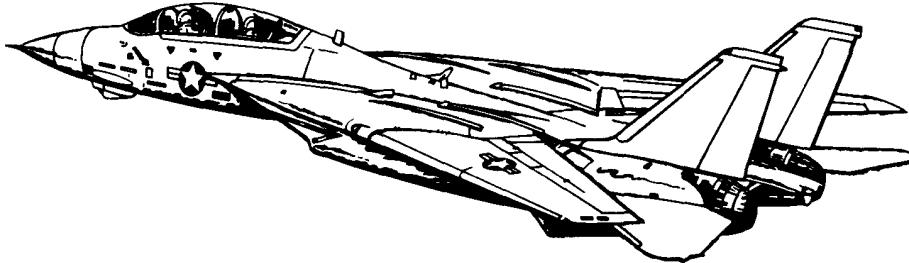




**NATOPS FLIGHT MANUAL
NAVY MODEL
F-14D
AIRCRAFT**

THIS PUBLICATION IS INCOMPLETE WITHOUT
NAVAIR 01-F14AAP-1.1 AND NAVAIR 01-F14AAD-1A

TACTICAL SOFTWARE EFFECTIVITY: OFP D04



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AND UNDER THE DIRECTION OF THE
COMMANDER, NAVAL AIR SYSTEMS COMMAND**

THE AIRCRAFT	1
INDOCTRINATION	2
NORMAL PROCEDURES	3
FLIGHT CHARACTERISTICS	4
EMERGENCY PROCEDURES	5
ALL-WEATHER OPERATIONS	6
COMM PROCEDURES	7
WEAPON SYSTEMS	8
FLIGHTCREW COORDINATION	9
NATOPS EVALUATION	10
PERFORMANCE DATA	11
INDEX & FOLDOUTS	



DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
WASHINGTON, D.C. 20350-2000

15 April 2002

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 F-14D operations and training should be made and carried for use in naval aircraft.

A handwritten signature in black ink, appearing to read "M.J. McCABE", with a long horizontal line extending to the right.

M.J. McCABE
Director, Air Warfare

NOTICE

NOTICE

NAVAIR 01-F14AAD-1

16 JANUARY 2004

NAVAIR 01-F14AAD-1, Change 2, dated 15 January 2004, has a print error on page 65 (incorrect configuration). Remove and discard previously provided page 65/66 and replace with attached pages.

Place this page behind title page after incorporation.

NOTICE

NOTICE

INTERIM CHANGE SUMMARY

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 through 26	Previously incorporated

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
27	Modifies the L and/or R Fuel Press Light(s) and Warning Tone Emergency Procedure, and Adds Fuel Imbalance / Fuel Quantity Balancing Emergency Procedure.

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

PTTUZYUW RULSABU1234 2032006-UUUU--RHMCSUU.
ZNR UUUUU
P 212006Z JUL 04 ZYB
FM COMNAVAIRSYS COM PATUXENT RIVER MD//4.0P//
TO ALL TOMCAT AIRCRAFT ACTIVITIES
AL ALL TOMCAT AIRCRAFT ACTIVITIES
INFO COMNAVAIRSYS COM PATUXENT RIVER MD//5.0F/4.1//
COMNAVSAFECEN NORFOLK VA//11//
COMNAVAILANT NORFOLK VA//N421B//
COMNAVAIRPAC SAN DIEGO CA//N421B1//
COMFITWINGLANT OCEANA VA//N4//
NAVAIRDEPOT JACKSONVILLE FL//3.3.3//
NAVSURVTRAINST PENSACOLA FL//02/025//
BT
UNCLAS //N03711//
MSGID/GENADMIN/COMNAVAIRSYS COM/4.0P//
SUBJ/F-14ABD AIRCRAFT NATOPS PUBLICATIONS INTERIM CHANGE -
/SAFETY OF FLIGHT//
REF/A/EML/COMNAVAIRFOR/20JUL2004//
REF/B/MSG/FITRON ON ZERO ONE/021438ZJUN2004//
REF/C/DOC/COMNAVAIRSYS COM/15JAN2004//
REF/D/DOC/COMNAVAIRSYS COM/15JAN2004//
REF/E/DOC/COMNAVAIRSYS COM/15JAN2004//
REF/F/DOC/COMNAVAIRSYS COM/15JAN2004//
REF/G/DOC/COMNAVAIRSYS COM/15JAN2004//
REF/H/DOC/COMNAVAIRSYS COM/15JAN2004//
NARR/REF A IS NATOPS REQUEST FOR RELEASE.
REF B IS NATOPS URGENT CHANGE RECOMMENDATION.
REF C IS F-14D POCKET CHECKLIST (PCL) 01-F14AAD-1B, DTD 15 APR 02
WITH CHANGE 2 DTD 15 JAN 04.
REF D IS F-14D FLIGHT MANUAL (NFM) 01-F14AAD-1, DTD 15 APR 02 WITH
CHANGE 2 DTD 15 JAN 04.
REF E IS F-14B POCKET CHECKLIST (PCL) 01-F14AAP-1B, DTD 01 AUG 01
WITH CHANGE 3 DTD 15 JAN 04.
REF F IS F-14B FLIGHT MANUAL (NFM) 01-F14AAP-1, DTD 01 AUG 01 WITH
CHANGE 3 DTD 15 JAN 04.
REF G IS F-14A POCKET CHECKLIST (PCL) 01-F14AAA-1B, DTD 15 MAY 03
WITH CHANGE 1 DTD 15 JAN 04.
REF H IS F-14A FLIGHT MANUAL (NFM) 01-F14AAA-1, DTD 15 MAY 03 WITH
CHANGE 1 DTD 15 JAN 04.//
RMKS/1. IRT REFS A AND B, THIS MESSAGE ISSUES INTERIM CHANGE (IC)
NUMBER 18 TO REF C, INTERIM CHANGE (IC) NUMBER 29 TO REF D, INTERIM
CHANGE (IC) NUMBER 33 TO REF E, INTERIM CHANGE (IC) NUMBER 49 TO REF
F, INTERIM CHANGE (IC) NUMBER 107 TO REF G AND INTERIM CHANGE (IC)
NUMBER 151 TO REF H.
2. SUMMARY. THE FOLLOWING CHANGES MAKE MINOR CORRECTIONS TO REFS C
THROUGH H FOR THE L AND/OR R FUEL PRESS LIGHT(S) AND WARNING
TONE EMERGENCY PROCEDURE. THE CORRECTIONS FOLLOW A SIMPLE AND
LOGICAL PROGRESSION THROUGH EACH PCL AND NFM AS INDICATED.
3. CHANGE REF C (F-14D PCL) AS FOLLOWS:
A. PAGE 114, TITLE:
(1) DELETE: WARNING TONE.
(2) ADD: 10 SEC WARNING TONE.

- B. PAGE 114, LINE 3 (AFTER STEP 2):
 - (1) DELETE: AND WARNING TONE
 - (2) ADD: NA
- C. PAGE 114, LINE 20 (AFTER WARNING PARAGRAPHS):
 - (1) DELETE: AND THE WARNING TONE
 - (2) ADD: NA
- D. PAGE 114A, NOTE SECTION, SECOND NOTE PARAGRAPH, LINE 1:
 - (1) DELETE: AND
 - (2) ADD: AND/OR
- 4. CHANGE REF D (F-14D NFM) AS FOLLOWS:
 - A. CHAPTER 14, PAGE 14-18, PARAGRAPH 14.6.1.1, TITLE:
 - (1) DELETE: WARNING TONE
 - (2) ADD: 10 SEC WARNING TONE.
 - B. CHAPTER 14, PAGE 14-18, PARAGRAPH 14.6.1.1, LINE 3:
 - (1) DELETE: AND WARNING TONE
 - (2) ADD: NA
 - C. CHAPTER 14, PAGE 14-18, PARAGRAPH 14.6.1.1, SECOND COLUMN, LINE 13:
 - (1) DELETE: AND THE WARNING TONE
 - (2) ADD: NA
 - D. CHAPTER 14, PAGE 14-18, SECOND COLUMN, SECOND NOTE PARAGRAPH, LINE 1:
 - (1) DELETE: AND
 - (2) ADD: AND/OR
- 5. CHANGE REF E (F-14B PCL) AS FOLLOWS:
 - A. PAGE 123, TITLE:
 - (1) DELETE: WARNING TONE.
 - (2) ADD: 10 SEC WARNING TONE.
 - B. PAGE 123, LINE 3 (AFTER STEP 2):
 - (1) DELETE: AND WARNING TONE
 - (2) ADD: NA
 - C. PAGE 124, LINE 1:
 - (1) DELETE: AND THE WARNING TONE
 - (2) ADD: NA
 - D. PAGE 124A, NOTE PARAGRAPH, LINE 1:
 - (1) DELETE: AND
 - (2) ADD: AND/OR
- 6. CHANGE REF F (F-14B NFM) AS FOLLOWS:
 - A. CHAPTER 14, PAGE 14-19, PARAGRAPH 14.6.1.1, TITLE:
 - (1) DELETE: WARNING TONE
 - (2) ADD: 10 SEC WARNING TONE.
 - B. CHAPTER 14, PAGE 14-19, PARAGRAPH 14.6.1.1, LINE 3:
 - (1) DELETE: AND WARNING TONE
 - (2) ADD: NA
 - C. CHAPTER 14, PAGE 14-19, PARAGRAPH 14.6.1.1, LINE 20:
 - (1) DELETE: AND THE WARNING TONE
 - (2) ADD: NA
 - D. CHAPTER 14, PAGE 14-19, PARAGRAPH 14.6.1.1, SECOND COLUMN, SECOND NOTE PARAGRAPH, LINE 1:
 - (1) DELETE: AND
 - (2) ADD: AND/OR
- 7. CHANGE REF G (F-14A PCL) AS FOLLOWS:
 - A. PAGE 94, TITLE:

(1) DELETE: WARNING TONE.
(2) ADD: 10 SEC WARNING TONE.

B. PAGE 94, LINE 3 (AFTER STEP 2):
(1) DELETE: AND WARNING TONE
(2) ADD: NA

C. PAGE 94, LINE 20 (AFTER WARNING PARAGRAPHS):
(1) DELETE: AND THE WARNING TONE
(2) ADD: NA

D. PAGE 94A, NOTE SECTION, SECOND NOTE PARAGRAPH, LINE 1:
(1) DELETE: AND
(2) ADD: AND/OR

8. CHANGE REF H (F-14A NFM) AS FOLLOWS:

A. CHAPTER 14, PAGE 14-15, PARAGRAPH 14.6.1.1, TITLE:
(1) DELETE: WARNING TONE
(2) ADD: 10 SEC WARNING TONE.

B. CHAPTER 14, PAGE 14-15, PARAGRAPH 14.6.1.1, LINE 3:
(1) DELETE: AND WARNING TONE
(2) ADD: NA

C. CHAPTER 14, PAGE 14-15, PARAGRAPH 14.6.1.1, SECOND COLUMN,
LINE 1:
(1) DELETE: AND THE WARNING TONE
(2) ADD: NA

D. CHAPTER 14, PAGE 14-15, PARAGRAPH 14.6.1.1, SECOND COLUMN,
SECOND NOTE PARAGRAPH, LINE 1:
(1) DELETE: AND
(2) ADD: AND/OR

9. POINTS OF CONTACT:

A. F-14ABD NATOPS PROGRAM MANAGER, LT KYLE MILLER, TEL DSN 433-5147,
OR COMM (757)433-5147, EMAIL: MILLERKA(AT)VF101.NAVY.MIL

B. NAVAIR POCS:

1. LT MIKE DOXEY, F-14ABD CLASS DESK, TEL DSN 757-7021, OR COMM
(301)757-7021, EMAIL: MICHAEL.DOXEY(AT)NAVY.MIL

2. LCDR JR NASH, 4.0P NATOPS OFFICER, TEL DSN 995-2052, OR
COMM (301)995-2052, EMAIL: JAMES.NASH(AT)NAVY.MIL

3. KRISTIN SWIFT, 4.0P NATOPS CHIEF ENGINEER, TEL DSN 995-4193,
OR COMM (301)995-4193, EMAIL: KRISTIN.SWIFT(AT)NAVY.MIL

10. THIS MESSAGE WILL BE POSTED ON THE NATEC WEBSITE,
WWW.NATEC.NAVY.MIL WITHIN 15 DAYS OF RELEASE. NEW NATOPS IC MESSAGES
MAY BE FOUND IN TWO PLACES ON THIS WEBSITE:

(1) IN THE NATOPS IC DATABASE FOUND UNDER THE TMAPS OPTION, AND
(2) IN THE AFFECTED PUBLICATION(S) JUST AFTER THE IC SUMMARY PAGE
IF THE IC MESSAGE INCLUDES REPLACEMENT PAGES, THEY WILL BE
ADDITIONALLY PLACED WITHIN THE MANUAL AND REPLACED PAGES DELETED.
MESSAGES ARE NORMALLY POSTED IN THE DATABASE BEFORE APPEARING IN THE
PUBLICATION. THIS MESSAGE WILL ALSO BE POSTED ON THE NATOPS WEBSITE,
NATOPS.NAVAIR.NAVY.MIL. IF UNABLE TO VIEW THIS MESSAGE ON EITHER
THE NATEC OR NATOPS WEBSITES, INFORM THE NATOPS GLOBAL CUSTOMER
SUPPORT TEAM AT (301) 342-3276, DSN 342-3276, OR BY EMAIL AT
NATOPS(AT)NAVY.MIL.//

