASPJ MBUS 1 CHAN B	SPJ1B		Mission Bus NO. 1 channel B fail
CIU MBUS 2 CHAN A	CIU2A		Mission Bus NO. 2 channel A fail
CIU MBUS 2 CHAN B	CIU2B		Mission Bus NO. 2 channel B fail
DSS MBUS 2 CHAN A	DSS2A		Mission Bus NO. 2 channel A fail
DSS MBUS 2 CHAN B	DSS2B		Mission Bus NO. 2 channel B fail
DP1 MBUS 1 CHAN A	DP11A		Mission Bus NO. 1 channel A fail
DP1 MBUS 1 CHAN B	DP11B		Mission Bus NO. 1 channel B fail
DP2 MBUS 2 CHAN A	DP22A		Mission Bus NO. 2 channel A fail
DP2 MBUS 2 CHAN B	DP22B		Mission Bus NO. 2 channel B fail
DEKI MBUS 2 CHAN A	DEU2A		Mission Bus NO. 2 channel A fail
DEKI MBUS 2 CHAN B	DEU2B		Mission Bus NO. 2 channel B fail
INS MBUS 2 CHAN A	INS2A		Mission Bus NO. 2 channel A fail

Figure 38-9. OBC Failure Acronyms (Sheet 4 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
INS MBUS 2 CHAN B	*INS2B*		Mission Bus NO. 2 channel B fail
IRST MBUS 1 CHAN A	IR1A		Mission Bus NO. 1 channel A fail
IRST MBUS 1 CHAN B	IR1B		Mission Bus NO. 1 channel B fail
JTIDS MBUS 2 CHAN A	JT2A		
JTIDS MBUS 2 CHAN B	JT2B		
MC1 MBUS 2 CHAN A	MC12A		Mission Bus NO. 2 channel A fail
MC1 MBUS 2 CHAN B	MC12B		Mission Bus NO. 2 channel B fail
MC2 MBUS 2 CHAN A	MC22A		Mission Bus NO. 2 channel A fail
MC2 MBUS 2 CHAN B	MC22B		Mission Bus NO. 2 channel B fail
MC1 MBUS 1 CHAN A	MC11A		Mission Bus NO. 1 channel A fail
MC1 MBUS 1 CHAN B	MC11B		Mission Bus NO. 1 channel B fail
MC2 MBUS 1 CHAN A	MC2IA		Mission Bus NO. 1 channel A fail
MC2 MBUS 1 CHAN B	MC2IB		Mission Bus NO. 1 channel B fail
MC2 IBUS CHAN A	MC21A		Intercomputer Bus NO. 1 channel A fail
MC2 IBUS CHAN B	MC21B		Intercomputer Bus NO. 1 channel B fail
SAHRS MBUS 1 CHAN A	SHR1A		Mission Bus NO. 1 channel A fail
SAHRS MBUS 1 CHAN B	SHR1B		Mission Bus NO. 1 channel B fail
SDIS MBUS 1 CHAN A	SDI1A		Mission Bus NO. 1 channel A fail
SDIS MBUS 1 CHAN B	SDI1B		Mission Bus NO. 1 channel B fail
SMP MBUS 2 CHAN A	SMP2A		Mission Bus NO. 2 channel A fail
SMP MBUS 2 CHAN B	SMP2B		Mission Bus NO. 2 channel B fail
DEU	DEU	Data Entry Unit	DEU failure

Figure 38-9. OBC Failure Acronyms (Sheet 5 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
DINS	DINS	Digital Inertial Navigation System	INS or battery failure
INERTIAL NAV SYSTEM	INS		INS failure
INS BATTERY BACK–UP	DNSPS		INS battery failure
DLS	DLS	Data Link System	Data Link powered off. Run commanded BIT
JTIDS	JTIDS	Joint Tactical Information Distribution System	JTIDS failure
SDU	JTSDU	Secure Data Unit	SDU (KGV–8) failure/JTIDS crypto keys are not loaded.
BATTERY	JTBAT	JTIDS Battery	JTIDS Battery Failure. Keys will not load/hold in STBY with a failed battery.
RCVR/XMTR	JTRT	JTIDS Receiver/Transmitter	JTIDS R/T failure. This can also effect Tacan operation.
DATA PROCESSOR	JTDDP	JTIDS Digital Data Processor	JTIDS DDP failure. This unit is part of the JTIDS Data Processor Group.
INTERFACE UNIT	JTIU	JTIDS Interface Unit	JTIDS IU failure. This unit is part of the JTIDS Data Processor Group.
DSS	DSS	Data Storage Set	DSS failure. Possible loss of data on data storage unit
EMSP1	EMSP1	Engine Monitoring Signal Processor no. 1	EMSP1 failure
EMSP2	EMSP2	Engine Monitoring Signal Processor no. 2	EMSP2 failure
IFB	IFB	Interference Blanker	Possible interference between Tacan, Radar Altimeter, IFF, APG–71, RWR, and ASPJ
IRST	IRST	Infrared Search and Track	IRST failure
SENSOR UNIT	IRSU		Sensor unit failure
ELECTRONIC UNIT	IREU		Electronic unit failure
IFI	IFI	IFF Interrogator	APX–76 failure
RECEIVER/ TRANSMITTER	IFIRT		Receiver/transmitter failure
SWITCH/AMP	IFISW		Switch amplifier failure
KIR COMPUTER	IFN		APX–76 computer failure/not installed
SYNCHRONIZER	IFISYS		Synchronizer failure

Figure 38-9. OBC Failure Acronyms (Sheet 6 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
IFX	IFX	IFF Transponder	APX-100 failure
TRANSPONDER	IFXPN		IFF failure. Set MASTER switch on IFF control panel to NORM. Select test for each mode and observe light.
COMPUTER	IFA		APX-100 computer failure
MC1	MC1	Mission Computer NO. 1	MC1 failure. System will revert to backup mode if MC2 is functional.
MC2	MC2	Mission Computer NO. 2	M2 failure. System will revert to backup mode if MC1 is functional.
MDS1		Multifunction Display System NO. 1	MDS1 failure
DISPLAY PROCESSOR	DCP1		DP NO. 1 failure
PILOT CENTER MFD 1	MFD1		Pilot center MFD failure
HUD	HUD		Head-up display failure
PILOT RIGHT - MFD 2	MFD2		Pilot right MFD failure
RIO - MFD 3	MFD3		RIO MFD failure
HUD INTERFACE	HUDI		Interface failure between DP NO. 1 and HUD, or HUD not powered up
MFD 1 INTERFACE	MFD1I		Interface failure between DP No. 1 and MFD NO. 1, or MFD NO. 1 not powered up
MFD 2 INTERFACE	MFD2I		Interface failure between DP NO. 1 and MFD NO. 2, or MFD NO. 2 not powered up
MFD 3 INTERFACE	MFD3I		Interface failure between DP NO. 1 and MFD NO. 3, or MFD NO. 3 not powered up
MDS2		Multifunction Display System NO. 2	MDS2 failure
DISPLAY PROCESSOR	DCP2		DP No. 2 failure. System will revert to DP. backup mode if DP No. 1 is functional.

Figure 38-9. OBC Failure Acronyms (Sheet 7 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
PILOT CENTER - MFD 1	MFD1		Pilot center MFD failure
HUD	HUD		Head-up display failure
PILOT RIGHT - MFD 2	MFD2		Pilot right MFD failure
RIO - MFD 3	MFD3		RIO MFD failure
HUD INTERFACE	HUDI		Interface failure between DP NO. 2 and HUD, or HUD not powered up
MFD 1 INTERFACE	MFD1I		Interface failure between DP NO. 2 and MFD NO. 1, or MFD NO. 1 not powered up
MFD 2 INTERFACE	MFD2I		Interface failure between DP NO. 2 and MFD NO. 2, or MFD NO. 2 not powered up
MFD 3 INTERFACE	MFD3I		Interface failure between DP NO. 2 and MFD NO. 3, or MFD NO. 3 not powered up
DP1/DP2 INTERFACE	DP12I		Interface failure between DP NO. 1 and DP NO. 2
MFAL		Multiple Filter Assembly Left	MFA left failure
FILTER A	MFALA		Filter A failure
FILTER B	MFALB		Filter B failure
FILTER C	MFALC		Filter C failure
MFAR		Multiple Filter Assembly Right	MFA right failure
FILTER A	MFARA		Filter A failure
FILTER B	MFARB		Filter B failure
FILTER C	MFARC		Filter C failure
RDR		Radar	APG-71 failure
RADAR			Radar not powered/not installed

Figure 38-9. OBC Failure Acronyms (Sheet 8 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
	ARDP	Advanced Radar Data Processor	ARDP failure
	ARSP	Advanced Radar Signal Processor	ARSP failure
	BPS	Beam Power Supply	BPS failure
	RCVR	Receiver	RCVR failure
	DD	Digital Display	DD failure
	RDHCU	Sensor Hand Control	SHC failure
	XMTR	Transmitter	XMTR failure
	CPS	Collector Power Supply	CPS failure
	SPS	Solenoid Power Supply	SPS failure
	ANT	Antenna Array	ANT failure
	RIC	Radome Interlock	RIC failure
	ASC	Advanced Signal Converter	ASC failure
	RDSCU	Radar Sensor Control Unit	RDSCU failure
	TID	Tactical Information Display	TID failure
	TCS	Television Camera System	TCS failure
RALT	RALT	Radar Altimeter	RALT failure (OBC BASIC)
RADAR ALT	RALT	Radar Altimeter	RALT failure (OBC CNI)
RFP	RFP	Radio Frequency Pilot	Pilot RFI failure
RFR	RFR	Radio Frequency RIO	RIO RFCI failure
SAHRS	SAHRS	Standard Attitude Heading Reference Set	SAHRS failure. Loss of back-up navigation mode

Figure 38-9. OBC Failure Acronyms (Sheet 9 of 11)

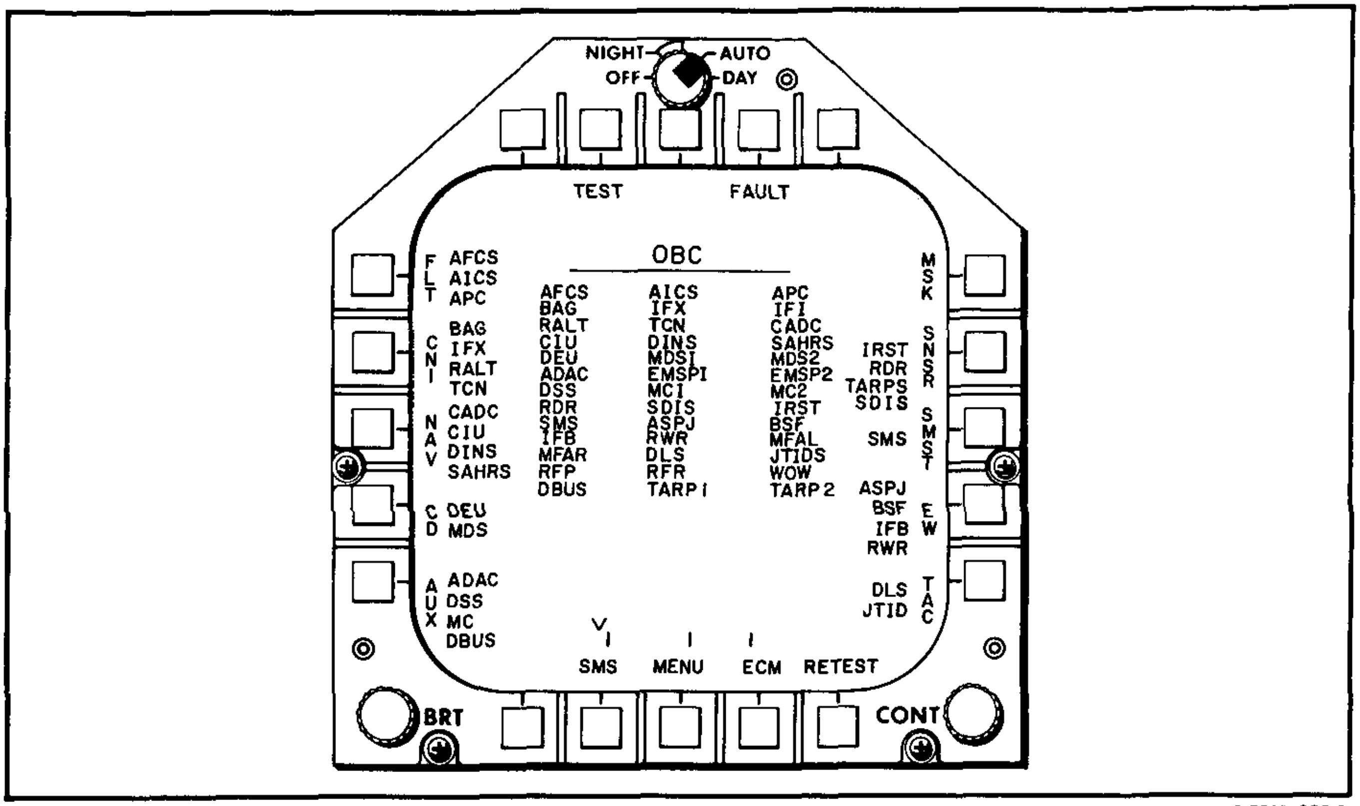
OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
SDIS	SDIS	Sensor Display Indicator Set	SDIS failure
SENSOR CONTROL UNIT	SDSCU		Sensor control unit failure
SENSOR SLAVING PANEL	SDSSP		Sensor slaving panel failure
SMS		Stores Management Set	SMS failure
SMP	SMP		Stores management processor failure
MPRU	MPRU		Missile power relay unit failure
GUN CONT UNIT	GCU		Gun control unit failure
FTJU STA 2	FTJ2		Fuel tank jettison unit station No. 2 failure
FTJU STA 7	FTJ7		Fuel tank jettison unit station No. 7 failure
TYPE 1 DECODER 1A/B	D1S1		Type 1 decoder station 1A/B failure
TYPE 1 DECODER 3/6	D1S36		Type 1 decoder station 3/6 failure
TYPE 1 DECODER 4/5	D1S45		Type 1 decoder station 4/5 failure
TYPE 1 DECODER 8A/B	D1S8		Type 1 decoder station 8A/B failure
TYPE 2 DECODER 1B	D2S1B		Type 2 decoder station 1B failure
TYPE 2 DECODER 3	D2S3		Type 2 decoder station 3 failure
TYPE 2 DECODER 4	D2S4		Type 2 decoder station 4 failure
TYPE 2 DECODER 5	D2S5		Type 2 decoder station 5 failure
TYPE 2 DECODER 6	D2S6		Type 2 decoder station 6 failure
TYPE 2 DECODER 8B	D2S8B		Type 2 decoder station 8B failure
AWW-4	AWW-4		AWW-4 electrical fuzing switch failure
MISSILE PS	MPS		AIM-54 missile power supply failure

N2/97

Figure 38-9. OBC Failure Acronyms (Sheet 10 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
TCN	TACAN	Tactical Air Navigation	TACAN failure (OBC BASIC)
TACAN	TACAN	Tactical Air Navigation	TACAN failure (OBC CNI)
TARP1	TARP1	Tactical Airborne Reconnaissance Pod	TARP system failure (crew alert)
TARP2	TARP2	Tactical Airborne Reconnaissance Pod	TARP/CIU communication failure
RWR	RWR	Radar Warning Receiver	RWR failure
COMPUTER	RWRCP		Analyzer (CP-1293) failure
CONTROL STATUS UNIT	RWRCU		Control status unit failure
QUAD RECEIVER 45	RWRQ1		Quadrant receiver (45 degrees) failure
QUAD RECEIVER 135	RWRQ2		Quadrant receiver (135 degrees) failure
QUAD RECEIVER 225	RWRQ3		Quadrant receiver (225 degrees) failure
QUAD RECEIVER 315	RWRQ4		Quadrant receiver (315 degrees) failure
SPECIAL RCVR	RWRSR		Superhet receiver failure
INTEGRATED ANTENNA	RWRAN		Integrated antenna failure
ASPJ INTERFACE	RWRAI		Interface failure between RWR and ASPJ
IFB INTERFACE	RWRBI		Interface failure between RWR and IFB
WOW	WOW		Weight on/off wheel discrete failure

Figure 38-9. OBC Failure Acronyms (Sheet 11 of 11)



0-F50D-382-0

Figure 38-10. OBC Basic Format

38.3.3.2 Avionic Test Operation. Tests may be done in a sequence (preflight/in-flight, and retest sequence), or in groups (functional group), or on an individual basis. For any equipment selected and validated for test, the progress of testing is indicated on all OBC format types that contain equipment pushbutton legends. Refer to Figure 38-11 for format examples. Test progress is indicated on the OBC formats as follows:

1. Equipment pushbutton legends appear bright and steady when a test cannot begin immediately because of a dependency with at least one other equipment. When the dependency no longer exists, the equipment is commanded to test and the pushbutton legend will then appear flashing.

2. Equipment pushbutton legends flash at bright intensity when an equipment is in test.

3. Equipment pushbutton legends appear steady at a normal level of intensity when an equipment is not in test.

Commanded BIT testing interferes with normal operational modes of equipment. Testing can be initiated only when equipment is powered up and ready. If equipment is currently not ready, equipment pushbutton legends will remain steady.

All testing is terminated by the system when any of the following occurs:

1. The ACM guard is lifted.

2. A weapon is selected.

3. A radar ACM mode is selected.

4. Interlock status changes from those conditions satisfied at the initiation of test.

Note that not all tests can be terminated.

38.3.3.2.1 Automatic Test Sequences. There are three types of automatic test sequences, all of which are initiated through the OBC basic format: in flight, preflight, and retest. Each sequence allows the testing of many WRAs with a single pushbutton. The system commands each WRA to test in a predetermined order so that equipment conflicts are eliminated. Refer to BIT interlocks/restrictions for the tests in each sequence.

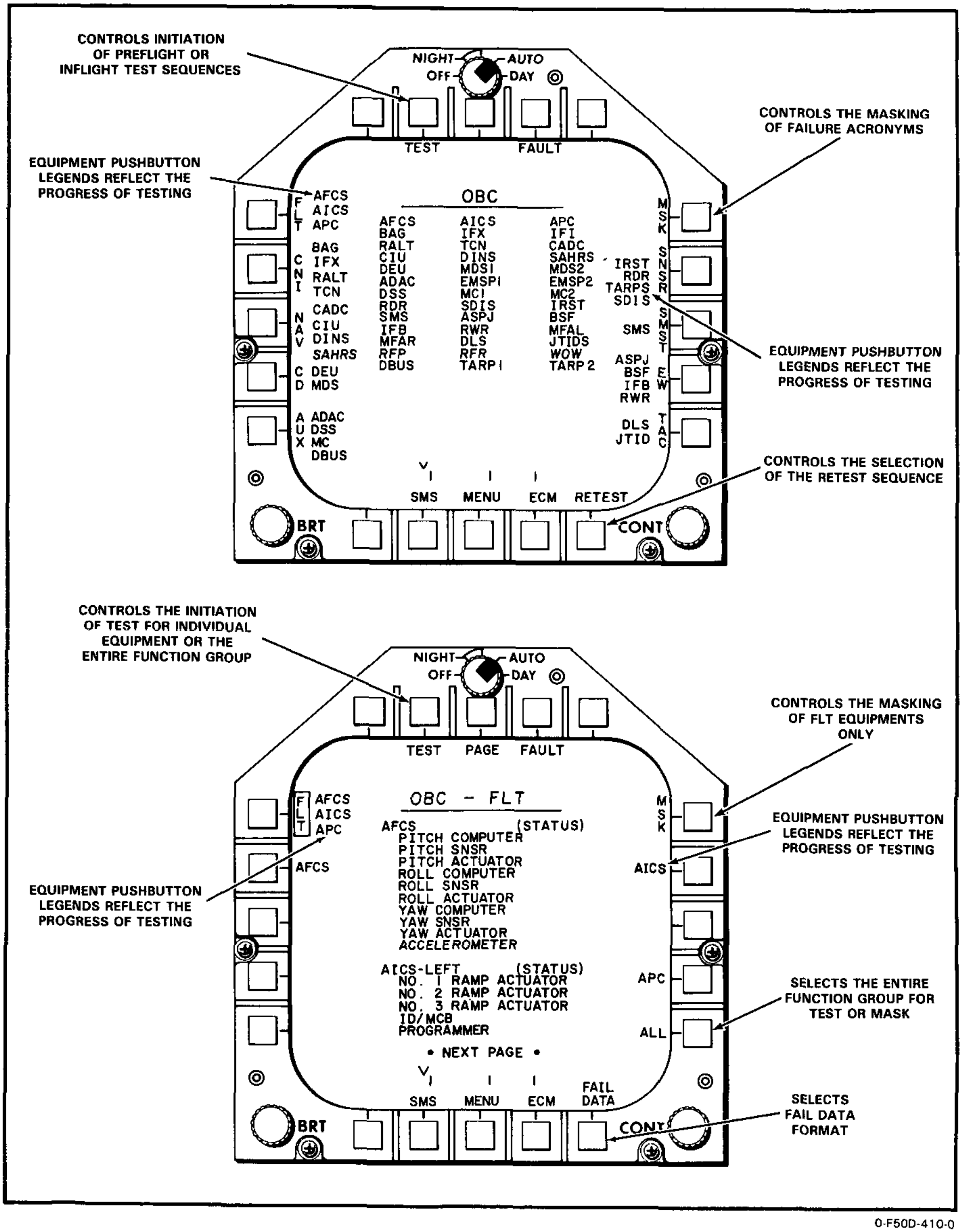


Figure 38-11. Format Examples

1. In-flight/preflight test sequences are initiated through the OBC basic format by pressing the TEST pushbutton while the aircraft is on the ground or airborne. Depending on the flight status, either the in-flight or preflight test sequence will be initiated (refer to BIT interlocks/restrictions).

2. If interlock conditions/restrictions are not satisfied, testing will not be initiated and a computer message will be displayed to indicate the reason for rejection. Refer to paragraph 38.3.3.2.3 for computer message descriptions.

3. If interlock conditions are satisfied, the TEST pushbutton legend is boxed to indicate a valid test selection and BIT is initiated in parallel or in sequential order for all WRAs in the sequence that are powered on and ready.

4. Nominal test sequence time for preflight is 69 seconds, and in flight is 35 seconds. (Note: Test times may vary as a function of equipment status.)

5. Reselecting the TEST pushbutton while the sequence is in progress will terminate test for WRAs that are still in test. WRAs that cannot be terminated will continue in test until normal completion. When all WRAs have completed test, the TEST pushbutton legend is unboxed to indicate that the sequence is no longer in progress.

6. The retest sequence is initiated through the OBC basic format by pressing the RETEST pushbutton while the aircraft is on the ground or airborne. WRAs are selected by the system for retest if the last entry in the FHF indicates a NOT READY status and if individual equipment interlocks are satisfied. Refer to BIT interlocks/restrictions for the equipment applicable to this sequence.

7. If interlock conditions/restrictions are not satisfied, testing will not be initiated. Refer to paragraph 38.3.3.2.3 for computer message descriptions.

8. If the interlock conditions are satisfied, the RETEST pushbutton is boxed to indicate a valid test selection and BIT is initiated in parallel or in sequential order for all WRAs in the sequence that are powered on and ready.

9. At the completion of the RETEST sequence, the last FHF entry (indicating NOT READY) will be removed from the FHF for all equipment that currently indicates a status other than NOT READY.

10. Nominal test time varies based on the mix of equipment. Maximum test time is 35 seconds. (Note: Test times may vary as a function of equipment status.)

11. Reselecting the RETEST pushbutton while the sequence is in progress will terminate test for equipment still in test. Equipment that cannot be terminated will continue in test to normal completion. When all tests are completed, the RETEST pushbutton is unboxed to indicate that the sequence is no longer in progress.

38.3.3.2.2 Function Group/Unit Test. OBC functional group formats allow groups of functionally related or individual (i.e., unit) WRAs to be selected for test. Refer to Figure 38-8. The OBC functional group formats are accessible from the OBC basic format: FLT, CNI, NAV, CD, AUX, SNSR, SMS, EW, and TAC.

Group tests are initiated with the respective OBC functional group format by pressing the ALL and TEST pushbuttons. The ALL pushbutton legend is boxed to indicate its selection and is unboxed when deselected. Group testing is only initiated if the ALL pushbutton is boxed prior to making the selection of the TEST pushbutton. Depending on flight status, all WRAs that satisfy individual interlock conditions will be initiated into test. Refer to Figure 38-7 for group test selects.

1. If interlock conditions/restrictions are not satisfied for at least one WRA, testing will not be initiated.

2. If interlock conditions are satisfied for at least one WRA, the TEST pushbutton legend is boxed on the applicable OBC functional group format to indicate a valid test selection and BIT is initiated in parallel or in sequential order for all powered-on and ready WRAs in the sequence.

3. Nominal test times may vary as a function of the selected functional group and are based on the equipment initiated to test (refer to Figure 38-4).

4. Reselecting the ALL and TEST pushbuttons while the functional group test is in progress will terminate test for equipment in test. Equipment that cannot be terminated will continue in test until normal completion. When all equipment has completed test, the TEST pushbutton legend is unboxed to indicate that testing is complete.

Unit tests are initiated from any OBC functional group format by pressing equipment and TEST pushbuttons. Any number of equipment pushbuttons may be pressed prior to pressing the TEST pushbutton in order to test more than one item at the same time. For each selection, the pushbutton legend is boxed to indicate selection and unboxed when deselected. Only equipment with a boxed legend will be tested. Depending on flight status, all equipment that satisfies individual interlock conditions will be initiated into test. Refer to Figure 38-7 for individual test selects.

1. If interlock conditions/restrictions are not satisfied for at least one equipment, testing will not be initiated.

2. If interlock conditions are satisfied for at least one equipment, the TEST pushbutton legend is boxed on the applicable OBC functional group format to indicate a valid test selection and BIT is initiated for all equipment that is powered on and ready.

3. Nominal test times may vary as a function of the selected equipment initiated to test (refer to Figure 38-4).

4. Reselecting equipment and TEST pushbuttons while test is in progress will terminate test for equipment still in test. Equipment that cannot be terminated will continue in test until normal completion. When all tests are complete, the TEST pushbutton legend is unboxed to indicate that testing is no longer in progress.

38.3.3.2.3 OBC Display Messages. OBC display messages are shown on the MFDs in response to invalid test selections resulting from interlocks not being satisfied, interlocks changing, and for tests completed.

Normally, OBC computer messages are displayed on the pilot center MFD and the RIO MFD. If the pilot center MFD is powered off or failed, computer messages will be displayed on the pilot right MFD. These messages are removed from the display head by pressing the ACK pushbutton, which is boxed to indicate that at least one display message requires acknowledgment (refer to Figure 38-12).

OBC/CSS messages are displayed on the MFD from which the test selection is made and also displayed on the same MFD if a CSS format is presented. There are two types of messages within this class: 3-second type, displayed for 3 seconds and then removed by the system; conditionally removed type, displayed until either the applicable interlock condition is satisfied, or until the format is changed (refer to Figure 38-13).

38.3.3.2.4 OBC-Related Warning/Caution/Advisory Messages. Figure 38-14 shows acronyms that are displayed on MFD3 in response to equipment failures or overheating.

38.3.3.2.5 Failure History File Format. The FHF format displays a history of WRA failures. There is a maximum of 10 entries per WRA for which the WRA failure status and the time of failure are displayed. The time of failure is relative to the last time the system was cold started or SYSTEM RESET was pressed. The FHF is cleared when the CLR pushbutton is pressed with preflight conditions satisfied. The preflight conditions are: weight on wheels, TAS < 76 knots, pilot's OBC discrete via the MASTER TEST panel, and handbrake set.

38.3.4 Joint Tactical Information Distribution System On-Board Check. JTIDS OBC can be selected whenever electrical power and cooling air are available. The JTIDS secure data unit needs to be installed and loaded for JTIDS to pass OBC. Without the unit installed and loaded, JTIDS OBC will display a DDP fail. A JTIDS download is not required for JTIDS OBC; however, if the DSS is loaded, a download is recommended. The selection of JTIDS OBC when not in sync (receiving messages) will pass but the fail data will have bit 4 in word 11 and bit 8 in word 12 because no messages are received.

The selection of JTIDS OBC will interrupt tacan data (momentary display of tacan fail detected computer message) and initiate a tacan self-test. This will disable tacan steering and tacan navigation updates, if selected; range will go invalid; bearing will display 270°; then range will display 000 miles and bearing 180°.

COMPUTER MESSAGE	DESCRIPTION
PRE–FLT OBC COMPLETE	Displayed when the preflight OBC test sequence is completed. Message is displayed if sequence completes normally or is terminated, or if interlock conditions change.
IN–FLT OBC COMPLETE	Displayed when the in–flight OBC test sequence is completed. Message is displayed if sequence completes normally or is terminated, or if interlock conditions change.
RETEST COMPLETE	Displayed when the retest OBC sequence is completed. Message is displayed if sequence completes normally or is terminated, or if interlock conditions change.
TEST COMPLETE –<GROUP NAME>	Displayed when a functional group test is completed. Message is displayed if group test completes normally or is terminated, or if interlock conditions change. <GROUP NAME> appears as AUX, CD, CNI, FLT, NAV, EW, TAC, or IRST for the functional group that completed test.
OBC SEQ ABORTED	Displayed when an OBC sequence (preflight or in–flight) is terminated through the OBC BASIC format while it is in progress.
RETEST ABORTED	Displayed when a retest sequence is terminated through the OBC BASIC format while it is in progress.
PILOT OBC DISABLE	Displayed when the Pilot's MASTER TEST panel switch remains in OBC 10 seconds after commanded BIT completes for an equipment that required this interlock to initiate test.
INTERLOCK ABORT	Displayed when an interlock condition changes state (i.e., no longer satisfied) for an equipment that is already in test. Commanded BIT will be terminated for the affected equipment.
CHALLENGE IFF	Displayed when the IFF Interrogator has not been challenged prior to the selection of a test sequence. This message is displayed only once at the time of the test sequence selection. If the system cold starts, or SYSTEM RESET is pressed, this message will be displayed again when a test sequence selection is made.
INVALID <WRA NAME> LOAD	Displayed when an equipment has an inconsistent firmware load, or is not compatible with the mission computer software load. The <WRA NAME> field applies to the following equipments: MC1, MC2, CIU, SAHR, MDS1, MDS2, DEU, INS, ADAC, SMS, RWR, ASPJ, RDR, SDIS, IRST.

Figure 38-12. OBC Computer Messages

OBC/CSS MESSAGE	DESCRIPTION
WOW NOT SATISFIED	Displayed when equipment is selected for test via a unit, inflight, or preflight test selection, and the WOW (Weight–on/off–Wheel) interlock condition is not satisfied. Testing will not be initiated for the selected equipment. Note that this message will not be displayed for functional group or retest test selections.
TAS NOT SATISFIED	Displayed when equipment is selected for test via a unit, inflight, or preflight test selection, and the TAS (True Air Speed interlock condition less than or greater than 76 knots) is not satisfied. Testing will not be initiated for the selected equipment. Note that this message will not be displayed for functional group or retest selections.
MULTI INTLK NOT MET	Displayed when equipment is selected for test via a unit, inflight or preflight test selection, and more than one (i.e., multiple) interlock conditions are not satisfied (WOW, TAS, PARKING BRAKE, or MTP). Testing will not be initiated for the selected equipment. Note that this message will not be displayed for functional group or retest selections.
EQUIPMENT CONFLICT	Displayed when equipment is selected for test which conflicts with other equipment already in test. These conflicts are primarily between equipments subordinate to the CIU, between CIU subordinate equipment and the CIU itself, between DP1 and DP2, and between MC1 and MC2. Testing will not be initiated for equipment that conflict operationally.
NO COMMANDED BIT	Displayed when equipment that does not support command BIT is selected for test.
OBC SEQ IN PROGRESS	Displayed when equipment is selected for test that is the same as equipment already in test as part of an OBC inflight or preflight test sequence. Testing for the selected equipment will not be initiated.
RETEST IN PROGRESS	Displayed when equipment is selected for test that is the same as equipment already in test as part of an OBC RETEST sequence. Testing for the selected equipment will not be initiated.
MASTER TEST NOT SET	Displayed when equipment is selected for test through a unit or preflight test selection and the pilot's MASTER TEST panel switch is not set to OBC. This message is displayed as long as an OBC or CSS format is presented, and removed when the switch is set to OBC.
HANDBRAKE NOT SET	Displayed when equipment is selected for test via a unit or preflight test sequence selection and the handbrake is not set. This message is continuously displayed as long as an OBC or CSS format is presented and is removed when the handbrake is set.
BAD JTID DATA LOAD	Displayed when JTIDS test is selected during initialization (Down Load) of JTIDS.
TACAN FAIL DETECTED	Displayed for a TACAN failure or JTIDS NOT READY.
JTIDS FAIL DETECTED	Displayed for a JTIDS failure or JTIDS NOT READY.

Figure 38-13. OBC/CSS Messages

ACRONYM	DISPLAYED CONDITION	CAUSE
MC1	Mission computer No. 1 is NO GO or NOT READY	Mission computer No. 1 is failed, or powered off
MC2	Mission computer No. 2 is NO GO or NOT READY	Mission computer No. 2 is failed, or powered off
CIU	CIU is NO GO or NOT READY	CIU is failed, or powered off
INS	INS is NO GO or NOT READY	INS is failed,or powered off
IMU	IMU is not valid	IMU is failed. Loss of inertial and attitude data from INS
RWR	RWR is NO GO or NOT READY	RWR is failed, or powered off
FWD ASPJ	ASPJ receiver (low or high), ASPJ transmitter (low or high) or processor is NO GO	ASPJ RECEIVER, TRANSMITTER, or PROCESSOR is failed
AFT ASPJ	ASPJ processor, receiver augmentation or transmitter augmentation is NO GO	ASPJ PROCESSOR, RECEIVER AUG, or TRANSMITTER AUG is failed
MC1 HOT	Mission computer No. 1 overheated	Possible loss of cooling air
MC2 HOT	Mission computer No. 2 overheated	Possible loss of cooling air
ASPJ HOT	ASPJ is overheated	Possible loss of cooling air
CIU HOT	CIU is overheated	Possible loss of cooling air
DP1 HOT	DP1 is overheated	Possible loss of cooling air
DP2 HOT	DP2 is overheated	Possible loss of cooling air
SMS HOT	SMS is overheated	Possible loss of cooling air
RDR HOT	RDR is overheated	Possible loss of cooling air
HUD HOT	HUD is overheated	Possible loss of cooling air
RWR HOT	RWR is overheated	Possible loss of cooling air
DSS HOT	DSS is overheated	Possible loss of cooling air
DEU HOT	DEU is overheated	Possible loss of cooling air
MPS HOT	MPS is overheated	Possible loss of cooling air
IRST HOT	IRST is overheated	Possible loss of cooling air
SAHRS HOT	SAHRS is overheated	Possible loss of cooling air
JTID HOT	JTIDS R/T is overheated	Possible loss of cooling air or a high JTIDS transmit duty cycle.
IPF	JTIDS Interference Protection Feature detected failure	JTIDS is failed, a momentary glitch or 20% duty cycle has been exceeded in "Limit". Select IPF Reset on JTIDS Control Panel.
SDU ALRM	JTIDS Secure Data Unit failure or no crypto load	SDU fail or the crypto key is erased.

Figure 38-14. OBC-Related Warning/Caution/Advisory Messages

38.4 COOPERATIVE SUPPORT SOFTWARE

CSS allows capture and display of system data in real time and the optional recording of data from avionics processors that are CSS compatible. CSS is typically used to aid in troubleshooting system problems. The CSS compatible processors include mission computer No. 1, mission computer No. 2, multifunction display system No. 1, multifunction display system No. 2, airborne data acquisition system, stores management processor, converter interface unit, data entry unit, infrared search and track system, joint tactical information distribution system, and sensor display indicator set. Note that radar flycatcher displays are provided on the tactical information display.

Note

The JTIDS processor only supports the flycatcher functions (start address, increment, decrement, and disable).

CSS supports the following modes, all of which are selectable on the DEU: flycatcher, block address, and trap. CSS data is displayed on the MFD CSS format. The CSS format is selected by pressing the FAULT pushbutton on the OBC basic format and then pressing CSS on the MAINT CURRENT FAILURES format.

38.4.1 CSS Operation. The CSS page (see Figure 38-15), displayed on the DEU, allows the entry of DATA TYPE and OPER CODE used for data recording purposes, and allows the selection of all CSS modes including flycatcher, block address, and trap. All CSS data is displayed on an MFD CSS format, using pushbutton controls. Note that if the DEU is slaved to the RIO MFD, selection of the CSS format on that MFD will cause the CSS page of the DEU to be displayed.

38.4.1.1 Data Recording Operations. The CSS DATA TYPE page (see Figure 38-16) allows the optional selection of a recording/storage device for the retention of data that is captured via a CSS mode. CSS data can be telemetered or recorded for offline analysis based on one or more of the following selections:

1. Pressing the AUX pushbutton allows CSS data to be displayed on an auxiliary display head (this function is not available).

2. Pressing the REC pushbutton allows CSS data to be recorded on a flight recorder, if one is installed in the aircraft.

3. Pressing the TM pushbutton allows CSS data to be telemetered or down-linked to a ground-based station.

4. Pressing MC1 or MC2 allows CSS data to be stored in mission computer No. 1 or mission computer No. 2 memory, respectively, and is only accessible for future reference by the CSS function. A maximum of 300 blocks of CSS data can be stored in either mission computer. A block of data is saved when a trap or block address function completes, and one block per second is saved for an active flycatcher. This data will only be retained by the mission computers until the system cold starts or is reset.

5. Pressing the DSS pushbutton allows CSS data to be recorded by the data storage set.

The CSS OPER CODE page format (see Figure 38-16) allows the optional selection of an operator code. This code is used to identify the operator/aircraft when CSS data is analyzed offline. The code is entered by pressing the corresponding numerics and then pressing ENT.