BT
#1234
NNNN



PTTUZYUW RULSABU1234 2032005-UUUU--RHMCSUU.
ZNR UUUUU
P 212005Z JUL 04
FM COMNAVAIRSYS COM PATUXENT RIVER MD//4.0P//
TO ALL TOMCAT AIRCRAFT ACTIVITIES
AL ALL TOMCAT AIRCRAFT ACTIVITIES
INFO COMNAVAIRSYS COM PATUXENT RIVER MD//5.0F/4.1//
COMNAVSAFECEN NORFOLK VA//11//
COMNAVAIRPAC SAN DIEGO CA//N421B1//
COMNAVAIRLANT NORFOLK VA//N421B//
COMFITWINGLANT OCEANA VA//N4//
NAVAIRDEPOT JACKSONVILLE FL//3.3.3//
NAVSURVTRAINST PENSACOLA FL//02/025//
FITRON ONE ZERO ONE
BT
UNCLAS //N03711//
MSGID/GENADMIN/COMNAVAIRSYS COM/4.0P//
SUBJ/F-14ABD AIRCRAFT NATOPS PUBLICATIONS INTERIM CHANGE -
/SAFETY OF FLIGHT//
REF/A/EML/COMNAVAIRFOR/20JUL2004//
REF/B/MSG/FITRON ONE ZERO ONE/011815ZJUL2004//
REF/C/DOC/COMNAVAIRSYS COM/15JAN2004//
REF/D/DOC/COMNAVAIRSYS COM/15JAN2004//
REF/E/DOC/COMNAVAIRSYS COM/15JAN2004//
REF/F/DOC/COMNAVAIRSYS COM/15JAN2004//
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NARR/REF A IS NATOPS REQUEST FOR RELEASE.
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REF C IS F-14D POCKET CHECKLIST (PCL) 01-F14AAD-1B, DTD 15 APR 02
WITH CHANGE 2 DTD 15 JAN 04.
REF D IS F-14D FLIGHT MANUAL (NFM) 01-F14AAD-1, DTD 15 APR 02 WITH
CHANGE 2 DTD 15 JAN 04.
REF E IS F-14B POCKET CHECKLIST (PCL) 01-F14AAP-1B, DTD 01 AUG 01
WITH CHANGE 3 DTD 15 JAN 04.
REF F IS F-14B FLIGHT MANUAL (NFM) 01-F14AAP-1, DTD 01 AUG 01 WITH
CHANGE 3 DTD 15 JAN 04.
REF G IS F-14A POCKET CHECKLIST (PCL) 01-F14AAA-1B, DTD 15 MAY 03
WITH CHANGE 1 DTD 15 JAN 04.
REF H IS F-14A FLIGHT MANUAL (NFM) 01-F14AAA-1, DTD 15 MAY 03 WITH
CHANGE 1 DTD 15 JAN 04.//
RMKS/1. IRT REFS A AND B, THIS MESSAGE ISSUES INTERIM CHANGE (IC)
NUMBER 17 TO REF C, INTERIM CHANGE (IC) NUMBER 28 TO REF D, INTERIM
CHANGE (IC) NUMBER 32 TO REF E, INTERIM CHANGE (IC) NUMBER 48 TO REF
F, INTERIM CHANGE (IC) NUMBER 106 TO REF G AND INTERIM CHANGE (IC)
NUMBER 150 TO REF H.
2. SUMMARY. THE FOLLOWING CHANGES MAKE CORRECTIONS TO
REFS C THROUGH H FOR THE FUEL IMBALANCE/FUEL QUANTITY BALANCING
EMERGENCY PROCEDURE. THE CORRECTIONS FOLLOW A SIMPLE AND LOGICAL
PROGRESSION THROUGH EACH PCL AND NFM AS INDICATED. CHANGES MAY
REQUIRE THE INSERTION OF A NEW PAGE IN SOME PCLS. REPLACEMENT
PAGES CONTAINING THIS INTERIM CHANGE FOR DOWNLOADING AND
INSERTION INTO REFS C THRU H WILL BE ATTACHED TO THIS INTERIM

CHANGE MSG WHEN IT IS POSTED ON THE NATEC AND NATOPS WEBSITES (SEE LAST PARA BELOW).

3. CHANGE REF C (F-14D PCL), FUEL CHAPTER, PAGE 118, AS FOLLOWS:

A. (1) DELETE: STATEMENTS UNDER FIRST WARNING: "DURING AB OPERATIONS, NORM SHALL BE SELECTED. FWD OR AFT COULD DEplete THE SUMP TANKS."

(2) ADD (REPLACE WITH): "AB OPERATION IS NOT RECOMMENDED WITH A FUEL IMBALANCE OR WITH INDICATIONS OF VENTING FUEL."

B. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH BEFORE THE EXISTING NOTE PARAGRAPH AT THE BEGINNING OF THE PROCEDURE TO READ: "FUEL QUANTITY BALANCING IS NOT REQUIRED PRIOR TO COMPLETION OF WING/EXTERNAL TANK TRANSFER OR UNTIL ONE FUSELAGE TAPE DROPS BELOW 4,500 POUNDS."

C. (1) DELETE: NA

(2) ADD: STATEMENT IN CAPITAL ITALICS, PRIOR TO STEP 1, TO READ: "WITH A FUEL STATE BELOW 4500 POUNDS IN A SINGLE FEED GROUP AND A FUEL SPLIT GREATER THAN 1500 POUNDS BETWEEN THE AFT/LEFT AND FWD/RIGHT FEED GROUPS:"

D. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH IMMEDIATELY AFTER STEP 2 TO READ: "IF PRACTICAL, OBTAIN A VISUAL INSPECTION FOR VENTING FUEL. DO NOT DELAY EXECUTION OF EMERGENCY PROCEDURES FOR VISUAL INSPECTION."

E. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH AFTER PRECEDING (INSERTED) NOTE PARAGRAPH, BUT PRIOR TO THE EXISTING WARNING PARAGRAPH TO READ: "INDICATION OF FUEL BALANCING SHOULD APPEAR WITHIN 3 MINUTES OF SELECTING THE HIGH FUSELAGE TAPE SIDE."

F. (1) DELETE: ENTIRE WARNING THAT BEGINS WITH "AIRCRAFT ATTITUDE WILL HAVE A SIGNIFICANT INFLUENCE..."

(2) ADD: NA

G. (1) DELETE: NA

(2) ADD (MOVE): FIRST NOTE PARAGRAPH OF EXISTING PROCEDURE THAT BEGINS, "WITH A HIGH QUANTITY...", TO A POSITION IMMEDIATELY FOLLOWING THE SECOND ADDED NOTE PARAGRAPH BETWEEN STEPS 2 AND 3. UPDATE THE NOTE PARAGRAPH TO READ: "WITH A HIGH QUANTITY IN THE FWD/RT FUEL SYSTEM, THE GREATER STATIC HEAD PRESSURE, PARTICULARLY IN NOSE-UP ATTITUDES CAN CAUSE OVERFILLING OF THE AFT/LT FUEL SYSTEM AND SUBSEQUENT FUEL VENTING. TO PREVENT THIS, THE FEED SWITCH SHOULD BE RETURNED TO NORM BEFORE THE AFT/LT TAPE REACHES 6,200 POUNDS. OVERFILLING IS INDICATED BY A QUANTITY OF 6,600 POUNDS OR GREATER IN THE FWD/RT SYSTEM OR 6,200 POUNDS OF GREATER IN THE AFT/LT SYSTEM."

H. (1) DELETE: STATEMENT IMMEDIATELY PRECEDING STEP 3 THAT READS: "IF FUEL IMBALANCE INCREASES:"

(2) ADD (REPLACE WITH): "IF NO VENTING IS OBSERVED AND/OR THE FUEL IMBALANCE IS CORRECTED WITH THE FUEL FEED SWITCH:"

I. (1) DELETE: EXISTING STEP 3.

(2) ADD (REPLACE WITH): "3. FUEL FEED SWITCH - AS REQUIRED AND LAND AS SOON AS PRACTICABLE."

J. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT IMMEDIATELY PRIOR TO STEP 4 TO READ: "IF FUEL VENTING EXISTS AND/OR FUEL IMBALANCE EXCEEDS 2,000 POUNDS:"

K. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 4 TO READ: "FUEL FEED SWITCH - NORM."

L. (1) DELETE: NA

(2) ADD (INSERT): WARNING PARAGRAPH IMMEDIATELY FOLLOWING NEW STEP 4 TO READ: "VENTING FUEL IN CONJUNCTION WITH AN UNCONTROLLABLE FUEL SPLIT IS INDICATIVE OF A MOTIVE FLOW FAILURE AND CAN RESULT IN THE HIGH FEED GROUP HAVING TRAPPED/UNUSABLE FUEL. IF THIS OCCURS, AIRCREW MAY HAVE AS LITTLE AS 4,500 POUNDS OF USABLE FUEL REMAINING AND A NEW BINGO PROFILE MAY BE REQUIRED."

M. (1) DELETE (CHANGE): RENUMBER EXISTING STEP 4 TO NEW STEP 5 WITHOUT CHANGING VERBIAGE.

N. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT AFTER NEW STEP 5 TO READ: "IF INDICATIONS OF A FUEL LEAK EXIST:"

O. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 6 AFTER STATEMENT TO READ:

"6. REFER TO FUEL LEAK PROCEDURE (PAGE 116)."

4. CHANGE REF D (F-14D NFM), CHAPTER 14, PAGE 14-20, PARAGRAPH 14.6.6 AS FOLLOWS:

A. (1) DELETE: STATEMENTS UNDER FIRST WARNING: "DURING AB OPERATIONS, NORM SHALL BE SELECTED. FWD OR AFT COULD DEplete THE SUMP TANKS."

(2) ADD (REPLACE WITH): "AB OPERATION IS NOT RECOMMENDED WITH A FUEL IMBALANCE OR WITH INDICATIONS OF VENTING FUEL."

B. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH BEFORE THE EXISTING NOTE PARAGRAPH AT THE BEGINNING OF THE PROCEDURE TO READ: "FUEL QUANTITY BALANCING IS NOT REQUIRED PRIOR TO COMPLETION OF WING/EXTERNAL TANK TRANSFER OR UNTIL ONE FUSELAGE TAPE DROPS BELOW 4,500 POUNDS."

C. (1) DELETE: NA

(2) ADD: STATEMENT IN CAPITAL ITALICS, PRIOR TO STEP 1, TO READ: "WITH A FUEL STATE BELOW 4500 POUNDS IN A SINGLE FEED GROUP AND A FUEL SPLIT GREATER THAN 1500 POUNDS BETWEEN THE AFT/LEFT AND FWD/RIGHT FEED GROUPS:"

D. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH IMMEDIATELY AFTER STEP 2 TO READ: "IF PRACTICAL, OBTAIN A VISUAL INSPECTION FOR VENTING FUEL. DO NOT DELAY EXECUTION OF EMERGENCY PROCEDURES FOR VISUAL INSPECTION."

E. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH AFTER PRECEEDING (INSERTED) NOTE PARAGRAPH, BUT PRIOR TO THE EXISTING WARNING PARAGRAPH TO READ: "INDICATION OF FUEL BALANCING SHOULD APPEAR WITHIN 3 MINUTES OF SELECTING THE HIGH FUSELAGE TAPE SIDE."

F. (1) DELETE: ENTIRE WARNING THAT BEGINS WITH "AIRCRAFT ATTITUDE WILL HAVE A SIGNIFICANT INFLUENCE..."

(2) ADD: NA

G. (1) DELETE: NA

(2) ADD (MOVE): FIRST NOTE PARAGRAPH OF EXISTING PROCEDURE THAT BEGINS, "WITH A HIGH QUANTITY...", TO A POSITION IMMEDIATELY FOLLOWING THE SECOND ADDED NOTE PARAGRAPH BETWEEN STEPS 2 AND 3. UPDATE THE NOTE PARAGRAPH TO READ: "WITH A HIGH QUANTITY IN THE FWD/RT FUEL SYSTEM, THE GREATER STATIC HEAD PRESSURE, PARTICULARLY IN NOSE-UP ATTITUDES CAN CAUSE OVERFILLING OF THE AFT/LT FUEL SYSTEM AND SUBSEQUENT FUEL VENTING. TO PREVENT THIS, THE FEED SWITCH SHOULD BE RETURNED TO NORM BEFORE THE AFT/LT TAP REACHES 6,200 POUNDS. OVERFILLING IS INDICATED BY A QUANTITY OF 6,600 POUNDS OR GREATER IN THE FWD/RT SYSTEM OR 6,200 POUNDS OF GREATER IN THE AFT/LT SYSTEM."

H. (1) DELETE: STATEMENT IMMEDIATELY PRECEDING STEP 3 THAT READS: "IF FUEL IMBALANCE INCREASES:"

(2) ADD (REPLACE WITH): "IF NO VENTING IS OBSERVED AND/OR THE FUEL IMBALANCE IS CORRECTED WITH THE FUEL FEED SWITCH:"

I. (1) DELETE: EXISTING STEP 3.

(2) ADD (REPLACE WITH): "3. FUEL FEED SWITCH - AS REQUIRED AND LAND AS SOON AS PRACTICABLE."

J. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT IMMEDIATELY PRIOR TO STEP 4 TO READ: "IF FUEL VENTING EXISTS AND/OR FUEL IMBALANCE EXCEEDS 2,000 POUNDS:"

K. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 4 TO READ: "FUEL FEED SWITCH - NORM."