38.4.1.2 Flycatcher Operation. Flycatcher mode allows memory contents for a selected processor to be continuously examined and displayed on the MFD CSS format. The contents of 16 contiguous memory locations are displayed relative to a specified flycatcher memory start address, updated at a 1-second rate. A previously specified start address may be incremented or decremented by a fixed bias. Each processor supports only one flycatcher at a time.

Flycatcher is initiated or terminated as follows, using the DEU (see Figure 38-17):

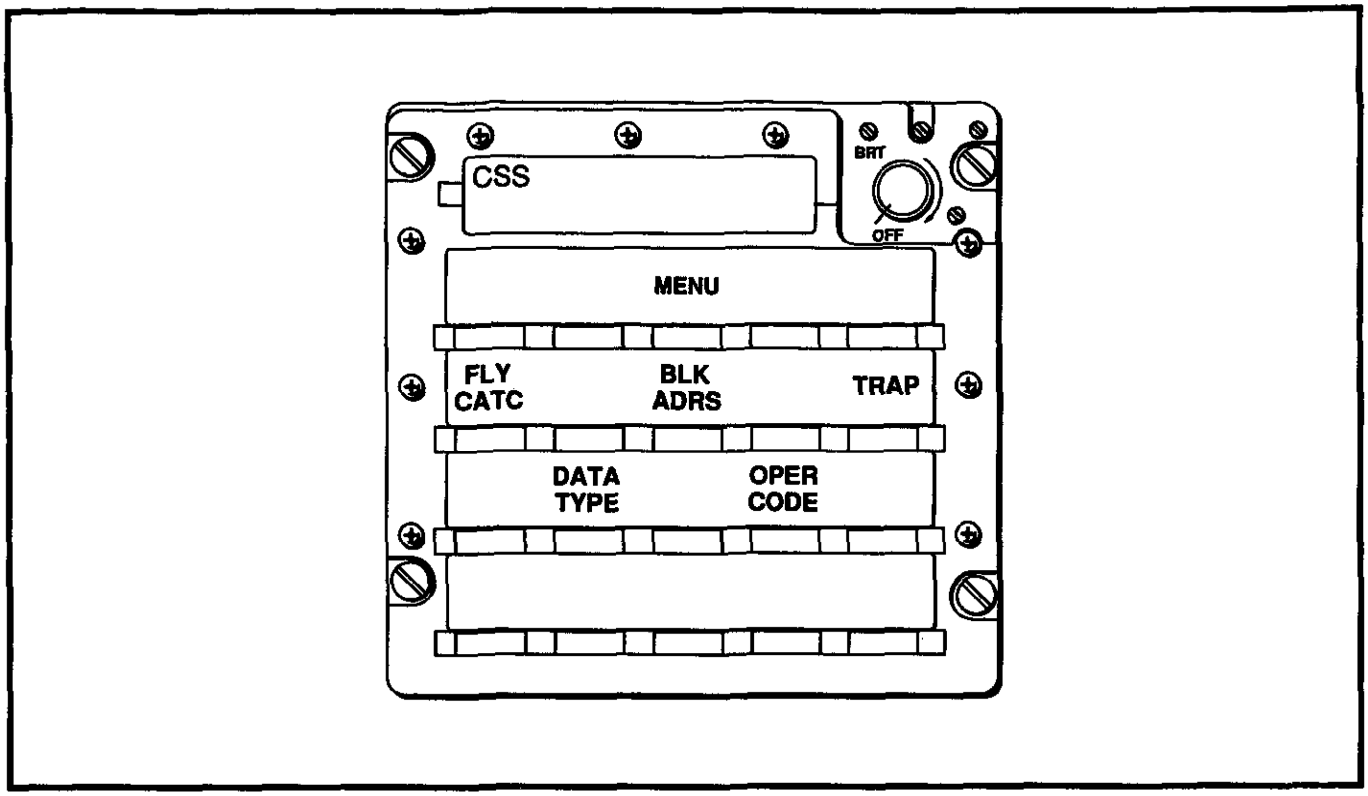
1. Select flycatcher by pressing FLY CATC on CSS page of DEU.

2. Select processor to be examined by pressing one of the WRA pushbuttons on F-CATC page.

3. Initiate flycatcher. Press STRT ADRS to allow entry of starting memory address for selected processor; enter start address in hexadecimal with numeric pushbuttons. Press ENT to complete address entry and activate flycatcher.

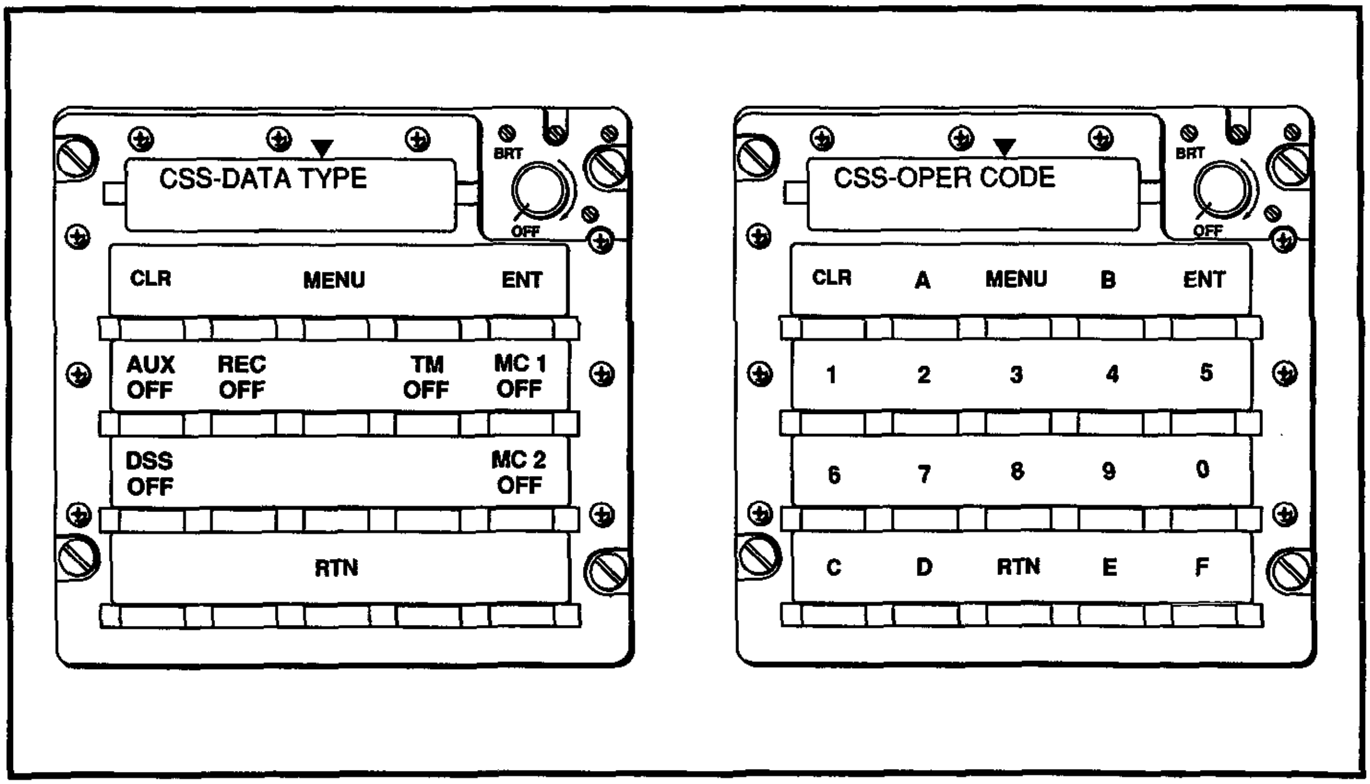
4. For flycatcher termination, press DSBL to deactivate current flycatcher.

5. Repeat steps 2 and 3 to initiate or terminate additional flycatchers for other processors.



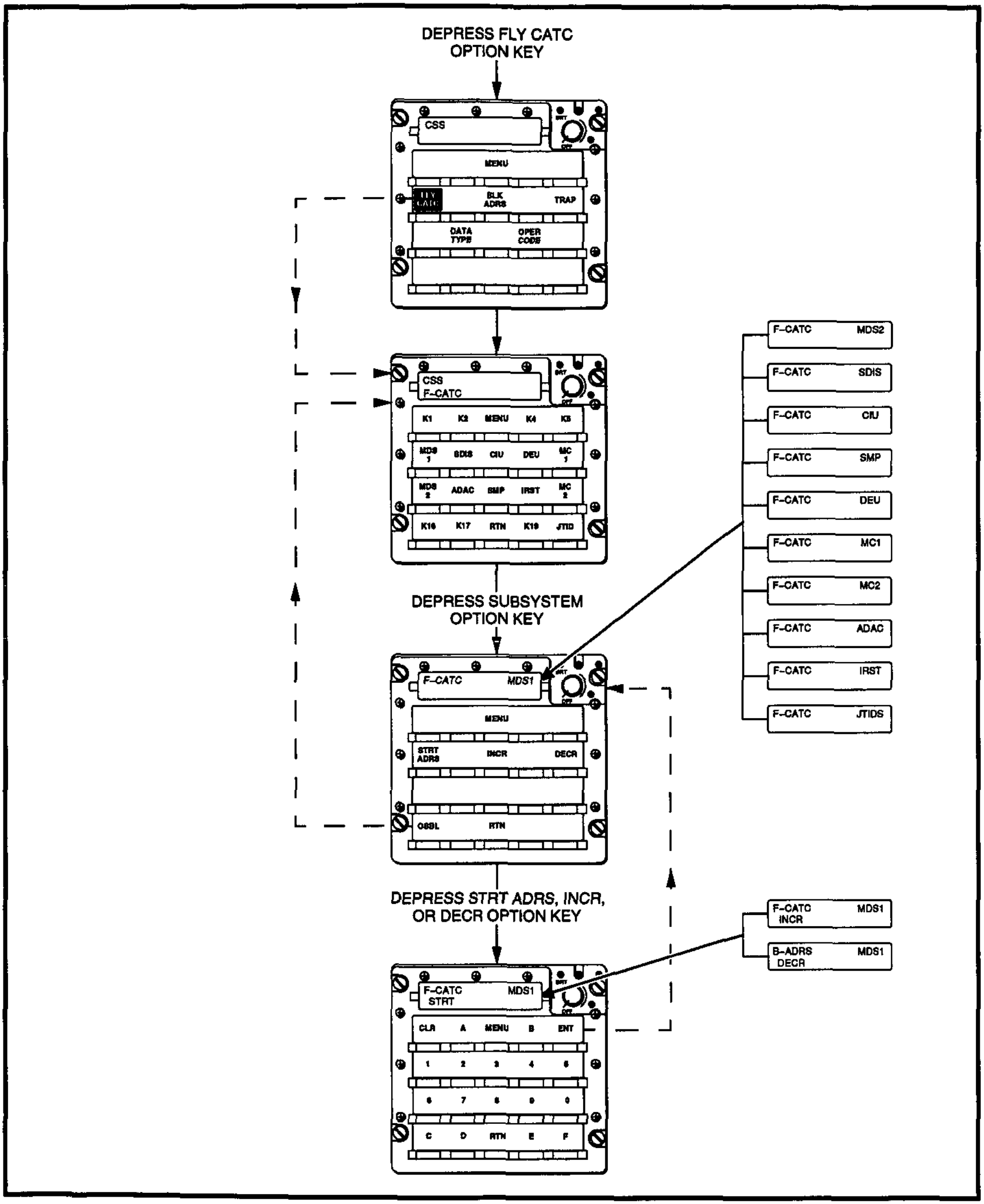
(AT)1-F50D-383-0

Figure 38-15. DEU CSS Page



(AT)1-F50D-384-0

Figure 38-16. DEU Pages for Operator Code and Data Type



(AT)2-F50D-385-0

Figure 38-17. DEU Flycatcher Pages

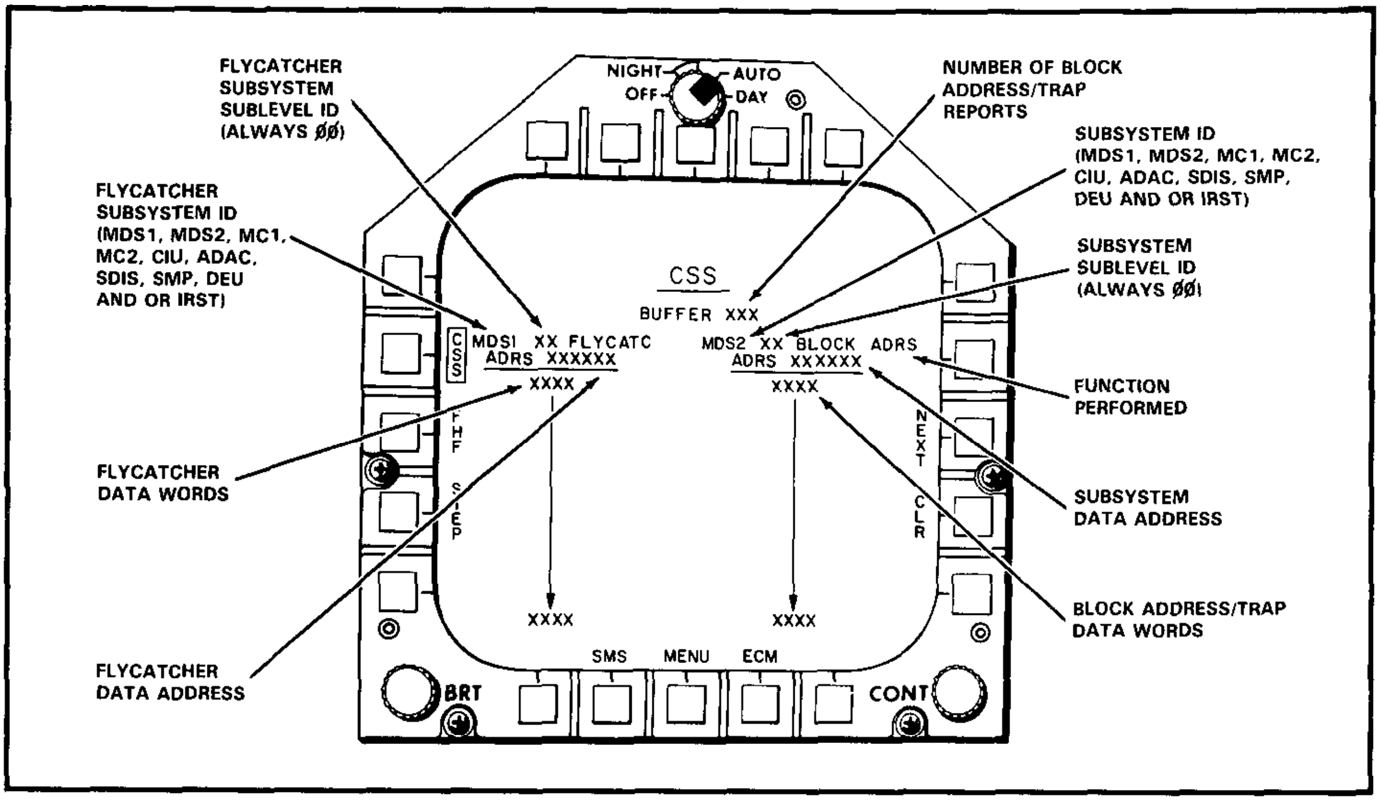


Figure 38-18. MFD CSS Display Format

An active flycatcher can be biased by a fixed number of memory locations, relative to the current memory address as follows, using the DEU (see Figure 38-17):

1. Select flycatcher by pressing FLY CATC on CSS page of DEU.

2. Select INCR (to increment) or DECR (to decrement) pushbutton. Enter bias value in hexadecimal with numeric pushbuttons and press ENT to complete entry.

3. Repeat step 2 for subsequent entry of bias values for selected processor.

Flycatcher data is displayed on the left half of the CSS format anytime there is at least one active flycatcher as follows, using the MFD (see Figure 38-18).

1. Select CSS format on any MFD by pressing FAULT pushbutton on OBC basic format and then pressing CSS pushbutton on MAINT CURRENT FAILURES format.

2. Select STEP pushbutton to display 16-word block of flycatcher data associated with next processor that has active flycatcher. Note that flycatcher data word field will display flycatcher last selected, if any, when format is first displayed.

The messages shown in Figure 38-19 are displayed on the RIO MFD computer message area in response to an invalid flycatcher operation.

38.4.1.3 Block Address/Trap Operation. Block address allows the memory contents of a selected processor to be captured once upon its selection; trap allows data to be captured once upon the satisfaction of a selected algorithm. Data captured as a result of either mode is displayed on the MFD CSS format. The contents of 16 contiguous memory locations are displayed relative to a specified memory start address.

Block address is initiated as follows, using the DEU (see Figure 38-20) (note that block address terminates automatically after its activation):

1. Select block address mode by pressing BLK ADRS on CSS page of DEU.

2. Select system to be examined by pressing one of equipment pushbuttons on B-ADRS page.

MESSAGE (Note 1)	REASON FOR DISPLAY
E FLYCH ADD {SSSS}	Error in DEU entered flycatcher start address for the subsystem identified in the {SSSS} field.
FLYCH EXISTS {SSSS}	Only one flycatcher can be active per subsystem. The subsystem is identified in the {SSSS} field. In order to setup the next flycatcher, the previous flycatcher must be disabled.
E FLYCH INC {SSSS}	Error in DEU entered flycatcher increment address for the subsystem identified in the {SSSS} field.
N FLYCH IN {SSSS}	Error in DEU entry to increment, decrement or disable a flycatcher for a subsystem that has no active flycatcher. The subsystem is identified in the {SSSS} field.
E FLYCH DEC {SSSS}	Error in DEU entered flycatcher decrement address for the subsystem identified in the {SSSS} field.
E NOT AVAIL	Flycatcher not available. System is not ready. JTIDS tape recording (TOMs 21−27) enabled.
Note: (1) {SSSS} identifies the affected CSS compatible subsystem.	

Figure 38-19. Flycatcher Error Messages

3. Enter start address in hexadecimal with numeric pushbuttons. Press ENT to complete the entry of data and to activate block address mode.

4. Repeat steps 2 and 3 for additional block address operations for other systems.

Trap is initiated or terminated as follows using the DEU (see Figure 38-21). There is a maximum of four traps per processor:

1. Select trap mode by pressing TRAP on CSS page of DEU.

2. Select system to be examined by pressing one of equipment pushbuttons on TRAP page.

3. Enter trap number (00 to 98) where number can represent existing trap or new one (depending on the desired function).

4. Set up trap algorithm as indicated below, or press DSBL to disable existing trap:

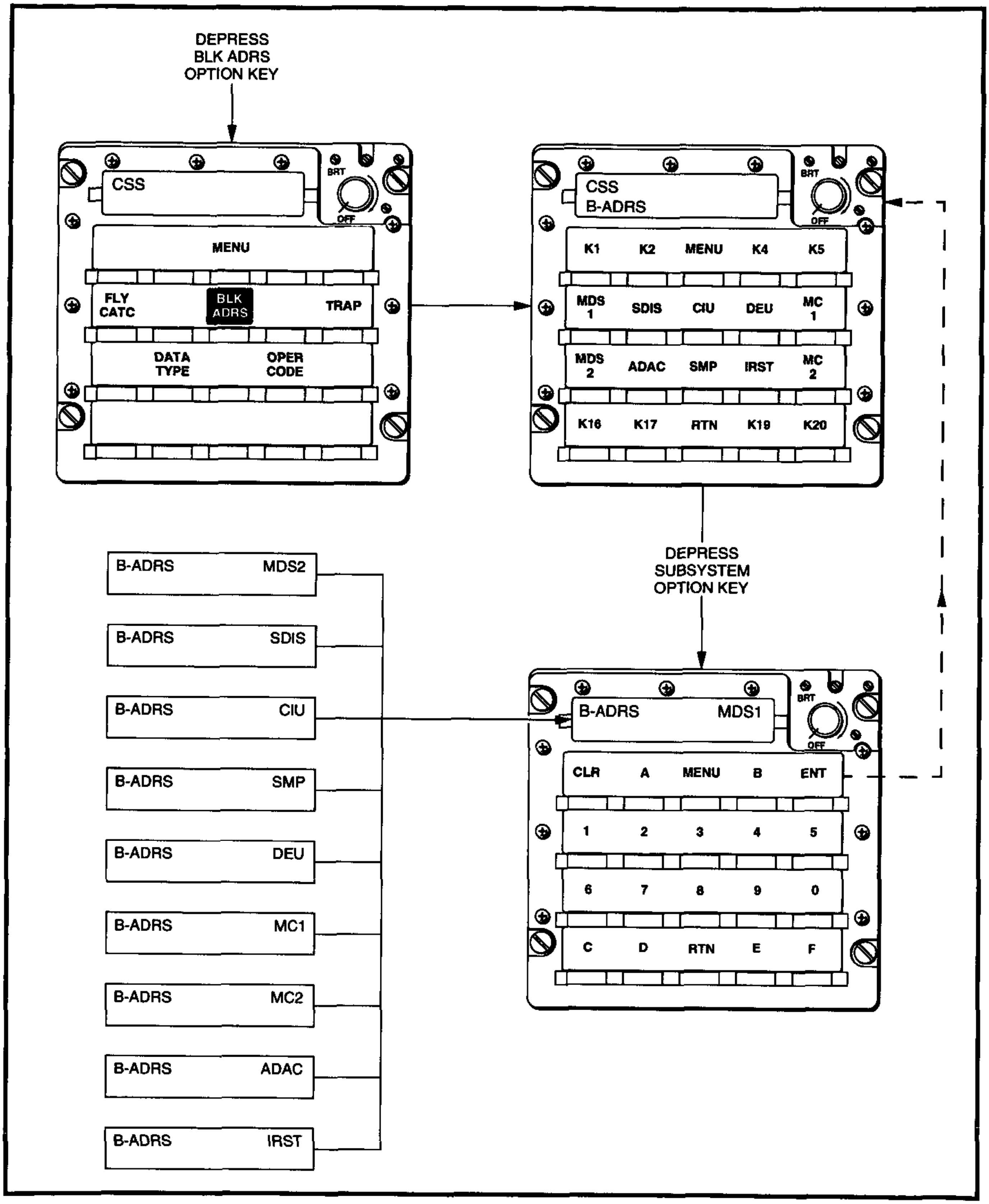
   a. Press ALGO to select algorithm that is used to trigger the capture of data. Enter algorithm number with numeric keypads, and press ENT to complete this entry.

   b. For each variable (i.e., V1, V2, V3) in selected algorithm, press either an appropriate address pushbutton (V1 ADRS, V2 ADRS, V3 ADRS), or constant pushbutton (V1 CNST, V2 CNST, V3 CNST). Both selections require numeric entry defining address of variable or actual constant to be used in evaluation of algorithm. Enter value with numeric pushbuttons and then press ENT to complete entry.

   c. Press DATA ADRS to allow entry of start address for data. Enter address via numeric pushbuttons, and press ENT to complete entry.

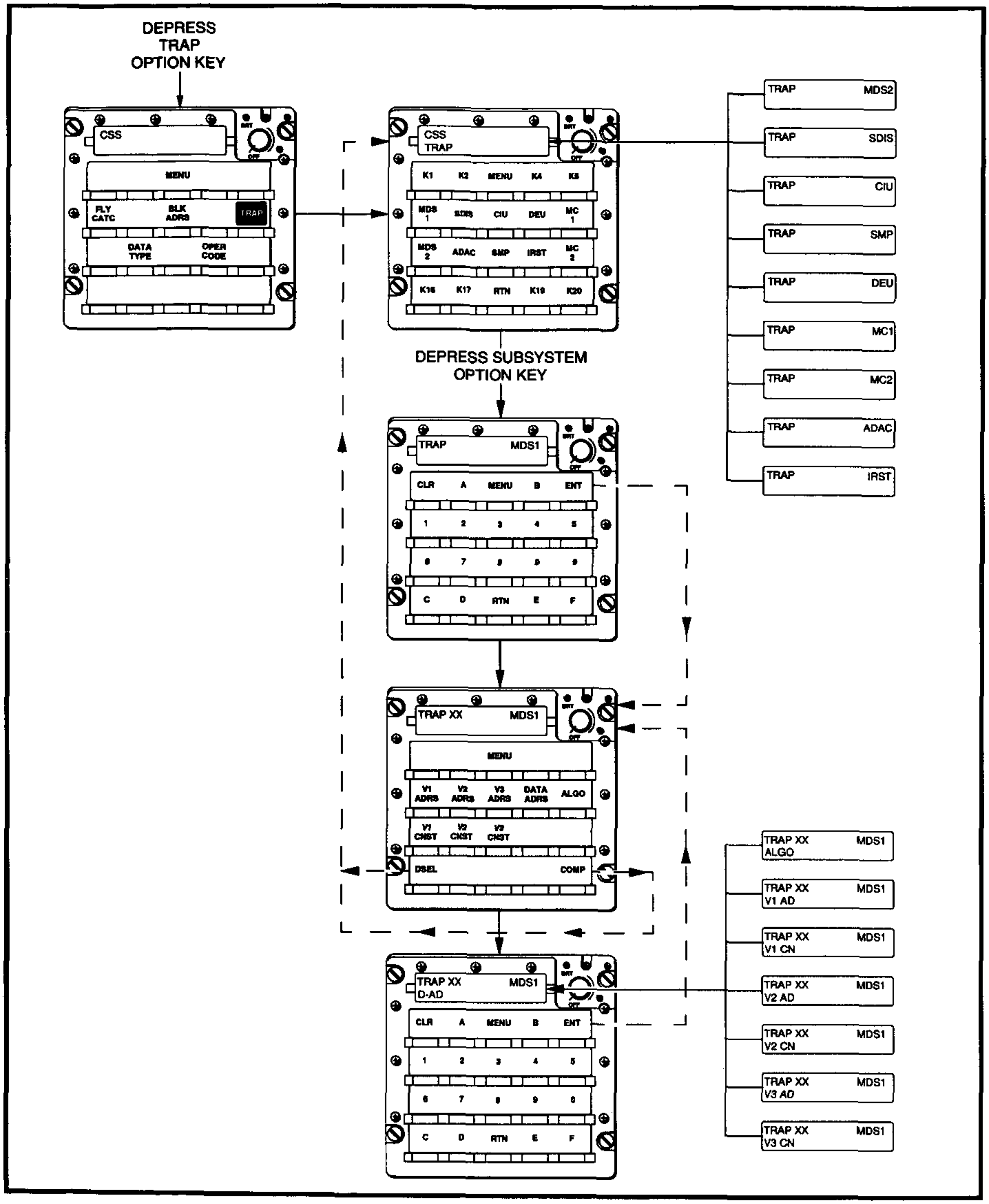
   d. Press COMP to complete the activation of trap.

5. Repeat steps 2 through 4 to initiate or terminate additional trap operations for other systems.



(AT)1-F50D-387-0

Figure 38-20. DEU Block Address Pages



(AT)1-F50D-388-0

Figure 38-21. DEU Trap Pages

MESSAGE (Note 1)	REASON FOR DISPLAY
E BLOCK ADD {SSSS}	Error in DEU entered block start address for the identified subsystem.
E TRAP ADD {SSSS} {NN}	Error in DEU entered trap start address for the identified subsystem and trap number.
E 4 TRAPS {SSSS} {NN}	Current trap entry exceeds the maximum of 4 allowable traps per subsystem.
E TRAP VAR {SSSS} {NN}	Error in DEU entered trap variable address for the identified subsystem and trap number.
E TRAP ALGO {SSSS} {NN}	Error in DEU entered algorithm code for the identified subsystem and trap number.
NO TRAP NO. {SSSS} {NN}	Error in DEU entered trap number that is selected to be disabled.
TRAP TRU IN {SSSS}	Trap in identified subsystem has been triggered. Contents of the captured data block can be displayed on the CSS format.

Note:

(1) {SSSS} identifies the affected CSS compatible subsystem. {NN} identifies a trap number ranging between 1 and 4.

Figure 38-22. Block Address/Trap Error Messages

Block address and trap data are displayed on the right half of the MFD CSS format when there is at least one block of data to be reported. As a maximum, only the last 15 block-address and trap reports will be retained by this function. Displays are selected as follows:

1. Select CSS format on any MFD by pressing FAULT pushbutton on OBC basic format, and then pressing CSS pushbutton on MAINT CURRENT FAILURES format.

2. Press NEXT pushbutton to display next data report. The number of block-address/trap reports indicates if any additional reports of data are available for display and is decremented upon each depression of NEXT pushbutton. Note that block-address/trap data-words field will display last selected block of data, if any, when format is first displayed. Repeat this step as necessary to display each report.

3. Press CLR pushbutton to clear any data reports. This action inhibits display of any remaining reports and resets the number of block-address/trap reports to zero.

The messages shown in Figure 38-22 are displayed in the computer message area of the RIO MFD in response to invalid block address or trap operations.

38.5 RADAR SYSTEM BUILT-IN TEST

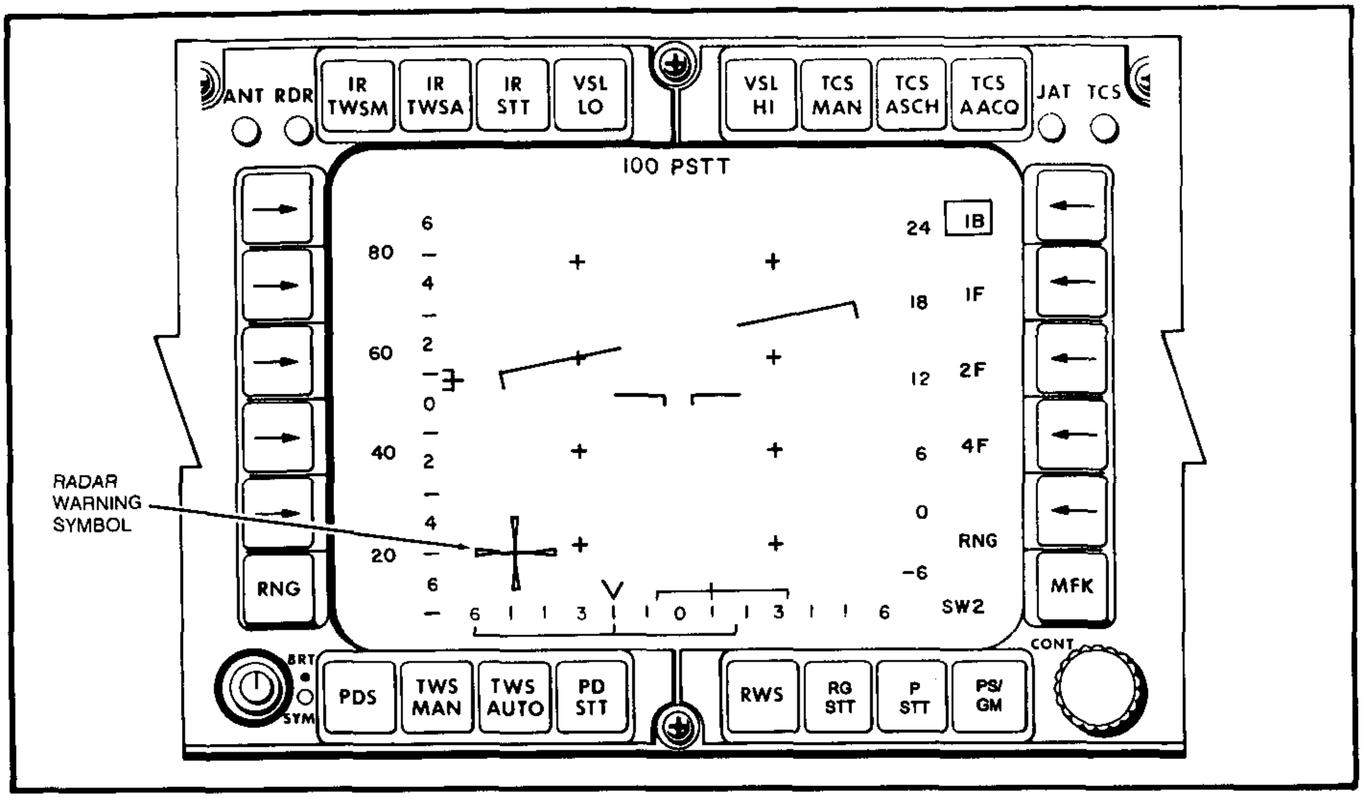
Radar system BIT detects AN/APG-71 radar system hardware faults and provides assessment of tactical radar mode availability. BIT has four major capabilities:

1. Fault detection uses computer-controlled and RIO-initiated tests to detect failures in flight or on the deck.

2. Fault isolation allows isolation of a detected system failure by indicating DP and the suspect WRA or group of WRAs.

3. DMA provides a pass, fail, or degraded evaluation of the operational modes.

4. CM automatically provides the RIO with a warning when system failures occur during tactical modes.



0-F50D-495-0
N2/97

Figure 38-23. DD Radar Warning Maltese Cross

BIT provides indication of AN/APG-71 radar functional status for ground-level maintenance and airborne operation. Prior to aircraft employment, or following an airborne mission, the groundcrew can execute BIT to determine radar set status. Corrective maintenance action recommendations are provided on the maintenance display. This display indicates the detected hardware failure(s) along with replacement recommendations for associated WRA(s).

During tactical operation, the RIO will be alerted to any anomalies that will impact radar or aircraft operation. A Maltese cross is displayed in the lower left-hand quadrant of the DD if the radar has failed and/or the transmitter is not radiating (except in sniff mode). The Maltese cross is also displayed when the radar is in standby or during initiated display test (Figure 38-23). The cross is not tied to the WOW switch, and will not be displayed solely for a WOW condition. Radar anomalies will appear in the lower left quadrant of the TID as two-character acronyms. Aircraft anomalies will appear on the TID as three-character acronyms, displayed below the radar acronyms. Acronyms will be displayed continuously while the failure condition exists. If multiple failures occur, the appropriate acronyms will be automatically cycled at a 2-second rate. More detailed failure information is available on the continuous monitor maintenance display. The RIO can initiate BIT at any time to confirm that hardware status is unchanged.

38.5.1 BIT Modes. BIT allows the flightcrew to quickly assess radar set status, identify hardware faults, and take the corrective action. This assessment includes a radar confidence test, verification of controls and displays functionality, and, as necessary, confirmation that the television camera set is operational.

The following BIT modes are available:

1. Operational readiness test
2. Computer and displays mode test
3. Initiated radar test
4. Initiated displays test
5. Television camera set test
6. Digital display built-in self-test
7. Initiated special test
8. Test-target BIT
9. Continuous monitoring.

38.5.1.1 Operational Readiness Test. ORT is automatically initiated when aircraft power is applied to the radar, with the sensor hand control in either STBY or XMIT or if a radar power interruption occurs for longer than 2.65 seconds. This radar confidence test includes tests of radar computers, RF subsystems, system interfaces, and target detection capability. ORT requires nominally 3.5 minutes to complete (including 3 minutes for transmitter warmup), but could take as long as 7 to 8 minutes if radar functions are degraded. When ORT has completed, the DMA display is automatically displayed on the TID and the BIT menu will appear on the DD (see Figure 38-24). The DMA algorithm provides an evaluation of the working status of tactical modes. If additional information is required, the maintenance display can be selected from the BIT menu.

At the completion of ORT, the following tests can be selected from the BIT menu on the DD: radar test, displays test, television camera set test, special test, or test target. If no further testing is required, a tactical mode can be entered directly by selecting the DD pushtile for the desired mode.

If ORT is running when a tactical situation arises, the RIO can abort ORT by pushing the PGM RST button in the lower right corner of the DD. ORT abort is not recognized until after the initialization phase is complete (5 seconds or less). To report that ORT has been aborted, the CM acronym OA is displayed in the lower left position of the TID and the event is recorded in the failure history file. The system will transition to 5-nm pulse search. The 3-minute transmitter warmup period will, however, still be in effect. This means that the system capabilities will be limited to a nonradiation mode until warmup is complete. The system may have some performance degradation because of insufficient calibrations. These calibrations are normally executed during the ORT sequence. Possible radar performance degradations are as follows:

1. LPRF

    a. Short pulse – Up to 500-foot range bias.

    b. Pulse compression – Up to 2-nm range bias.

2. HPRF – RWS and PDS perform as required.

3. RAM – RAM accuracy may be degraded.

4. PDSTT/RGSTT – Noise jammer problem will occur first time until periodic calibrations are performed. These calibrations shall be performed within 5 minutes of the exist or ORT.

38.5.1.2 Computer and Displays Mode Test. CDM is automatically initiated when aircraft power is applied to the radar with the SHC in CMPTR. CDM is interruptible by pressing the PGM RST pushtile on the DD. This radar confidence test includes a subset of the tests performed during ORT. It differs from ORT in that the antenna hydraulics and transmitter subsystem are not tested. CDM requires, nominally, 2.5 minutes to complete (the 3-minute transmitter warmup delay is not required). At the completion of CDM, the degraded mode assessment display is automatically displayed on the TID, and the BIT menu will appear on the DD. The DMA algorithm will give an evaluation of the working status of tactical modes. If additional information is required, the maintenance display can be selected from the BIT menu.