L. (1) DELETE: NA

(2) ADD (INSERT): WARNING PARAGRAPH IMMEDIATELY FOLLOWING NEW STEP 4 TO READ: "VENTING FUEL IN CONJUNCTION WITH AN UNCONTROLLABLE FUEL SPLIT IS INDICATIVE OF A MOTIVE FLOW FAILURE AND CAN RESULT IN THE HIGH FEED GROUP HAVING TRAPPED/UNUSABLE FUEL. IF THIS OCCURS, AIRCREW MAY HAVE AS LITTLE AS 4,500 POUNDS OF USABLE FUEL REMAINING AND A NEW BINGO PROFILE MAY BE REQUIRED."

M. (1) DELETE (CHANGE): RENUMBER EXISTING STEP 4 TO NEW STEP 5 WITHOUT CHANGING VERBIAGE.

N. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT AFTER NEW STEP 5 TO READ: "IF INDICATIONS OF A FUEL LEAK EXIST:"

O. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 6 AFTER STATEMENT TO READ: "6. REFER TO FUEL LEAK PROCEDURE (PAGE 14-19)."

5. CHANGE REF E (F-14B PCL), FUEL CHAPTER, PAGE 127 & 128 AS FOLLOWS:

A. (1) DELETE: STATEMENTS UNDER FIRST WARNING: "DURING AB OPERATIONS, NORM SHALL BE SELECTED. FWD OR AFT COULD DEplete THE SUMP TANKS."

(2) ADD (REPLACE WITH): "AB OPERATION IS NOT RECOMMENDED WITH A FUEL IMBALANCE OR WITH INDICATIONS OF VENTING FUEL."

B. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH BEFORE THE EXISTING NOTE PARAGRAPH AT THE BEGINNING OF THE PROCEDURE TO READ: "FUEL QUANTITY BALANCING IS NOT REQUIRED PRIOR TO COMPLETION OF WING/EXTERNAL TANK TRANSFER OR UNTIL ONE FUSELAGE TAP DROPS BELOW

4,500 POUNDS."

C. (1) DELETE: NA

(2) ADD: STATEMENT IN CAPITAL ITALICS, PRIOR TO STEP 1, TO READ: "WITH A FUEL STATE BELOW 4500 POUNDS IN A SINGLE FEED GROUP AND A FUEL SPLIT GREATER THAN 1500 POUNDS BETWEEN THE AFT/LEFT AND FWD/RIGHT FEED GROUPS:"

D. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH IMMEDIATELY AFTER STEP 2 TO READ: "IF PRACTICAL, OBTAIN A VISUAL INSPECTION FOR VENTING FUEL.DO NOT DELAY EXECUTION OF EMERGENCY PROCEDURES FOR VISUAL INSPECTION."

E. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH AFTER PRECEEDING (INSERTED) NOTE PARAGRAPH, BUT PRIOR TO THE EXISTING WARNING PARAGRAPH TO READ: "INDICATION OF FUEL BALANCING SHOULD APPEAR WITHIN 3 MINUTES OF SELECTING THE HIGH FUSELAGE TAPE SIDE."

F. (1) DELETE: ENTIRE WARNING THAT BEGINS WITH "AIRCRAFT ATTITUDE WILL HAVE A SIGNIFICANT INFLUENCE..."

(2) ADD: NA

G. (1) DELETE: NA

(2) ADD (MOVE): FIRST NOTE PARAGRAPH OF EXISTING PROCEDURE THAT BEGINS, "WITH A HIGH QUANTITY...", TO A POSITION IMMEDIATELY FOLLOWING THE SECOND ADDED NOTE PARAGRAPH BETWEEN STEPS 2 AND 3. UPDATE THE NOTE PARAGRAPH TO READ: "WITH A HIGH QUANTITY IN THE FWD/RT FUEL SYSTEM, THE GREATER STATIC HEAD PRESSURE, PARTICULARLY IN NOSE-UP ATTITUDES CAN CAUSE OVERFILLING OF THE AFT/LT FUEL SYSTEM AND SUBSEQUENT FUEL VENTING. TO PREVENT THIS, THE FEED SWITCH SHOULD BE RETURNED TO NORM BEFORE THE AFT/LT TAPE REACHES 6,200 POUNDS. OVERFILLING IS INDICATED BY A QUANTITY OF 6,600 POUNDS OR GREATER IN THE FWD/RT SYSTEM OR 6,200 POUNDS OF GREATER IN THE AFT/LT SYSTEM."

H. (1) DELETE: STATEMENT IMMEDIATELY PRECEDING STEP 3 THAT READS: "IF FUEL IMBALANCE INCREASES:"

(2) ADD (REPLACE WITH): "IF NO VENTING IS OBSERVED AND/OR THE FUEL IMBALANCE IS CORRECTED WITH THE FUEL FEED SWITCH:"

I. (1) DELETE: EXISTING STEP 3.

(2) ADD (REPLACE WITH): "3. FUEL FEED SWITCH - AS REQUIRED AND LAND AS SOON AS PRACTICABLE."

J. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT IMMEDIATELY PRIOR TO STEP 4 TO READ: "IF FUEL VENTING EXISTS AND/OR FUEL IMBALANCE EXCEEDS 2,000 POUNDS:"

K. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 4 TO READ: "FUEL FEED SWITCH - NORM."

L. (1) DELETE: NA

(2) ADD (INSERT): WARNING PARAGRAPH IMMEDIATELY FOLLOWING NEW STEP 4 TO READ: "VENTING FUEL IN CONJUNCTION WITH AN UNCONTROLLABLE FUEL SPLIT IS INDICATIVE OF A MOTIVE FLOW FAILURE AND CAN RESULT IN THE HIGH FEED GROUP HAVING TRAPPED/UNUSABLE FUEL. IF THIS OCCURS, AIRCREW MAY HAVE AS LITTLE AS 4,500 POUNDS OF USABLE FUEL REMAINING AND A NEW BINGO PROFILE MAY BE REQUIRED."

M. (1) DELETE (CHANGE): RENUMBER EXISTING STEP 4 TO NEW STEP 5 WITHOUT CHANGING VERBIAGE.

N. (1) DELETE: NA
 (2) ADD (INSERT): STATEMENT AFTER NEW STEP 5 TO READ: "IF INDICATIONS OF A FUEL LEAK EXIST:"

O. (1) DELETE: NA
 (2) ADD (INSERT): NEW STEP 6 AFTER STATEMENT TO READ: "6. REFER TO FUEL LEAK PROCEDURE (PAGE 126A)."
 6. CHANGE REF F (F-14B NFM), CHAPTER 14, PAGE 14-20A, PARAGRAPH 14.6.6 AS FOLLOWS:

A. (1) DELETE: STATEMENTS UNDER FIRST WARNING: "DURING AB OPERATIONS, NORM SHALL BE SELECTED. FWD OR AFT COULD DEplete THE SUMP TANKS."
 (2) ADD (REPLACE WITH): "AB OPERATION IS NOT RECOMMENDED WITH A FUEL IMBALANCE OR WITH INDICATIONS OF VENTING FUEL."

B. (1) DELETE: NA
 (2) ADD (INSERT): NOTE PARAGRAPH BEFORE THE EXISTING NOTE PARAGRAPH AT THE BEGINNING OF THE PROCEDURE TO READ: "FUEL QUANTITY BALANCING IS NOT REQUIRED PRIOR TO COMPLETION OF WING/EXTERNAL TANK TRANSFER OR UNTIL ONE FUSELAGE TAPE DROPS BELOW 4,500 POUNDS."

C. (1) DELETE: NA
 (2) ADD: STATEMENT IN CAPITAL ITALICS, PRIOR TO STEP 1, TO READ: "WITH A FUEL STATE BELOW 4500 POUNDS IN A SINGLE FEED GROUP AND A FUEL SPLIT GREATER THAN 1500 POUNDS BETWEEN THE AFT/LEFT AND FWD/RIGHT FEED GROUPS:"

D. (1) DELETE: NA
 (2) ADD (INSERT): NOTE PARAGRAPH IMMEDIATELY AFTER STEP 2 TO READ: "IF PRACTICAL, OBTAIN A VISUAL INSPECTION FOR VENTING FUEL.DO NOT DELAY EXECUTION OF EMERGENCY PROCEDURES FOR VISUAL INSPECTION."

E. (1) DELETE: NA
 (2) ADD (INSERT): NOTE PARAGRAPH AFTER PRECEEDING (INSERTED) NOTE PARAGRAPH, BUT PRIOR TO THE EXISTING WARNING PARAGRAPH TO READ: "INDICATION OF FUEL BALANCING SHOULD APPEAR WITHIN 3 MINUTES OF SELECTING THE HIGH FUSELAGE TAPE SIDE."

F. (1) DELETE: ENTIRE WARNING THAT BEGINS WITH "AIRCRAFT ATTITUDE WILL HAVE A SIGNIFICANT INFLUENCE..."
 (2) ADD: NA

G. (1) DELETE: NA
 (2) ADD (MOVE): FIRST NOTE PARAGRAPH OF EXISTING PROCEDURE THAT BEGINS, "WITH A HIGH QUANTITY...", TO A POSITION IMMEDIATELY FOLLOWING THE SECOND ADDED NOTE PARAGRAPH BETWEEN STEPS 2 AND 3. UPDATE THE NOTE PARAGRAPH TO READ: "WITH A HIGH QUANTITY IN THE FWD/RT FUEL SYSTEM, THE GREATER STATIC HEAD PRESSURE, PARTICULARLY IN NOSE-UP ATTITUDES CAN CAUSE OVERFILLING OF THE AFT/LT FUEL SYSTEM AND SUBSEQUENT FUEL VENTING. TO PREVENT THIS, THE FEED SWITCH SHOULD BE RETURNED TO NORM BEFORE THE AFT/LT TAPE REACHES 6,200 POUNDS. OVERFILLING IS INDICATED BY A QUANTITY OF 6,600 POUNDS OR GREATER IN THE FWD/RT SYSTEM OR 6,200 POUNDS OF GREATER IN THE AFT/LT SYSTEM."

H. (1) DELETE: STATEMENT IMMEDIATELY PRECEDING STEP 3 THAT READS: "IF FUEL IMBALANCE INCREASES:"

(2) ADD (REPLACE WITH): "IF NO VENTING IS OBSERVED AND/OR THE FUEL IMBALANCE IS CORRECTED WITH THE FUEL FEED SWITCH:"

I. (1) DELETE: EXISTING STEP 3.

(2) ADD (REPLACE WITH): "3. FUEL FEED SWITCH - AS REQUIRED AND LAND AS SOON AS PRACTICABLE."

J. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT IMMEDIATELY PRIOR TO STEP 4 TO READ: "IF FUEL VENTING EXISTS AND/OR FUEL IMBALANCE EXCEEDS 2,000 POUNDS:"

K. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 4 TO READ: "FUEL FEED SWITCH - NORM."

L. (1) DELETE: NA

(2) ADD (INSERT): WARNING PARAGRAPH IMMEDIATELY FOLLOWING NEW STEP 4 TO READ: "VENTING FUEL IN CONJUNCTION WITH AN UNCONTROLLABLE FUEL SPLIT IS INDICATIVE OF A MOTIVE FLOW FAILURE AND CAN RESULT IN THE HIGH FEED GROUP HAVING TRAPPED/UNUSABLE FUEL. IF THIS OCCURS, AIRCREW MAY HAVE AS LITTLE AS 4,500 POUNDS OF USABLE FUEL REMAINING AND A NEW BINGO PROFILE MAY BE REQUIRED."

M. (1) DELETE (CHANGE): RENUMBER EXISTING STEP 4 TO NEW STEP 5 WITHOUT CHANGING VERBIAGE.

N. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT AFTER NEW STEP 5 TO READ: "IF INDICATIONS OF A FUEL LEAK EXIST:"

O. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 6 AFTER STATEMENT TO READ: "6. REFER TO FUEL LEAK PROCEDURE (PAGE 14-20)."

7. CHANGE REF G (F-14A PCL), FUEL CHAPTER, PAGE 98, AS FOLLOWS:

A. (1) DELETE: STATEMENTS UNDER FIRST WARNING: "DURING AB OPERATIONS, NORM SHALL BE SELECTED. FWD OR AFT COULD DEplete THE SUMP TANKS."

(2) ADD (REPLACE WITH): "AB OPERATION IS NOT RECOMMENDED WITH A FUEL IMBALANCE OR WITH INDICATIONS OF VENTING FUEL."

B. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH BEFORE THE EXISTING NOTE PARAGRAPH AT THE BEGINNING OF THE PROCEDURE TO READ: "FUEL QUANTITY BALANCING IS NOT REQUIRED PRIOR TO COMPLETION OF WING/EXTERNAL TANK TRANSFER OR UNTIL ONE FUSELAGE TAPE DROPS BELOW 4,500 POUNDS."

C. (1) DELETE: NA

(2) ADD: STATEMENT IN CAPITAL ITALICS, PRIOR TO STEP 1, TO READ: "WITH A FUEL STATE BELOW 4500 POUNDS IN A SINGLE FEED GROUP AND A FUEL SPLIT GREATER THAN 1500 POUNDS BETWEEN THE AFT/LEFT AND FWD/RIGHT FEED GROUPS:"

D. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH IMMEDIATELY AFTER STEP 2 TO READ: "IF PRACTICAL, OBTAIN A VISUAL INSPECTION FOR VENTING FUEL. DO NOT DELAY EXECUTION OF EMERGENCY PROCEDURES FOR VISUAL INSPECTION."

E. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH AFTER PRECEEDING (INSERTED) NOTE PARAGRAPH, BUT PRIOR TO THE EXISTING WARNING PARAGRAPH TO READ:

"INDICATION OF FUEL BALANCING SHOULD APPEAR WITHIN 3 MINUTES OF SELECTING THE HIGH FUSELAGE TAPE SIDE."

F. (1) DELETE: ENTIRE WARNING THAT BEGINS WITH "AIRCRAFT ATTITUDE WILL HAVE A SIGNIFICANT INFLUENCE..."

(2) ADD: NA

G. (1) DELETE: NA

(2) ADD (MOVE): FIRST NOTE PARAGRAPH OF EXISTING PROCEDURE THAT BEGINS, "WITH A HIGH QUANTITY...", TO A POSITION IMMEDIATELY FOLLOWING THE SECOND ADDED NOTE PARAGRAPH BETWEEN STEPS 2 AND 3. UPDATE THE NOTE PARAGRAPH TO READ: "WITH A HIGH QUANTITY IN THE FWD/RT FUEL SYSTEM, THE GREATER STATIC HEAD PRESSURE, PARTICULARLY IN NOSE-UP ATTITUDES CAN CAUSE OVERFILLING OF THE AFT/LT FUEL SYSTEM AND SUBSEQUENT FUEL VENTING. TO PREVENT THIS, THE FEED SWITCH SHOULD BE RETURNED TO NORM BEFORE THE AFT/LT TAPE REACHES 6,200 POUNDS. OVERFILLING IS INDICATED BY A QUANTITY OF 6,600 POUNDS OR GREATER IN THE FWD/RT SYSTEM OR 6,200 POUNDS OF GREATER IN THE AFT/LT SYSTEM."

H. (1) DELETE: STATEMENT IMMEDIATELY PRECEDING STEP 3 THAT READS: "IF FUEL IMBALANCE INCREASES:"

(2) ADD (REPLACE WITH): "IF NO VENTING IS OBSERVED AND/OR THE FUEL IMBALANCE IS CORRECTED WITH THE FUEL FEED SWITCH:"

I. (1) DELETE: EXISTING STEP 3.

(2) ADD (REPLACE WITH): "3. FUEL FEED SWITCH - AS REQUIRED AND LAND AS SOON AS PRACTICABLE."

J. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT IMMEDIATELY PRIOR TO STEP 4 TO READ: "IF FUEL VENTING EXISTS AND/OR FUEL IMBALANCE EXCEEDS 2,000 POUNDS:"

K. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 4 TO READ: "FUEL FEED SWITCH - NORM."

L. (1) DELETE: NA

(2) ADD (INSERT): WARNING PARAGRAPH IMMEDIATELY FOLLOWING NEW STEP 4 TO READ: "VENTING FUEL IN CONJUNCTION WITH AN UNCONTROLLABLE FUEL SPLIT IS INDICATIVE OF A MOTIVE FLOW FAILURE AND CAN RESULT IN THE HIGH FEED GROUP HAVING TRAPPED/UNUSABLE FUEL. IF THIS OCCURS, AIRCREW MAY HAVE AS LITTLE AS 4,500 POUNDS OF USABLE FUEL REMAINING AND A NEW BINGO PROFILE MAY BE REQUIRED."

M. (1) DELETE (CHANGE): RENUMBER EXISTING STEP 4 TO NEW STEP 5 WITHOUT CHANGING VERBIAGE.

N. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT AFTER NEW STEP 5 TO READ: "IF INDICATIONS OF A FUEL LEAK EXIST:"

O. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 6 AFTER STATEMENT TO READ: "6. REFER TO FUEL LEAK PROCEDURE (PAGE 97)."

8. CHANGE REF H (F-14A NFM), CHAPTER 14, PAGE 14-17, PARAGRAPH 14.6.6 AS FOLLOWS:

A. (1) DELETE: STATEMENTS UNDER FIRST WARNING: "DURING AB OPERATIONS, NORM SHALL BE SELECTED. FWD OR AFT COULD DEplete THE SUMP TANKS."

(2) ADD (REPLACE WITH): "AB OPERATION IS NOT RECOMMENDED WITH A FUEL IMBALANCE OR WITH INDICATIONS OF VENTING FUEL."

B. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH BEFORE THE EXISTING NOTE PARAGRAPH AT THE BEGINNING OF THE PROCEDURE TO READ: "FUEL QUANTITY BALANCING IS NOT REQUIRED PRIOR TO COMPLETION OF WING/EXTERNAL TANK TRANSFER OR UNTIL ONE FUSELAGE TAPE DROPS BELOW 4,500 POUNDS."

C. (1) DELETE: NA

(2) ADD: STATEMENT IN CAPITAL ITALICS, PRIOR TO STEP 1, TO READ: "WITH A FUEL STATE BELOW 4500 POUNDS IN A SINGLE FEED GROUP AND A FUEL SPLIT GREATER THAN 1500 POUNDS BETWEEN THE AFT/LEFT AND FWD/RIGHT FEED GROUPS:"

D. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH IMMEDIATELY AFTER STEP 2 TO READ: "IF PRACTICAL, OBTAIN A VISUAL INSPECTION FOR VENTING FUEL.DO NOT DELAY EXECUTION OF EMERGENCY PROCEDURES FOR VISUAL INSPECTION."

E. (1) DELETE: NA

(2) ADD (INSERT): NOTE PARAGRAPH AFTER PRECEEDING (INSERTED) NOTE PARAGRAPH, BUT PRIOR TO THE EXISTING WARNING PARAGRAPH TO READ: "INDICATION OF FUEL BALANCING SHOULD APPEAR WITHIN 3 MINUTES OF SELECTING THE HIGH FUSELAGE TAPE SIDE."

F. (1) DELETE: ENTIRE WARNING THAT BEGINS WITH "AIRCRAFT ATTITUDE WILL HAVE A SIGNIFICANT INFLUENCE..."

(2) ADD: NA

G. (1) DELETE: NA

(2) ADD (MOVE): FIRST NOTE PARAGRAPH OF EXISTING PROCEDURE THAT BEGINS, "WITH A HIGH QUANTITY...", TO A POSITION IMMEDIATELY FOLLOWING THE SECOND ADDED NOTE PARAGRAPH BETWEEN STEPS 2 AND 3. UPDATE THE NOTE PARAGRAPH TO READ: "WITH A HIGH QUANTITY IN THE FWD/RT FUEL SYSTEM, THE GREATER STATIC HEAD PRESSURE, PARTICULARLY IN NOSE-UP ATTITUDES CAN CAUSE OVERFILLING OF THE AFT/LT FUEL SYSTEM AND SUBSEQUENT FUEL VENTING. TO PREVENT THIS, THE FEED SWITCH SHOULD BE RETURNED TO NORM BEFORE THE AFT/LT TAPE REACHES 6,200 POUNDS. OVERFILLING IS INDICATED BY A QUANTITY OF 6,600 POUNDS OR GREATER IN THE FWD/RT SYSTEM OR 6,200 POUNDS OF GREATER IN THE AFT/LT SYSTEM."

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(2) ADD (REPLACE WITH): "IF NO VENTING IS OBSERVED AND/OR THE FUEL IMBALANCE IS CORRECTED WITH THE FUEL FEED SWITCH:"

I. (1) DELETE: EXISTING STEP 3.

(2) ADD (REPLACE WITH): "3. FUEL FEED SWITCH - AS REQUIRED AND LAND AS SOON AS PRACTICABLE."

J. (1) DELETE: NA

(2) ADD (INSERT): STATEMENT IMMEDIATELY PRIOR TO STEP 4 TO READ: "IF FUEL VENTING EXISTS AND/OR FUEL IMBALANCE EXCEEDS 2,000 POUNDS:"

K. (1) DELETE: NA

(2) ADD (INSERT): NEW STEP 4 TO READ: "FUEL FEED SWITCH - NORM."

L. (1) DELETE: NA
 (2) ADD (INSERT): WARNING PARAGRAPH IMMEDIATELY FOLLOWING NEW STEP 4 TO READ: "VENTING FUEL IN CONJUNCTION WITH AN UNCONTROLLABLE FUEL SPLIT IS INDICATIVE OF A MOTIVE FLOW FAILURE AND CAN RESULT IN THE HIGH FEED GROUP HAVING TRAPPED/UNUSABLE FUEL. IF THIS OCCURS, AIRCREW MAY HAVE AS LITTLE AS 4,500 POUNDS OF USABLE FUEL REMAINING AND A NEW BINGO PROFILE MAY BE REQUIRED."

M. (1) DELETE (CHANGE): RENUMBER EXISTING STEP 4 TO NEW STEP 5 WITHOUT CHANGING VERBIAGE.
 N. (1) DELETE: NA
 (2) ADD (INSERT): STATEMENT AFTER NEW STEP 5 TO READ: "IF INDICATIONS OF A FUEL LEAK EXIST:"

O. (1) DELETE: NA
 (2) ADD (INSERT): NEW STEP 6 AFTER STATEMENT TO READ: "6. REFER TO FUEL LEAK PROCEDURE (PAGE 14-16)."

9. POINTS OF CONTACT:
 A. F-14ABD NATOPS PROGRAM MANAGER, LT KYLE MILLER, TEL DSN 433-5147, OR COMM (757)433-5147, EMAIL: MILLERKA(AT)VF101.NAVY.MIL
 B. NAVAIR POCS:
 1. LT MIKE DOXEY, F-14ABD CLASS DESK, TEL DSN 757-7021, OR COMM(301)757-7021, EMAIL: MICHAEL.DOXEY(AT)NAVY.MIL
 2. LCDR JR NASH, 4.0P NATOPS OFFICER, TEL DSN 995-2052, OR COMM (301)995-2052, EMAIL: JAMES.NASH(AT)NAVY.MIL
 3. KRISTIN SWIFT, 4.0P NATOPS CHIEF ENGINEER, TEL DSN 995-4193, OR COMM (301)995-4193, EMAIL: KRISTIN.SWIFT(AT)NAVY.MIL

10. THIS MESSAGE WILL BE POSTED ON THE NATEC WEBSITE, WWW.NATEC.NAVY.MIL WITHIN 15 DAYS OF RELEASE. NEW NATOPS IC MESSAGES MAY BE FOUND IN TWO PLACES ON THIS WEBSITE:
 (1) IN THE NATOPS IC DATABASE FOUND UNDER THE TMAPS OPTION, AND
 (2) IN THE AFFECTED PUBLICATIONS(S) JUST AFTER THE IC SUMMARY PAGE. IF THE IC MESSAGE INCLUDES REPLACEMENT PAGES, THEY WILL BE ADDITIONALLY PLACED WITHIN THE MANUAL AND REPLACED PAGES DELETED. MESSAGES ARE NORMALLY POSTED IN THE DATABASE BEFORE APPEARING IN THE PUBLICATION. THIS MESSAGE WILL ALSO BE POSTED ON THE NATOPS WEBSITE, NATOPS.NAVAIR.NAVY.MIL. IF UNABLE TO VIEW THIS MESSAGE ON EITHER THE NATEC OR NATOPS WEBSITES, INFORM THE NATOPS GLOBAL CUSTOMER SUPPORT TEAM AT (301) 342-3276, DSN 342-3276, OR BY EMAIL AT NATOPS(AT)NAVY.MIL.//
 BT
 #1234
 NNNN

NAVAIR 01-F14AAD-1
F-14D AIRCRAFT
NATOPS FLIGHT MANUAL
INTERIM CHANGE 28 & 29
REPLACEMENT PAGES

1. Replacement pages for Interim Change Numbers 28 & 29 to the F-14D NFM, NAVAIR 01-F14AAD-1 dated 15 Jan 2004, are attached as follows:

Page	Page Version Marking
-----	-----
14-17	Change 2
14-18	Change 2 W/ IC 29
14-19	Change 2
14-20	Change 2 W/ IC 28
14-20a	Change 2 W/ IC 28
14-20b	Change 2 W/ IC 28

Note

Pulling the AICS cb while airborne may illuminate the FCS CAUTION and ARI DGR lights. Above about 600 knots, the PITCH SAS and ROLL DGR lights will also be illuminated. These should clear with a MASTER RESET following a programmer reset.

8. Affected INLET RAMPS switch — AUTO.
9. Remain below 1.2 TMN.

When AICS programmer reset attempts are completed:

12. Wing sweep drive cb's — Reset (LD1 and LE1).

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.

CAUTION

The formation of ice on pitot-static sensors may result in DFCS detected failures that may not clear with a MASTER RESET.

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:

4. Rpm — Set Minimum Rpm.
5. Avoid high-g or large throttle movements.
6. 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.
- If after 1 minute light is still illuminated:
3. Throttle (affected engine) — OFF.
 4. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.
 5. Relight engine for landing, if necessary.
 6. Land as soon as possible.

If light goes out, land as soon as practicable.

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.
- With ANTI ICE CONTR HOOK CONT/ WSHLD/AIR cb (8C2) pulled, approach indexers will flash.

14.6 FUEL SYSTEM MALFUNCTIONS**14.6.1 Fuel Pressure Caution Lights/Low Fuel Pressure Warning Tone**

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 flame-out occur. The first indication of this condition may be a fuel pressure light or an aural tone (engine stall warning tone).

14.6.1.1 L and/or R FUEL PRESS Light(s) and 10 sec Warning Tone

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 and the warning tone 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).
5. Land as soon as practicable.

If migration occurs after balancing, as indicated by a 100 to 300 PPM increase on the inoperative side or a 100 to 300 PPM decrease on the operative side above expected burn rate according to indicated fuel flow:

6. FUEL PRESS ADVSY CB - PULL (8F1).

Note

Pulling the FUEL PRESS ADVSY CB will cause the engine crossfeed valve to close and the inoperative side fuselage motive flow shutoff valve to open. This will reduce the amount of fuel transfer from the operative side to the inoperative side.