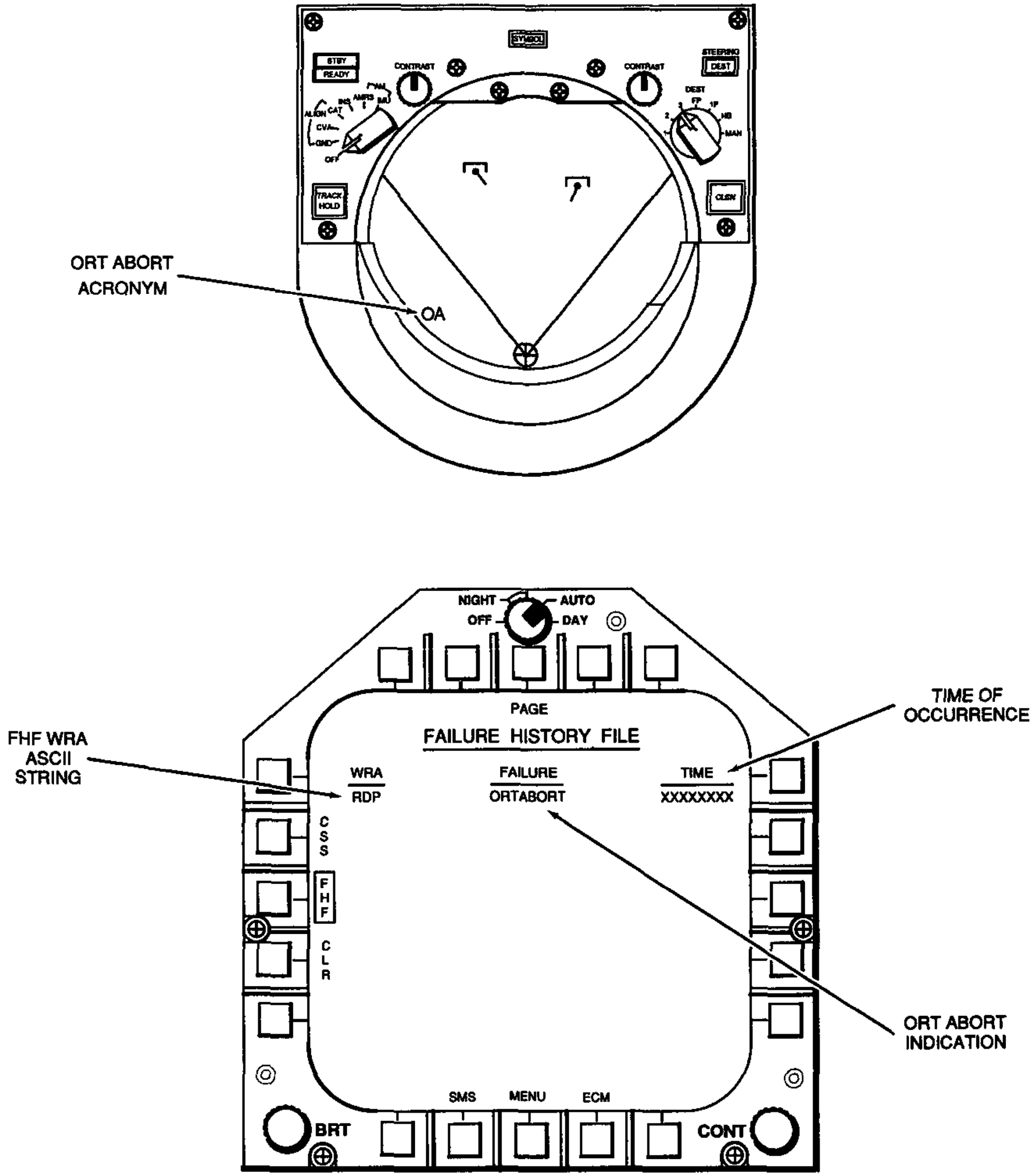
At the completion of CDM, the following tests can be selected from the DD BIT menu: radar test, displays test, television camera set test, special test, or test target. if no further testing is required, a tactical mode can be entered directly by selecting the DD pushtile for the desired mode.

38.5.1.3 Initiated BIT. The IBIT mode contains five submodes: radar BIT, displays BIT, television camera set BIT, digital display built-in self-test, and special tests BIT.

38.5.1.3.1 Radar BIT. Initiated radar test (RDR) allows retest of the radar system. If the SHC is in either STBY or XMIT, radar BIT will be the same as ORT (with the exception that the 3-minute transmitter warmup delay is not required). Consequently, radar BIT execution time is shorter. If the SHC is in CMPTR, radar BIT will be the same as CDM.

Radar BIT is initiated by depressing the MFK pushtile on the DD to obtain the radar modes menu, selecting the pushtile adjacent to BIT to obtain the BIT submenu, and then depressing the pushtile adjacent to RDR on the BIT menu. Test execution requires approximately 2.0 minutes, and is interruptible by a program restart (depressing PGM RST pushtile on the DD), another BIT selection, or a radar mode selection.

38.5.1.3.2 Displays BIT. DISP is a controls and displays subsystem confidence check. The TID and DD display a predefined set of static and dynamic symbology for evaluation of symbol intensity, completeness, contrast, and motion. Displays BIT symbology is dependent on the TID mode switch setting and DD keypad entry. The RIO must confirm visually that this subsystem is functioning properly.



(AT)0-F50D-496-0

Figure 38-24. MFD/TID ORT Abort Displays

Displays BIT is initiated by depressing the MFK pushtile on the DD to obtain the radar modes menu, selecting the pushtile adjacent to BIT to obtain the BIT submenu, and then depressing the pushtile adjacent to DISP on the BIT menu. Displays BIT is interruptible by a program restart (depressing PGM RST pushtile on the DD), another BIT selection, or a radar mode selection.

38.5.1.3.3 Television Camera Set BIT. The TCS test verifies the status of the television camera set. The capability of the TCS slave modes is verified, the mechanical tracking functions (i.e., slewing and track) are checked, and the radar-related TCS support functions are monitored. Detected faults are displayed on the TID at test completion.

TCS TEST is initiated by depressing the MFK pushtile on the DD to obtain the radar modes menu, selecting the pushtile adjacent to BIT to obtain the BIT submenu, and then depressing the pushtile adjacent to TCS on the BIT menu. TCS testing is interruptible by a program restart (depressing PGM RST pushtile on the DD), another BIT selection, or a radar mode selection.

38.5.1.3.4 Digital Display Built-In Self-Test. The DD has a standalone BIST capability that must be initiated and evaluated by the RIO. It tests DD functions as well as its discrete interfaces with the sensor control unit, sensor hand control, and TID.

DD BIST is initiated by depressing the C/D TEST pushtile on the radar control panel portion of the digital display. When in flight, continuous depression of the C/D TEST pushtile clears DD display and initiates BIST. Release causes the DD to revert to tactical operation. When not airborne, the first depression clears the DD display and initiates BIST; the second depression causes DD to revert to tactical operation.

38.5.1.3.5 Special Tests BIT. Initiated SPL TEST is designed to validate the operation of a specific radar submode or subfunction, and is used primarily for maintenance purposes. These tests are initiated with selection of the SPL TEST pushtile on the BIT menu, selection of the NBR pushbutton on the DD keypad, entering the appropriate test number, and then pushing the ENTER button.

38.5.1.4 Test Target BIT. The test target function is a RIO activated and evaluated end-to-end test of the radar system. It can be used to quickly verify that the radar system is capable of detecting, processing, and displaying reasonably sized targets. It is available in, and can be used to check the operation of low, medium, or high PRF tactical modes. Test target entry is indicated by a TT display on the lower left position of the TID.

To initiate test target BIT, MFK pushtile on the digital display is depressed, selecting the BIT menu. The test target is selected by depressing the button adjacent to TEST TGT. To enable the location for test target injection, the pushtile adjacent to RDM TGT or RCVR TGT is depressed. To terminate the test target BIT, the pushtile adjacent to the enabled target injection location is reselected.

38.5.1.5 Continuous Monitoring. CM periodically samples mission essential radar set signals during tactical operation, and informs the RIO of detected problems.

CM performs passive monitoring of key radar signals, at a one-quarter-second rate. These signals include power faults, overtemperature indicators, BIST status (i.e., equipment ready) signals, processor load status, transmitter peak power, calibration failures, antenna hydraulic interlocks, and transmitter interlocks.

Radar anomalies appear on the TID, in the lower left quadrant, as two character acronyms. Acronyms will be displayed continuously while a failure condition exists. If multiple failures occur, the appropriate acronyms will be automatically updated at a 2-second rate. When an acronym is displayed, the RIO can select the CM maintenance display to obtain more detailed information on the specific unit that has a malfunction or anomaly. The RIO can also initiate BIT at any time to confirm that hardware status is unchanged.

Aircraft system anomalies will appear on the TID, in the lower left quadrant directly below the radar CM acronyms, whenever a fault is detected. Corresponding failure acronyms will be displayed for 2 seconds.

38.5.2 Radar BIT Operation. The radar BIT function is contained in the RDP. This specialized radar computer provides necessary timing and control signals to F-14D radar subsystems to conduct various tests. BIT testing is generally independent of RIO interaction, with the exception of some manual switch settings, such as those on the SHC, which are not software controllable.

BIT execution can be either automatic or operator initiated. Upon application of aircraft radar power, ORT is automatically initiated. The RIO either switches the SHC from OFF to CMPTR (to start CDM execution), or STBY or XMIT (to start ORT execution). After powerup, CDM or ORT may be aborted by pressing the PGM RST button on the lower right corner of the DD. If CDM/ORT is not aborted, ORT requires nominally 3.5 minutes to complete and CDM requires nominally 2.5 minutes to complete.

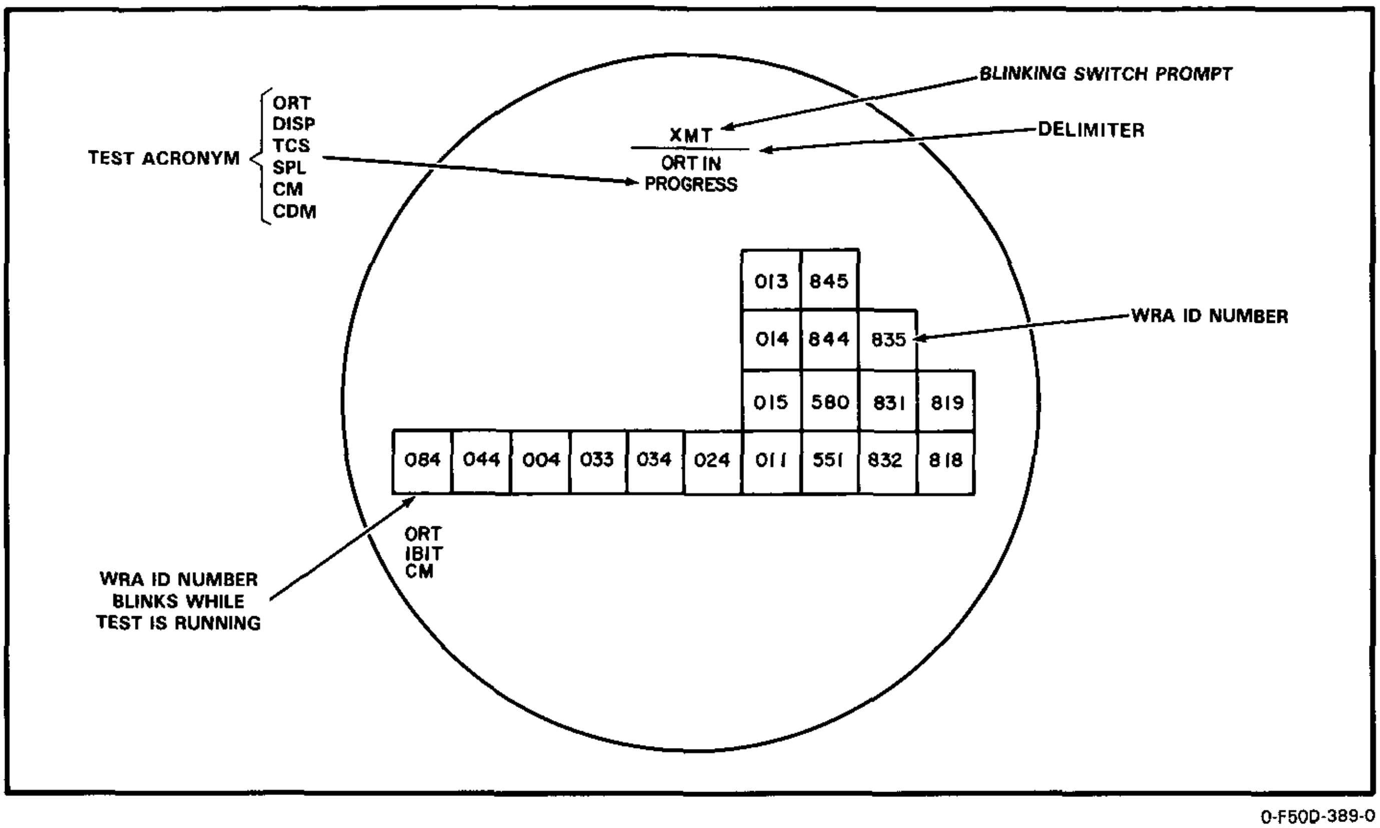


Figure 38-25. Test-in-Progress Display

The test-in-progress display is presented on the TID (see Figure 38-25). The WRA unit designators blink for those units that are undergoing test. Approximately 3 minutes after radar turn-on, an XMT acronym at the top of the TID prompts the RIO to switch to XMT, if the SHC switch is in STBY. The RIO has 25 seconds to respond. Failure to do so within the allotted time results in bypassing the system transmitter test. If the RIO responds in time, the transmitter test is executed and the transmitter subsystem unit group blinks, indicating that testing is in progress. At the completion of ORT (and CDM) DMA is presented on the TID. This display provides an evaluation of the working status of the tactical modes. If the RIO desires more detailed information, the maintenance display can be selected by depressing the DD pushtile adjacent to MAINT DISP. This display provides test fail or pass status, the detected malfunctioning WRAs, and the associated DPs. DPs provide specific detailed information on the faults detected within a particular unit. In order to get back to the DMA display, the pushtile adjacent to MAINT DISP is reselected.

38.5.2.1 BIT Display Formats. BIT displays provide feedback on test progress, required RIO actions, pass/fail status, detected faults, and maintenance action recommendations. These displays include the test in progress, BIT menu, degraded mode assessment, maintenance display, test target, CM, TCS test, DD BIST, displays test (static and dynamic), and special test.

38.5.2.1.1 Test-In-Progress Display. The test-in-progress TID display is presented upon initiation of ORT, CDM, or IRT (see Figure 38-25). This display provides status on WRA testing progress, OBC, continuous monitor failures, missile channel selection, and the DPs from previous ORT, CDM, IRT, or CM tests (if power was not interrupted to the radar). The appropriate WRA reference designators blink for units undergoing test. WRA designators and their corresponding common names are listed in Figure 38-26.

At the completion of ORT, CDM or IRT, the degraded mode assessment format (described in paragraph 38.5.2.1.3) is displayed on the TID.

38.5.2.1.2 BIT Menu Display Format. The DD BIT menu is presented at the completion of ORT or CDM, and provides allowable RIO BIT test selections (see Figure 38-27). The RIO can initiate the following tests from this menu: displays test, radar test, TCS test, special test, or test target. These tests are initiated by depressing the pushtile adjacent to the desired test name on the DD. A highlighted box appears around the test name on the DD to indicate that a test has been selected. Tests cannot be initiated concurrently.

WRA ID#		
004	-	Radar master oscillator (RMO)
011	-	Radar transmitter (TX)
013	-	Collector power supply (CPS)
014	-	Beam power supply (BPS)
015	-	Solenoid power supply (SPS)
024	-	Radar receiver (RCVR)
033	-	Radar antenna (ANT)
034	-	Analog signal converter (ASC)
044	-	Advanced Radar signal processor (ARSP)
084	-	Advanced Radar data processor (ARDP)
551	-	Digital display (DD)
580	-	Tactical information display (TID)
818	-	Television camera set (TCS)
819	-	Radome interlock circuitry (RIC)
831	-	Mission computer 2 (MC2)
832	-	Mission computer 1 (MC1)
835	-	Converter interface unit (CIU)
844	-	Sensor control unit (SCU)
845	-	Sensor hand control (SHC)

Figure 38-26. WRA Common Names and Designators

The BIT menu can also be accessed while the radar is in a tactical mode by depressing the MFK pushtile to obtain the radar mode menu and then selecting BIT.

38.5.2.1.3 Degraded Mode Assessment Format. The display shown in Figure 38-28 is provided on the TID at the completion of DMA. The purpose of DMA is to give the RIO an evaluation of the working status of tactical modes. An acronym for each mode is displayed on the TID and a pass (✓), fail (X), degraded (□), or unevaluated indication is presented with each acronym.

The symbols that appear on the displays and the corresponding modes or function named for the basic DMA are as follows:

1. PDS — Pulse Doppler search.
2. RWS — Range while search.
3. TWS — Track while scan.
4. PDSTT — Pulse Doppler single-target track.
5. MRL — Manual rapid lock-on.
6. PAL — Pilot automatic lock-on.
7. PSTT — Pulse single-target track.
8. RGSTT — Range-gated single-target track.
9. VSL — Vertical scan lock-on.
10. PLM — Pilot lock-on mode.
11. PS — Pulse search.
12. GM — Ground map.
13. AGR — Air-to-ground ranging.
14. BIT — Built-in test.

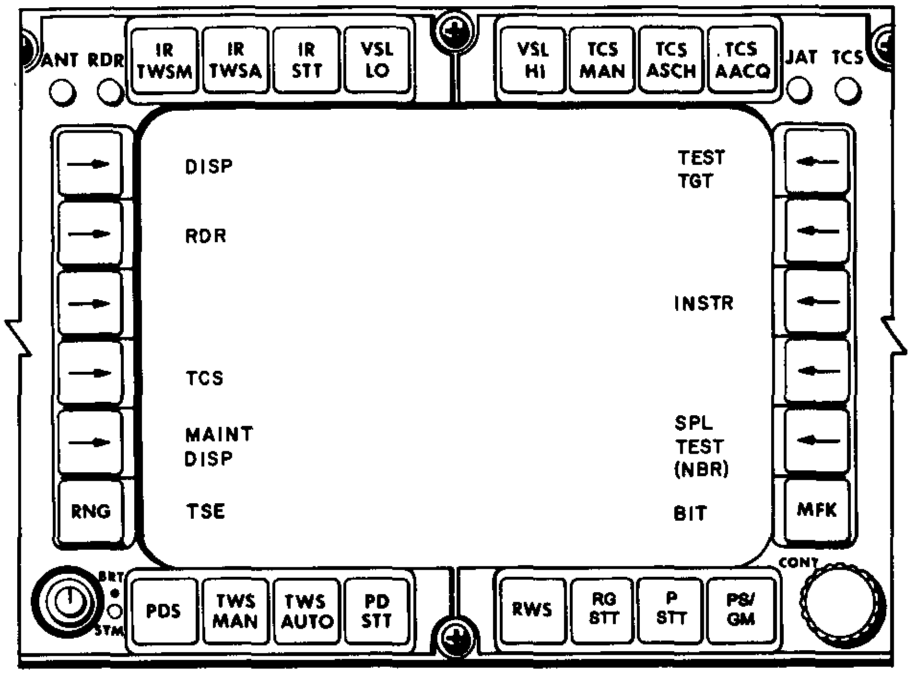
For a more detailed description of the pass/fail status of ORT, CDM, or IRT, the maintenance display format (described in paragraph 38.5.2.1.4) is called up on the TID by depressing the pushtile adjacent to MAINT DISP (on the DD BIT menu). The DMA display format is restored by reselecting the pushtile adjacent to MAINT DISP.

Note

After a tactical mode is entered, the DMA display format cannot be restored.

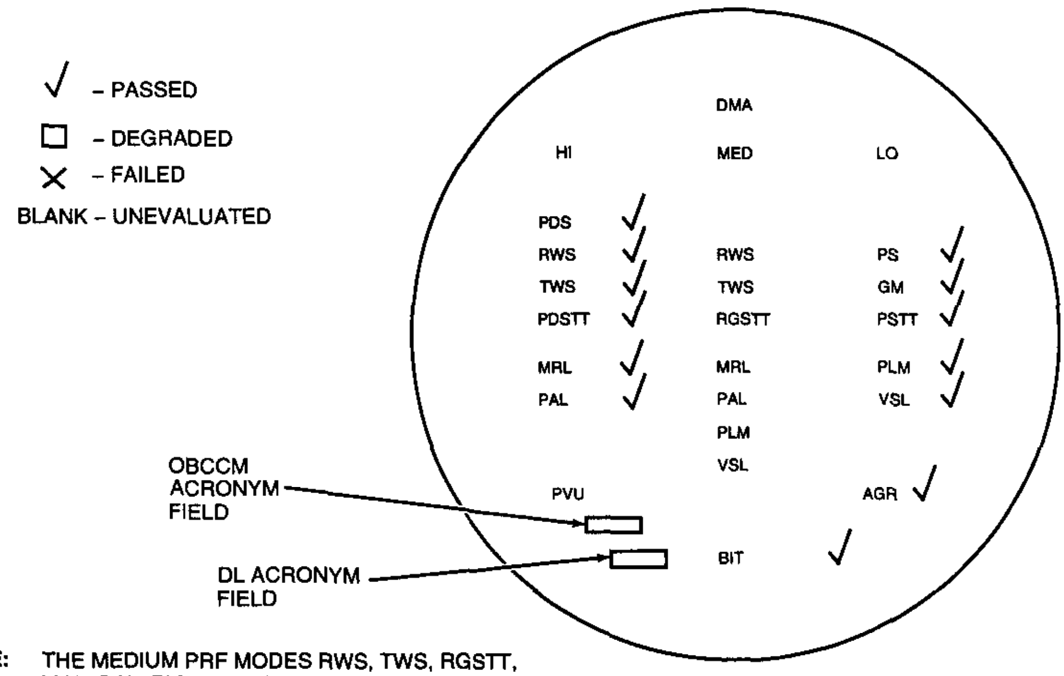
38.5.2.1.4 Maintenance Display Format. The maintenance display is obtained by depressing the DD BIT menu pushtile adjacent to MAINT DISP. It can be selected during displays test, a tactical radar mode, or special test. It can also be obtained by transitioning from the DMA display (described in paragraph 38.5.2.1.3).

The maintenance display provides test pass or fail status to the RIO. If no faults are detected, an RDR PASSED indication is displayed near the top of the TID, no WRA designators are displayed, and a checkmark appears adjacent to the appropriate test (see Figure 38-29). If a failure is detected, an RDR FAILED indication is displayed near the top of the TID, and the WRAs recommended for replacement, along with the associated DPs, are displayed on the TID (see Figure 38-30). The WRA designators and their corresponding common names are listed in Figure 38-26.



0-F50D-390-0
N2/97

Figure 38-27. BIT Menu Display Format



NOTE: THE MEDIUM PRF MODES RWS, TWS, RGSTT, MRL, PAL, PLM, VSL, AND THE PVU MODE REMAIN UNEVALUATED FOR OFP DØ1.

(AT)1-F50D-391-0

Figure 38-28. Degraded Mode Assessment Format

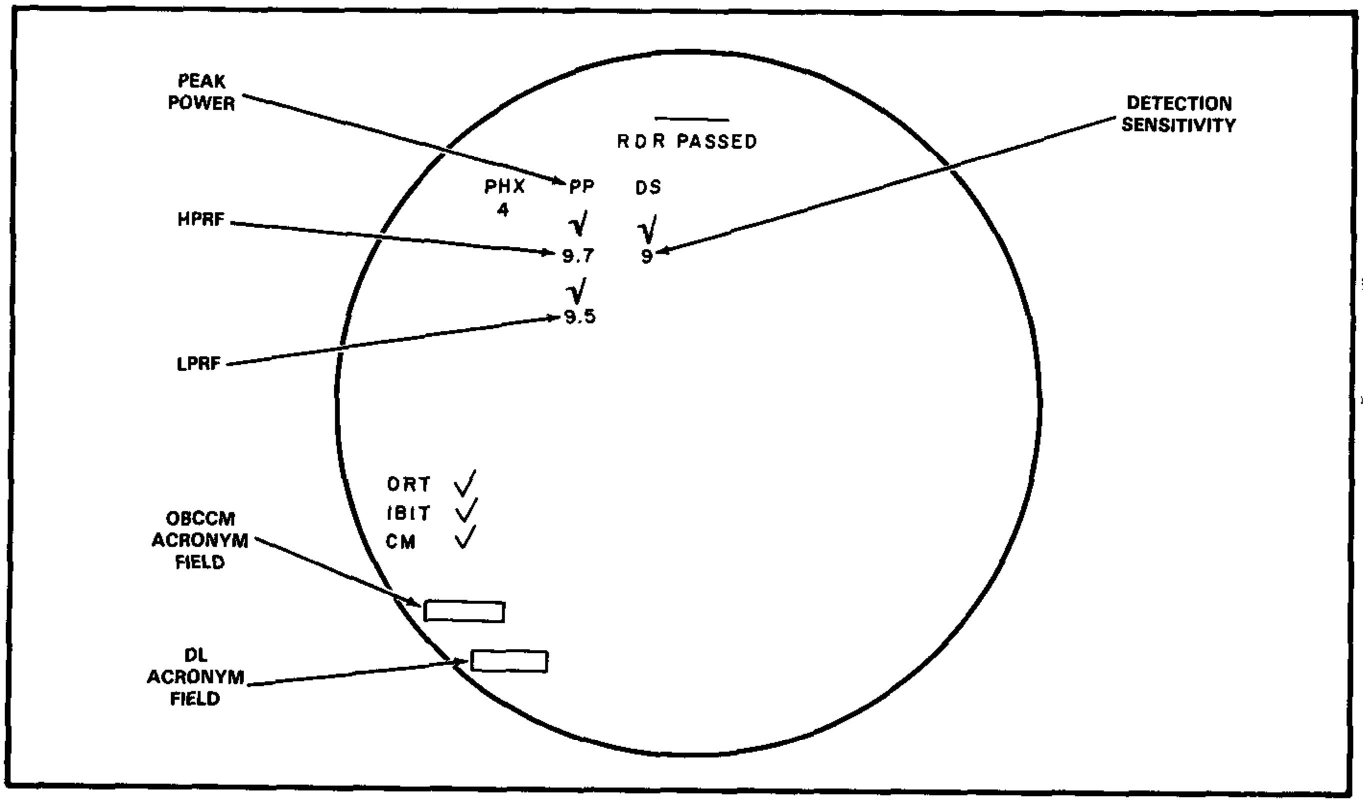


Figure 38-29. Maintenance Display Format (Test Complete)

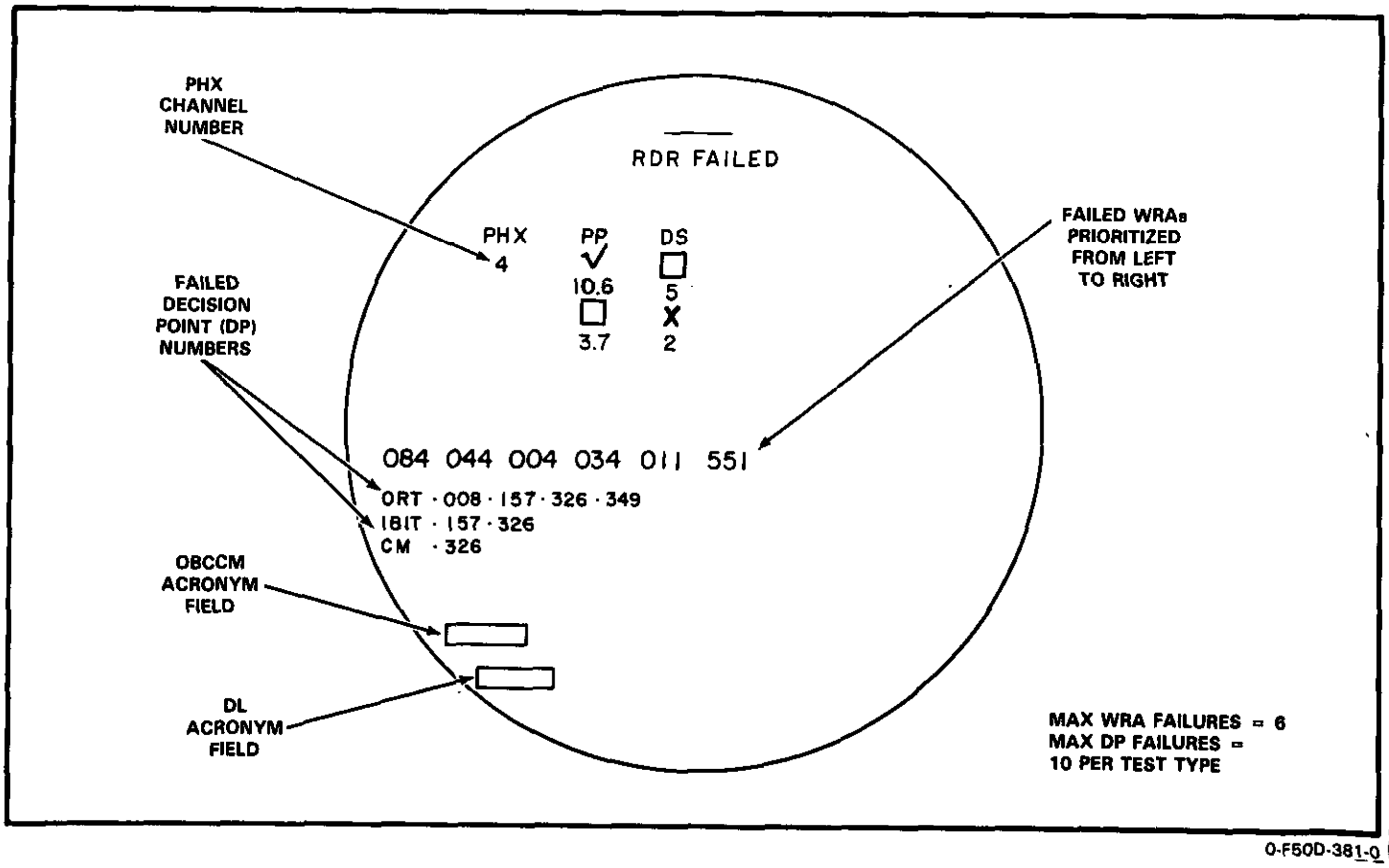


Figure 38-30. Maintenance Display (Test Complete)

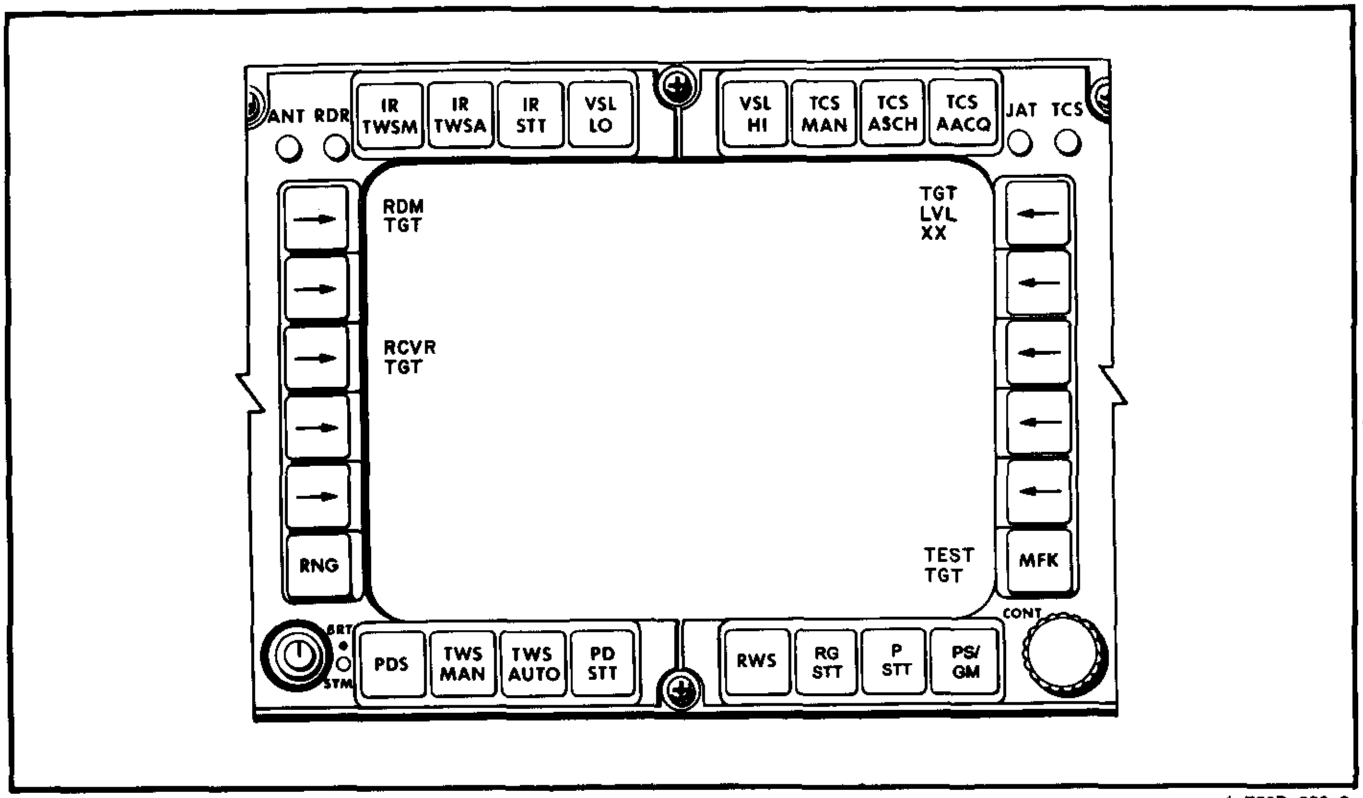


Figure 38-31. Test Target Menu

Detected failures are isolated to a maximum of six WRAs. A maximum of 10 DPs are displayed adjacent to the test that was performed: ORT, IBIT (radar test, displays test), or CM.

Values for DS and PP for HPRF and LPRF modes are displayed on the TID along with the AIM-54 or AIM-7 channel being tested.

38.5.2.1.5 Test-Target BIT. The test-target function is an end-to-end test of the radar system, initiated and evaluated by the RIO. It can be used to quickly verify that the radar system is capable of detecting, processing, and displaying reasonably sized targets. It is available in and can be used to check the operation of low, medium, or high PRF tactical modes.

To initiate the test target, the DD MFK pushtile is used to select the BIT menu. The test target is selected by depressing the button adjacent to TEST TGT. The test-target menu is displayed on the DD (see Figure 38-31). The test target can be injected in two places *depending on RIO switch activation. By depressing the* pushtile adjacent to RDM TGT, the target is injected through the radome radar test horn and is received and processed through the antenna array. By depressing the pushtile adjacent to RCVR TGT, the target is injected directly through the receiver, thus bypassing the antenna. To terminate test target BIT, the pushtile adjacent to the enabled test target injection location is reselected.

The RIO can now select any tactical mode by depressing the DD pushtile for the desired mode. The radar test target will be processed and displayed on the DD and TID just as any newly detected target in the mode being tested would be.

In addition to testing the operation of the various modes, the test target can also be used to check many radar controls (such as display controls) and verify computer functions such as hooking. For example, the RIO can hook the test target (which first appears as an unknown target) on the TID; designate it hostile (noting symbol change); initiate single-target track (noting operation of ANT and RDR indicator lamps); enter data pertaining to the target; and even test the track hold function after deselecting the test target.

All targets have nominal initial values inserted for *range, range-rate, and target power level. HPRF targets* have initial range set to 20 miles and range-rate set to 800 knots (closing). LPRF targets have initial range set to 18 miles, with the DD range scale set to 20 or greater, or 4.5 miles, with the DD range scale set to 5 or 10.

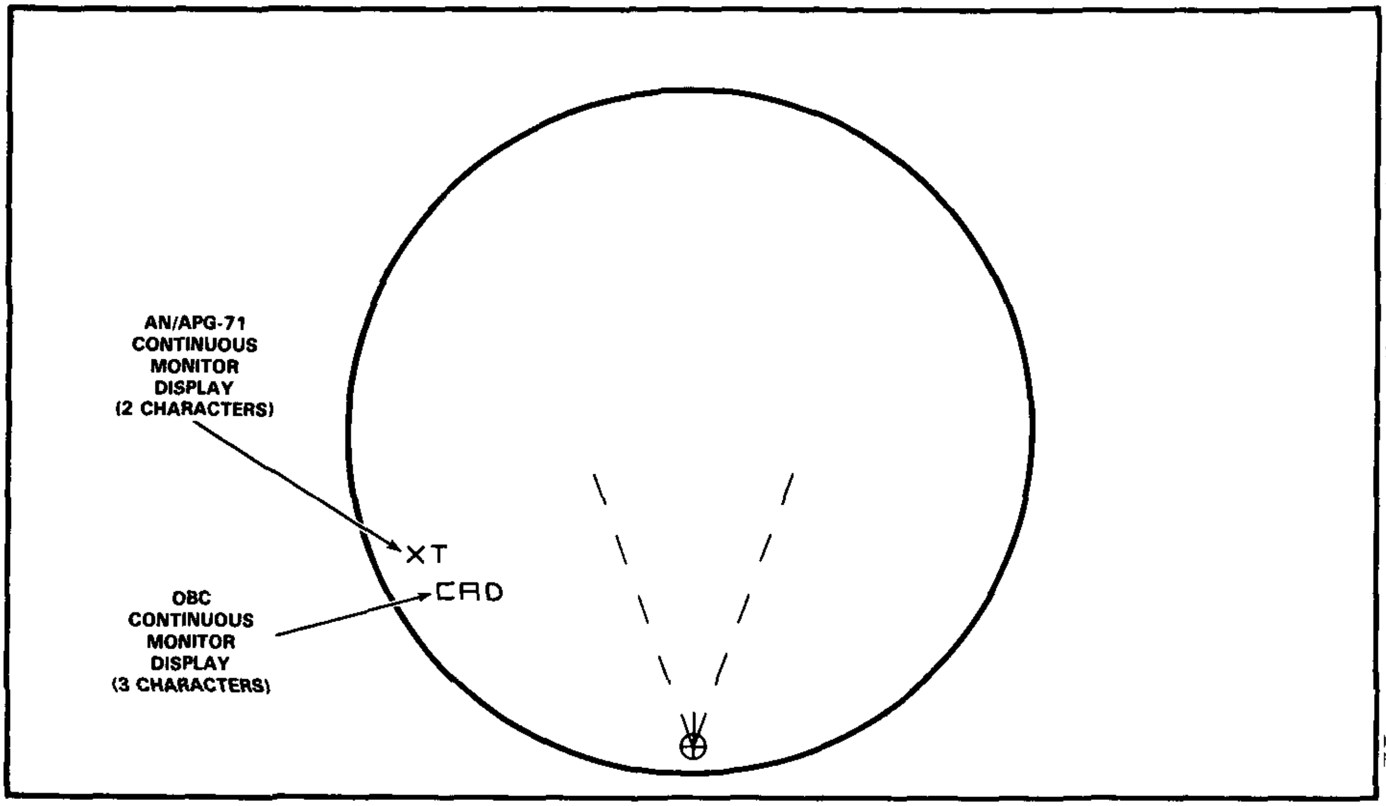


Figure 38-32. Continuous Monitor Display

Target power level selection can be entered manually after enabling test-target BIT. A power level is selected by depressing the pushtile adjacent to TGT LVL and entering the following keyboard commands:

Low values of X are correlated with weak target returns and allow for testing the radar's sensitivity. High values of X are correlated with strong target returns.