Note

The L or R FUEL PRESS light and/or warning tone will extinguish when the FUEL PRESS ADVSY CB is pulled.

7. Maintain cruise power or less.
8. Fuel distribution - monitor (balance if required).

WARNING

If the sump tank interconnect valve has failed, selecting AFT or FWD on the 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 PPM increase on the inoperative side), immediately return the feed switch to NORM.

9. Land as soon as possible.

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

Wing and external fuel will not transfer with refuel probe switch in ALL EXTD. If probe extension required, select FUS EXTD to enable transfer.

Note

Fuel management panel will be inoperative if FUEL MGT PNL cb (RD1) is out.

1. Fuel Management Panel cb—Check in (RD1).

14.6.3.1 Wing Fuel Fails To Transfer

If wing fuel fails to 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**Note**

Descending below freezing level may thaw possible frozen valves.

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 RAM 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).

WARNING

Pulling the FUEL FEED/DUMP circuit breaker (RE1) isolates the right and left fuel systems. It also deactivates the function of the feed switch, the automatic balance functions, and the fuel dump system. Should single engine operation subsequently become necessary, useable fuel will be limited to only what is available on the operating side.

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 until the wings are empty.

If leak is not stopped, it is in engine/nacelle area, proceed immediately with next step.

3. FUEL FEED/DUMP cb — Pull (RE1).

WARNING

Pulling the FUEL FEED/DUMP circuit breaker (RE1) isolates the right and left fuel systems. It also deactivates the function of the feed switch, the automatic balance functions, and the fuel dump system. Should single engine operation subsequently become necessary, useable fuel will be limited to only what is available on the operating side.

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.

14.6.6 Fuel Imbalance/Fuel Quantity Balancing**WARNING**

AB operation is not recommended with a fuel imbalance or with indications of venting fuel.

Note

Fuel quantity balancing is not required prior to completion of wing/external tank transfer or until one fuselage tape drops below 4,500 pounds.

WITH A FUEL STATE BELOW 4500 POUNDS IN EITHER THE AFT/LEFT OR FWD/RT FEED GROUPS AND A FUEL SPLIT GREATER THAN 1500 POUNDS BETWEEN THE AFT/LEFT AND FWD/RIGHT FEED GROUPS:

1. Both throttles - MIL power or less.
2. FEED SWITCH - select high fuselage tape side.

Note

- If practical, obtain a visual inspection for venting fuel. **Do not delay execution of emergency procedures for visual inspection.**
- Indication of fuel balancing should appear within 3 minutes of selecting the high fuselage tape side.
- With a high quantity in the FWD/RT fuel system, the greater static head pressure, particularly in nose-up attitudes can cause overfilling of the AFT/LT fuel system and subsequent fuel venting. To prevent this, the feed switch should be returned to NORM before the AFT/LT tape reaches 6,200 pounds. Overfilling is indicated by a quantity of 6,600 pounds or greater in the FWD/RT system or 6,200 pounds or greater in the AFT/LT system.

If no venting is observed and/or the fuel imbalance is corrected with the fuel feed switch:

3. FUEL FEED SWITCH - As required and land as soon as practicable.

WARNING

If the sump tank interconnect valve has failed closed, selecting AFT or FWD on the FUEL FEED SWITCH could result in rapid increase of the fuel imbalance. If this occurs (as indicated by an imbalance increase of 100 to 300 PPM) immediately return the FEED SWITCH to NORM.

If fuel venting exists and/or fuel imbalance exceeds 2,000 pounds:

4. FUEL FEED SWITCH - NORM.

WARNING

Venting fuel in conjunction with an uncontrollable fuel split is indicative of a motive flow failure and can result in the high feed group having trapped/unusable fuel. If this occurs, aircrew may have as little as 4,500 pounds of usable fuel remaining and a new bingo profile may be required.

5. Determine useable fuel and land as soon as possible.

If indications of a fuel leak exist:

6. Refer to FUEL LEAK PROCEDURE (page 14-19).

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 DFCS 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 EMERG 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 EMERG 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.



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.

4. Land as soon as practicable.

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
AFC 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
AFC 850	F-14D GPS Aircraft Mod	15 April 2002	None
AFC 874	Modification of Color Cockpit Television System (CCTVS) Wiring (LECP 1291N5-001)	15 April 2002	Effectivity: All F-14D and F-14D(R)s
AFC 880	AN/AVX-3 Tactical Imaging Set	15 April 2002	None
AVC 4412	Incorporation of Low Fuel Pressure Aural Tone Alarm (ECP 222)	15 April 2002	None
AFC 919	NGS SAHRS	15 May 2003	None

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

CHANGE NUMBER	DESCRIPTION	VISUAL IDENTIFICATION

F-14D NATOPS FLIGHT MANUAL

CONTENTS

	<i>Page No.</i>
PART I — THE AIRCRAFT	
CHAPTER 1 — AIRCRAFT AND ENGINE	
1.1 AIRCRAFT	1-1
1.1.1 Aircraft Weight	1-1
1.1.2 Cockpit	1-1
1.1.3 Electronic Nomenclature	1-2
1.1.4 Technical Directives	1-2
1.1.5 Block Numbers	1-2
CHAPTER 2 — SYSTEMS	
2.1 AIR INLET CONTROL SYSTEM (AICS)	2-1
2.1.1 Normal AICS Operations	2-1
2.1.2 AICS Test	2-1
2.1.3 AICS Failure Modes of Operation	2-4
2.1.4 AICS Anti-Ice	2-9
2.2 ENGINE	2-9
2.2.1 Engine Control	2-11
2.2.2 Variable Exhaust Nozzle	2-16
2.3 FATIGUE ENGINE MONITORING SYSTEM	2-18
2.3.1 FEMS Functional Description	2-18
2.3.2 FEMS Operation	2-21
2.3.3 FEMS and OBC	2-21
2.4 ENGINE FUEL SYSTEM	2-21
2.4.1 Motive Flow Fuel Pump	2-21
2.4.2 Engine Fuel Boost Pump	2-21
2.4.3 Main Fuel Pump	2-21
2.4.4 Main Engine Control	2-21
2.4.5 Afterburner Fuel Pump	2-23
2.4.6 Afterburner Fuel Control	2-23
2.5 THROTTLES	2-23
2.5.1 Throttle Control Modes	2-23
2.6 ENGINE BLEED AIR	2-27
2.6.1 Engine Anti-Ice	2-27
2.6.2 Environmental Control System Leak Detection	2-29
2.7 ENGINE COMPARTMENT VENTILATION	2-30
2.7.1 Engine In-Flight Ventilation	2-30
2.7.2 Engine Ground Ventilation	2-30

	<i>Page No.</i>
2.8	ENGINE IGNITION SYSTEM 2-30
2.8.1	Main High-Energy Ignition 2-30
2.8.2	Afterburner Ignition 2-32
2.8.3	Backup Ignition 2-32
2.9	ENGINE STARTING SYSTEM 2-32
2.9.1	External Airstart 2-32
2.9.2	Engine Crank 2-32
2.9.3	Crossbleed Start 2-34
2.9.4	Airstarts 2-34
2.10	ENGINE OIL SYSTEM 2-34
2.10.1	Oil Cooling 2-35
2.10.2	Oil Pressure Indicators 2-35
2.10.3	OIL HOT Caution Lights 2-35
2.11	ENGINE INSTRUMENTS 2-35
2.11.1	Engine RPM Indicator 2-35
2.11.2	Exhaust Gas Temperature Indicator 2-35
2.11.3	Fuel Flow Indicator 2-37
2.11.4	Engine Instrument Group BIT 2-37
2.11.5	Engine Instrument Group Self-Test 2-37
2.11.6	Engine Oil Pressure Indicator 2-37
2.11.7	Exhaust Nozzle Position Indicator 2-37
2.11.8	Engine Monitor Display Format 2-37
2.11.9	MFD Engine Caution Legends 2-38
2.11.10	Engine Stall/Overtemperature Warning 2-38
2.12	FIRE DETECTION SYSTEM 2-39
2.12.1	Fire Detection Test 2-40
2.13	FIRE EXTINGUISHING SYSTEM 2-40
2.13.1	Fire Extinguisher Pushbuttons 2-40
2.13.2	Fire Extinguisher Advisory Lights 2-40
2.13.3	Fire Extinguisher Test 2-40
2.14	AIRCRAFT FUEL SYSTEM 2-40
2.14.1	Fuel Tankage 2-42
2.14.2	Fuel Quantity System 2-42
2.14.3	Engine Feed 2-43
2.14.4	Fuel Transfer 2-50
2.14.5	Fuel Quantity Balancing 2-54
2.14.6	Fuel Transfer/Feed During Single-Engine Operation 2-54
2.14.7	Fuel Dump 2-55
2.14.8	Internal Tank Pressurization and Vent 2-56
2.14.9	Fueling and Defueling 2-56
2.14.10	In-Flight Refueling 2-57
2.14.11	Hot Refueling 2-58
2.14.12	Automatic Fuel Electrical Controls 2-59
2.15	ELECTRICAL POWER SUPPLY SYSTEM 2-59
2.15.1	Normal Electrical Operation 2-59

	<i>Page No.</i>	
2.15.2	Electrical Power Distribution	2-61
2.15.3	Degraded Electrical Operation	2-62
2.16	HYDRAULIC POWER SUPPLY SYSTEMS	2-69
2.16.1	Flight and Combined Systems	2-69
2.16.2	Hydraulic Power Distribution	2-72
2.16.3	Outboard Spoiler System	2-73
2.16.4	Backup Flight Control System	2-73
2.17	PNEUMATIC POWER SUPPLY SYSTEMS	2-77
2.17.1	Normal Canopy Control	2-77
2.17.2	Auxiliary Canopy Open Control	2-77
2.17.3	Emergency Gear Extension	2-77
2.18	MISSION COMPUTER SYSTEM	2-77
2.18.1	Aircrew Interface	2-77
2.18.2	Operational States	2-79
2.18.3	Aircraft Master Modes	2-79
2.19	STANDARD CENTRAL AIR DATA COMPUTER	2-79
2.19.1	Standard Central Air Data Computer Tests	2-79
2.20	WING-SWEEP SYSTEM	2-82
2.20.1	Wing-Sweep Performance	2-82
2.20.2	Wing-Sweep Modes	2-83
2.20.3	Wing-Sweep Interlocks	2-87
2.20.4	Wing-Sweep System Test	2-87
2.21	FLAPS AND SLATS	2-89
2.21.1	Flap and Slat Controls	2-89
2.21.2	Flap and Slat Operation	2-93
2.22	SPEEDBRAKES	2-95
2.22.1	Speedbrake Operation	2-95
2.23	FLIGHT CONTROL SYSTEMS	2-97
2.23.1	Longitudinal Control	2-97
2.23.2	Integrated Trim System	2-97
2.23.3	Lateral Control	2-102
2.23.4	Spoiler Control	2-105
2.23.5	Yaw Control	2-107
2.23.6	Direct Lift Control	2-109
2.24	DIGITAL FLIGHT CONTROL SYSTEM	2-109
2.24.1	Stability Augmentation System	2-110
2.24.2	Voltage Monitoring	2-125
2.24.3	Autopilot	2-125
2.24.4	Pilot Relief and Guidance Modes	2-126
2.24.5	DFCS Test	2-129
2.24.6	DFCS Control Panel Fault Reporting	2-131
2.25	LANDING GEAR SYSTEMS	2-132
2.25.1	Landing Gear Handle	2-132
2.25.2	Main Landing Gear	2-133

	<i>Page No.</i>
2.25.3	Nose Landing Gear 2-133
2.25.4	Landing Gear Normal Operation 2-135
2.25.5	Emergency Gear Extension 2-136
2.26	WHEELBRAKE SYSTEM 2-136
2.26.1	Brake Characteristics 2-138
2.26.2	Normal Braking 2-138
2.26.3	Antiskid 2-138
2.26.4	Auxiliary Brake 2-140
2.26.5	BRAKES Warning Light 2-140
2.26.6	Parking Brake 2-140
2.26.7	Wheel Antirotation 2-141
2.27	NOSEWHEEL STEERING SYSTEM 2-141
2.27.1	Nosewheel Steering Control 2-141
2.27.2	Nosewheel Centering 2-143
2.27.3	Shimmy Damping 2-143
2.28	NOSEGEAR CATAPULT SYSTEM 2-143
2.28.1	Nose Strut Kneel 2-143
2.28.2	Launch Bar 2-145
2.28.3	Holdback Fitting 2-145
2.29	ARRESTING HOOK SYSTEM 2-145
2.29.1	Arresting Hook Operation 2-145
2.30	ENVIRONMENTAL CONTROL SYSTEM 2-148
2.30.1	ECS Air Sources 2-148
2.30.2	Cockpit Air-Conditioning 2-151
2.30.3	Electronic Equipment Cooling 2-152
2.30.4	Pressurization 2-152
2.30.5	Windshield Air and Anti-Ice 2-154
2.30.6	Gun-Gas Purging 2-154
2.30.7	Degraded ECS Operation 2-154
2.31	OXYGEN SYSTEM 2-157
2.31.1	On-Board Oxygen Generating System (OBOGS) 2-157
2.31.2	Backup Oxygen System (BOS) 2-159
2.31.3	BOS Pressure Indicator 2-160
2.31.4	Emergency Oxygen Supply 2-160
2.32	PITOT-STATIC SYSTEM 2-160
2.32.1	Pitot-Static Heat 2-160
2.33	CONTROL AND DISPLAY SYSTEM 2-161
2.33.1	Display Types 2-161
2.33.2	Display Processors 2-169
2.33.3	System Operation 2-169
2.33.4	Heads-Up Display (HUD) 2-169
2.33.5	Multistatus Indicator (MSI) 2-170
2.33.6	Multifunction Displays (MFD) 2-174
2.33.7	Cursor Controls 2-174
2.33.8	Displays, Formats, and Symbology 2-176
2.33.9	MFD Formats 2-197