38.5.2.1.6 CM Display Format. CM fault detection is an integral part of the tactical radar display. A two-character acronym is displayed in the lower left quadrant of the TID whenever a fault is detected (see Figure 38-32). This acronym is continually displayed while the failure condition exists. If multiple failures occur, failure acronyms will cycle at a 2-second rate. The RIO can obtain more detailed failure information by accessing the BIT menu on the DD (depressing MFK pushtile) and depressing the pushtile adjacent to MAINT DISP. The RIO can also initiate BIT at any time to confirm that the hardware status is unchanged.

A list containing the two-letter acronyms that may appear as a result of radar CM failures is shown in Figure 38-33.

Aircraft anomalies will appear on the TID (lower left quadrant directly below the radar CM acronyms) whenever a fault is detected (see Figure 38-33). All acronyms (except for MM) appear for 2 seconds when corresponding equipment is failed. The acronym MM overrides any previously displayed acronym for 4 seconds. The corresponding acronym is masked when an equipment is masked through the MFDs.

A list containing the OBCCM acronyms that may appear as a result of aircraft CM failures is shown in Figure 38-34.

38.5.2.1.7 TCS Test Format. The TCS test is an RIO-initiated test of the TCS and associated switches. It is initiated by depressing the DD MFK pushtile to obtain the radar modes menu, selecting the pushtile adjacent to BIT to obtain the BIT submenu, and then depressing the pushtile adjacent to TCS. TCS testing is interruptible by a program restart (DD PGM RST pushtile), another BIT selection, or a radar mode selection.

The TCS test function consists of 15 major subtests, that occur in the following order: TCS on-board checkout, TCS cursor, manual acquisition, TCS slaved to radar, TCS return to search, TCS slaved to radar pointing accuracy test, TCS slaved to computer pointing accuracy test, automatic search, TCS scan pattern test, independent mode, radar slaved to TCS, radar slaved to TCS pointing accuracy test, hand control forward right, hand control half-action, and TCS slewing test.

ACRONYM	EQUIPMENT
BB	Computer bus backup enabled (DP 409)
BF	TID buffer overload (DP 283)
CA	Calibration failure (DPs 418–421 426)
CB	Computer bus status word error (DPs 32, 34, 36, 38)
CC	No sparrow CW channels available (DP 373)
CS	RDP CPU checksum error (DPs 0–3)
CW	CW power failed to turn off or below acceptable levels (DPs 354, 360)
CX	Data check WMX CPU1, capacitor voltage error, or data check WMX CPU2 (DPs 4, 10, 13)
DD	DD CM function fault (DPs 273, 274, 276–280, 282, 284)
DP	Display power fault (DD, TID, SCU) (DPs 394, 395, 396)
DR	DD RAM checksum error (DP 275)
ER	Equipment ready failure (DPs 410–415)
FA	No frequency agility channels available (DP 374)
HI	Antenna hydraulics on interlock open (DP 288)
HS	RSP clock error (DP 51)
MM	Missed missile (AIM–54) message

ACRONYM	EQUIPMENT
MX	RMX status word error (DPs 40, 42, 44)
OA	ORT has been aborted
OH	Overheat (RMO, RX, DD, RDP, RSP, ASC) (DPs 184, 198, 272, 397, 398, 399)
PH	No PHX channels available (DP 371)
PL	RSP load error (DP 96)
PM	APG–71 liquid cooling pump failure (DPs 327, 331)
RO	RMO status word error (DP 176–183)
RP	Radar power fault (RX, ARSP, RMO, ANT, ASC, TX) (DPs 197, 385, 386, 387, 388, 390)
SA	Semi–active decoder error (DP 187)
SI	TID SSI parity error (DP 47)
SP	No sparrow PD channels available (DP 372)
TT	Test target switch enabled (DP 377)
XL	XMTR dummy load switch failure (DPs 336–338, 340)
XM	XMTR peak power output below minimum acceptable or XMTR is not selected (DPs 352, 353)
XO	Selected XMTR channel is not phase locked (DPs 185, 189, 190)
XT	Transmitter subsystem failure (DPs 320–326, 328–330, 332–334)

Figure 38-33. Radar Continuous Monitor Acronyms

OBCCM ACRONYM	EQUIPMENT
AFC	Automatic flight control system
AIC	Air inlet control system
APC	Approach power compensator
BAG	Beacon augmentor
BSF	Band suppression filters
BUS	Data bus
CAD	Central air data computer
CIU	Converter interface unit
DEU	Data entry unit
DLS	Data link system
DSS	Data storage set
ECM	Airborne self−protection jammer
FEM	Airborne data acquisition computer, engine monitoring signal processors 1/2
GCU	Gun control unit
HUD	Head−up display
IFB	Interference blanker
IFI	IFF interrogator
IFX	IFF transponder
INS	Inertial navigation system

OBCCM ACRONYM	EQUIPMENT
IR	Infrared search and track system
MC1	Mission computer no. 1
MC2	Mission computer no. 2
MFA	Multiple filter assemblies (Left or Right)
MFD	MFD no. 1, MFD no. 2, or MFD no. 3
NPS	Navigation power supply
PDP	Display processor no. 1 or display processor no. 2
POD	Tactical airborne reconnaissance POD
RAD	Radar altimeter
RFP	Radio frequency indicator −Pilot
RFR	Radio frequency control indicator −RIO
RWR	Radar warning receiver
SDI	Sensor display and indicator set
SMS	Stores management system
SRS	Standard attitude and heading reference set
TCN	Tactical air navigation
WOW	Weight−on/off−wheels sensor
(BLANKS)	No system failures

Figure 38-34. OBC Continuous Monitor Acronyms

When the TCS test begins, the display in Figure 38-35 shall appear on the TID. The TCS test-in-progress menu consists of acronyms denoting the conditions of the associated TCS test function subtest. The RIO has 15 seconds to supply the indicated action for each prompt. Figure 38-36 contains a list of the prompts and associated RIO responses.

38.5.2.1.8 Digital Display Controls and Displays Test (C/D Test). The DD has a standalone built-in self-test capability that must be initiated and evaluated by the RIO. It tests DD functions as well as its discrete interfaces with the sensor hand control and TID.

C/D test is initiated with the DD radar control panel C/D TEST pushtile. When the F-14D is airborne, continuous depression of the C/D TEST pushtile clears DD display and initiates test. Release causes the DD to revert to tactical operation. When the F-14D aircraft is not airborne, the first depression clears the DD display and initiates test; the second depression causes DD to revert to tactical operation. While the C/D TEST pushtile is depressed, a diagonal line should be displayed on the TID.

After the C/D TEST is selected, the DD display will appear as shown in Figure 38-37. Adjust DD BRT and CONT controls for optimal viewing of the eight displayed shades of gray. Adjust the SYM control for best display of stroke symbology. From this display, three separate tests may be selected by pressing the pushtiles (along the left edge of the DD display) next to the legends (1, 2, and 3) displayed on the CRT.

a. C/D TEST 1 Display. When C/D TEST 1 display is selected, the background will be shades of gray. Right to left sweeps start as soon as the display appears, with each sweep diminishing the intensity of the shades of gray (aging). After 13 sweeps, the shades of gray will have disappeared (the background will be uniform).

C/D 1 test is used to test all front panel momentary pushtiles. As each of the DD front panel momentary pushtiles are depressed, an X appears at the appropriate location on the CD TEST 1 display (see Figure 38-38).

Note

Depressing the C/D TEST pushtile will exit C/D TEST. Depressing the pushtile adjacent to legend 2 or legend 3 will exit C/D 1 and initiate C/D 2 or C/D 3.

b. C/D TEST 2 Display. When C/D TEST 2 is selected, the display shown in Figure 38-39 will appear on the DD. The numeric values next to BRT, CON, and SYM may differ slightly from those shown in the Figure, depending on knob position.

C/D TEST 2 tests all front panel toggle and rotary switches and potentiometers. As each of the SNIFF, TGT, TRACK, and MLC switches are toggled into their allowable positions, an X will be displayed in the appropriate location. Rotating the CHAN, FA/MAN, and JAM/JET switches into their allowable positions will cause corresponding symbology changes on the panel for the selected switch position. Rotating each potentiometer through its full movement range will display a corresponding decimal number that will vary from 00 to 10 to 90 to 99.

c. C/D TEST 3 Display. When C/D TEST 3 is selected, the DD display shown in Figure 38-40 will appear. This display tests the capability of the DD to respond to signals from interfacing units and to other signals. When the SHC RDR switch is set to CMPTR, and the commands shown in Figure 38-41 are issued by the SCU, SSP, or DD, the indicated responses are displayed next to the associated C 3 display legends. The SHC RDR CMPTR selection also enables tests initiated by other SHC controls and TID controls. Selections and responses are shown in Figures 38-42 and 38-43, respectively.

38.5.2.1.9 Display Test Formats. The displays test gives the RIO standard test patterns on the TID and DD for evaluation. The displays test is divided into static and dynamic testing. It is initiated by depressing the MFK pushtile on the DD to obtain the radar modes menu, selecting the pushtile adjacent to BIT to obtain the BIT submenu, and then depressing the pushtile adjacent to DISP.

a. Static Testing. When ATTK is selected with the TID MODE switch, the DD ANT, RDR, JAT, and TCS indicator lamps will illuminate. The TID LAUNCH ZONE, VEL VECTOR, and CLSN indicator lamps will illuminate. The TID center drum and steering drum will be blank. The test pattern shown in Figure 38-44 will be displayed on the DD, and the pattern shown in Figure 38-45 will be displayed on the TID.

When A/C STAB or GND STAB is selected with the TID MODE switch, all DD indicator lamps will go off. In addition, all TID indicator lamps will go off, the TID center drum will read SENSOR, and the steering drum will read MAN. The DD test pattern shown in Figure 38-46 will be displayed, and the TID will display the pattern shown in Figure 38-47.

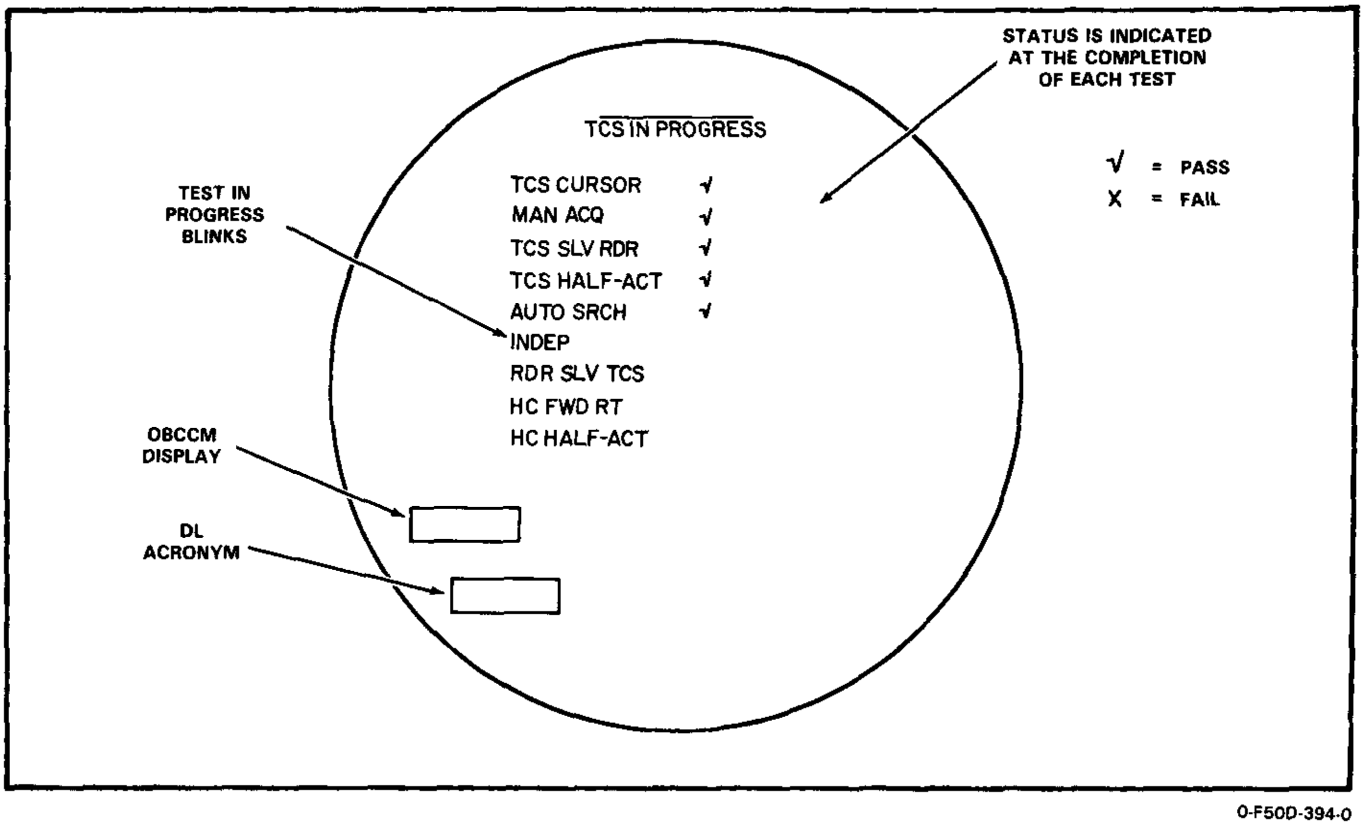


Figure 38-35. TID Menu for TCS IBIT, In Progress

PROMPT DISPLAY ON TID	RIO RESPONSE UNIT	RIO RESPONSE ACTION
TCS CURSOR	Sensor hand control	Select TCS cursor
MAN ACQ	Digital display	Depress TCS MAN pushtile
TCS SLV RDR	Sensor slaving panel	Select TCS slave
TCS HALF-ACT	Sensor hand control	Select half action and release
AUTO SRCH	Digital display	Depress TCS ASCH pushtile
INDEP	Sensor slaving panel	Select TCS IND
RDR SLV TCS	Sensor slaving panel	Select RDR slave
HC FWD RT	Sensor hand control	Position hand control to upper right corner
HC HALF-ACT	Sensor hand control	Select half action, maintaining HCN in upper right corner

Figure 38-36. TCS BIT Prompts and RIO Responses

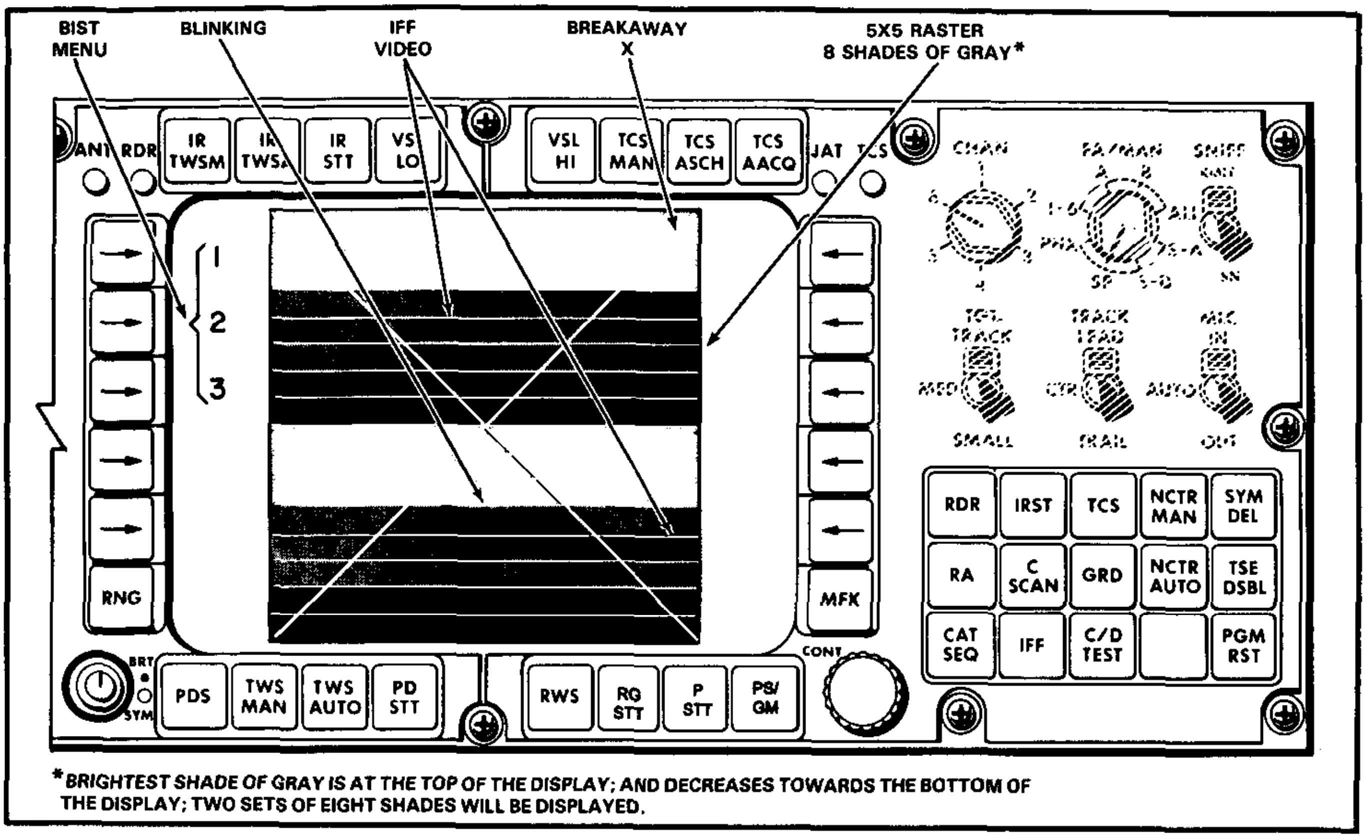


Figure 38-37. Initial C/D TEST Display

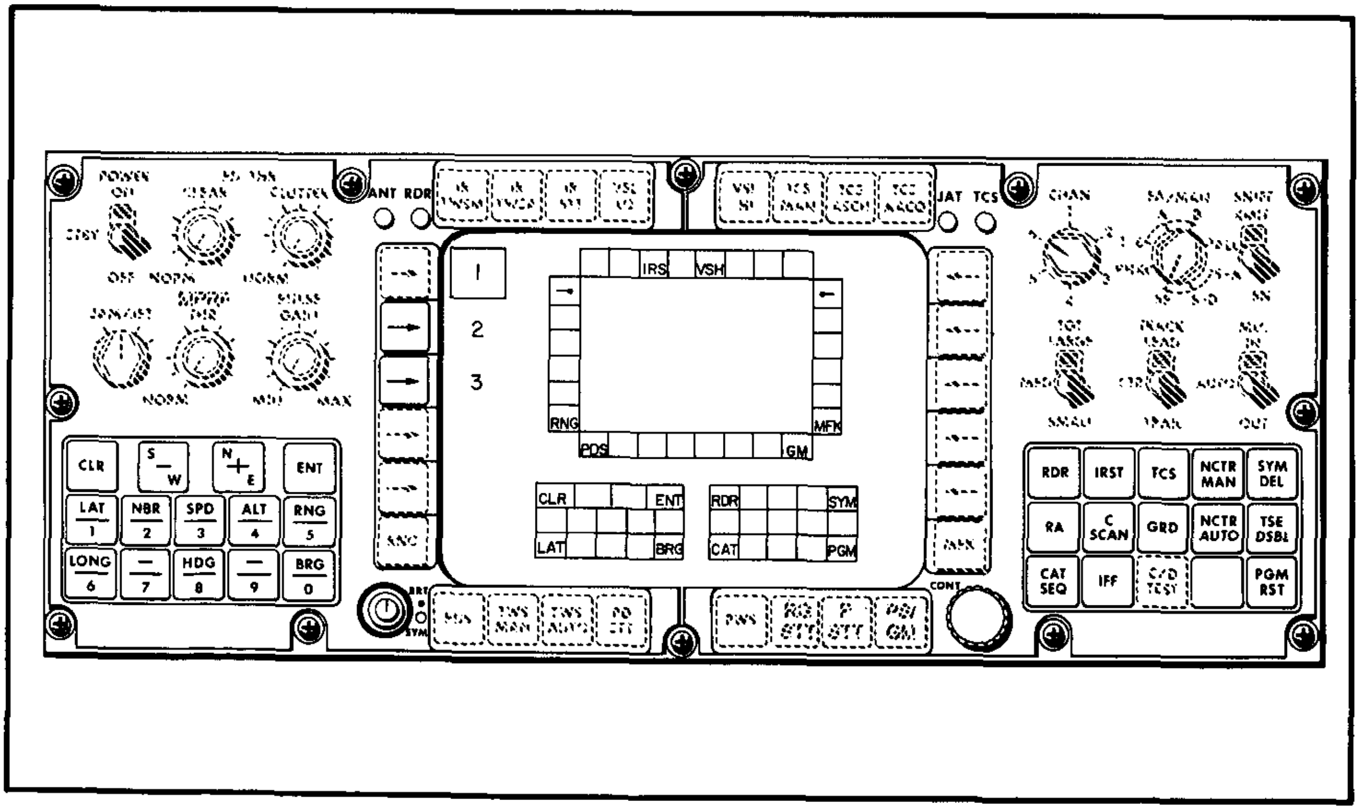


Figure 38-38. C/D TEST 1 Display (After Aging Is Completed)

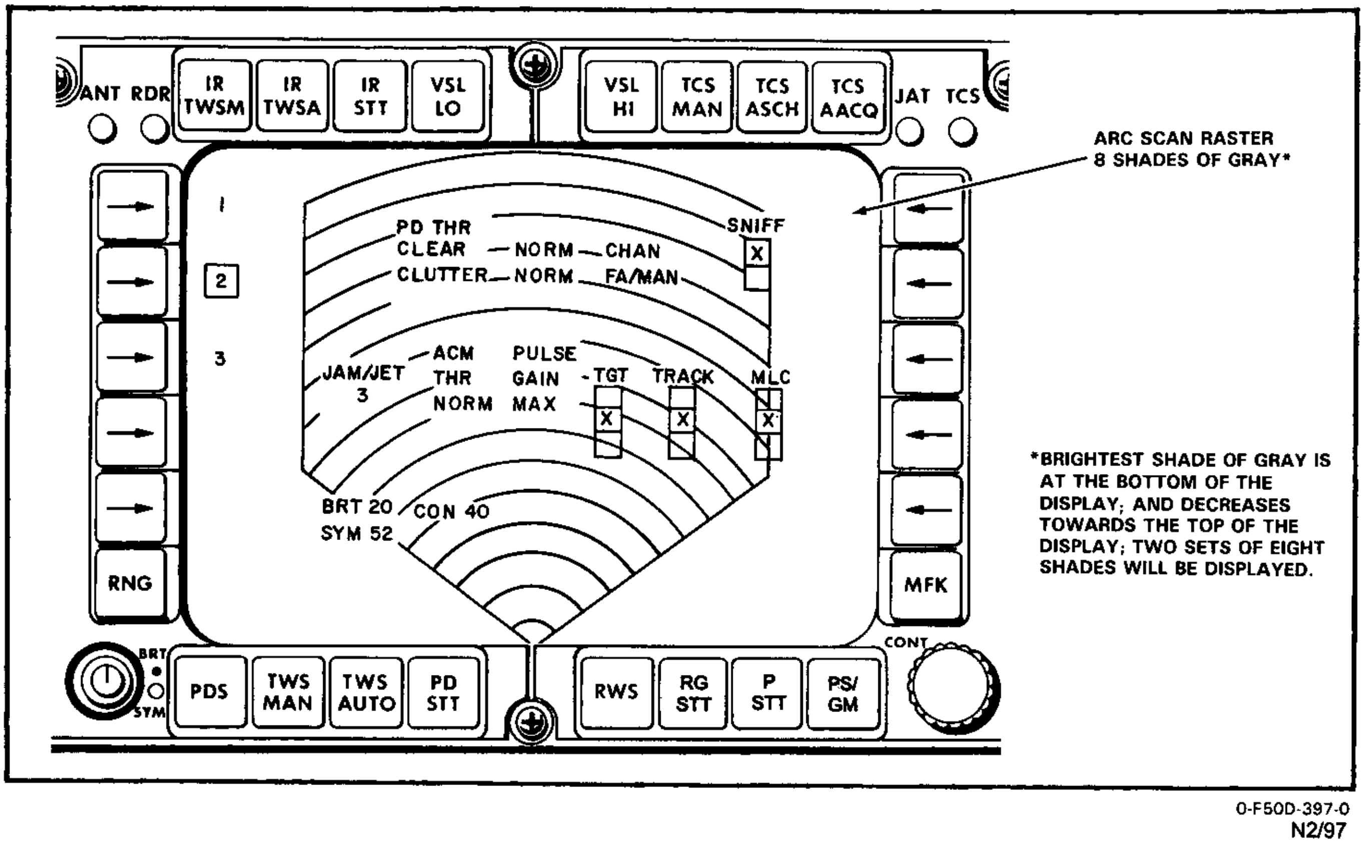


Figure 38-39. C/D TEST 2 Display

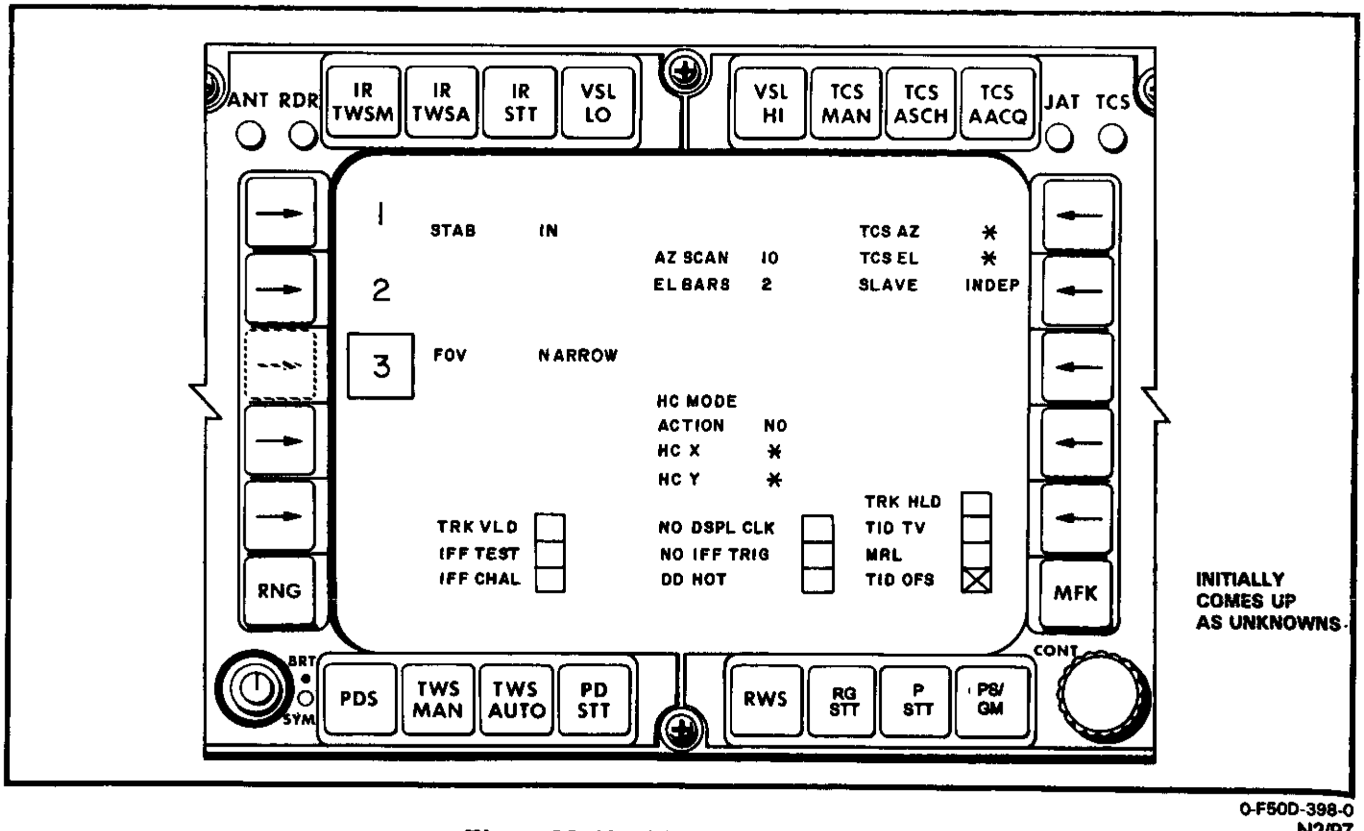


Figure 38-40. C/D TEST 3 Display

SCU CONTROL/SELECTION	DD RESPONSE
STAB/IN	IN
STAB/OUT	OUT
FOV/WIDE	WIDE
FOV/NAR	NARROW
TCS TRIM/AZ	−22 to +22
TCS TRIM/EL	−44 to +44
AZ SCAN/±10°	10
AZ SCAN/±20°	20
AZ SCAN/±40°	40
AZ SCAN/±65°	65
EL BARS/1	1
EL BARS/2	2
EL BARS/4	4
EL BARS/8	8
SSP CONTROL/SELECTION	**DD RESPONSE**
SLAVE/RDR	RDR
SLAVE/INDEP	INDEP
SLAVE/TCS	TCS
DD CONTROL/SELECTION	**DD RESPONSE**
ACQ/AUTO SRCH	AUTO SEARCH
ACQ/MAN	MANUAL
ACQ/AUTO	AUTO
VSL/HI	HI
VSL/OFF	OFF
VSL/LO	LO

Figure 38-41. DD Responses for SCU/SSP/DD Select Tests

SHC CONTROL/SELECTION	DD RESPONSE
HC MODE/IR/TV	IR/TV
HC MODE/RDR	RDR
HC MODE/TID CURSOR	TID CURSOR
HC MODE/DD CURSOR	DD CURSOR
HANDGRIP ACTION SWITCH/ (NO DETENT)	NO
HANDGRIP ACTION SWITCH/ (FIRST DETENT)	HALF
HANDGRIP ACTION SWITCH/ (FULL DETENT)	FULL
HCX (HANDGRIP) LEFT/RIGHT	−99 to +99
HCY (HANDGRIP) FORE/AFT	−99 to +99
MRL	X
OFFSET	X

Figure 38-42. DD Responses for SHC Select Tests

TID CONTROL/SELECTION	DD RESPONSE
TRACK HOLD	X
TID MODE/TV	C

Figure 38-43. DD Responses for TID Select Tests

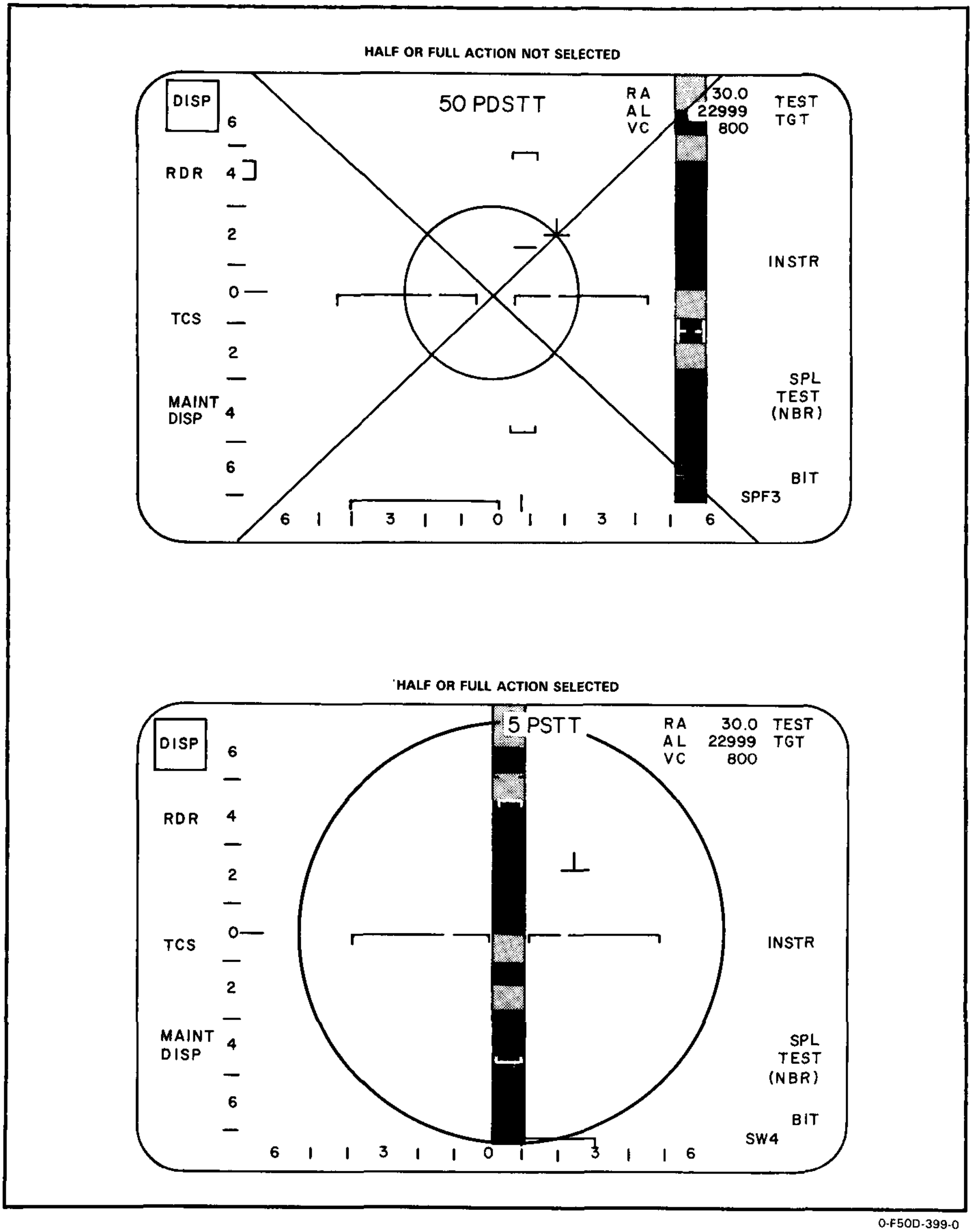


Figure 38-44. BIT Static DD Display (ATTK Selected)

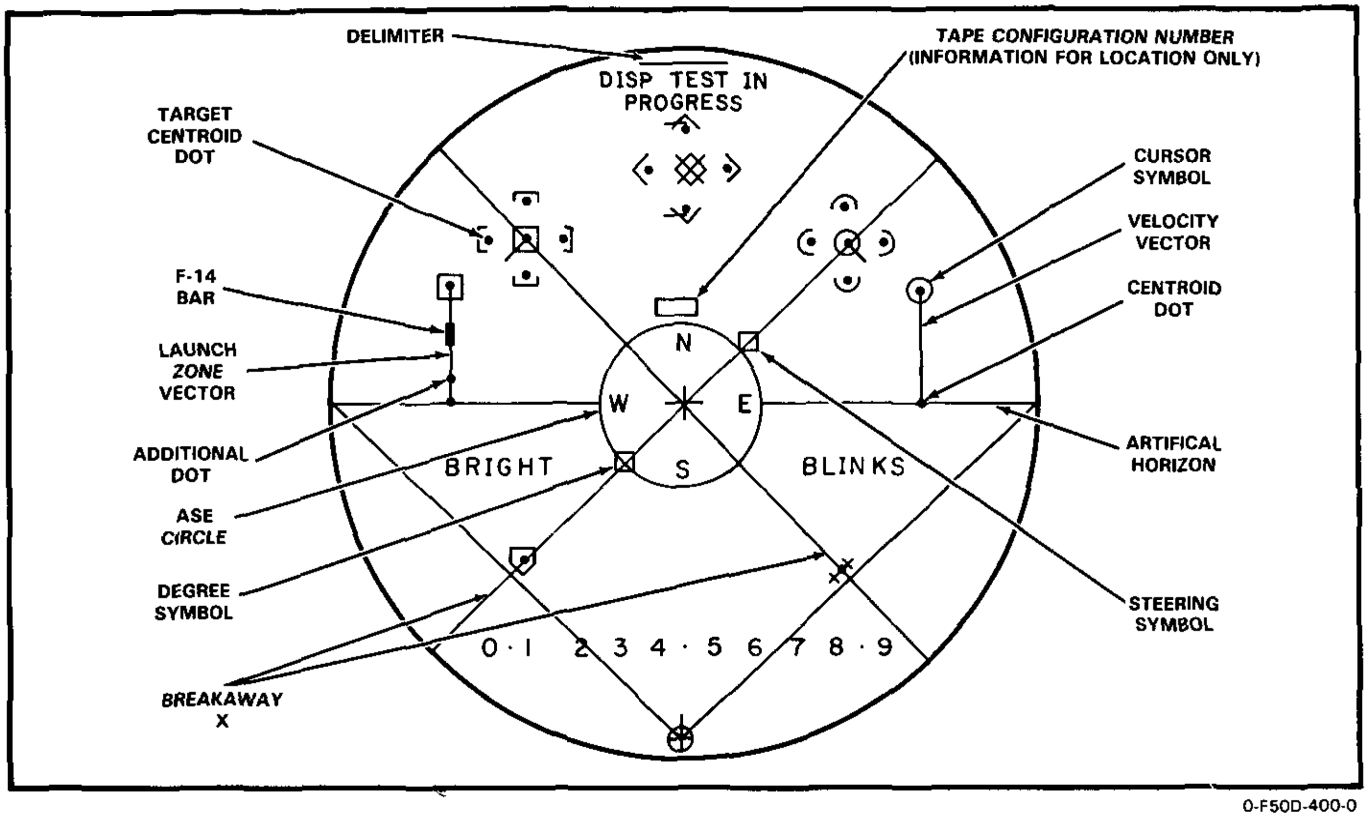


Figure 38-45. BIT Static TID Display (ATTK Selected)

These test patterns should be examined by the RIO for the absence of any required symbols, symbol intensity, and symbol position. During the running of the static test, the RIO should also select half action or full action on the hand control. The RIO should ensure that the TID cursor can be moved throughout the range of the TID by moving the hand control. Upon release of the action switch, the cursor symbols should return to their original positions.

The static portion of the displays test gives the RIO an indication that the computer does or does not have the display capability for each of the indicated symbols. It is more than a displays test because it also tests computer ability to generate symbols needed for a tactical situation. The computer assists the RIO in the static portion of the displays test by monitoring power failures that have occurred in the controls and displays units. A DISP FAILED indicator will appear on the maintenance display if a power failure is detected. The maintenance display indicates DISP PASSED until a failure occurs.

b. Dynamic Testing. The dynamic test consists of a visual evaluation of the movement of the artificial horizon, ASE circle, steering symbol, closing range rate indicator, launch zone symbols, and a velocity vector with TUIR and TUOR markers that sequentially vary in size or position. A fixed initial point symbol is displayed for reference. To enter the dynamic test, the RIO selects CLEAR, NBR, 1, 1, and ENT *on the DD keypad.*

When the RIO selects ATTK with the TID MODE switch, the displays on the TID and DD (Figures 38-38 and 38-39) will go through the following movements every 2 seconds:

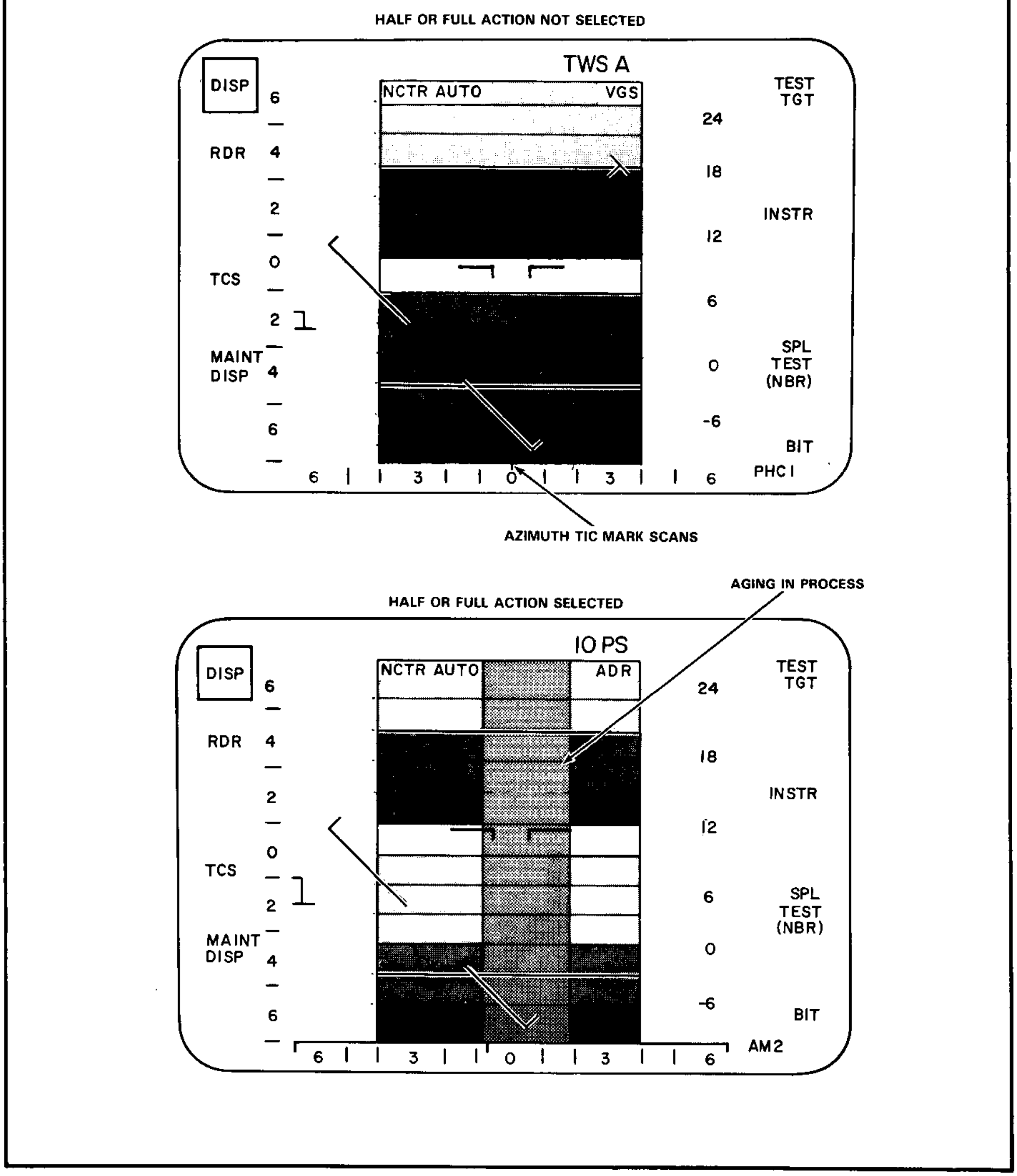
On the DD, the following occur simultaneously:

1. The artificial horizon steps in pitch from zero to +15° (up), +30°, +45°, 0°, -15° (down), -30°, -45°, then back to 0°.

2. The artificial horizon steps in roll from 0° to +15° (right wing down), +30°, +45°, back to 0°, -15°(left wing down), -30°, -45°, and back to 0°.

3. The ASE circle steps from 0.8 inch in diameter to 0.1, 0.3, 0.56, then back to 0.8.

4. The steering symbol steps around the ASE circle in a clockwise direction in steps from its position in the upper right quadrant to the lower right, lower left, upper left, then back to the upper right quadrant.



0-F50D-401-1

Figure 38-46. BIT Static DD Display (GND STAB or TV Selected) (Sheet 1 of 2)

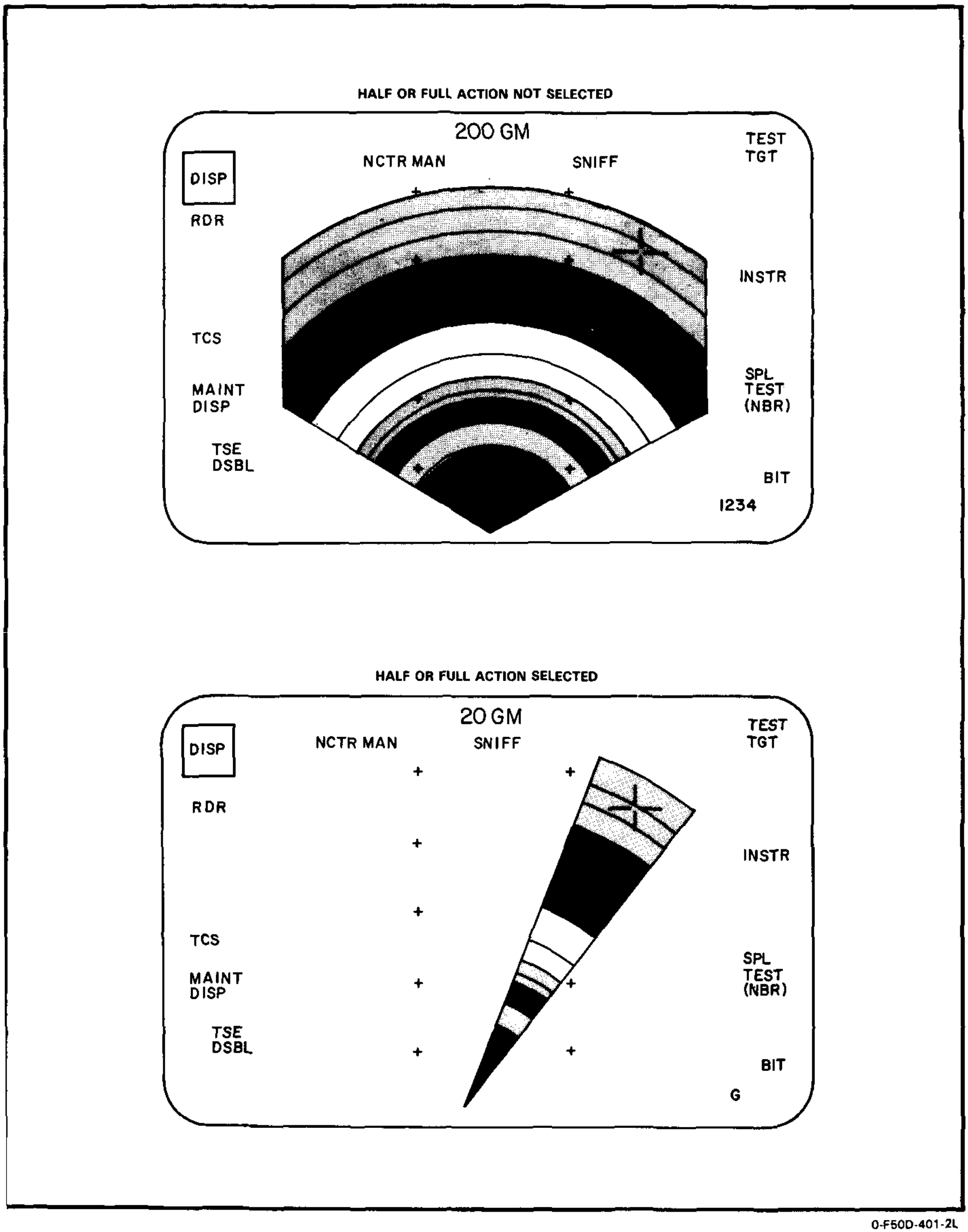


Figure 38-46. BIT Static DD Display (GND STAB or TV Selected) (Sheet 2 of 2)

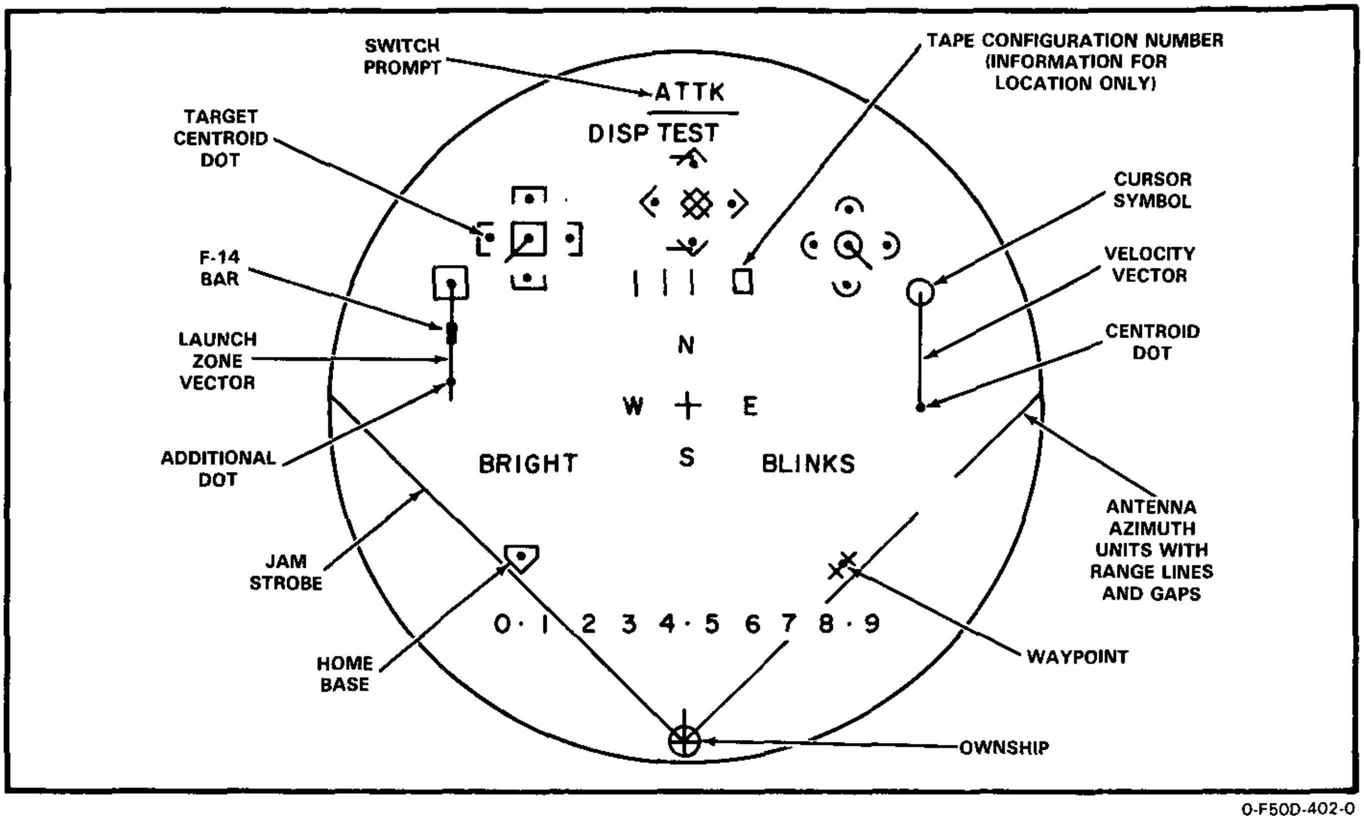


Figure 38-47. BIT Static TID Display (Non-ATTK Selection)

On the TID, the following occur simultaneously:

1. The artificial horizon steps in pitch from zero to +15° (up), +30°, +45°, 0°, -15° (down), -30°, -45° then back to 0°.

2. The artificial horizon steps in roll from 0° to +15° (right wing down), +30°, +45°, back to 0°, -15° (left wing down), -30°, -45°, and back to 0°.

3. The bar marker steps from 1.5 inches above the artificial horizon to 1.0, 0.5, 0, and back to 1.5 inches.

4. The dot marker steps from above the artificial to 0.5, 1.0, 1.5 inches and back to the artificial horizon.

5. The artificial horizon, ASE, and steering symbol move on the TID at the same rate as the DD.

6. The ASE circle steps from 2.0 inches in diameter to 0.2, 0.8, 1.4, then back to 2.0 inches in diameter.

7. The velocity vector will vary in length from 1.5 inches to 0 inches, 0.5 inches, 1.0 inches, then back to 1.5 inches.

8. The F-14 bar origin will vary its distance above the artificial horizon along the velocity vector from 1.5 inches to 1.0 inches, 0.5 inches, 0 inches, then back to 1.5 inches.

9. The additional dot marker will vary its distance above the artificial horizon along the velocity vector from 0 to 0.5 inch, 1.0 inch, 1.5 inches, then back to 0 inches.

The events occurring during the dynamic portion of the test are repeated until the RIO selects another BIT sequence test, selects another category, interrupts via a program restart, or selects another radar mode.

When the RIO selects A/C STAB or GND STAB with the TID MODE switch, the displays on the TID and DD will go through the following movements every 2 seconds.

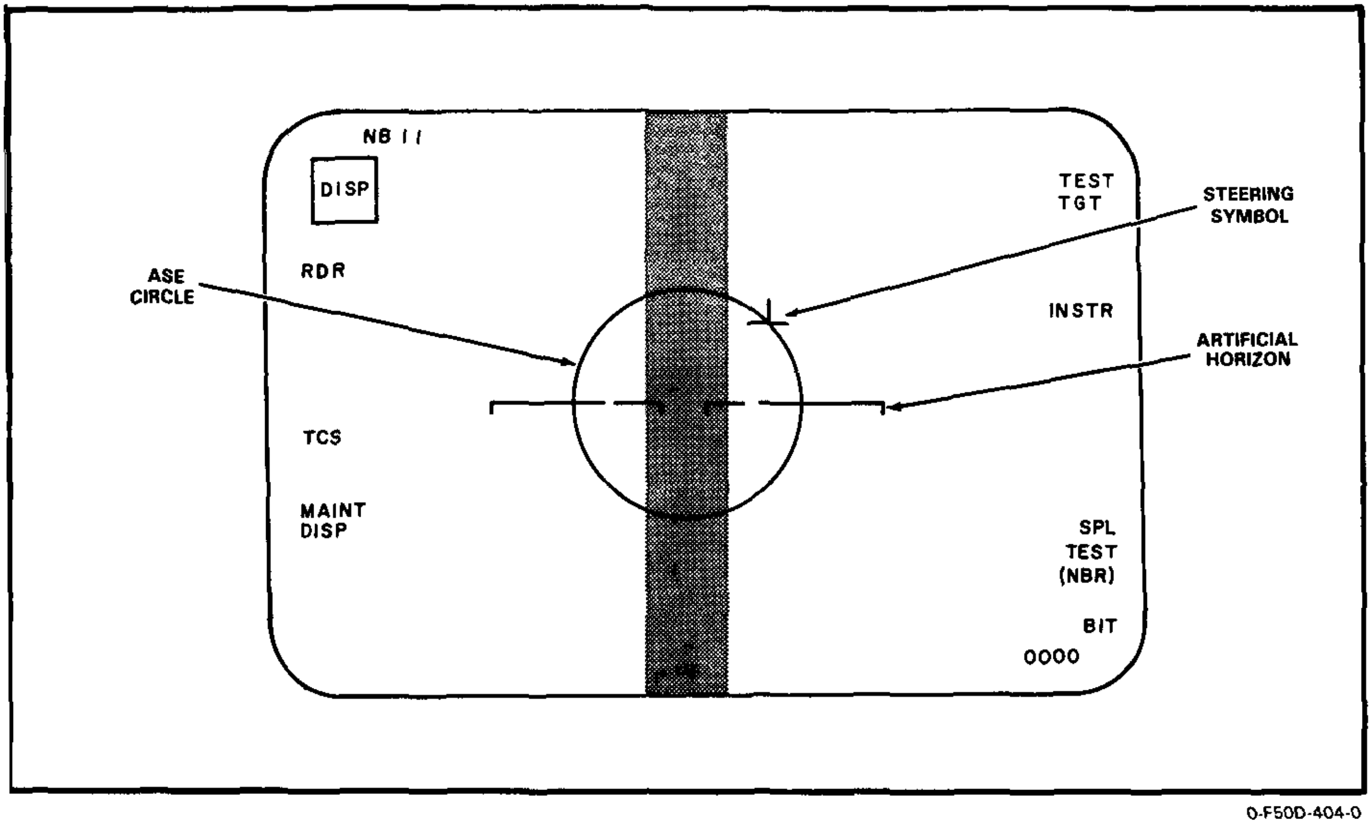


Figure 38-48. BIT DD Dynamic Display

Dynamic test in A/C STAB and GND STAB will have displays similar to those shown in Figures 38-48 and 38-49, except that ATTK will blink above the BIT horizontal boundary, and the artificial horizon, ASE circle, and steering symbol will be deleted. A DISP FAILED message will appear on the TID during the static or dynamic tests when a fault is detected. A fault isolation display can be requested by depressing the pushtile adjacent to MAINT DISP on the DD BIT menu. If a power fault or computer subsystem fault was detected, the unit designator of the malfunctioned WRA is displayed along with the associated DPs on the TID.

38.5.2.1.10 Special Test Format. Special test is initiated via the selection of the SPL TEST pushtile on the BIT menu, selection of the NBR pushtile on the DD keypad, entering the appropriate test number, and then pushing the ENT pushtile. Test execution is continual while special test is selected. Testing is interruptible by a program restart (by depressing PGM RST on the DD), another BIT selection, or radar mode selection.

The special test 80-instrumentation test verifies the proper operation of the APG-71 instrumentation system. This system includes the IST and ICU modules within the RDP and RSP, respectively, and the interface to the data recorder. When commanded by this function, instrumentation modules in the RDP and RSP are configured to output repeatable test patterns to the instrumentation recorders. Failure indications are determined by analysis of these recordings offline. The display is shown in Figure 38-50.

38.5.3 Flycatcher. Flycatcher is a computer routine that allows the operator to examine the contents of specific RDP memory locations. This information is generally used in troubleshooting. Flycatcher readouts will be displayed on the upper left portion of the DD. The display will consist of the computer designation readout, address readout, and data readout (in hexadecimal).

To initiate these readouts, the following sequence of entries on the CAP portion of the DD must be used:

1. CLR

2. 7

3. 1

4. ENT.

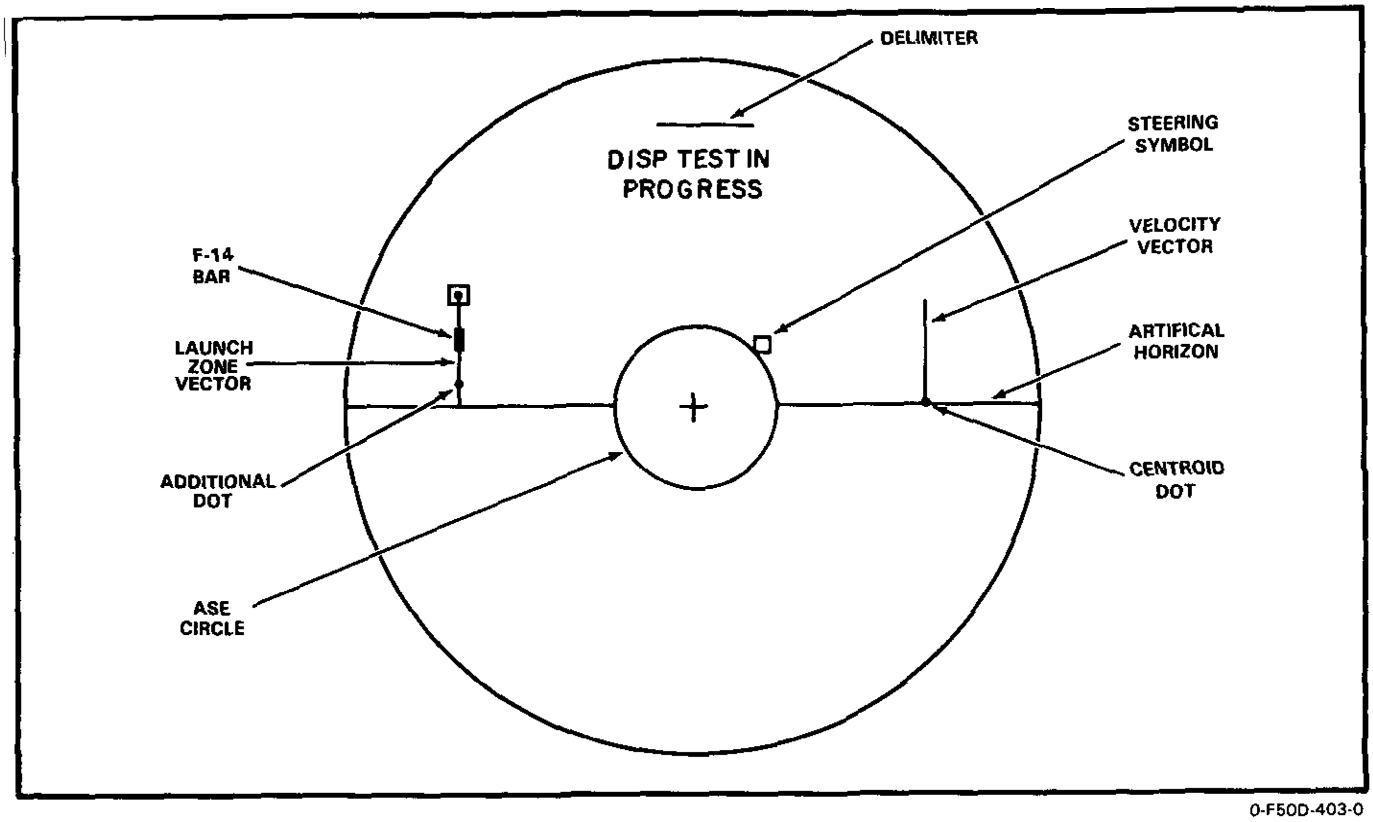


Figure 38-49. BIT Dynamic TID Display (ATTK Selected)

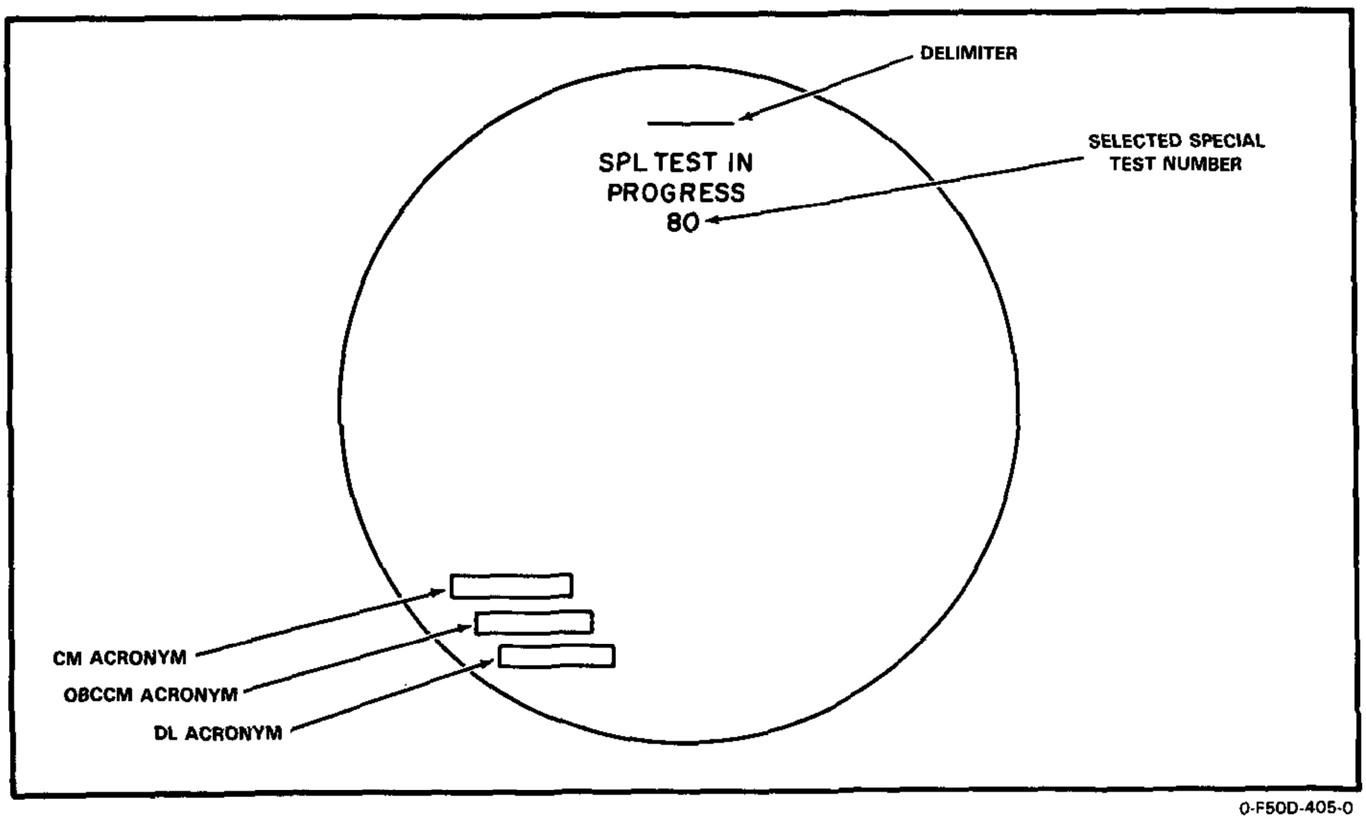


Figure 38-50. Special Test 80-Instrumentation Test

A computer number of 1 selects the RDP memory, currently the only valid selection. Next, a hexadecimal memory address must be entered in the following sequence:

1. 9

2. 0

3. 1- to 5-digit hex address

4. ENT.

The flycatcher has the capability to increment or decrement the displayed address. To increment the displayed address, the following sequence must be entered:

1. CLR

2. 7

3. N+E

4. ENT.

To decrement the displayed address, the following sequence must be entered:

1. CLR

2. 7

3. S-W

4. ENT.

If an increment is performed, and no further CAP selections have been made, subsequent increments or decrements can be made by simply pressing the ENT pushtile repeatedly.

The flycatcher is turned off with the following CAP sequence:

1. CLR

2. 7

3. 0

4. ENT.

PART X

NATOPS Evaluation

Chapter 39 — NATOPS Evaluation and Question Bank

CHAPTER 39

NATOPS Evaluation

39.1 NATOPS EVALUATION PROGRAM

39.1.1 Concept. The standard operating procedures prescribed in this manual represent the optimum method of operating the aircraft. The NATOPS evaluation is intended to evaluate compliance with NATOPS procedures by observing and grading individuals and units. This evaluation is tailored for compatibility with various operational commitments and missions of both Navy and Marine Corps units. The prime objective of the NATOPS evaluation program is to assist the unit commanding officer in improving unit readiness and safety through constructive comment. Maximum benefit from the NATOPS program is achieved only through the vigorous support of the program by commanding officers as well as by flightcrewmembers.

39.1.2 Implementation. The NATOPS evaluation program shall be carried out in every unit operating naval aircraft. The various categories of flightcrewmembers desiring to attain and retain qualification in the F-14D shall be evaluated initially in accordance with the current OPNAV Instruction 3710, and at least once during the 12 months following initial and subsequent evaluations. Individual and unit NATOPS evaluations will be conducted annually; however, instruction in and observation of adherence to NATOPS procedures must be on a daily basis within each unit to obtain maximum benefits from the program. The NATOPS coordinators, evaluators, and instructors shall administer the program as outlined in the current OPNAVINST 3710. Evaluees who receive a grade of Unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a reevaluation. A maximum of 60 days may elapse between the date of the initial ground and flight evaluation and the date that qualification is satisfactorily completed. F-14A/A(PLUS) NATOPS evaluations can be accomplished during the same evaluation flight, provided the currency requirements for each model established in Chapter 5 are met. The results will be recorded on the NATOPS evaluation report (OPNAV Form 3710/7).

39.1.3 Definitions. The following terms, used throughout this chapter, are defined below as to their specific meaning within the NATOPS program.

39.1.3.1 NATOPS Evaluation. A periodic evaluation of individual flightcrewmembers standardization consisting of an open-book examination, closed-book examination, oral examination, and flight evaluation.

39.1.3.2 NATOPS Reevaluation. A partial NATOPS evaluation administered to a flightcrewmember who has been placed in an Unqualified status by receiving an Unqualified grade for any ground examination or for the flight evaluations. Only those areas in which an unsatisfactory level was identified need be observed during a reevaluation.

39.1.3.3 Qualified. The evaluation term applied to a flightcrewmember who is well standardized and who demonstrates highly professional knowledge of and compliance with NATOPS standards and procedures. Momentary deviations from or minor omission in noncritical areas are permitted if prompt and timely remedial action was initiated by the evaluee.

39.1.3.4 Conditionally Qualified. The evaluation term applied to a flightcrewmember who is satisfactorily standardized, who may have made one or more significant deviations from NATOPS standards and procedures but made no errors in critical areas and no errors jeopardizing mission accomplishment or flight safety.

39.1.3.5 Unqualified. The evaluation term applied to a flightcrewmember who is not acceptably standardized, who failed to meet minimum standards regarding knowledge of and/or ability to apply NATOPS procedures, or who made one or more significant deviations from NATOPS standards and procedures that could jeopardize mission accomplishment or flight safety.

39.1.3.6 Area. An area is a routine of preflight, flight, or postflight.

39.1.3.7 Subarea. A performance subdivision within an area that is covered and evaluated during an evaluation flight.

39.1.3.8 Critical Area and Subarea. Any area or subarea that covers items of significant importance to the overall mission requirements, the marginal performance of which would jeopardize safe conduct of the flight.

39.2 GROUND EVALUATION

Prior to commencing the flight evaluation, an evaluee must achieve a minimum grade of Qualified on the open-book and closed-book examinations. The oral examination is also part of the ground evaluation but may be conducted as part of the flight evaluation. To assure a degree of standardization between units, the NATOPS instructors may use the bank of questions contained in this chapter in preparing portions of the written examinations.

39.2.1 Open-Book Examination. The open-book examination shall consist of, but not be limited to, the question bank. The purpose of the open-book examination portion of the written examination is to evaluate the flightcrewmember's knowledge of appropriate publications and the aircraft.

39.2.2 Closed-Book Examination. The closed-book examination may be taken from, but shall not be limited to, the question bank and shall include questions concerning normal and emergency procedures and aircraft limitations. Questions designated critical will be so marked.

39.2.3 Oral Examination. The questions may be taken from this manual and may be drawn from the experience of the instructor-evaluator. Such questions should be direct and positive and should in no way be based solely on opinion.

39.2.4 Emergency. An aircraft component or system failure or condition that requires instantaneous recognition, analysis, and proper action.

39.2.5 Malfunction. An aircraft component or system failure or condition that requires recognition and analysis, but which permits more deliberate action than that required for an emergency.

39.2.6 MFT and WST Procedures Evaluation. An MFT and WST may be used to assist in measuring the flightcrewmember's efficiency in the execution of normal operating procedures and reaction to emergencies and malfunctions. In areas not covered by the OFT and WST facilities, this may be done by placing the flightcrewmember in an aircraft and administering appropriate questions.

39.2.7 Grading Instructions. Examination grades shall use a 4.0 scale and be converted to an adjective grade of Qualified or Unqualified.

39.2.7.1 Open-Book Examination. To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.5.

39.2.7.2 Closed-Book Examination. To obtain a grade of Qualified, an evaluee must obtain a minimum score of 3.3.

39.2.7.3 Oral Examination and MFT and WST Procedure Check (If Conducted). A grade of Qualified or Unqualified shall be assigned by the instructor-evaluator.

39.3 FLIGHT EVALUATION

The flight evaluation may be conducted on any routine syllabus flight with the exception of flights launched for FCLP and CARQUAL or ECCM training. Emergencies will not be simulated.

The number of flights required to complete the flight evaluation should be kept to a minimum, normally one flight. The areas and subareas to be observed and graded on a flight evaluation are outlined in the grading criteria with critical areas marked by an asterisk (*). Grades on subareas will be assigned in accordance with the grading criteria. Grades on subareas shall be combined to arrive at the overall grade for the flight. If desired, grades of areas shall also be determined in this manner. At the discretion of the squadron or unit commander, the evaluation may be conducted in WST, MFT, or COT.

39.3.1 Instrument Flight Evaluation. Annual NATOPS instrument flight evaluations and the IFR portions of NATOPS flight evaluations, whether conducted in flight or in an approved simulator, must be conducted by a NATOPS-qualified pilot or RIO, who is designated in writing by the unit commanding officer. Such instrument flight evaluations must be conducted in accordance with the procedures outlined in the current OPNAVINST 3710.

39.4 OPERATIONAL DEPLOYABLE SQUADRONS

Pilots and RIOs assigned to operational deployable squadrons will normally be checked as a team, with the flight evaluation being conducted by the checkcrew flying wing. RIO commentary will be transmitted on the GCI or CIC control frequency in use.

39.5 TRAINING AND EVALUATION SQUADRONS

Units with training or evaluation missions that are concerned with individual instructor pilot or RIO standardization rather than with team standardization may conduct the flight evaluation with the checkcrew-pilot flying wing or on an individual basis. A pilot may be individually checked with the instructor-evaluator conducting the flight evaluation from the rear seat. The RIO may be individually checked by flying with the instructor-evaluator as the pilot.

39.6 FLIGHT EVALUATIONS

The areas and subareas in which pilots and RIOs may be observed and graded for adherence to standardized operating procedures are outlined in the following paragraphs.

Note

If desired, units with training missions may expand the flight evaluation to include evaluation of standardized training methods and techniques.

(*) The IFR portions of the flight evaluation shall be in accordance with the procedure outlined in the NATOPS Instrument Flight Manual.

39.6.1 Mission Planning and Briefing

1. Flight planning (pilot and RIO)
2. Briefing (pilot and RIO)
3. Personal flying equipment (pilot and RIO).

39.6.2 Preflight and Line Operations. Inasmuch as preflight and line operation procedures are graded in detail during the ground evaluation, only those areas observed on the flight check will be graded.

1. Aircraft acceptance (pilot and RIO)
2. Start
3. Before-taxiing procedures (pilot).

39.6.3 Taxi and Runup

(*) Takeoff and transition

1. ATC clearance (pilot)
2. Takeoff (pilot)
3. Transition to climb schedule.

39.6.4 Climb and Cruise

1. Departure (pilot)
2. Climb and level-off (pilot)
3. Procedures en route (pilot)

(*) Approach and landing

4. Radar, tacan (pilot)
5. Recovery (pilot).

39.6.5 Communications

1. Receiving and transmitting procedures (pilot and RIO)
2. Visual signals (pilot and RIO)
3. IFF and SIF procedures (RIO).

39.6.6 (*) Emergency and Malfunction Procedures. In this area, the pilot and RIO will be evaluated only in the case of actual emergencies unless evaluation is conducted in the COT, WST, or OFT.