	<i>Page No.</i>
2.34 DATA ENTRY UNIT	2-242
2.34.1 Data Entry Unit Operating Modes	2-242
2.34.2 DEU Menu Pages	2-248
2.35 FLIGHT INSTRUMENTS	2-248
2.35.1 Standby Attitude Indicator	2-248
2.35.2 Standby Airspeed Indicator	2-250
2.35.3 Standby Altimeter	2-250
2.35.4 AN/APN-194(V) Radar Altimeter System	2-250
2.35.5 Vertical Velocity Indicator	2-251
2.35.6 Standby Compass	2-251
2.35.7 Clock	2-251
2.36 ANGLE-OF-ATTACK SYSTEM	2-251
2.36.1 AOA Test	2-251
2.36.2 AOA Indicator	2-251
2.36.3 AOA Indexer	2-251
2.36.4 Approach Lights	2-251
2.37 CANOPY SYSTEM	2-254
2.37.1 Canopy Operation	2-255
2.38 EJECTION SYSTEM	2-256a
2.38.1 Ejection Seat	2-258
2.38.2 Command Ejection Lever	2-263
2.38.3 Ejection Initiation	2-263
2.38.4 Seat Operation After Ejection	2-265
2.39 LIGHTING SYSTEM	2-265
2.39.1 Exterior Lights	2-265
2.39.2 Interior Lights	2-268
2.39.3 Warning and Indicator Lights	2-269
2.40 STORES MANAGEMENT SYSTEM/JETTISON	2-278
2.40.1 SMS Weapons Replaceable Assemblies	2-278
2.40.2 Multistatus Indicator (MSI)	2-279
2.40.3 Stores Jettison Modes	2-279
2.41 MISCELLANEOUS EQUIPMENT	2-283
2.41.1 Boarding Ladder	2-283
2.41.2 Nose Radome	2-283
2.41.3 Systems Test and System Power Ground Panel	2-283
2.41.4 External Baggage Container (CNU-188/A)	2-284

CHAPTER 3 — SERVICING AND HANDLING

3.1 SERVICING DATA	3-1
3.1.1 Ground Refueling	3-1
3.1.2 Engine Oil	3-4
3.1.3 Integrated Drive Generator Oil	3-4
3.1.4 Hydraulic Systems	3-4
3.1.5 Pneumatic Systems	3-8
3.1.6 Backup Oxygen Supply	3-8

3.2	GROUND HANDLING	3-8
3.2.1	Danger Areas	3-8
3.2.2	Radar Radiation Areas	3-8
3.2.3	Towing Turn Radii and Ground Clearances	3-15
3.2.4	Tiedown Points	3-15

CHAPTER 4 — OPERATING LIMITATIONS

4.1	LIMITATIONS	4-1
4.1.1	Engine Limits	4-1
4.1.2	Starter Limits	4-1
4.1.3	Airstart Envelope	4-1
4.1.4	Crosswind Limits	4-1
4.1.5	Ground Operations Limits	4-1
4.1.6	Ejection Seat Operation Limits	4-1
4.1.7	Autopilot Limits	4-1
4.2	AIRSPPEED LIMITATIONS	4-1
4.2.1	Maximum Airspeeds	4-5
4.3	ACCELERATION LIMITS	4-5
4.3.1	Cruise Configuration	4-5
4.3.2	Approach Configuration	4-5
4.4	ANGLE-OF-ATTACK LIMITS	4-5
4.4.1	Cruise Configuration	4-5
4.4.2	Approach Configuration	4-10
4.5	MANEUVERING LIMITS	4-10
4.5.1	Approach Configuration	4-10
4.5.2	Cruise Configuration	4-10
4.5.3	Rolling Limits	4-10
4.5.4	Sideslip Limits	4-10
4.5.5	Prohibited Maneuvers	4-10
4.6	SAS LIMITS	4-13
4.7	TAKEOFF AND LANDING FLAP AND SLAT AND TRANSITION LIMITS	4-13
4.7.1	Clean and Symmetric Stores Loading	4-13
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 63,000 inch-pounds)	4-18
4.7.3	External Stores Loading With Greater Than 66,000 Inch-Pounds (5,500 Foot-Pounds) Asymmetry	4-18
4.8	GROSS WEIGHT LIMITS — TAKEOFF, LAUNCH, AND LANDING	4-18
4.9	BARRICADE ENGAGEMENT LIMITS	4-18
4.10	CENTER OF GRAVITY POSITION LIMITS	4-18

	<i>Page No.</i>	
4.11	EXTERNAL STORES AND GUN LIMITS	4-19
4.11.1	280-Gallon External Fuel Tank Limits	4-19
4.11.2	External Baggage Container (CNU-188/A)	4-19
4.11.3	Gun Burst Limits	4-19
4.11.4	Launch Limits	4-19
4.11.5	Jettison Limits	4-20
4.12	BANNER TOWING RESTRICTIONS	4-20
4.13	TACTICAL AIR RECONNAISSANCE POD SYSTEM LIMITATIONS	4-21
4.13.1	Authorized Stores Loading	4-21
4.13.2	Interim AIM-7 as Ballast	4-21

PART II — INDOCTRINATION

CHAPTER 5 — INDOCTRINATION

5.1	GROUND TRAINING SYLLABUS	5-1
5.1.1	Minimum Ground Training Syllabus	5-1
5.1.2	Waiving of Minimum Ground Training Requirements	5-1
5.2	FLIGHT TRAINING SYLLABUS	5-2
5.2.1	Flightcrew Flight Training Syllabus	5-2
5.2.2	Flightcrew Flight Training Phases	5-2
5.3	OPERATING CRITERIA	5-2
5.3.1	Ceiling/Visibility Requirements	5-2
5.3.2	NATOPS Qualification and Currency Requirements	5-3
5.3.3	Requirements for Various Flight Phases	5-4
5.3.4	Mission Commander	5-4
5.3.5	Minimum Flightcrew Requirements	5-5
5.4	FLIGHT CREWMEMBER FLIGHT EQUIPMENT REQUIREMENTS	5-5

PART III — NORMAL PROCEDURES

CHAPTER 6 — FLIGHT PREPARATION

6.1	PREFLIGHT BRIEFING	6-1
6.1.1	Administration	6-1
6.1.2	Missions	6-1

CHAPTER 7 — SHORE-BASED PROCEDURES

7.1	CHECKLISTS	7-1
7.1.1	Tactical Air Reconnaissance Pod System	7-1
7.2	EXTERIOR INSPECTION	7-1
7.2.1	Area Around Aircraft	7-1
7.2.2	Foreign Object Damage and Leak Inspection	7-1
7.2.3	Ground Safety Devices and Covers	7-1
7.2.4	Surface Condition	7-2

	<i>Page No.</i>
7.2.5	Security of Panels 7-2
7.2.6	Leaks 7-2
7.2.7	Movable Surfaces 7-2
7.2.8	Inspection Areas 7-2
7.3	EJECTION SEAT INSPECTION 7-6
7.4	PILOT PROCEDURES 7-8
7.4.1	Interior Inspection — Pilot 7-8
7.4.2	Prestart — Pilot 7-10
7.4.3	Engine Start — Pilot 7-11
7.4.4	Poststart — Pilot 7-13
7.4.5	Taxiing 7-18
7.4.6	Taxi — Pilot 7-20
7.4.7	Takeoff 7-20
7.4.8	Flaps-Up Takeoff 7-21
7.4.9	Formation Takeoff 7-22
7.4.10	Takeoff Aborted 7-22
7.4.11	Takeoff Checklist 7-22
7.4.12	Ascent Checklist 7-23
7.4.13	In-Flight BIT 7-23
7.4.14	Preland and Descent 7-23
7.4.15	Pattern Entry 7-24
7.4.16	Landing 7-24
7.4.17	Landing Checklist 7-26
7.4.18	Postlanding — Pilot 7-27
7.5	RIO PROCEDURES 7-28
7.5.1	Interior Inspection — RIO 7-28
7.5.2	Prestart — RIO 7-29
7.5.3	Engine Start — RIO 7-30
7.5.4	Poststart — RIO 7-30
7.5.5	Taxi — RIO 7-32
7.5.6	In-Flight Reconnaissance System Check — RIO 7-32
7.5.7	TARPS Degraded Mode Procedures 7-33
7.5.8	Postlanding — RIO 7-34
7.6	HOT REFUELING PROCEDURES 7-34
7.7	DECK-LAUNCHED INTERCEPT PROCEDURES 7-35
7.7.1	Pilot Procedures 7-35
7.7.2	RIO Procedures 7-35
7.8	HOT SWITCH PROCEDURES 7-36
7.8.1	On-Deck, Maintenance Troubleshooting 7-36
7.8.2	Hot Switch Procedures 7-36
7.9	FIELD CARRIER LANDING PRACTICE 7-36
7.9.1	Preflight Inspection 7-36
7.9.2	Takeoff 7-37
7.9.3	Radio Procedures and Pattern Entry 7-37
7.9.4	Pattern 7-37
7.9.5	Night FCLP 7-37

CHAPTER 8 — CARRIER-BASED PROCEDURES

8.1	CARRIER PREFLIGHT	8-1
8.1.1	Launch	8-1
8.1.2	Briefing	8-1
8.1.3	Preflight	8-1
8.2	START AND POSTSTART	8-1
8.2.1	Carrier Alignment	8-1
8.2.2	SAHRS Standalone Carrier Alignment	8-3
8.2.3	GPS On-Deck IFA Alignment	8-3
8.3	TAXIING	8-4
8.3.1	Nosewheel Steering	8-4
8.3.2	Taxi Speed	8-4
8.3.3	Final Checker Aboard CV	8-4
8.4	CATAPULT HOOKUP (DAY)	8-4
8.4.1	Catapult Trim Requirements	8-5
8.4.2	Catapult Launch	8-5
8.4.3	Catapult Abort Procedures (Day)	8-6
8.5	LANDING	8-7
8.5.1	Carrier Landing Pattern (VFR)	8-7
8.5.2	Manual Approach Technique	8-7
8.5.3	Approach Power Compensator Technique	8-9
8.5.4	Waveoff Technique	8-9
8.5.5	Bolter Technique	8-9
8.5.6	Bingo Fuel	8-9
8.5.7	Arrested Landing and Exit From the Landing Area	8-10
8.5.8	Carrier-Controlled Approaches	8-10
8.5.9	Hold Phase	8-10
8.5.10	Platform	8-10
8.5.11	Ten-Mile DME Fix	8-10
8.5.12	Six-Mile DME Fix	8-10
8.5.13	Meatball Contact	8-12
8.6	WAVEOFF AND BOLTER	8-12
8.7	NIGHT FLYING	8-12
8.7.1	Briefing	8-12
8.7.2	Preflight	8-12
8.7.3	Poststart	8-12
8.7.4	Taxi	8-12
8.7.5	Catapult Hookup (Night)	8-12
8.7.6	Catapult Launch	8-12
8.7.7	Catapult Abort Procedures (Night)	8-13
8.7.8	Arrested Landing and Exit From Landing Area (Night)	8-13

CHAPTER 9 — SPECIAL PROCEDURES

9.1	IN-FLIGHT REFUELING PROCEDURES	9-1
9.1.1	In-Flight Refueling Controls	9-1
9.1.2	In-Flight Refueling Checklist	9-1
9.1.3	In-Flight Refueling Techniques	9-1

	<i>Page No.</i>
9.2	FORMATION FLIGHT 9-2
9.2.1	Parade Formation 9-2
9.2.2	Break Formation 9-3
9.2.3	Diamond Four-Plane Formation 9-3
9.2.4	Cruise Formation 9-3
9.2.5	Aircraft Lighting During Night Formation Flight 9-4
9.3	BANNER TOWING 9-4
9.3.1	Ground Procedures 9-4
9.3.2	Shipboard Procedures 9-4
9.3.3	Flight Procedures 9-4
9.4	FUEL MANAGEMENT SYSTEM OPERATIONAL CHECK 9-7

CHAPTER 10 — FUNCTIONAL CHECKFLIGHT PROCEDURES

10.1	FUNCTIONAL CHECKFLIGHTS 10-1
10.2	CHECKFLIGHT PROCEDURES 10-1
10.2.1	General Conduct 10-1
10.3	FUNCTIONAL CHECKFLIGHT PROCEDURES (PILOT) 10-2
10.3.1	Prestart 10-2
10.3.2	Start 10-2
10.3.3	Poststart 10-6
10.3.4	Taxi 10-13
10.3.5	Engine Runup 10-13
10.3.6	Takeoff and Climb 10-14
10.3.7	Ten Thousand Foot Checks 10-15
10.3.8	Fifteen Thousand Foot Checks 10-16
10.3.9	Ten Thousand Foot Checks 10-19
10.3.10	Airstarts (Twenty Thousand Feet) 10-20
10.3.11	Climb to Thirty-Five Thousand Feet 10-20
10.3.12	High-Speed Dash (Thirty-Five Thousand Feet) 10-21
10.3.13	Zoom Climb (Forty Thousand Feet) 10-22
10.3.14	Twenty Thousand Foot Checks 10-22
10.3.15	Fifteen Thousand Foot Checks 10-24
10.3.16	Approach and Landing 10-27
10.4	FUNCTIONAL CHECKFLIGHT PROCEDURES (RIO) 10-27
10.4.1	Prestart 10-27
10.4.2	Poststart 10-27
10.4.3	Taxi 10-28
10.4.4	Takeoff and Climb 10-28
10.4.5	Ten Thousand Foot Checks 10-28
10.4.6	Fifteen Thousand Foot Checks 10-28
10.4.7	Twenty-Five Thousand Foot Checks 10-29
10.4.8	Climb to Thirty-Five Thousand Feet 10-29
10.4.9	High-Speed Dash (Thirty-Five Thousand Feet) 10-29
10.4.10	Descent/Twenty Thousand Foot Checks 10-29
10.4.11	Approach 10-31
10.4.12	Landing 10-32
10.4.13	In Chocks 10-32
10.4.14	Postflight 10-32

PART IV — FLIGHT CHARACTERISTICS**CHAPTER 11 — FLIGHT CHARACTERISTICS**

11.1	PRIMARY FLIGHT CONTROLS	11-1
11.1.1	Pitch Control	11-1
11.1.2	Roll Control	11-1
11.1.3	Directional (Yaw) Control	11-1
11.1.4	Stability Augmentation System	11-1
11.2	SECONDARY FLIGHT CONTROLS	11-2
11.2.1	Maneuver Flaps and Slats	11-2
11.2.2	Landing Flaps, Slats, and DLC	11-2
11.2.3	Speedbrakes	11-2
11.3	GENERAL FLIGHT CHARACTERISTICS	11-2
11.3.1	Static Longitudinal Stability	11-2
11.3.2	Dynamic Longitudinal Response Characteristics	11-2
11.3.3	Maneuvering Stick Force	11-2
11.3.4	Roll Performance	11-3
11.3.5	Roll Response	11-3
11.3.6	Dutch Roll	11-3
11.3.7	Trim Characteristics	11-4
11.4	ASYMMETRIC THRUST FLIGHT CHARACTERISTICS IN COMBAT AND CRUISE CONFIGURATION	11-4
11.4.1	General	11-4
11.5	ENGINE STALLS AND FLAMEOUT	11-5
11.5.1	Medium and High-Subsonic Airspeed	11-5
11.5.2	Low Subsonic Airspeed	11-6
11.6	HIGH ANGLE OF ATTACK FLIGHT CHARACTERISTICS	11-6
11.6.1	Directional Stability	11-6
11.6.2	Dihedral Effect	11-6
11.6.3	External Stores	11-6
11.6.4	DFCS Stability Augmentation System	11-6
11.6.5	Maneuvering Flaps and Slats	11-7
11.6.6	Lateral Control Reversal	11-7
11.6.7	Miscellaneous	11-9
11.6.8	Stall Characteristics	11-9
11.6.9	Vertical Stalls	11-9
11.6.10	DFCS Degraded Control Modes	11-9
11.7	DEPARTURE FROM CONTROLLED FLIGHT	11-10
11.7.1	General	11-10
11.7.2	Lateral Stick-Induced Departures	11-13
11.7.3	Rudder-Induced Departures	11-13
11.7.4	Multi-Axis Control-Induced Departures	11-13
11.7.5	Asymmetric-Thrust-Induced Departures	11-14
11.7.6	Accelerated Departures	11-14
11.7.7	Inertia Coupling	11-14
11.7.8	Departure Recovery	11-15
11.7.9	Upright Departure Recovery	11-15

	<i>Page No.</i>
11.7.10 Flat Spin	11-20
11.7.11 Negative AOA Departures	11-20
11.7.12 Inverted Stall/Departure	11-20
11.7.13 Inverted Spin	11-21
11.8 TAKEOFF AND LANDING CONFIGURATION FLIGHT CHARACTERISTICS	11-21
11.8.1 Baseline Flight Characteristics	11-21
11.8.2 Crosswind Landings	11-22
11.8.3 Normal Stalls	11-22
11.8.4 Stall Recovery	11-22
11.8.5 Asymmetric Thrust Flight Characteristics	11-22
11.8.6 Degraded Approach Configuration	11-27
11.8.7 Outboard Spoiler Module Failure	11-27
11.8.8 SAS Off	11-27
11.8.9 Aft Wing-Sweep Landings	11-27
11.8.10 DFCS Degraded Control Modes	11-30
11.9 ASYMMETRIC WING SWEEP	11-31
11.9.1 Wing-Sweep Design Limitations	11-31
11.9.2 Asymmetric Wing-Sweep Flight Characteristics	11-32
11.10 DUAL HYDRAULIC FAILURES BACKUP FLIGHT CONTROL MODULE FLIGHT CHARACTERISTICS	11-33
11.10.1 General	11-33
11.10.2 Low Mode Cruise and Formation	11-36
11.10.3 High Mode Cruise and Formation	11-36
11.10.4 In-Flight Refueling	11-36
11.10.5 Landing	11-37
11.10.6 BFCM Thermal Durability	11-37
11.11 FLIGHT CHARACTERISTICS WITH AFT CG LOCATIONS	11-38
11.11.1 Store Effects on Cg Location	11-38
11.11.2 Wing-Sweep Effects on Stability	11-38
11.11.3 Cruise and Combat Flight Characteristics With Aft Cg	11-38
11.11.4 Takeoff and Landing Configuration Flight Characteristics with Aft Cg	11-38

PART V — EMERGENCY PROCEDURES

CHAPTER 12 — GROUND EMERGENCIES

12.1 ON-DECK EMERGENCIES	12-1
12.1.1 Engine Fire on the Deck	12-1
12.1.2 Abnormal Start	12-1
12.1.3 START VALVE Light After Engine Start	12-1
12.1.4 Uncommanded Engine Acceleration on Deck	12-1
12.1.5 Ground Egress Without Parachute and Survival Kit	12-2
12.1.6 Emergency Entrance	12-2
12.1.7 Weight On-Off Wheels Switch Malfunction	12-2
12.1.8 Binding/Jammed Flight Controls On Deck	12-4
12.1.9 Brake Failure at Taxi Speed	12-4

CHAPTER 13 — TAKEOFF EMERGENCIES

13.1	ABORTED TAKEOFF	13-1
13.1.1	Aborted Takeoff Checklist	13-1
13.2	SINGLE-ENGINE FAILURE FIELD/CATAPULT LAUNCH/WAVEOFF	13-2
13.2.1	Angle-of-Attack/Endspeed Consideration	13-2
13.2.2	Rate of Climb Consideration	13-2
13.2.3	Stores Jettison Considerations	13-2
13.2.4	Aircrew Coordination	13-2
13.2.5	Single-Engine Failure Field/Catapult Launch/Waveoff	13-3
13.3	BLOWN TIRE DURING TAKEOFF	13-3
13.3.1	Blown Tire During Takeoff; Takeoff Aborted or After Landing Touchdown	13-3
13.3.2	Blown Tire During Takeoff; Takeoff Continued or After Landing Go-Around	13-3

CHAPTER 14 — IN-FLIGHT EMERGENCIES

14.1	COMMUNICATIONS FAILURE	14-1
14.1.1	Flightcrew Attention Signals	14-1
14.1.2	COMM-NAV Emergency Procedures	14-1
14.2	PITOT-STATIC SYSTEM FAILURES	14-1
14.3	EMERGENCY JETTISON	14-2
14.4	FIRE LIGHT AND/OR FIRE IN FLIGHT	14-4
14.5	ENGINE EMERGENCIES	14-5
14.5.1	Compressor Stall	14-5
14.5.2	Airstarts	14-7
14.5.3	Single-Engine Flight Characteristics	14-11
14.5.4	Engine Overspeed (N1 or N2 OSP Legend)	14-12
14.5.5	Engine START VALVE Light	14-12
14.5.6	Engine Transfer to SEC Mode	14-12
14.5.7	Uncommanded SEC Mode Rpm Decay	14-13
14.5.8	Uncommanded Engine Acceleration Airborne (No Throttle Movement)	14-15
14.5.9	Exhaust Nozzle Failed (No Nozzle Response to Throttle Movement)	14-15
14.5.10	Stuck/Jammed Throttle(s)	14-15
14.5.11	AICS Malfunctions	14-16
14.5.12	INLET ICE Light	14-17
14.5.13	Oil System Malfunction	14-17
14.5.14	RATS Operation In Flight	14-17
14.6	FUEL SYSTEM MALFUNCTIONS	14-18
14.6.1	Fuel Pressure Caution Lights/Low Fuel Pressure Warning Tone	14-18
14.6.2	L or R FUEL LOW Light	14-19
14.6.3	Fuel Transfer Failures	14-19
14.6.4	Uncommanded Dump	14-19
14.6.5	Fuel Leak	14-19
14.6.6	Fuel Imbalance/Fuel Quantity Balancing	14-20
14.7	ELECTRICAL FAILURE	14-20
14.7.1	Generator Failure	14-20
14.7.2	Double Generator Failure	14-20a

	<i>Page No.</i>
14.7.3 Double Transformer-Rectifier Failure	14-22
14.7.4 TRANS/RECT Light	14-22
14.7.5 Electrical Fire	14-22
14.7.6 Total Electrical Failure	14-24
14.8 ECS MALFUNCTIONS/FAILURES	14-25
14.8.1 ECS Leak/Elimination of Smoke and Fumes	14-25
14.8.2 COOLING AIR Light	14-27
14.8.3 TARPS ECS Lights Illuminate	14-27
14.8.4 SENSOR COND Light Illuminated and/or PUMP Phase Circuit Breakers Popped or APG-71 PM Acronym	14-28
14.8.5 Cockpit Temperature Control Malfunction	14-28
14.8.6 Cockpit Overpressurization on Deck	14-28
14.8.7 CABIN PRESS Light	14-28
14.8.8 WSHLD HOT Light	14-28
14.9 OXYGEN SYSTEM FAILURE	14-29
14.9.1 OBOGS Light	14-29
14.9.2 B/U OXY LOW Light (Both Cockpits)	14-29
14.9.3 B/U OXY LOW Light (Pilot Only)	14-30
14.9.4 B/U OXY LOW Light (RIO Only)	14-30
14.10 LAD/CANOPY LIGHT AND/OR LOSS OF CANOPY	14-30
14.10.1 LAD/CANOPY Light With RIO CANOPY Light/Canopy Loss	14-30
14.10.2 LAD/CANOPY Light Without RIO CANOPY Light	14-31
14.11 HYDRAULIC SYSTEM MALFUNCTIONS	14-31
14.11.1 Combined Pressure Approximately 2,400 to 2,600 Psi	14-31
14.11.2 Flight Pressure Approximately 2,400 to 2,600 Psi	14-31
14.11.3 Combined Pressure Zero	14-32
14.11.4 Flight Pressure Zero	14-33
14.11.5 Both Combined and Flight Pressure Zero	14-33
14.11.6 Backup Flight Module Malfunction	14-35
14.11.7 Low Brake Accumulator Pressure	14-35
14.12 FLIGHT CONTROL FAILURES OR MALFUNCTIONS	14-35
14.12.1 Controllability Check	14-35
14.12.2 Uncommanded Roll and/or Yaw	14-37
14.12.3 DFCS Flight Control Failures or Malfunctions	14-38
14.12.4 Rudder Authority Failure	14-40
14.12.5 Horizontal Tail Authority Failure	14-42
14.12.6 Spoiler Malfunction	14-42
14.12.7 FLAP Light	14-45
14.12.8 Flap and Slat Asymmetry	14-46
14.12.9 WING SWEEP Lights	14-47
14.12.10 Unscheduled Wing Sweep	14-47
14.12.11 CADC Light	14-47
14.12.12 AUTOPILOT Light	14-48
14.12.13 Weight On-Off Wheels Switch Malfunction	14-48
14.13 DEPARTURE/SPIN	14-49
14.13.1 Vertical Recovery	14-49
14.13.2 Upright Departure/Flat Spin	14-49
14.13.3 Inverted Departure/Spin	14-50

CHAPTER 15 — LANDING EMERGENCIES

15.1	DUAL-ENGINE LANDING, ONE OR BOTH ENGINES IN SECONDARY MODE	15-1
15.2	SINGLE-ENGINE LANDING PRIMARY MODE	15-1
15.3	SINGLE-ENGINE LANDING SECONDARY MODE	15-3
15.3.1	Single-Engine Landing — SEC Mode	15-4
15.4	LANDING GEAR EMERGENCIES	15-6
15.4.1	Landing Gear Emergency Lowering	15-6
15.4.2	Landing Gear Malfunctions	15-8
15.4.3	LAUNCH BAR Light	15-9
15.5	BLOWN-TIRE LANDING	15-10
15.6	FLAP AND SLAT LANDING EMERGENCIES	15-10
15.6.1	No-Flaps and No-Slats Landing	15-10
15.6.2	Auxiliary Flap Failure	15-10
15.7	WING-SWEEP EMERGENCIES	15-11
15.7.1	Aft Wing-Sweep Landings	15-11
15.7.2	Asymmetric Wing Sweep	15-11
15.8	AFT HUNG ORDNANCE LANDINGS	15-16
15.8.1	Landing with Aft Hung Ordnance	15-17
15.9	FIELD ARRESTMENTS	15-17
15.9.1	Field Arresting Gear	15-17
15.9.2	Short-Field Arrestment	15-18
15.9.3	Long-Field Arrestment	15-18
15.9.4	Engaging Speeds	15-18
15.10	BARRICADE ARRESTMENT	15-18
15.11	ARRESTING HOOK EMERGENCY DOWN	15-21
15.12	FORCED LANDING	15-21
15.13	GROUND ROLL BRAKING FAILURES	15-21