39.6.7 Postflight Procedures

1. Taxi in (pilot)
2. Shutdown (pilot and RIO)
3. Inspection and records (pilot and RIO)
4. Flight debriefing (pilot and RIO).

39.6.8 Mission Evaluation. This area includes missions covered in the NATOPS flight manual, F-14D tactical manual, and naval warfare publications for which standardized procedures and techniques have been developed.

39.7 RECORD AND REPORTS

A NATOPS evaluation report (OPNAV Form 3710/7) shall be completed for each evaluation and forwarded to the evaluee's commanding officer only. This report shall be filed and retained in the individual's NATOPS jacket. In addition, an entry shall be made in the pilot's and RIO's flight logbooks under "Qualifications and Achievements" as follows:

QUALIFICATION	DATE	SIGNATURE
NATOPS EVALUATION (Aircraft Model) (Crew Position)	(Date)	(Authenticating signature) (Unit that administered evaluation)

39.7.1 Critique. The critique is the terminal point in the NATOPS evaluation and will be given by the evaluator-instructor administering the check. Preparation for the critique involves processing, reconstructing data collected, and oral presentation of the NATOPS evaluation report. Deviations from standard operating procedures will be covered in detail using all collected data and worksheets as a guide. Upon completion of the critique, the pilot and RIO will receive the completed copy of the NATOPS evaluation report for certification and signature. The completed NATOPS evaluation report will then be presented to the unit commanding officer.

39.8 FLIGHT EVALUATION GRADING CRITERIA

Only those subareas provided or required shall be graded. The grades assigned for a subarea shall be determined by comparing the degree of adherence to standard operating procedures with adjectival ratings listed below. Momentary deviations from standard operating procedures should not be considered as unqualifying provided such deviations do not jeopardize flight safety and the evaluee applied prompt corrective action.

39.8.1 Flight Evaluation Grade Determination. The following procedure shall be used in determining the flight evaluation grade. A grade of Unqualified in any critical area and subarea will result in an overall grade of Unqualified for the flight. Otherwise, flight evaluation (or area) grades shall be determined by assigning the following numerical equivalents to the adjective grade for each subarea. Only the numerals 0, 2, or 4 will be assigned in subareas. No interpolation is allowed.

1. Unqualified — 0.0
2. Conditionally Qualified — 2.0
3. Qualified — 4.0.

To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the subareas and divide this sum by the number of subareas graded. The adjective grade shall then be determined on the basis of the following scale.

1. 0.0 to 2.19 — Unqualified.
2. 2.2 to 2.99 — Conditionally Qualified.
3. 3.0 to 4.0 — Qualified.

Example (add subarea numerical equivalents):

$$\frac{4+2+4+2+4}{5} = \frac{16}{5} = 3.20 \text{ or Qualified}$$

39.8.2 Final Grade Determination. The final NATOPS evaluation grade shall be the same as the grade assigned to the flight evaluation. An evaluee who receives an Unqualified on any ground examination or the flight evaluation shall be placed in an Unqualified status until a grade of Conditionally Qualified or Qualified is achieved on a reevaluation.

39.9 APPLICABLE PUBLICATIONS

The NATOPS flight manual contains the standard operations criteria for F-14D aircraft. Publications regarding environmental procedures peculiar to shore-based and shipboard operations and tactical missions are listed below:

1. F-14D tactical manuals
2. NWPs
3. NATOPS Air Refueling Manual
4. Air Traffic Control NATOPS Manual
5. Local Air Operations Manual
6. Carrier Air Operations Manual.

39.10 NATOPS EVALUATION QUESTION BANK

The following bank of questions is intended to assist the unit NATOPS instructor-evaluator in the preparation of ground examinations and to provide an abbreviated study guide. The questions from the bank may be combined with locally originated questions in the preparation of ground examinations. The closed-book examination will consist of not less than 25 questions nor more than 75 questions. The time limit for the closed-book examination is 1 hour and 30 minutes. The requirements for the open-book examination are the same as those for the closed-book examination, except there is no time limit.

NATOPS EVALUATION QUESTION BANK

1. The aircraft weighs approximately ____________ including trapped fuel, oil, gun, pilot, and RIO.

2. The aircraft is ________ in length and has a wingspan of __________ at 20° and _________ in oversweep.

3. The L INLET and R INLET caution lights indicate ______________.

4. During normal system operation, the status of AICS ramp control is as follows:

SPEED	Ramp Hydraulic Power	
M < 0.35	ON/OFF	Restrained by ____________________________________.
M 0.35 to 0.5	ON/OFF	Commanded ______________________________________.
M > 0.5	ON/OFF	Programmed as a function of ________________________.

5. An AICS failure that causes illumination of an INLET and/or RAMP caution light results in the following:

Speed Range	Ramp Resultant
M < 0.35	____.
M 0.5 to 0.9	____.
M > 0.9	____.

6. During the AICS portion of OBC, simulated variant flight conditions cycle the ______________ through their full range of operation in about ______ seconds. This exercises the _________________________ and ensures____ .

7. Operation of the L and R AICS is completely independent.

   a. True

   b. False

8. AICS anti-ice is available between ________ Mach and ________ Mach.

9. With the gear handle down and one or more ramps not in the stow position, the ramp light will be illuminated.

   a. True

   b. False

10. The installed thrust of the F110-GE-400 engine is ________ pounds at MRT and ________ pounds at MAX A/B.

11. In SEC mode, both main engine fuel flow and compressor VSVs are scheduled ___________by the ___________, and fan speed is limited _________ by the ___________.

12. A 3-percent increase in windmill rpm can be achieved by selecting ___________.

13. Nonemergency selection of the SEC mode should be performed in _________________.

14. The augmenter fan temperature control system regulates five parameters of the engine to provide stall-free operation for any rate of throttle movement throughout the flight envelope. These parameters are:

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

    e. ______________________________

15. The engine electrical control subsystem is powered by an engine gearbox-mounted (ac or dc) alternator that contains __________ separate windings, which are:

    a. ______________________________

    b. ______________________________

    c. ______________________________

    d. ______________________________

16. What are the two power sources for fan speed limiting?

    a. ______________________________

    b. ______________________________

17. The backup ignition is powered by the aircraft ______________ bus.

18. Autorelight logic is provided by the ______________.

19. What are the throttle interlocks at the military power detent?

    a. ______________________________

    b. ______________________________

    c. ______________________________

20. Autothrottle may be preflight ground tested on deck either in ______________ or ______________. Indications that a malfunction exists in the autothrottle system are ______________________ or ______________________.

21. List oil pressure readings

    a. MRT__________________ psi

    b. Minimum at IDLE__________ psi

22. An engine stall with no overtemperature will illuminate the appropriate STALL WARNING light in both PRI and SEC mode.

    a. True

    b. False

23. Normal ranges of nozzle position are:

    a. IDLE weight on wheels____________________

    b. In-flight MRT ____________________

    c. MIN A/B ____________________

    d. MAX A/B ____________________

24. What interlocks must be satisfied to activate the nozzle to the full-open position to reduce residual thrust?

    a. ____

    b. ____

25. Minimum rpm for ground start of the F110-GE-400 engine is __________________ percent rpm.

26. Maximum allowable EGT for ground starting the F110-GE-400 engine is _____________°C.

27. The starting temperature limits are the same for both ground starts and airstarts.

    a. True

    b. False

28. At EGT readings of _____________°C ±10, a warning tone is present in the pilot earphones.

29. At ____________°C, the EGT chevrons begin to flash.

30. A hot engine should not be started until EGT is below ___________°C airborne.

31. Zero- or negative-g flight is limited to a maximum of ________ seconds in military power or less and ________ seconds in afterburner in order not to ______________________________.

32. Above __________ rpm, the MEC should shut off fuel flow to the F110-GE-400 engine.

33. If the throttle boost system fails, the throttles automatically revert to manual mode, and the throttle mode switch returns to MAN.

    a. True

    b. False

34. What pilot action is required to reset the boost mode of throttle control subsequent to reversion to the manual mode?

35. ____ is the controlling parameter for the APCS.

36. Autothrottle engagement range is between ______________ and ________________ percent rpm.

37. If the autothrottles are disengaged by any means, the AUTO THROT light illuminates for a 10-second duration.

    a. True

    b. False

38. Engine rpm must be above _________ percent to supply sufficient power for the main engine ignition system.

39. When attempting a crossbleed or normal ground start, the ENG CRANK switch will not reengage if the engine is spooling down and engine rpm is between ___________ and ___________percent.

40. During spooldown airstarts, hung starts in the low rpm range (less than 45 percent) can be assisted with _____________. Hung starts in the mid-rpm range (50 to 60 percent) can be corrected by______________.

41. If the IGV linkage breaks, the IGVs assume a ______________ position, which is near normal for ______________ power settings.

42. The number of delta Ps to check on each engine during preflight is _________________.

43. During an engine ground fire or abnormal start, be sure that the BACK UP IGNITION switch is in the ____________ position.

44. The L or R FIRE warning lights illuminate when the respective entire sensing loop is heated approximately _________°F or when any 6-inch section is heated to approximately _________°F.

45. What procedures should be followed to check oil level if it was not checked within 5 to 30 minutes after shutdown?

46. During preflight, the oil sight gauge is always a reliable indicator of oil level.

    a. True

    b. False

47. The No. _________ bearing receives priority lubrication in the event of a loss of oil.

48. During cold starts, oil pressure greater than 80 psi should not be exceeded for more than _________minute(s).

49. The electrical source for the oil pressure indicator is________.

50. The OIL PRESS warning light will illuminate when the pressure drops below ________ psi and extinguishes when pressure rises above ________ psi.

51. The L or R OIL HOT warning light indicates that the supply oil temperature has exceeded __________or the scavenge pump temperature has exceeded _____________.

52. The INLET ICE caution light illuminates when ____________or _____________.

53. In AUTO, pitot probe heat is available only with weight off wheels.

    a. True

    b. False

54. Which of the following would result in illumination of the FUEL PRESS caution light?

    a. Failure of a motive flow pump.

    b. Failure of a main fuel pump stage.

56. Failure of the second stage on the main engine fuel pump will have what effect on engine operation?

55. Failure of a motive flow fuel pump will have what effect on the engine and fuel system operation?

57. The loss of an engine-driven boost pump will have what effect on operation of both engines?

58. Selecting either AFT or FWD with the fuel FEED switch performs what functions in the fuel system?

    a. ______________________ c. ______________________ e. ______________________

    b. ______________________ d. ______________________

59. The L/R FUEL LOW light illuminates with approximately ___________ pounds remaining in the respective feed group.

60. Automatic shutoff of wing and drop tank transfer occurs with WING/EXT TRANS switch in either AUTO or ORIDE.

    a. True

    b. False

61. The engine boost pump is powered by ______________________________.

62. To increase bingo fuel specifications, the engine mode select switch may be placed in ________________ during descents or ____.

63. The BINGO caution light illuminates when ______________________.

64. Is vent tank fuel quantity included in the fuel totalizer on the AFT and L indicator readings?

65. When should the FEED switch be activated to FWD or AFT?

66. What medium is used to actuate the feed tank interconnect valve, wing motive flow shut-off valves, and fuel dump valve?

67. Wing fuel is transferred by:

    a. Engine bleed air

    b. Motive flow fuel

68. The fuel thermistors in the outboard section of the wing tanks perform what function?

69. The fuel thermistors in fuel cell Nos. 2 and 5 perform these functions when either is uncovered:

    a. ______________________________________ d.

    b. ______________________________________ e.

    c. ______________________________________

70. All fuel entering the vent tank is vented overboard through the vent mast in the tailhook attachment fairing.

a. True

b. False

71. Fuel transfer from the external drop tanks is accomplished by _______________.

72. External fuel transfer can be checked on the deck by _______ or ________.

73. Fuel dump is prohibited with speedbrakes open and/or afterburner operation.

a. True

b. False

74. When the fuel dump circuit is activated, wing and external drop tank transfer is automatically initiated.

a. True

b. False

75. Is it possible to refuel in flight and accomplish total fuel transfer without electrical power or a combined hydraulic system? If not, why?

76. On engine start with the generator switch in normal, the generator is automatically excited and the generator control unit brings it on the line when engine rpm is approximately ______________ percent.

77. _____________________ stage bleed air is used for IDG oil ground cooling.

78. If the thermal cutout decouples the drive clutch to either main generator in flight, the IDG may be recoupled (reset) a maximum of three times.

a. True

b. False

79. Failure of either ac generator automatically connects the left and right main ac buses to the operative generator. The cockpit indicator will be a ______________ caution light.

80. The emergency generator is powered by ________________.

81. If the emergency generator switch is in NORM, it will come on the line automatically when ______________ ____.

82. When operating on the emergency generator, the cockpit lighting available consists of ______________ and ________________________.

83. A single engine-driven pump on the left powers the combined hydraulic system and a single engine-driven pump on the right powers the flight hydraulic system.

a. True

b. False

84. If the pilot extinguishes the MASTER CAUTION light after a failure of one main hydraulic system, failure of the other system (will or will not) illuminate the MASTER CAUTION light. Why?

85. List the requirements for operation of DLC.

86. With the left engine shut down in flight and 0 percent windmill rpm, the combined hydraulic system can be powered by __________________________.

88. With total loss of fluid from either main hydraulic system, the hydraulic transfer pump will ____.

89. The cockpit handpump will charge the brake accumulator in flight if ____.

90. Loss of all hydraulic fluid from the flight hydraulic system will mean loss of power to the right inlet ramps.

a. True

b. False

91. With loss of the combined hydraulic system (combined system pressure zero), the main flaps are powered by ________________ and the auxiliary flaps are ____.

92. With the landing gear emergency blown down, the nosewheel steering and normal brakes will operate after touchdown.

a. True

b. False

93. The outboard spoiler module uses combined system fluid.

a. True

b. False

94. Outboard spoilers are inoperative with wing-sweep angles aft of _________.

95. The outboard spoiler module thermal cutout is inhibited when ____.

96. The ON-OFF flag in the spoiler window of the hydraulic indicator indicates:

a. The outboard spoiler module is energized.

b. The outboard spoiler system is pressurized.

97. With loss of the combined hydraulic system (combined system pressure zero) the inboard spoilers will: __________________________.

98. The backup flight control module powers the ___________ and the ___________.

99. With the backup flight control module switch in AUTO, the module is automatically energized when ____.

100. The backup flight control module switch has three positions: AUTO, ____________ and ______________________________________.

101. The backup flight control module operates in the high-speed mode when ____________________ ____________________.

102. Operational status of the backup flight control module is indicated in the cockpit by ____________________ ____________________.

103. DLC requires an operable outboard spoiler module.

a. True

b. False

104. Failure of either the combined or flight hydraulic system will have what effect on wing sweep?

105. On the wing-sweep indicator, there are three position indicators. These show ______________, ____________________ and ____________________ wing-sweep position.

106. The aircraft is being operated with the wings aft of the forward limit. The wing-sweep control mode indicator reads MAN. If speed is now increased beyond where the wing-sweep angle and forward limit coincide, the control mode indicator will read ______________ and the wings will ________________.

107. The most forward wing-sweep angle allowed in bomb mode is __________.

108. The emergency wing-sweep mode is a manual method of positioning the wings. This method incorporates locks every ___________ from 20° to 68° to prevent random wing movement in this mode.

109. Illumination of the WING SWEEP warning light means: ____________________ ____________________.

110. Illumination of the WING SWEEP advisory light means: ____________________ ____________________.

111. Transient failures in the CADC may be reset by: ____________________ ____________________.

112. The CADC is self-tested in ________________________.

113. List the caution, advisory, and warning lights activated by the CADC directly or via the AFCS:

a. ____________________ e. ____________________

b. ____________________ f. ____________________

c. ____________________ g. ____________________

d. ____________________ h. ____________________

114. When instrument test has been selected on the MASTER TEST panel, the EIG indications after 5 seconds are:

a. RPM

b. EGT

c. FUEL

d. FLOW

115. A degraded mode of EIG operation is indicated by____________________.

116. Maneuver flaps can be lowered at any wing-sweep angle between 20° and __________________.

117. The maneuvering flap thumbwheel will lower the main flaps __________, the auxiliary flaps _________, and the slats__________. Use of the maneuvering devices (does or does not) put more restrictive g limitations on the aircraft.

118. What is the meaning of the following (besides CADC failure)?

a. FLAP caution light

b. REDUCE SPEED warning (1)______________________________
(2)______________________________
(3)______________________________

119. Power for emergency extension of the landing gear is supplied by ______________________________
______________________________.

120. The minimum bottle pressure for accomplishing emergency extension of the landing gear is_______ psi but minimum preflight bottle pressure is _______ psi at 70 °F (21°C).

121. Full lateral trim in the direction of stick displacement will reduce maximum spoiler deflection to ____________ on that side.

122. Full slat asymmetry of 17° can result in an out-of-control situation at ___________units AOA or greater, even with 55° of spoilers available.

123. The rudder pedal shaker is armed with main flaps greater than__________° and the______________ computer operating.

124. With DLC engaged, full-up DLC positions the inboard spoilers at_________° and the horizontal stab trailing edges _________________.

125. The initial position for spoilers when DLC is engaged is ________________.

126. The correct positioning for stabilizers when DLC is given a full-down command (from trim) is_________ trailing edge __________________.

127. Full rudder throw of ±________________° corresponds to ± inches of rudder pedal travel.

128. Control surface authority of the stability augmentation system is:

Pitch ± ____________°.

Roll ± ____________°.

Yaw ± ____________°.

129. The gear handle is down and the three gear position indicators show the gear down, but the transition light is illuminated. What does this indicate and what action should be taken?

____

____

130. The ANTI SKID SPOILER BK switch is OFF and the BRAKE light is illuminated. This would indicate:

a. ____

b. ____

131. The BRAKE light (ANTI SKID SPOILER BK switch OFF) operates only when the brakes are depressed or the parking handle is pulled.

a. True

b. False

132. The two procedures for lowering the launch bar are: ________________ or ________________.

133. Nosewheel steering cannot be engaged until weight is on wheels.

a. True

b. False

134. With the nosewheel <70°, the nosewheel assumes the position commanded by the rudder pedals when nosewheel steering is engaged.

a. True

b. False

135. BLEED DUCT light indicates temperatures in excess of ____________°F between engine and primary heat exchanger or greater than _____________°F between primary heat exchanger and the ECS turbine.

136. The ram air door can be opened only if the __________ or __________ button is depressed on the ECS control panel.

137. The ram air door automatically closes with selection of L ENG, R ENG, or BOTH ENG on the ECS control panel.

a. True

b. False

138. The ram air door requires __________ seconds to go full open.

139. The RIO has a low-cockpit-pressure caution light (CABIN PRESS) that illuminates if __________ or ___________.

140. With the OBOGS light on, each flightcrewmember should have ___ hours of oxygen at 20,000 feet (8,000 feet cabin altitude).

141. Pulling the emergency oxygen actuator releases gaseous oxygen charged to psi and will provide approximately a ________-minute supply.

142. Windshield rain removal is accomplished by blowing 390 °F air over the outside of the windshield. If the temperature sensor detects an overtemperature condition, the WSHLD HOT advisory light will illuminate and ____________________.

143. Maximum allowable headwind for the open canopy is ______________ knots.

144. When the canopy is jettisoned, the sill locks are released by ________________.

145. The canopy pneumatic reservoir must be serviced by ground servicing unit.

a. True

b. False

146. The pilot can tell the position of the command ejection lever by ____________________.

147. The RIO can eject both himself and the pilot with EJECT CMD handle set to PILOT.

a. True

b. False

148. The pilot can eject both himself and the RIO with the EJECT CMD handle set to MCO.

a. True

b. False

149. In the event the canopy does not separate from the aircraft when either flightcrewmember has initiated ejection, "through the canopy" ejection will not occur.

a. True

b. False

150. There are __________________ safety pins per ejection seat.

151. Command ejection by either flightcrewmember will eject the RIO in _____ seconds and the pilot _________ seconds later.

152. For a high-altitude ejection, the seat is allowed to free-fall to ±_______________ feet.

153. All exterior lighting controls except for the ________ light are located on the MASTER LIGHT panel on the pilot console, and the exterior lights master switch on the outboard throttle.

154. When the wings are swept aft of ________, the _________ position lights are disabled and the glove vane position lights are operable.

155. When the ANTI-COLLISION light switch is ON, the _________ position lights flasher switch is disabled.

156. A proper indicator lights test has the MASTER CAUTION light on steady.

a. True

b. False

157. The RIO can monitor SW tones by selection of ___________ position on the ICS panel.

158. The standby attitude indicator is capable of providing reliable attitude information within _________ for up to _________ minutes after a complete loss of power.

159. On deck, the allowable error between the pilot and RIO altimeter readings is _________ feet at field elevation.

160. The angle-of-attack indicator is checked during __________ and the indexer during __________. Proper indications are:

a. Indicator — ______________

b. Indexer — ________________.

161. In the landing configuration, 15 units AOA is equivalent in airspeed for:

a. 48,000 pounds (DLC not engaged) = ____________ KIAS

b. 48,000 pounds (DLC engaged/neutral) = _________ KIAS

c. 50,000 pounds (DLC not engaged) = ___________ KIAS

162 . With an airspeed indicator failure, list the angle of attack to fly for the following conditions (drag index 8):

a. Catapult ______________________________.

b. Climb (MIL) SL __________________________ to combat ceiling.

c. Cruise at OPT. ALT. ______________________________.

d. Endurance at OPT. ALT. ______________________________.

163. Stores jettison is controlled by which aircraft system?

164. ACM jettison requires MASTER ARM ON.

a. True

b. False

165. Selective jettison can be completely controlled by either flightcrewmember.

a. True

b. False

166. In the emergency jettison mode, the weight-on-wheels interlock is bypassed.

a. True

b. False

167. Emergency jettison mode will jettison Sidewinders.

a. True

b. False

168. Sidewinder is jettisoned by firing the motor and safing the warhead.

a. True

b. False

169. The pretaxi (weight-on-wheels) OBC master test is a complete check of the SMS.

a. True

b. False

170. Selection of any pulse dogfight mode automatically provides stab out aircraft reference.

a. True

b. False

171. The pilot must clear maintenance display prior to running OBC for current test results

a. True

b. False

172. For normal UHF operation with the ARC-182, the AM/FM switch should be in the ____________________ position.

173. With track files established in TWS, the HUD and MFDs provide the pilot complete steering information to the centroid of the targets.

a. True

b. False

174. The navigation system may be updated by five methods; they are:

a. ______________________________ d. ______________________________

b. ______________________________ e. ______________________________

c. ______________________________

175. In TACAN BIT, the range and bearing on the HSD and BDHI should indicate _________ nm and _________°.

176. The target designator (diamond) is valid to ± __________° off the nose.

177. With MASTER ARM OFF, the HUD and VDI armament legend will appear with _____________.

178. To obtain an attack presentation, the air-to-air button must be selected on the PDCP.

a. True

b. False

179. The COOLING AIR light refers to air cooling out of tolerance while the SENSOR COND light indicates liquid cooling out of tolerance.

a. True

b. False

180. The TID is oriented to__________ north, with selection of GND STAB on the TID mode switch.

181. Which of the following presentations are available to the pilot:

a. IRSTS

b. PS

c. PDS

d. All of the above.

182. A ________ acronym indicates a failure of the SMS, thus preventing normal separation of stores in any launch mode.

183. The RADAR COOLING switch in the RIO cockpit controls liquid coolant to __________.

184. Hostile area altitude is entered in the ________ pseudo file to properly reject altitude line return.

185. Wind is automatically computed by the system in the INS mode.

a. True

b. False

186. A wind of 35 knots and 057° relative to the duty runway represents a headwind component of ________ knots and crosswind of _______ knots.

187. A blinking SHOOT cue indicates ____.

188. Hydraulic power to drive the gun comes from the ______________________________ system.

PART XI

Performance Data

For aircraft performance data and charts, refer to NAVAIR 01-F14AAP-1.1.

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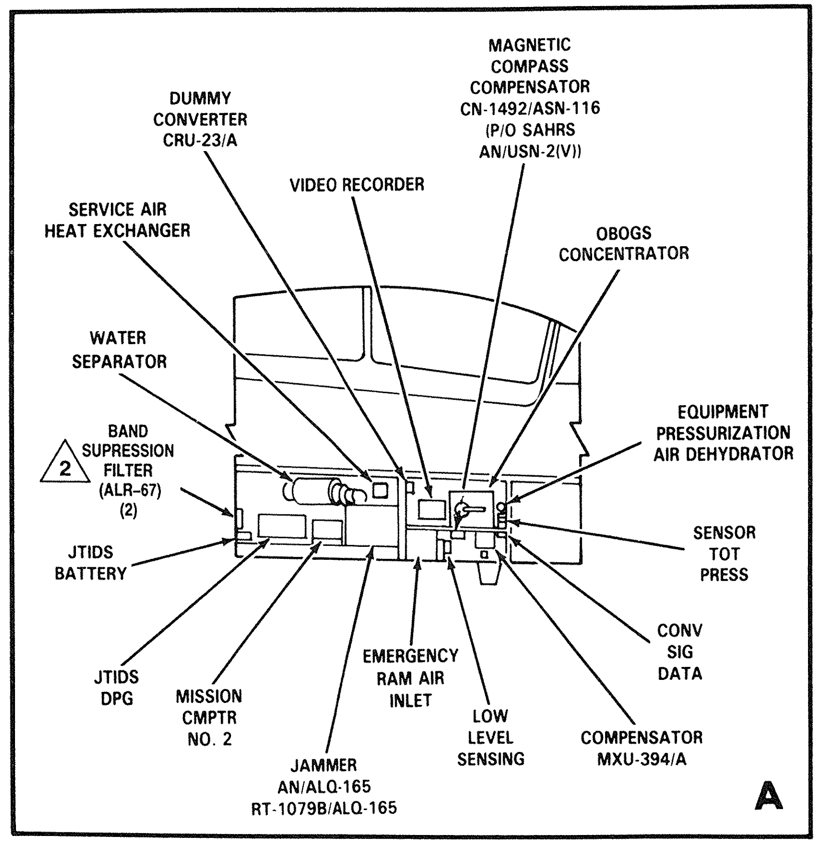

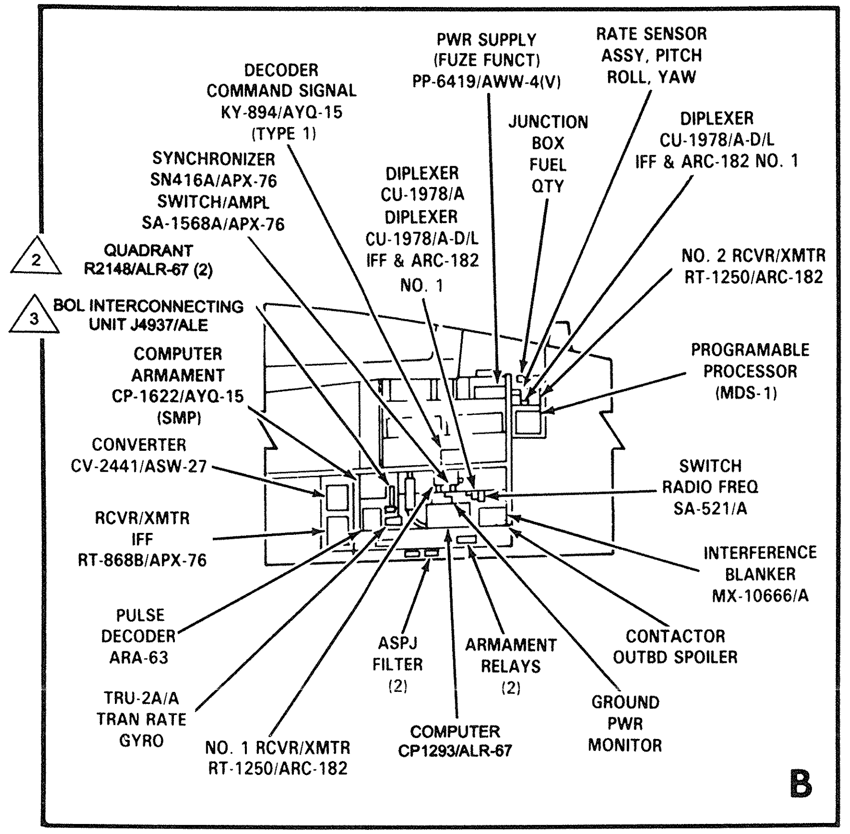

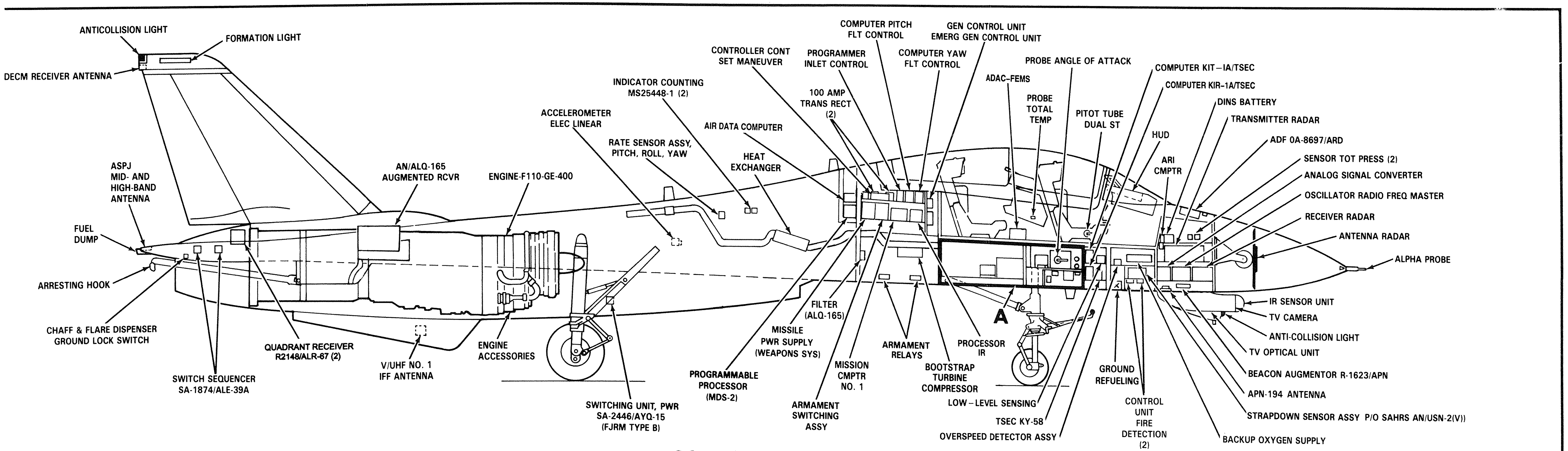

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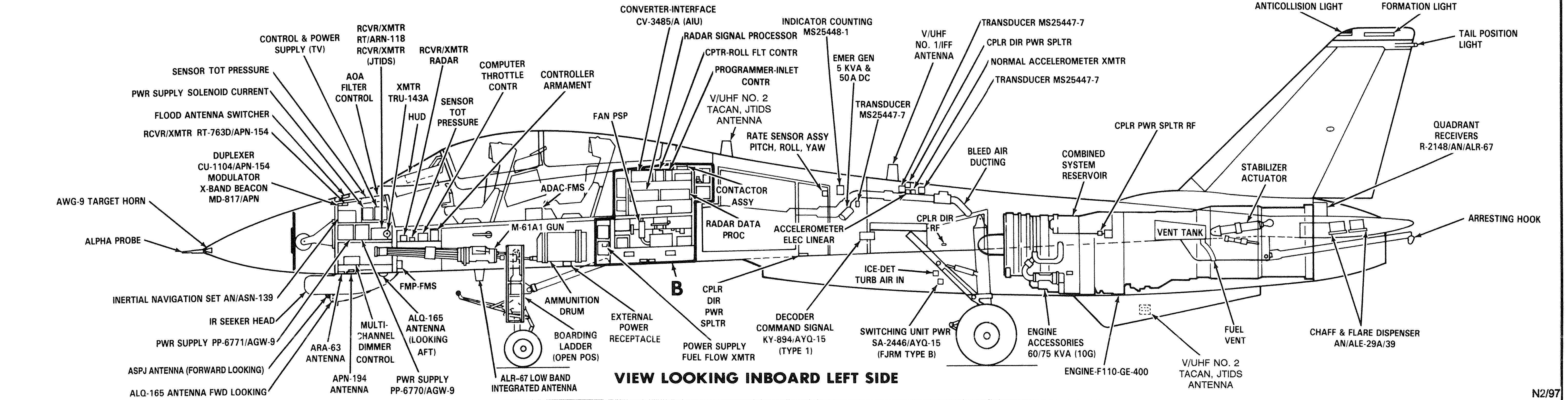

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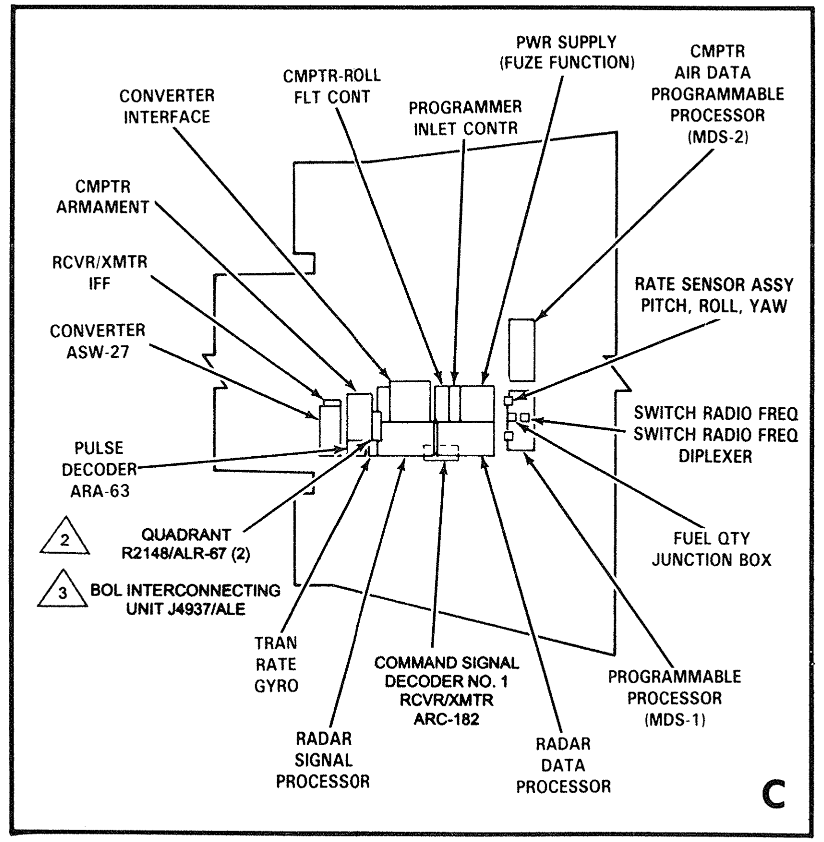
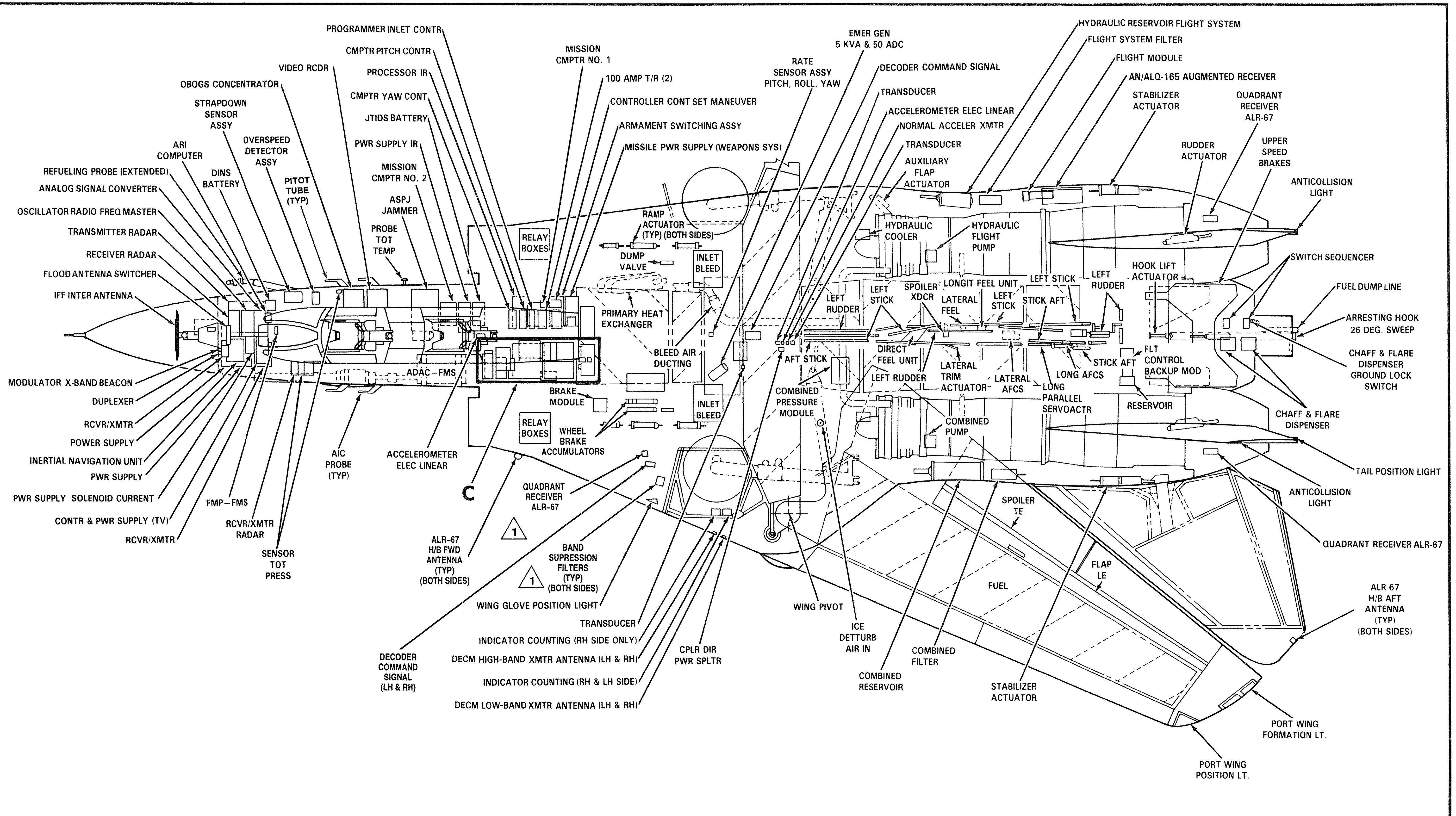
General Arrangement (Sheet 1 of 2)





VIEW LOOKING DOWN

EFFECTIVITY

1. AIRCRAFT INCORPORATING AFC 795, THE FORWARD QUADRANT RECEIVERS AND BAND SUPPRESSION FILTERS ARE RELOCATED TO THE GLOVE AREA.

2. AIRCRAFT NOT INCORPORATING AFC 795.

3. AIRCRAFT INCORPORATING BOL-CHAFF (AFC 843)

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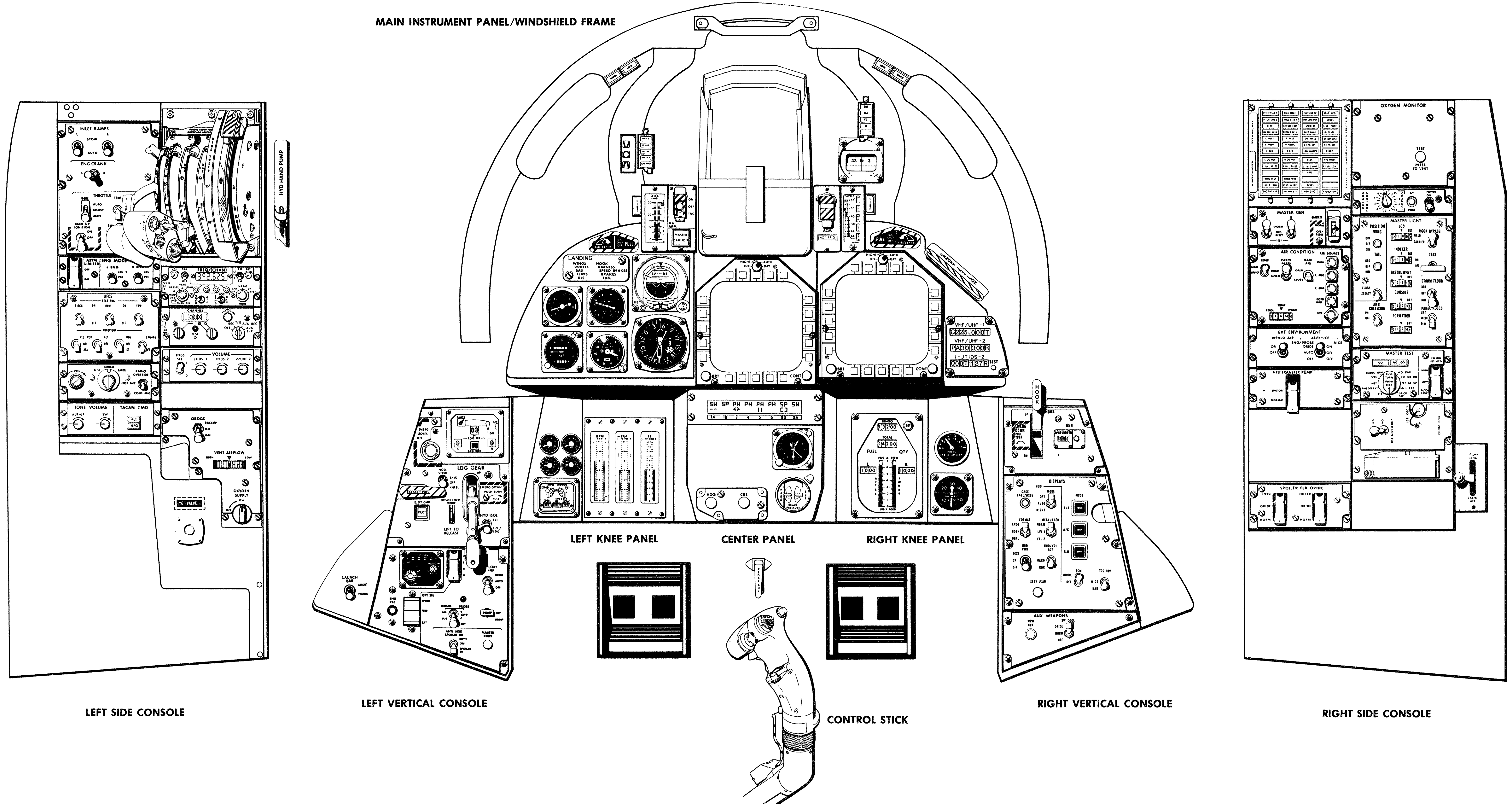
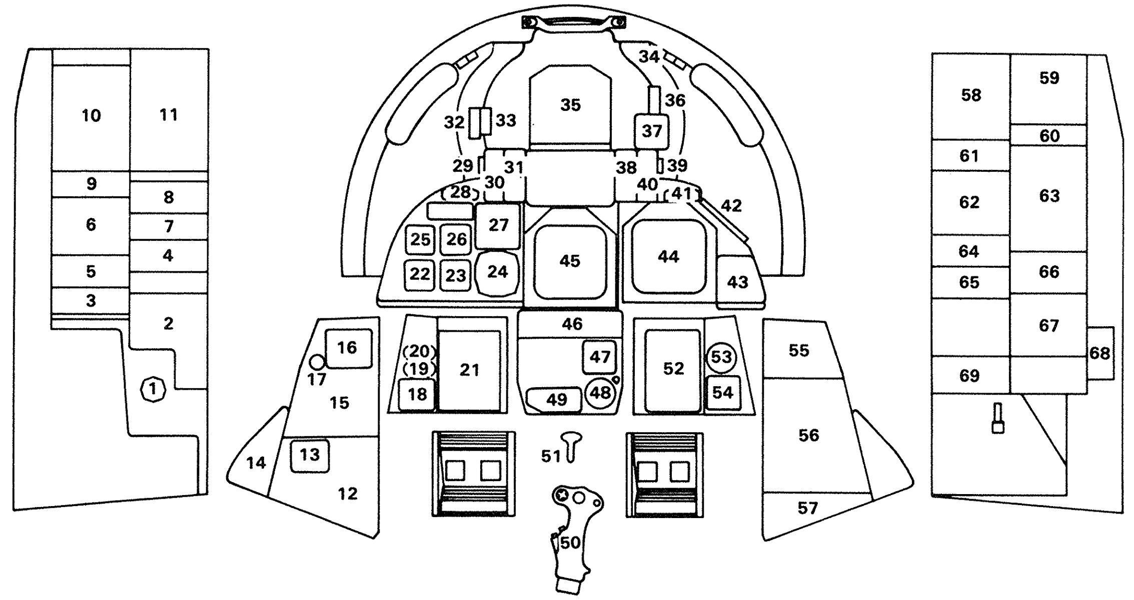
General Arrangement (Sheet 2 of 2)





LEFT SIDE CONSOLE

1. G VALVE PUSHBUTTON.
2. OXYGEN/VENT AIRFLOW CONTROL PANEL
3. TONE VOLUME/TACAN COMMAND PANEL
4. COMM VOLUME/JTIDS SELECT PANEL
5. ICS CONTROL PANEL
6. AFCS CONTROL PANEL
7. TACAN CONTROL PANEL
8. V/UHF CONTROL PANEL #1
9. ASYM LIMITER/ENGINE MODE SELECT PANEL
10. RAMPS/THROTTLE/RUDDER TRIM PANEL
11. THROTTLE QUADRANT

LEFT VERTICAL CONSOLE

12. FUEL/MASTER RESET/ANTI-SKID/SPOILER BRAKE PANEL
13. CONTROL SURFACE POSITION INDICATOR
14. LAUNCH BAR CONTROL PANEL
15. LANDING GEAR CONTROL PANEL
16. WHEELS/FLAPS/SPEED BRAKE POSITION INDICATOR
17. EMERGENCY STORES JETTISON BUTTON

LEFT KNEE PANEL

18. HYDRAULIC PRESSURE INDICATOR
19. OIL PRESSURE INDICATORS
20. NOZZLE POSITION INDICATORS
21. ENGINE INSTRUMENT GROUP

MAIN INSTRUMENT PANEL/WINDSHIELD FRAME

22. BAROMETRIC ALTIMETER
23. RADAR ALTIMETER
24. BEARING/DISTANCE/HEADING INDICATOR (BDHI)
25. VERTICAL VELOCITY INDICATOR
26. AIRSPEED INDICATOR
27. STANDBY ATTITUDE INDICATOR
28. LEFT FUEL SHUTOFF/FIRE EXTINGUISHER CONTROL
29. LEFT FIRE WARNING LIGHT
30. ANGLE OF ATTACK INDICATOR
31. MASTER CAUTION/MASTER ARM PANEL
32. APPROACH INDEXER
33. LEFT LADDER LIGHTS: WHEELS, BRAKES, ACLS/AP, NWS ENGA, AUTO THROT
34. SHOOT/LOCK LIGHTS
35. HEAD UP DISPLAY (HUD)/COCKPIT TV SENSOR (CTVS)
36. RIGHT LADDER LIGHTS: SAM, AAA, CW, AI
37. STANDBY COMPASS

MAIN INSTRUMENT PANEL/WINDSHIELD FRAME (CONT.)

38. ACM SWITCH/HOT TRIGGER LIGHT
39. RIGHT FIRE WARNING LIGHT
40. WING SWEEP INDICATOR
41. RIGHT FUEL SHUTOFF/FIRE EXTINGUISHER CONTROL
42. CANOPY JETTISON HANDLE
43. RADIO FREQUENCY/CONTROL INDICATOR
44. MULTIFUNCTION DISPLAY #2
45. MULTIFUNCTION DISPLAY #1

CENTER PANEL/CONTROL STICK

46. MULTISTATUS INDICATOR
47. CLOCK
48. BRAKE PRESSURE INDICATOR
49. COURSE/HEADING DISPLAY CONTROL
50. CONTROL STICK
51. RUDDER PEDAL ADJUST HANDLE

RIGHT KNEE PANEL

52. FUEL QUANTITY INDICATOR
53. OBOGS BACKUP OXYGEN PRESSURE INDICATOR
54. CABIN PRESSURE INDICATOR

RIGHT VERTICAL CONSOLE

55. ARRESTING HOOK/GUN ROUNDS PANEL
56. DISPLAYS CONTROL PANEL
57. AUX WEAPONS CONTROL PANEL

RIGHT SIDE CONSOLE

58. CAUTION/ADVISORY INDICATOR
59. OXYGEN MONITOR PANEL
60. ARA-63 CONTROL PANEL
61. MASTER GENERATOR CONTROL PANEL
62. AIR CONDITIONING CONTROL PANEL
63. MASTER LIGHT CONTROL PANEL
64. EXTERNAL ENVIRONMENT CONTROL PANEL
65. HYDRAULIC TRANSFER PUMP SWITCH
66. MASTER TEST CONTROL PANEL
67. HUD-VIDEO CONTROL PANEL
68. CANOPY DEFOG/CABIN AIR LEVER
69. SPOILER FAILURE OVERRIDE PANEL

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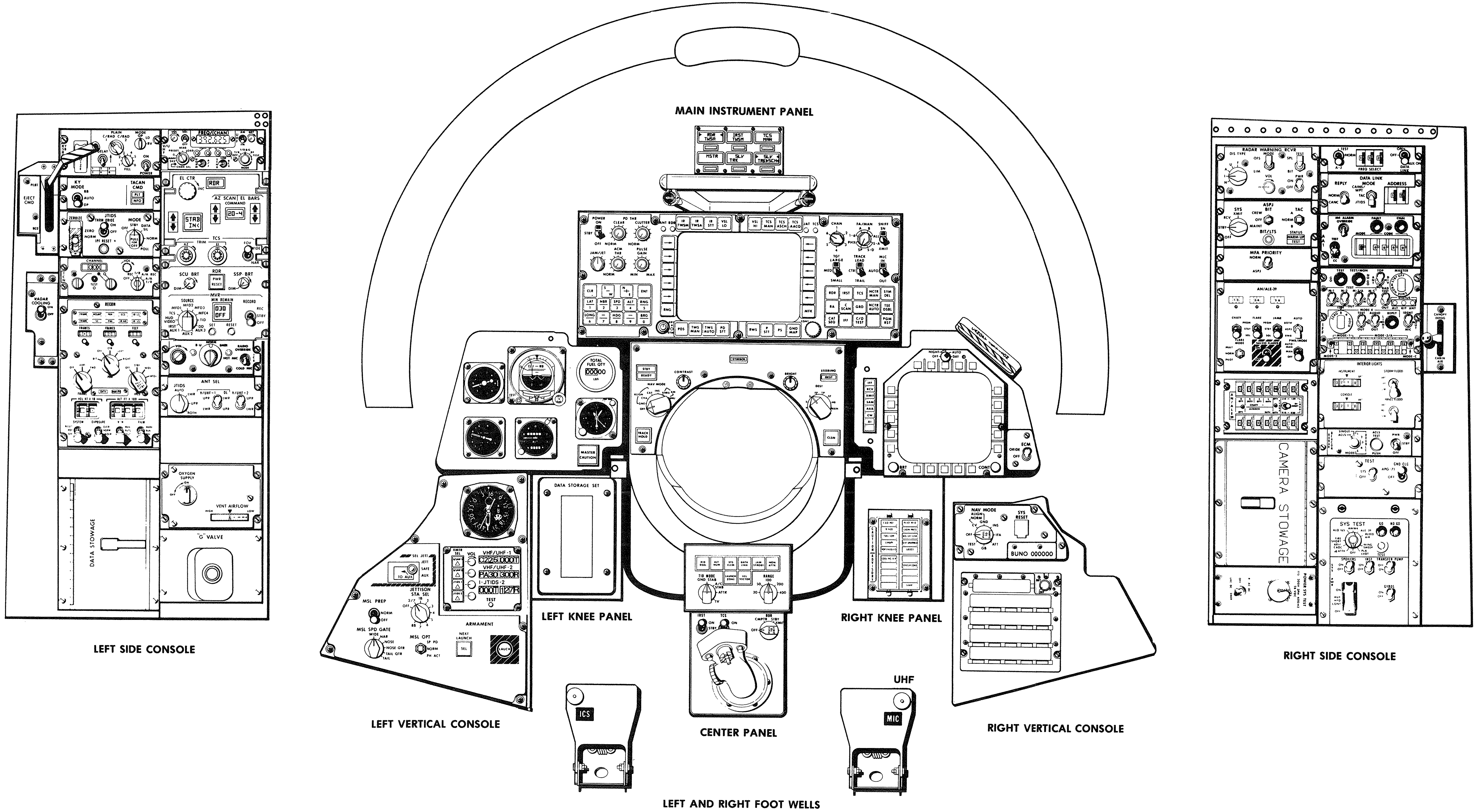
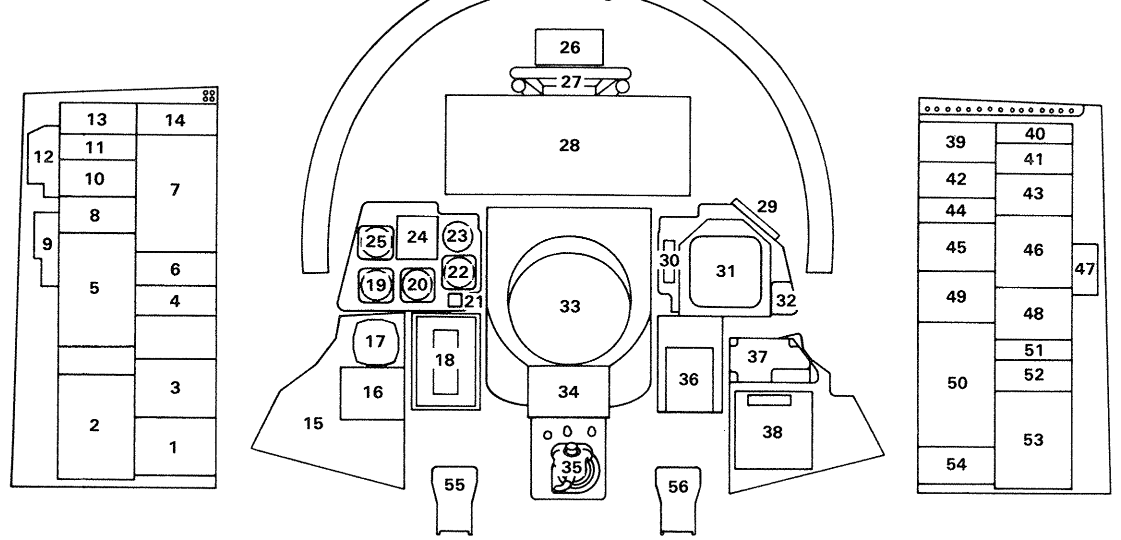
Pilot Instrument Panels and Consoles





LEFT SIDE CONSOLE

1. G VALVE PUSHBUTTON
2. DATA STOWAGE
3. OXYGEN/VENT AIRFLOW CONTROL PANEL
4. ANTENNA SELECT CONTROL PANEL
5. TARPS CONTROL PANEL
6. ICS CONTROL PANEL
7. SENSOR CONTROL PANEL
8. TACAN CONTROL PANEL
9. RADAR COOLING SWITCH
10. JTIDS CONTROL PANEL
11. KY MODE/TACAN COMMAND PANEL
12. EJECT COMMAND LEVER
13. KY-58 CONTROL PANEL
14. V/UHF CONTROL PANEL #2

LEFT VERTICAL CONSOLE

15. ARMAMENT CONTROL PANEL
16. RADIO FREQUENCY/CONTROL INDICATOR
17. BEARING/DISTANCE/HEADING INDICATOR (BDHI)

LEFT KNEE PANEL

18. DATA STORAGE SET

MAIN INSTRUMENT PANEL

19. AIRSPEED INDICATOR
20. BAROMETRIC ALTIMETER
21. MASTER CAUTION LIGHT
22. CLOCK
23. TOTAL FUEL INDICATOR
24. STANDBY ATTITUDE INDICATOR
25. VERTICAL VELOCITY INDICATOR
26. SENSOR SLAVING PANEL (NON-FUNCTIONAL AT THIS TIME)
27. COUNTERMEASURES DISPENSE SWITCHES
28. DIGITAL DISPLAY (DD)
29. CANOPY JETTISON HANDLE
30. LADDER LIGHTS: IFF, RCV, XMIT, SAM, CW, AI
31. MULTIFUNCTION DISPLAY #3
32. ECM OVERRIDE SWITCH

CENTER PANEL

33. TACTICAL INFORMATION DISPLAY (TID)
34. TID CONTROL PANEL
35. HAND CONTROL UNIT

RIGHT KNEE PANEL

36. CAUTION/ADVISORY INDICATOR

RIGHT VERTICAL PANEL

37. NAVIGATION MODE CONTROL PANEL
38. DATA ENTRY UNIT

RIGHT SIDE CONSOLE

39. RADAR WARNING RECEIVER CONTROL PANEL
40. DATA LINK CONTROL PANEL
41. DATA LINK REPLY/MODE/ADDRESS PANEL
42. ASPJ CONTROL PANEL
43. AAI (AN/APX-76) CONTROL PANEL
44. MULTIPLE FILTER ASSEMBLY PRIORITY CONTROL PANEL
45. COUNTERMEASURES DISPENSER CONTROL PANEL
46. IFF CONTROL PANEL
47. CANOPY DEFOG/CABIN AIR LEVER
48. INTERIOR LIGHTS CONTROL PANEL
49. DISPENSER PROGRAMMER
50. CAMERA STOWAGE
51. RADAR BEACON CONTROL PANEL
52. TEST/GROUND COOLING CONTROL PANEL
53. SYSTEM POWER/GROUND TEST PANEL
54. POWER SYSTEM TEST PANEL

LEFT AND RIGHT FOOT WELLS

55. ICS FOOT BUTTON
56. MIC FOOT BUTTON

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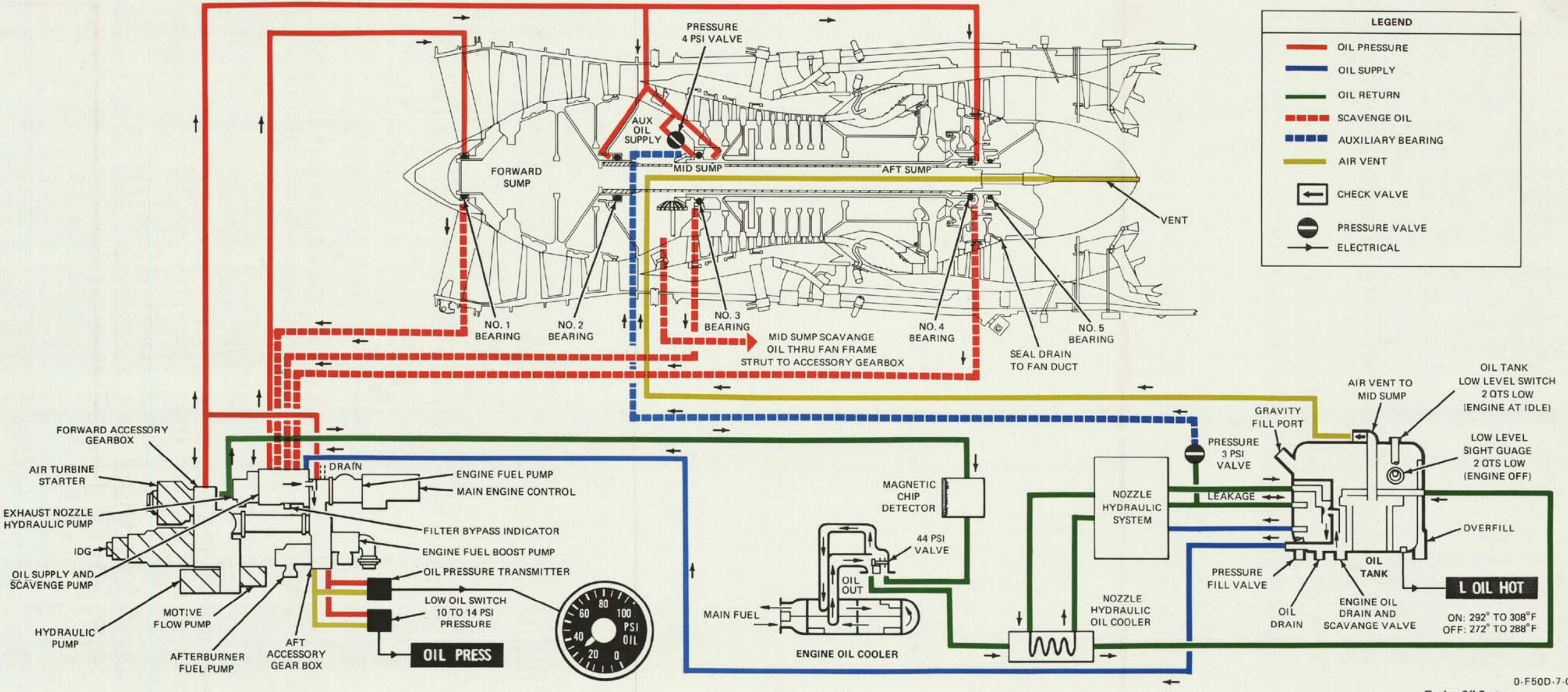
RIO Instrument Panel and Console



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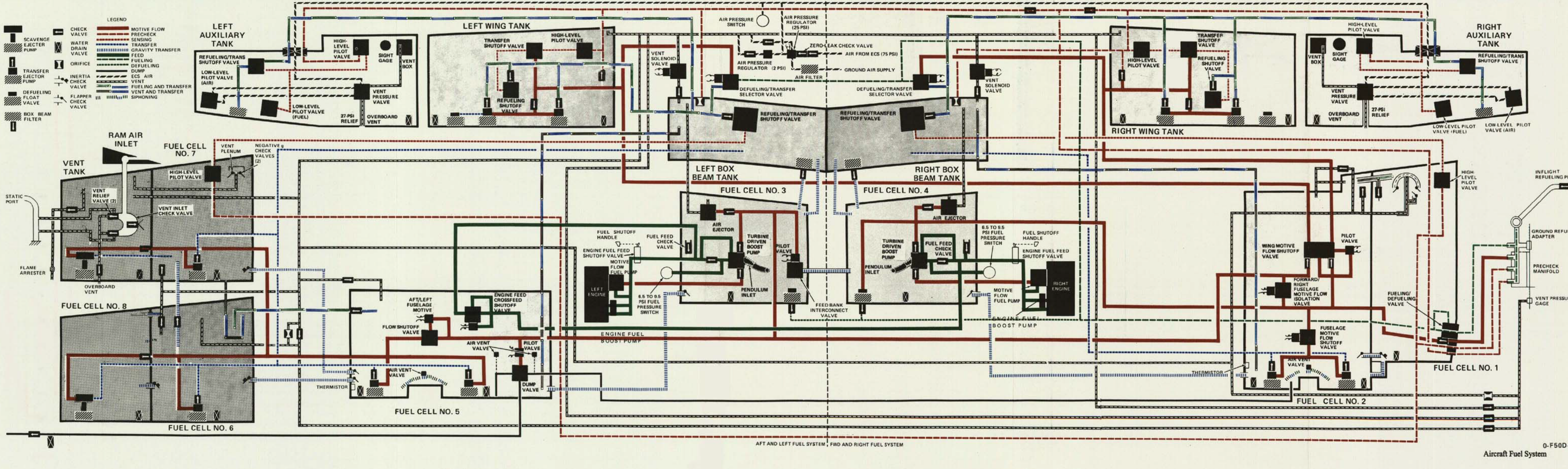
Engine Oil System



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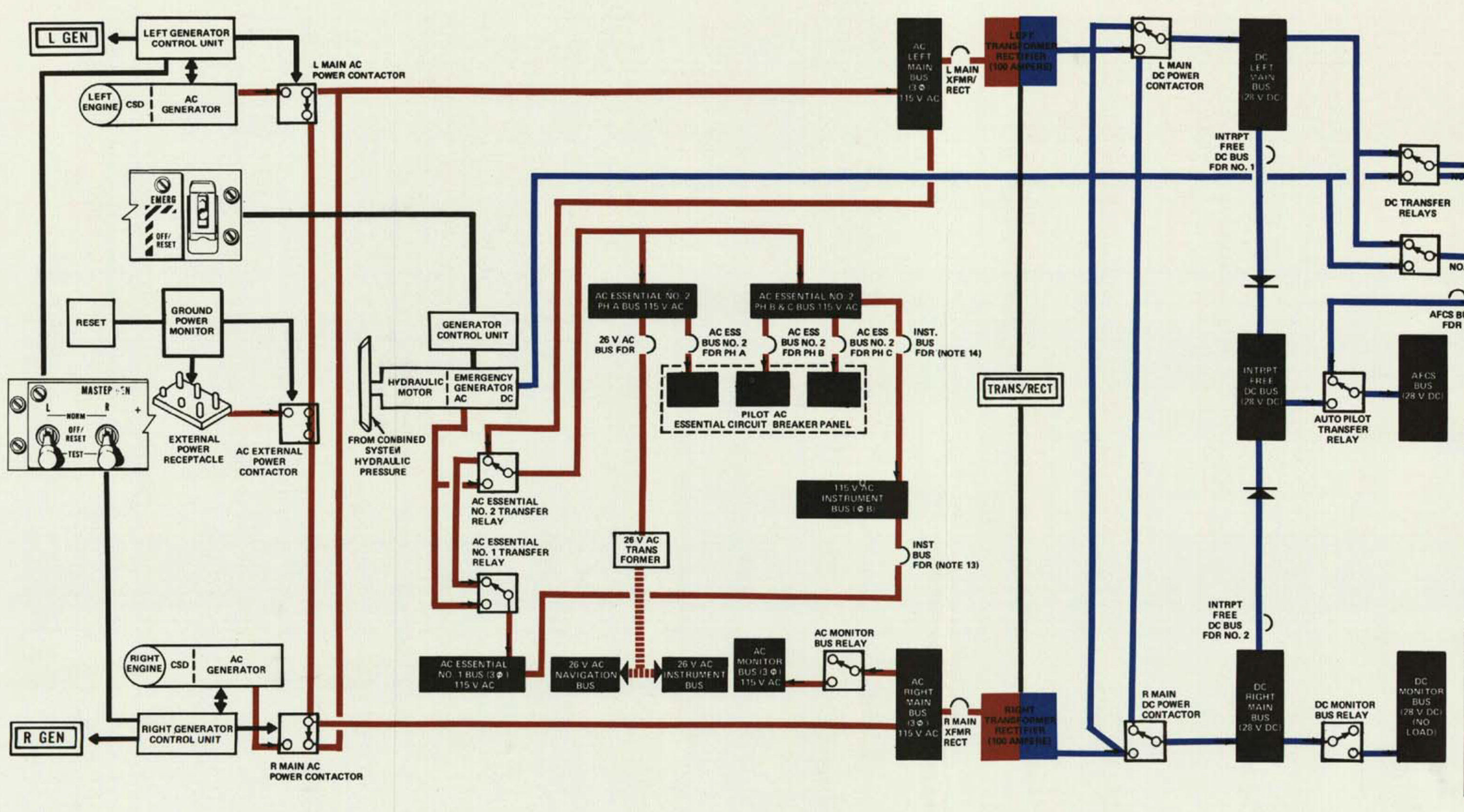
Aircraft Fuel System



LEGEND

- 115 V AC POWER
- 26 V AC POWER
- 28 V DC POWER
- CONTROL AND SIGNAL POWER
- BUSES INOPERATIVE WITH FAILURE OF LEFT AC GENERATOR AND LEFT MAIN AC POWER CONTACTOR.
- BUSES INOPERATIVE WITH FAILURE OF RIGHT AC GENERATOR AND RIGHT MAIN AC POWER CONTACTOR.

NOTE

- IF EITHER GENERATOR FAILS OR IS SHUT OFF THE ENTIRE AC LOAD IS AUTOMATICALLY TRANSFERRED TO THE REMAINING GENERATOR.
- IF EITHER TRANSFORMER RECTIFIER FAILS THE ENTIRE DC LOAD IS AUTOMATICALLY TRANSFERRED TO THE REMAINING TRANSFORMER RECTIFIER.
- IF BOTH GENERATORS OR BOTH TRANSFORMER RECTIFIERS FAIL THE EMERGENCY GENERATOR AUTOMATICALLY SUPPLIES THE ESSENTIAL AC AND DC BUSES.

AC ESSENTIAL NO. 1 AND NO. 2 PHASE A BUS — 115 V AC

FLT HYD PRESS IND
COMB HYD PRESS IND
ANGLE OF ATTK IND AC
WING POS IND AC
ILS ARA-63 PH A
R ENG OIL PRESS
L ENG OIL PRESS
JTIDS/DPG/BDHI INST PWR
JTIDS RT PH A
INS SYNC
INSTR BUS FDR
R ENG BACKUP IGN
L ENG BACKUP IGN
INST LTS
DEKI LTS
MSN CMPTR NO. 2 PH A
STBY ATTD IND PH A
26 VAC BUS FDR
AC ESS BUS NO. 2 FDR PH A
DP 1 PH A
RUDDER TRIM PH A
L PH A TEST/P-ROLL TRIM
TAXI/FORM LT
MFD 1/HUD PH A
INS PH A
CIU PH A
UTILITY LTS
ADF AC
OBOGS CONC
FUEL QTY IND AC
TAIL/RUDDER/FLAP IND

AC ESSENTIAL NO 1 AND NO. 2 PHASE B AND C BUS — 115 V AC

AC ESS BUS NO. 2 FDR PH B
AC ESS BUS NO. 2 FDR PH C
DP-1 PH B
DP-1 PH C
CIU PH B
ANL ATTK/TOTAL TEMP HTR
CIU PH C
JTIDS RT PH B
RUDDER TRIM PH C
TEMP CONT AC
JTIDS RT PH C
APX-100 AC
INS PH B
INS PH C
MSN CMPTR NO. 2 PH B
MSN CMPTR NO. 2 PH C
RUDDER TRIM PH E
R PITOT STATIC HTR
L PITOT STATIC HTR
MFD 1/HUD PH B
MFD 1/HUD PH C

L PH B TEST/P-ROLL TRIM
L PH C TEST/P-ROLL TRIM
RADAR ALTM
STBY ATTD IND PH B
BLEED DUCT AC
ILS ARA-63 PH B
ILS ARA-63 PH C
STBY ATTD IND PH C
PILOT LCD INST LTS
ALPHA HTR
PROBE LT
PILOT CONSOLE LTS
PANEL FLOOD LTS

ROLL CMPTR AC
R AICS
L AICS
PITCH CMPTR AC
CHAN 1 CADC PH A
AUTO PITCH DRIVE TRIM
YAW SAS A PWR SUP
YAW SAS B PWR SUP
YAW SAS M PWR SUP
FLT CONTR AUTH AC
MACH TRIM AC
ICE DET
WING SWEEP DRIVE NO. 1
WG SWP DR NO. 2/MANUV FLAP
CHAN 2 CADC
CHAN 1 CADC PH B
CHAN 1 CADC PH C

AC LEFT MAIN BUS 115 V AC

ASW-27 AC
AUTO THROT AC
IFF A/A AC
SAHRS PH C
SAHRS PH B
SAHRS PH A
ANT SVO HYD PH C
TCS PH C
SOL PWR SUP PH B
TCS PH B
TCS PH A
SOL PWR SUP PH A
RADAR DD PH C
RADAR DD PH B
RADAR DD PH A
ANT SVO HYD PH B
ANT SVO HYD PH A
RDP PH A
ASC PH C
ASC PH B
ASC PH A
RSP PH C
MFD 2/MFD 3 PH C
RSP PH B
MFD 2/MFD 3 PH B
RSP PH A
L MAIN XMFR/RECT

HV PWR SUP PH C
HV PWR SUP PH B
HV PWR SUP PH A
INTEG TRIM AC
RECON POD
HUD CAMERA PH A
HUD CAMERA PH B
HUD CAMERA PH C
ASPJ BASIC PH A
BEAM PS
JTIDS DPG PH A
MSN CMPTR NO. 1 PH B
ASPJ AUG PH B
ASPJ BASIC PH B
RDP PH B
JTIDS DPG PH B
MSN CMPTR NO. 1 PH C
ASPJ AUG PH C
ASPJ BASIC PH C
RDP PH C
SOL PWR SUP PH C
JTIDS DPG PH C
APG-71 XMITR AC
MFD 2/MFD 3 PH A
MSN CMPTR NO. 1 PH A
ASPJ AUG PH A
INS BAT PWR
JTIDS BATT HEATER
DP 2 PH A
DP 2 PH B
DP 2 PH C

AC RIGHT MAIN BUS 115 V AC

R AICS HTR
STORM FLOOD LT
L AICS HTR
SEATADJ/STDY POS LT
NFO CONSOLE LT
ANTICOLL/SUPP POS/POS LT
LIQUID COOLING CONTRA AC
ALR-67 RCVR PH C
R PH C TEST
ALR-67 RCVR PH B
OXY CONC HTR
R PH B TEST
ALR-67 RCVR PH A
R PH A TEST
ALR-67 CMPTR
IRST PH C
APG-71 PUMP PH C
APG-71 PUMP PH B
IRST PH B
RECON ECS CONT AC
APG-71 PUMP PH A
IRST PH A
R MAIN XMFR RECT
FLT HYD BACKUP PH C
FLT HYD BACKUP PH B
FLT HYD BACKUP PH A
OUTBD SPOILER PUMP
RECON HTR PWR PH C
RECON HTR PWR PH B
RECON HTR PWR PH A
STA 1 BOL PWR
STA 8 BOL PWR

GUN CONTROL PWR AC
STA 1A AIM-9 PWR AC
STA 1B PWR PH C
STA) 1B PWR PH B
STA 1B PWR PH A
MSL PWR SUP PH C
MSL PWR SUP PH B
MSL PWR SUP PH A
STA 3 PWR PH C
STA 3 PWR PH B
STA 3 PWR PH A
AN/AWW 4 PH C
AN/AWW 4 PH B
AN/AWW 4 PH A
STA 4 PWR PH C
STA 4 PWR PH B
STA 4 PWR PH A
SMP/MPRU PH C
SMP/MPRU PH B
SMP/MPRU PH A
STA 5 PWR PH C
STA 5 PWR PH B
STA 5 PWR PH A
STA 6 PWR PH C
STA 6 PWR PH B
STA 6 PWR PH A
STA 8A AIM-9 PWR AC
STA 8B PWR PH C
STA 8B PWR PH B
STA 8B PWR PH A

DC ESSENTIAL NO. 1 BUS — 28 V DC

ICS PILOT
ICS NFO
MLG SAFETY RLY NO. 2
MLG SAFETY RLY NO. 1
VHF/UHF CONTR
APX-100 DC
EMER JETT #2
EMER JETT #1
SMP ESS
FUEL QTY IND DC
WING POS IND DC
BARO ALT/TURN SLIP
ENG INST NO. 2
ENG INST NO. 1
WHEELS POS IND
ARC-182 NO. 2
ARC-182 NO. 1
KY-58/Z-AHP
R FIRE DET LT
L FIRE DET LT
HYD PRESS IND
DC ESS NO. 1 FDR
ALT LOW WARN
OBOGS/BACKUP CONTR
B/U OXY PRESS IND
ANGLE OF ATTACK IND DC
L DC TEST/RUDDER TRIM
EMER FLT HYD MAN
EMER FLT HYD AUTO

R AICS RAMP STOW
L AICS RAMP STOW
R FIRE EXT
L FIRE EXT

DC ESSENTIAL NO. 2 BUS 28 V DC

ENG ANTI-ICE VALVES
FUEL MGT PNL
FUEL FEED/DUMP
ENG START
ALPHA COMP/PEDAL SHAKER
FUEL P/MOTIVE FLOW ISOL V
SPD BK P-ROLL TRIM ENABLE
NOSE WHEEL STEER/AFCS
AIR SOURCE CONTROL
MACH TRIM DC
FLAP/SLAT CONTR SHUT-OFF
FLT CONTR AUTH DC
ENG/PROBE/ANTI-ICE

GND ROLL BRAKING/SPOILER POS IND
AUX FLAP/FLAP CONTR
MLG HANDLE RLY NO. 2
MLG HANDLE RLY NO. 1
FUEL PRESS ADVSY
BLEED AIR/L OIL HOT
TR ADVSY/PLT ANN PNL AUX PWR
R GEN CAUTION
L GEN CAUTION
BINGO CAUTION
FUEL LOW CAUTION
ANTI SKID/R AICS LKUP PWR
EMER GEN TEST/L AICS LKUP PWR
HYD VALVE CONTR
APN-154
JTIDS DPG/BDHI
ENG OIL COOL
R. OIL HOT
ENG SEC
ECS TEMP CONTR DC
ADF DC
ANN PNL PWR
WSHLD/AIR/ANTI ICE CONTR HOOK CONT
WSHLD DEFOG CONTR
CAN/LAD CAUTION/EJECT CMD IND
AFCS BUS FDR
ROLL CMPTR DC
PITCH CMPTR DC
YAW SAS M
YAW SAS B
YAW SAS A
CABIN PRESS
DC ESS NO. 2 FDR
NLG STRUT LCH BAR ADVSY

R ENG AFT CONT/EXHAUST NOZZLE
L ENG AFT CONT/ARMT GAS/RATS IND
ILS ARA-63 DC
FUEL TRANS ORIDE
INBD SPOILER CONTR
EXT LT CONTR
FUEL VENT VALVE
HYD PUMP SPOILER CONTR
STARTER VALVE LT
MSI PWR HUD TEST
ENG STALL TONE
SNSR/CURSOR CONT

DC MAIN BUS — 28 V DC

INTRPT FREE DC BUS FDR NO. 1
EMER GEN CONTR
SAHRS DC
INTRF BLANKER
DEKI
ELECT COOLING
MASTER TEST
JTIDS DP/DSS
ASW-27
ASPJ DC
IFF A/A DC
ALR-67 CONTR
GND PWR/COOLING INTLK
RECON ECS CONT DC
RECON POD CONTR
RECON POD DC PWR NO. 2
RECON POD DC PWR NO. 1
INTEG TRIM DC
BRAKE ACCUM SOV
MFA
R DC TEST/AMC BIT
FEMS
MONITOR BUS CONTR
IRST DC
GND TEST
ANN PNL DIM CONTR
OUTBD SPOILER CONTR
INTRPT FREE DC BUS FDR NO. 2
RDP
RDP/DD ENABLE
LIQUID COOLING CONTR DC
ALE-39 SEQ 1 & 2 SQUIBS
ALE-39 CHAFF/FLARE DISP
AUTO THROT DC
APG-71 ANT
APG-71 XMTR
ASC
TCS SEL
DYHR UNIT
ANT LOCK EXCIT
RSP

MASTER ARM
MPRU DC PWR
STA 8 TYPE II DCDR/REL PWR
STA 8 TYPE I DCDR/REL PWR
STA 6 DCDR/REL PWR
STA 5 DCDR/REL PWR
STA 4 DCDR/REL PWR
STA 3 DCDR/REL PWR
STA 1 TYPE II DCDR/REL PWR
STA 1 TYPE I DCDR/REL PWR
GUN PWR NO. 2
GUN PWR NO. 1
STA 8B NO. 1/2 DC
STA 6 NO. 1/2 DC
STA 5 NO. 1/2 DC
STA 4 NO. 1/2 DC
STA 3 NO. 1/2 DC
STA 1B NO. 1/2 DC
STA 8A AIM-9 PWR DC
STA 1A AIM-9 PWR DC
STA 8 AIM-9 COOL
STA 1 AIM-9 COOL
STA 8 IFOL
STA 4/5 IFOL
STA 3/6 IFOL
STA 1 IFOL

N2/97
1-F50D-464-0

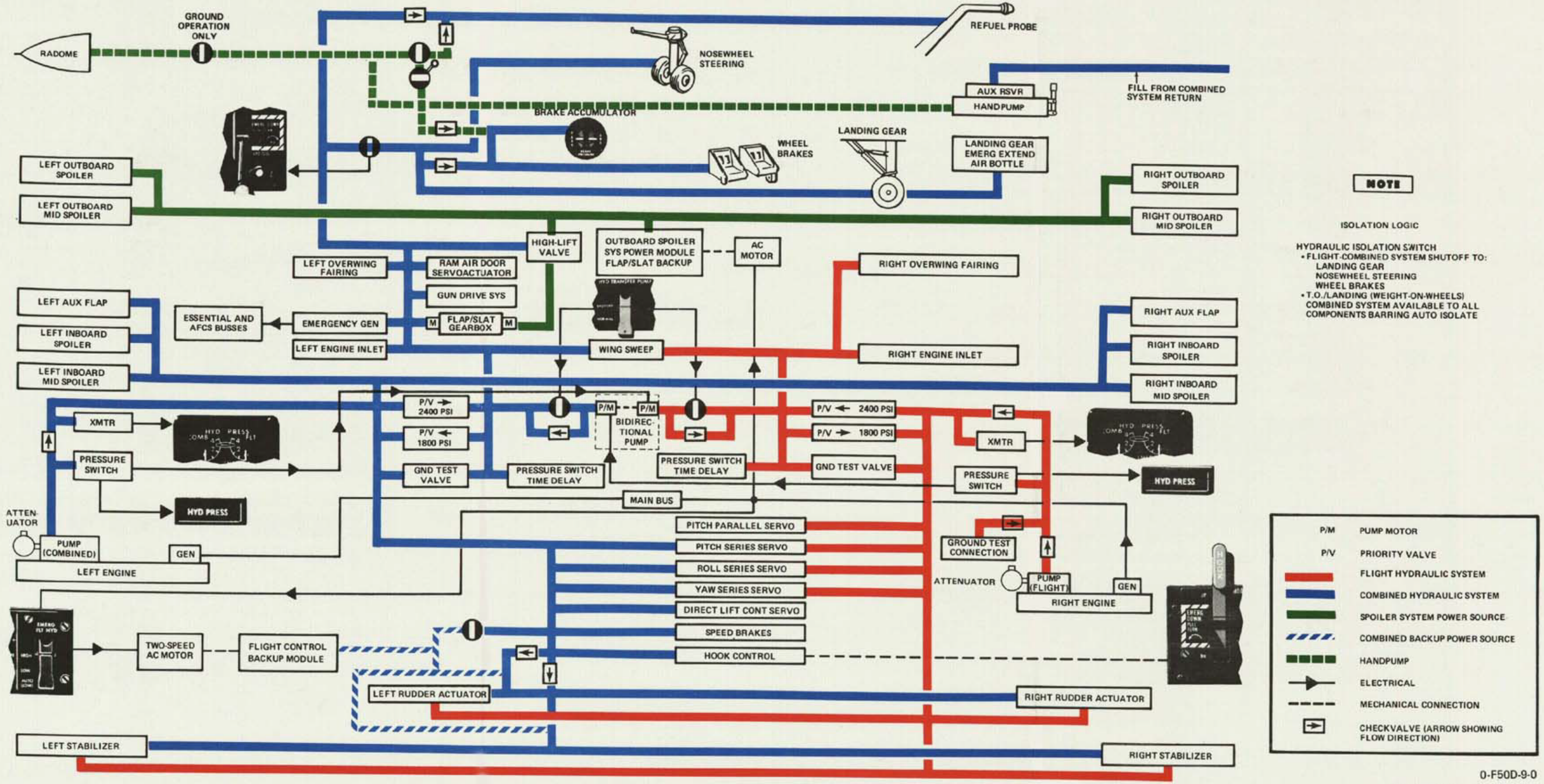
Electrical Power System

N2/97
1-F50D-465-0

Ac Cockpit Circuit Breaker Panels

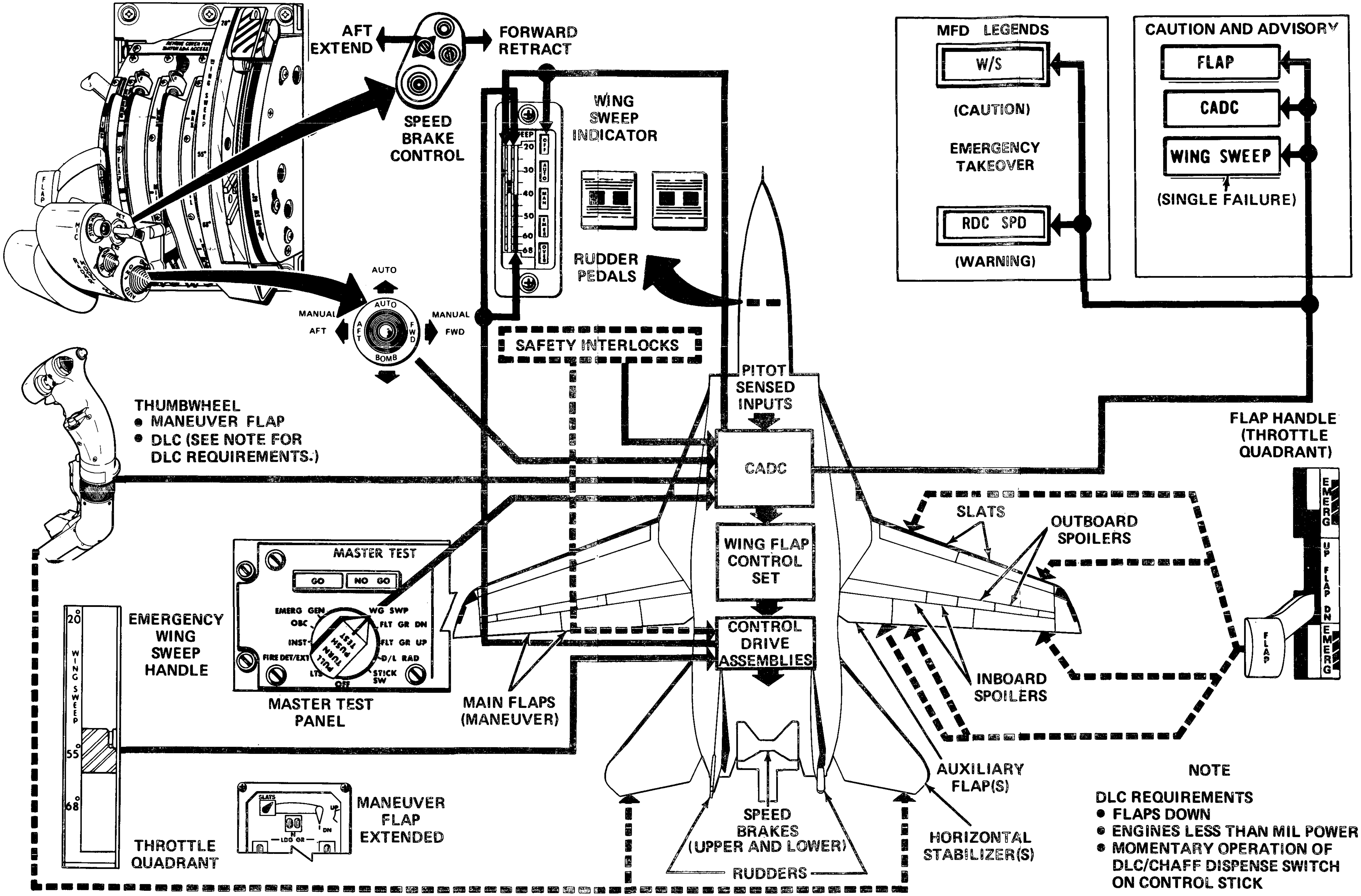
1-F50D-466-0

Dc Cockpit Circuit Breaker Panels



0-F50D-9-0

Hydraulic System

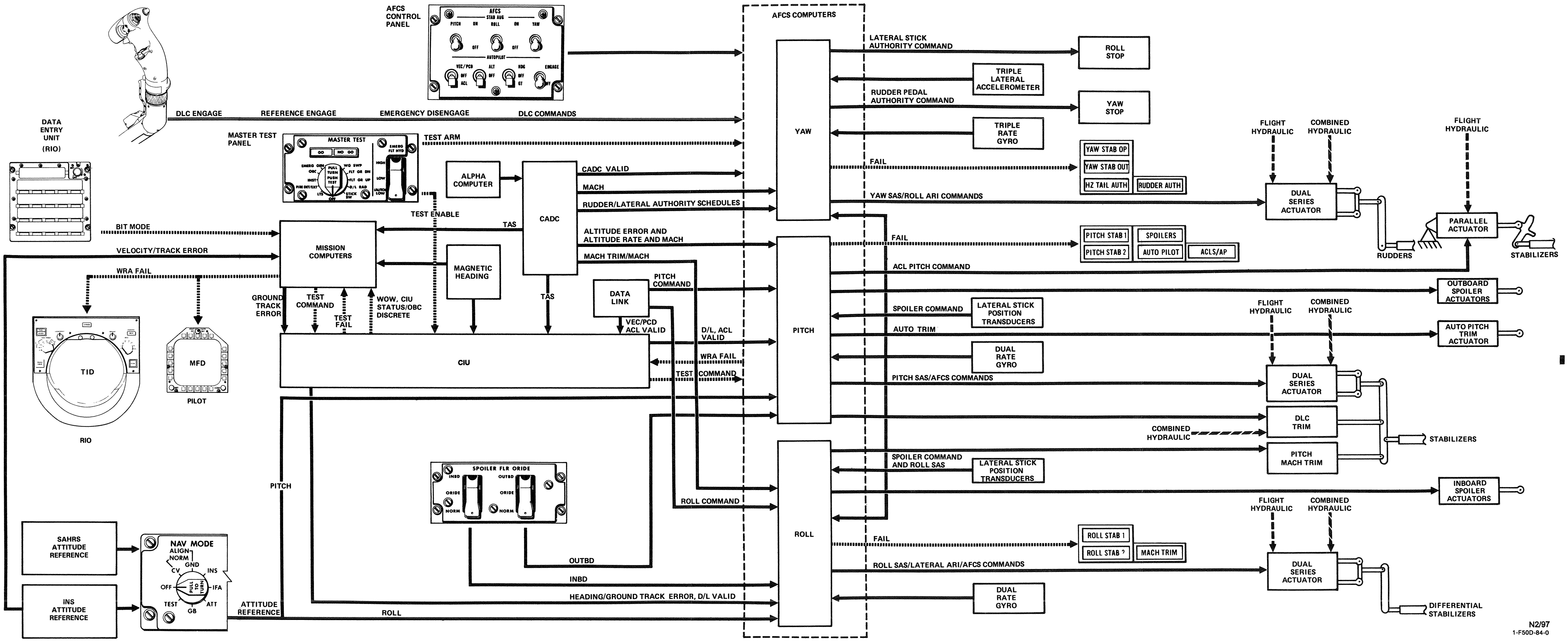


NOTE

DLC REQUIREMENTS
- FLAPS DOWN
- ENGINES LESS THAN MIL POWER
- MOMENTARY OPERATION OF DLC/CHAFF DISPENSE SWITCH ON CONTROL STICK

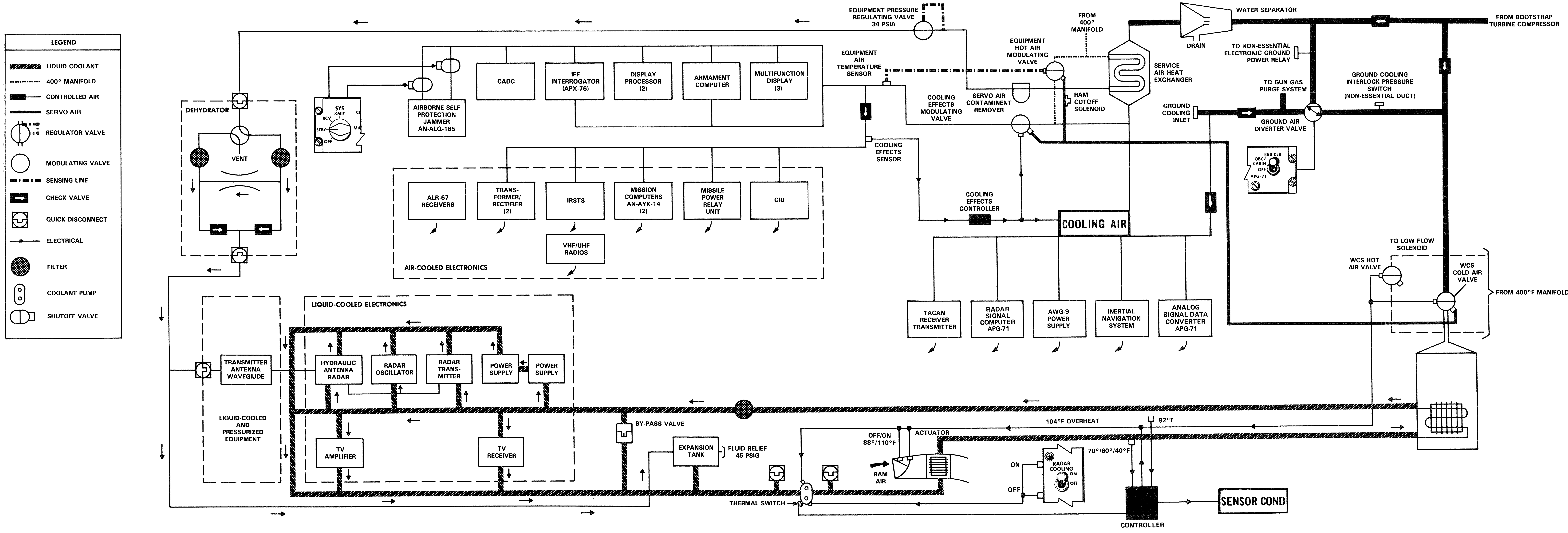
0-F50D-467-0

Wing Sweep and Control Surfaces



Automatic Flight Control System

Environmental Control System



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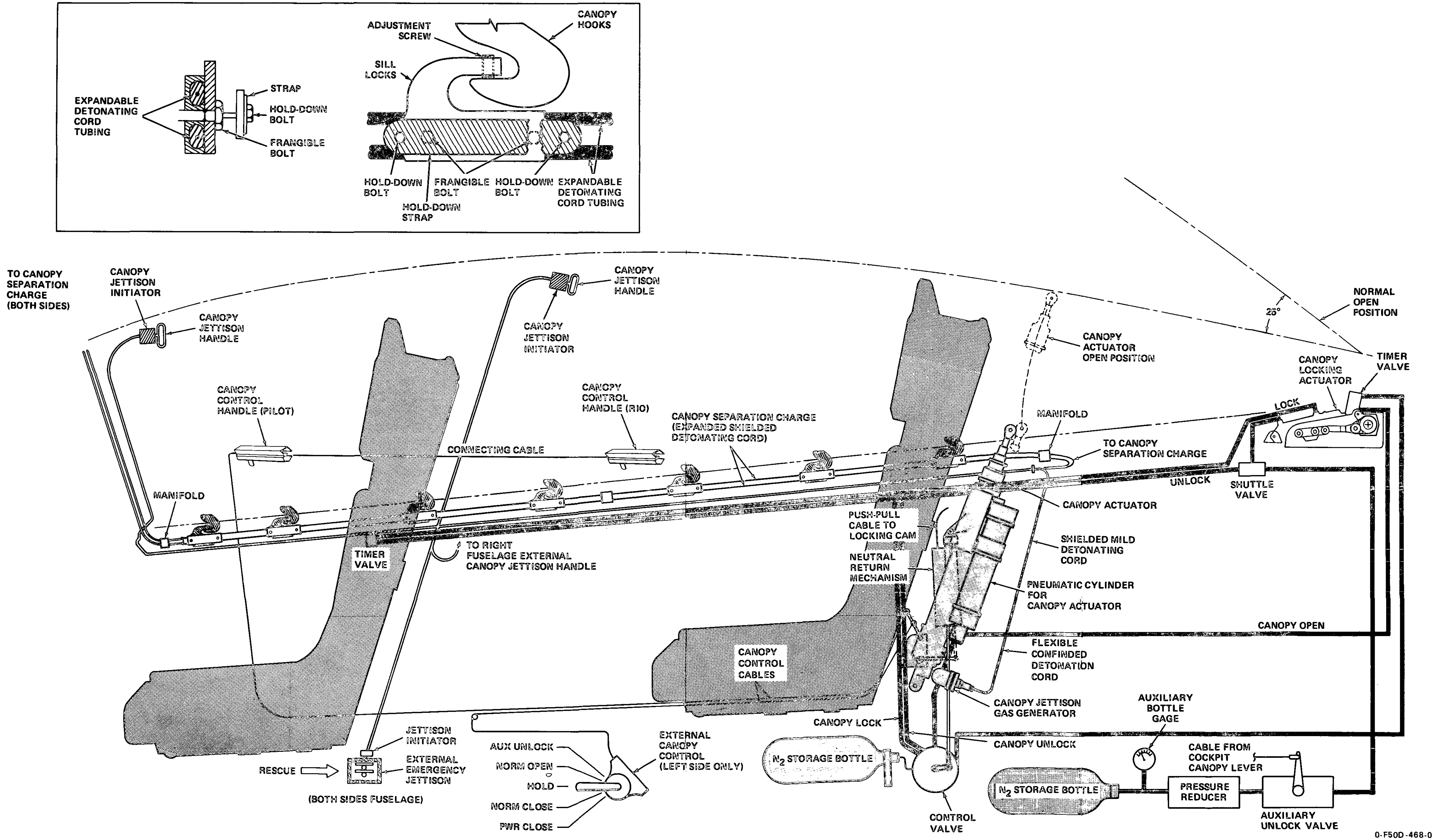
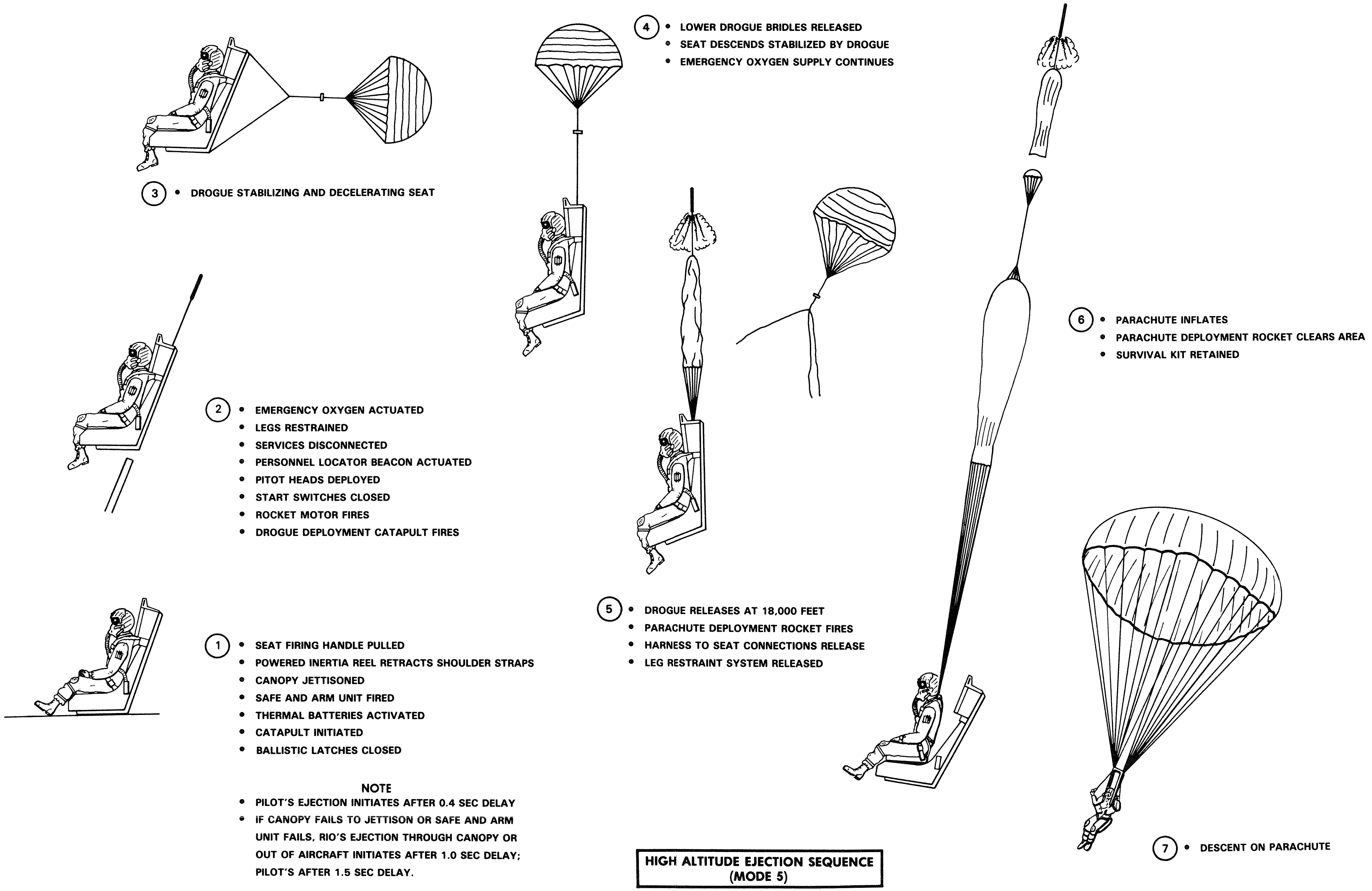
Avionic Equipment Cooling



Canopy Pneumatic and Pyrotechnic Systems



	ALTITUDE FT	0–8K			8K–18K	18K+
	KEAS	0-350	350-500	500-600	ALL	ALL
	MODE	1	2	3	4	5
HOT GAS FROM EJECTION INITIATOR FIRES SEAT CATAPULT		0.00	0.00	0.00	0.00	0.00
AFTER 35 INCHES OF SEAT TRAVEL, START SWITCHES ACTIVATED.		0.18	0.18	0.18	0.18	0.18
SEQUENCER FIRES DUAL PULSE TO FIRE DROGUE CATAPULT		0.22	0.22	0.22	0.22	0.22
SEQUENCER SUPPLIES DUAL PULSE TO FIRE LOWER DROGUE BRIDLE RELEASE		0.32	1.25	1.45	3.05	2.80
SEQUENCER SUPPLIES DUAL PULSE TO FIRE UPPER DROGUE BRIDLE RELEASE		0.33	1.26	1.46	3.06	4.80 +t SEE NOTE 3
SEQUENCER SUPPLIES DUAL PULSE TO FIRE PARACHUTE DEPLOYMENT ROCKET		0.45	1.10	1.30	2.90	4.87 +t
SEQUENCER SUPPLIES DUAL PULSE TO FIRE MAIN LOCKS RELEASE		0.65	1.30	1.50	3.10	5.07 +t
SEQUENCER SUPPLIES DUAL PULSE TO FIRE BACK-UP SEAT LOCK RELEASE (BAROSTAT CARTRIDGE)		0.66	1.31	1.51	3.11	5.08 +t

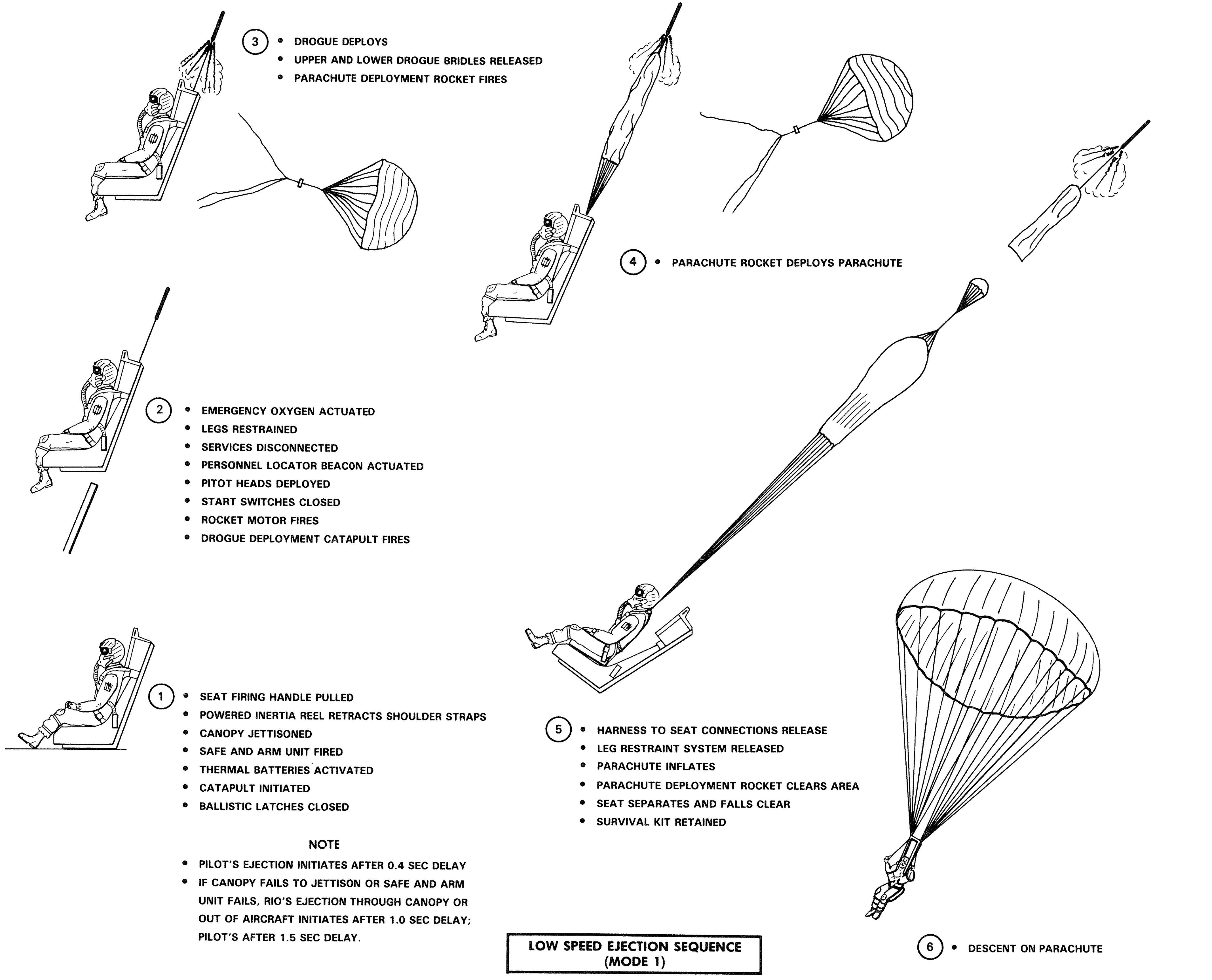
NOTES

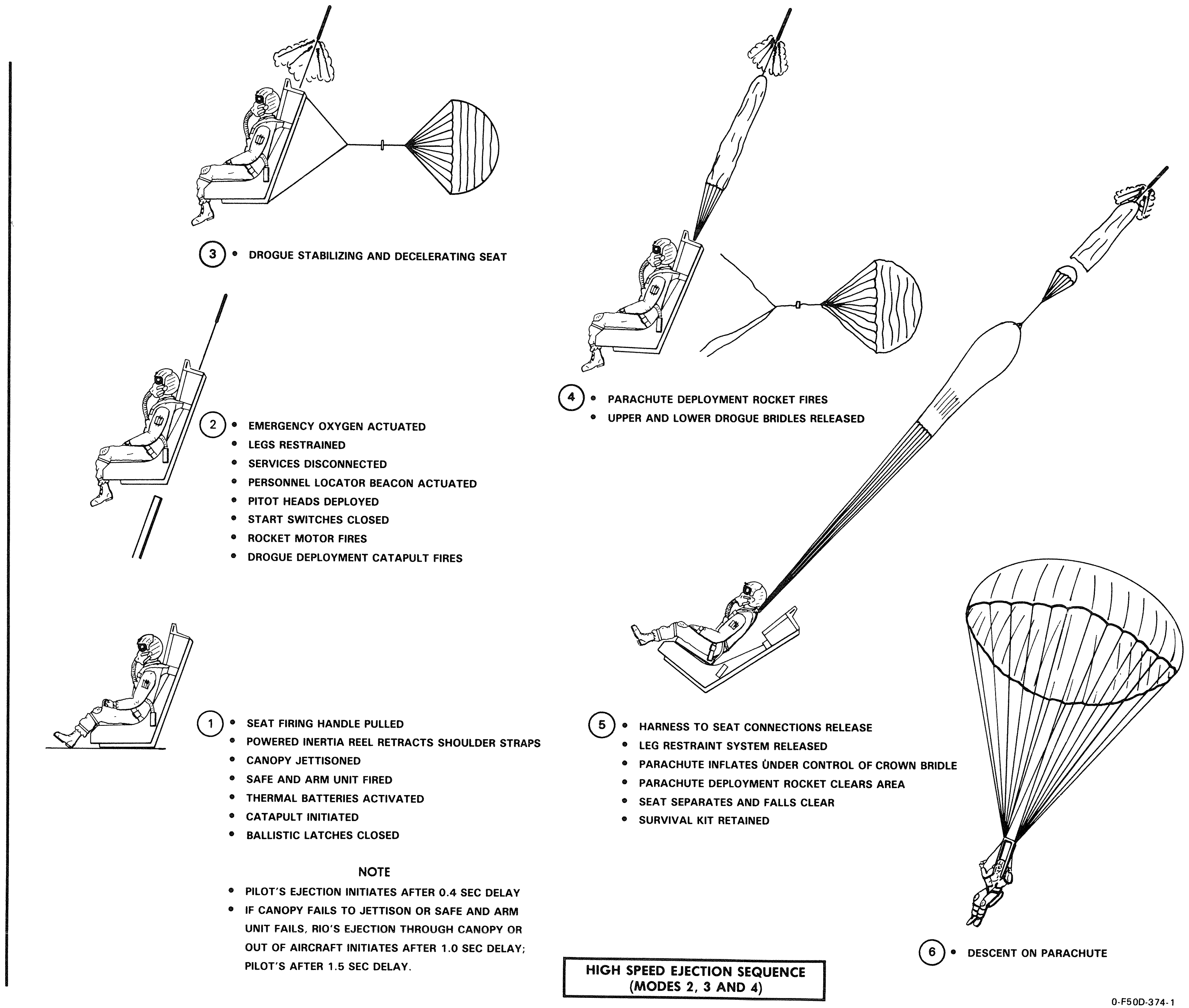
1. ALL TIMES ARE REFERENCED TO EJECTION-CATAPULT INITIATION. (TO OBTAIN TIMES REFERENCED TO SEQUENCER START SWITCH, SUBTRACT 0.18 SECONDS).
2. ENVIRONMENTAL SENSING FOR MORE SELECTION IS TO TAKE PLACE DURING THE TIME WINDOW 0.25 TO 0.30 SECONDS.
3. IN MODE 5 OPERATION, ALTITUDE SENSING IS TO RECOMMENCE AT 4.80 SECONDS CONTINUING UNTIL THE FALL-THROUGH CONDITION (BELOW 18K FT) IS DETECTED

t = TIME INTERVAL BETWEEN 4.80 SECONDS AND FALL-THROUGH CONDITION.

0-F50D-374-2L

Ejection Sequence (Sheet 1 of 2)





0-F50D-374-1

Ejection Sequence (Sheet 2 of 2)

LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers
Original	1 (Reverse Blank)
Original	3 (Reverse Blank)
Original	5 (Reverse Blank)
Original	7 (Reverse Blank)
Original	9 (Reverse Blank)
Original	11 thru 31 (Reverse Blank)
Original	33 thru 49 (Reverse Blank)
Original	51 thru 55 (Reverse Blank)
Original	1-1 thru 1-5 (Reverse Blank)
Original	2-1 thru 2-269 (Reverse Blank)
Original	3-1 thru 3-19 (Reverse Blank)
Original	4-1 thru 4-21 (Reverse Blank)
Original	57 (Reverse Blank)
Original	5-1 thru 5-5 (Reverse Blank)
Original	59 (Reverse Blank)
Original	6-1 thru 6-4
Original	7-1 thru 7-38
Original	8-1 thru 8-12
Original	9-1 thru 9-7 (Reverse Blank)
Original	10-1 thru 10-28
Original	61 (Reverse Blank)
Original	11-1 thru 11-34
Original	63 thru 84
Original	12-1 thru 12-5 (Reverse Blank)
Original	13-1 thru 13-3 (Reverse Blank)
Original	14-1 thru 14-46
Original	15-1 thru 15-21 (Reverse Blank)
Original	16-1 thru 16-9 (Reverse Blank)
Original	85 (Reverse Blank)
Original	17-1 thru 17-14
Original	18-1 thru 18-6
Original	87 (Reverse Blank)

Effective Pages	Page Numbers
Original	19-1 thru 19-31 (Reverse Blank)
Original	20-1 thru 20-68
Original	21-1 thru 21-8
Original	89 (Reverse Blank)
Original	22-1 thru 22-28
Original	23-1 thru 23-5 (Reverse Blank)
Original	24-1 (Reverse Blank)
Original	91 (Reverse Blank)
Original	37-1 thru 37-4
Original	38-1 thru 38-64
Original	93 (Reverse Blank)
Original	39-1 thru 39-18
Original	95 (Reverse Blank)
Original	Index-1 thru Index-10
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Original	FO-2 (Reverse Blank)
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Original	LEP-1 (Reverse Blank)