CHAPTER 16 — EJECTION

16.1	EJECTION	16-1
16.1.1	Ejection Envelope	16-1
16.1.2	Ejection Preparation	16-5
16.1.3	Ejection Initiation	16-6
16.2	MANUAL BAILOUT	16-6
16.3	SURVIVAL/POSTEJECTION PROCEDURES	16-6
16.3.1	Manual Man/Seat Separation	16-7
16.3.2	Survival Kit Deployment	16-7
16.3.3	Parachute Steering	16-9
16.3.4	Parachute Landing Preparation	16-9
16.3.5	Raft Boarding	16-9

PART VI — ALL-WEATHER OPERATIONS

CHAPTER 17 — INSTRUMENT PROCEDURES

17.1	AUTOMATIC CARRIER LANDING SYSTEM	17-1
17.1.1	Mode I	17-1
17.1.2	Mode II	17-1
17.1.3	Mode III	17-1
17.1.4	Flight Director	17-1
17.2	AIRCRAFT SUBSYSTEMS	17-2
17.2.1	Data Link	17-2
17.2.2	Digital Flight Control System	17-2
17.2.3	Radar Beacon (AN/APN-154)	17-2
17.2.4	ACLS Beacon Augmentor (R-1623)	17-2
17.2.5	Approach Power Compensator Performance	17-3
17.2.6	ACLS/ILS Displays (MFD and HUD)	17-3
17.2.7	Instrument Landing System (AN/ARA-63)	17-5
17.3	SURFACE SUBSYSTEMS	17-8
17.3.1	Automatic Landing System (AN/SPN-42)	17-8
17.3.2	Instrument Landing System (AN/SPN-41)	17-8
17.4	ACLS PROCEDURES	17-10
17.4.1	Preflight	17-10
17.4.2	Poststart Checks	17-10
17.4.3	Approach Phase	17-10
17.4.4	Landing Phase	17-12

CHAPTER 18 — EXTREME WEATHER OPERATIONS

18.1	ICE AND RAIN	18-1
18.1.1	Icing	18-1
18.1.2	Rain	18-1
18.2	HYDROPLANING	18-2
18.2.1	Dynamic Hydroplaning	18-2
18.2.2	Viscous Hydroplaning	18-3
18.2.3	Combined Dynamic and Viscous Hydroplaning	18-3
18.2.4	Reverted Rubber Skids	18-3
18.2.5	Landing On Wet Runway	18-4
18.3	TURBULENCE AND THUNDERSTORMS	18-4
18.3.1	In the Storm	18-4
18.4	COLD-WEATHER OPERATIONS	18-4
18.4.1	Preflight	18-5
18.4.2	Engine Start	18-5
18.4.3	Taxiing	18-5
18.4.4	Takeoff	18-5
18.4.5	Landing	18-6
18.4.6	After Landing	18-6
18.4.7	Before Leaving Aircraft	18-6

	<i>Page No.</i>
18.5	HOT-WEATHER AND DESERT OPERATIONS 18-6
18.5.1	Taxiing 18-6
18.5.2	Takeoff 18-6
18.5.3	Landing 18-6

PART VII — COMMUNICATIONS-NAVIGATION EQUIPMENT AND PROCEDURES

CHAPTER 19 — COMMUNICATIONS

19.1	COMMUNICATIONS AND ASSOCIATED EQUIPMENT 19-1
19.1.1	Communications Antennas 19-1
19.1.2	Communications Antenna Selection 19-1
19.1.3	Mutual Interference 19-1
19.2	INTERCOMMUNICATIONS 19-1
19.2.1	Audio Warning Signals 19-5
19.2.2	Pilot Tone Volume/TACAN Command Panel 19-7
19.3	V/UHF RADIO (AN/ARC-182) 19-7
19.3.1	Preset Channel(s) Load 19-7
19.3.2	Built-In Test (BIT) 19-7
19.3.3	Have Quick (Antijam) Mode 19-7
19.3.4	Have Quick Load Instructions 19-12
19.3.5	Radio Frequency Control/Indicators (RFCI) 19-18
19.4	V/UHF AUTOMATIC DIRECTION FINDER (OA-8697) 19-18
19.5	UHF VOICE SECURITY EQUIPMENT (TSEC/KY-58) 19-19
19.5.1	KY-58 Operation 19-19
19.5.2	Prelaunch 19-19
19.5.3	Postlaunch 19-19
19.5.4	After Landing 19-19
19.6	JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM 19-19
19.6.1	JTIDS Terminal 19-21
19.6.2	JTIDS Controls 19-23
19.6.3	Mission Data Loader (MDL) 19-23
19.6.4	JTIDS System Operation 19-23
19.7	IN-FLIGHT VISUAL COMMUNICATIONS 19-27
19.8	GROUND HANDLING SIGNALS 19-27

CHAPTER 20 — NAVIGATION SYSTEM

20.1	NAVIGATION SYSTEM 20-1
20.1.1	AN/ASN-139 Inertial Navigation Set 20-1
20.1.2	Miniature Airborne GPS Receiver (MAGR) 20-3
20.1.3	AN/USN-2(V) Standard Attitude Heading Reference System (SAHRS) 20-5
20.1.4	Mission Computer System (MCS) 20-5
20.1.5	Navigation Data Initialization 20-6
20.1.6	Displays Subsystem 20-6
20.1.7	Programmable Tactical Information Display (PTID) 20-6

	<i>Page No.</i>
20.1.8 Converter Interface Unit (CIU)	20-6
20.1.9 Standard Central Air Data Computer (SCADC)	20-6
20.1.10 AN/ARN-118 Tactical Air Navigation (TACAN) System or AN/URC-107 Joint Tactical Information Distribution System (JTIDS)	20-8
20.1.11 AN/ASW-27C Data Link (D/L)	20-11
20.1.12 UHF Automatic Direction Finder (ADF)	20-11
20.1.13 Bearing Distance Heading Indicator (BDHI)	20-11
20.1.14 AN/URC-107 Joint Tactical Information Distribution System (JTIDS)	20-12
 20.2 NAVIGATION SYSTEM DATA DISTRIBUTION	 20-12
20.2.1 Navigation Data Display	20-12
 20.3 NAVIGATION SYSTEM OPERATION	 20-20
20.3.1 GPS Operation	20-20
20.3.2 Navigation Modes	20-27
20.3.3 MAGR Initialization	20-37
20.3.4 INS and SAHRS Concurrent Alignment	20-38
20.3.5 Concurrent Carrier Alignment	20-45
20.3.6 Initially Entered Navigation Parameters	20-52
20.3.7 Navigation Database	20-55
20.3.8 Flight Plan Management	20-59
20.3.9 Tactical Navigation	20-72

CHAPTER 21 — IDENTIFICATION

21.1 IDENTIFICATION TRANSPONDER (AN/APX-100)	21-1
21.1.1 IFF Transponder	21-1
21.1.2 Altitude Computations	21-6
 21.2 IFF INTERROGATOR (AN/APX-76)	 21-6
21.2.1 IFF Self-Test	21-7

PART VIII — WEAPON SYSTEMS

CHAPTER 22 — TARPS SUBSYSTEM

22.1 RECONNAISSANCE SYSTEM	22-1
22.1.1 TARPS Pod	22-2
22.1.2 Serial Frame Camera	22-2
22.1.3 Panoramic Camera	22-2
22.1.4 Data Display System	22-2
22.1.5 TARPS Environmental Control System	22-2
22.1.6 Controller Processor Signal Unit	22-2
 22.2 DISPLAY SYSTEM	 22-2
22.3 TARPS EQUIPMENT CIRCUIT BREAKERS	22-2

	<i>Page No.</i>
22.4 RECONNAISSANCE DISPLAYS AND FORMATS	22-9
22.4.1 MFD RECON DATA Status Format	22-9
22.4.2 Reconnaissance Fault/Problem Reporting	22-9
22.4.3 Reconnaissance Steering Selection	22-11
22.4.4 HUD/VDI Symbology	22-13
22.5 RECONNAISSANCE SYSTEM OPERATION	22-13
22.5.1 Reconnaissance Parameter Entry	22-13
22.5.2 In-Flight Entry of Reconnaissance Waypoint Parameters	22-21
22.5.3 One-Fix Update	22-21
22.5.4 Plotting Command Course/Map Target Leg	22-21
22.5.5 Cycling Sensors	22-21
22.6 PILOT RECONNAISSANCE OPERATION	22-21
22.6.1 Navigation Visual Surface Waypoint Update	22-21
22.6.2 Pilot TARPS Steering	22-21
22.6.3 Identification of Targets Using Television Camera Set	22-22
22.6.4 Altitude (AGL) Mechanization	22-22
22.7 SENSOR CAPABILITIES AND LIMITATIONS	22-22
22.7.1 Lineal Coverage	22-22
22.7.2 Serial Frame Camera	22-22
22.7.3 Panoramic Camera	22-23
22.7.4 Long-Range Oblique Photography Camera (KS-153A With 610-mm Lens)	22-24
22.7.5 Photographic Film	22-26
22.7.6 Digital Data System	22-26

CHAPTER 23 — NAVIGATION COMMAND AND CONTROL GRID

23.1 NAVIGATION COMMAND AND CONTROL GRID	23-1
23.1.1 NAV GRID Data Entry	23-1
23.1.2 NAV GRID Displays	23-3

CHAPTERS 24 TO 36 — (REFER TO NAVAIR 01-F14AAD-1A)

PART IX — FLIGHTCREW COORDINATION

CHAPTER 37 — FLIGHTCREW COORDINATION

37.1 INTRODUCTION	37-1
37.2 PILOT AND RIO RESPONSIBILITIES	37-1
37.2.1 Aircrew Coordination	37-1
37.2.2 Pilot Responsibilities	37-1
37.2.3 Radar Intercept Officer Responsibilities	37-1
37.2.4 Mission Commander	37-1
37.2.5 Specific Responsibilities	37-1

37.3	SPECIAL CONSIDERATIONS	37-4
37.3.1	Functional Checkflights	37-4
37.3.2	Formation Flights	37-4
37.3.3	Training	37-4
37.3.4	SAR	37-4
37.4	PROCEDURES, TECHNIQUES, AND CHECKLISTS	37-4
37.4.1	General	37-4
37.4.2	Pilot	37-5
37.4.3	RIO	37-5

CHAPTER 38 — AIRCRAFT SELF-TEST

38.1	AIRCRAFT SELF-TEST OVERVIEW	38-1
38.2	MASTER TEST PANEL CHECKS	38-1
38.2.1	MASTER TEST Switch Operation	38-3
38.3	ON-BOARD CHECKOUT	38-3
38.3.1	Built-in-Test Description	38-7
38.3.2	Test Prerequisites/Restrictions	38-9
38.3.3	Avionic BIT Operation	38-10
38.3.4	Joint Tactical Information Distribution System On-Board Check	38-36
38.4	COOPERATIVE SUPPORT SOFTWARE	38-40
38.4.1	CSS Operation	38-40
38.5	RADAR SYSTEM BUILT-IN TEST	38-47
38.5.1	BIT Modes	38-48
38.5.2	Radar BIT Operation	38-51
38.5.3	Flycatcher	38-70

PART X — NATOPS EVALUATION

CHAPTER 39 — NATOPS EVALUATION AND QUESTION BANK

39.1	NATOPS EVALUATION PROGRAM	39-1
39.1.1	Concept	39-1
39.1.2	Implementation	39-1
39.1.3	Definitions	39-1
39.2	GROUND EVALUATION	39-2
39.2.1	Open-Book Examination	39-2
39.2.2	Closed-Book Examination	39-2
39.2.3	Oral Examination	39-2
39.2.4	Emergency	39-2
39.2.5	Malfunction	39-2
39.2.6	MFT and WST Procedures Evaluation	39-2
39.2.7	Grading Instructions	39-2
39.3	FLIGHT EVALUATION	39-2
39.3.1	Instrument Flight Evaluation	39-2

	<i>Page No.</i>
39.4 OPERATIONAL DEPLOYABLE SQUADRONS	39-3
39.5 TRAINING AND EVALUATION SQUADRONS	39-3
39.6 FLIGHT EVALUATIONS	39-3
39.6.1 Mission Planning and Briefing	39-3
39.6.2 Preflight and Line Operations	39-3
39.6.3 Taxi and Runup	39-3
39.6.4 (*) Takeoff and Transition	39-3
39.6.5 Climb and Cruise	39-3
39.6.6 (*) Approach and Landing	39-3
39.6.7 Communications	39-3
39.6.8 (*) Emergency and Malfunction Procedures	39-3
39.6.9 Postflight Procedures	39-3
39.6.10 Mission Evaluation	39-3
39.7 RECORD AND REPORTS	39-3
39.7.1 Critique	39-4
39.8 FLIGHT EVALUATION GRADING CRITERIA	39-4
39.8.1 Flight Evaluation Grade Determination	39-4
39.8.2 Final Grade Determination	39-4
39.9 APPLICABLE PUBLICATIONS	39-4
39.10 NATOPS EVALUATION QUESTION BANK	39-4

PART XI — PERFORMANCE DATA (REFER TO NAVAIR 01-F14AAP-1.1)

CHAPTER 40 — TACTICAL IMAGING SET

40.1 AN/AVX-3 TACTICAL IMAGING SET	40-1
40.1.1 Remote Control Unit (RCU)	40-1
40.1.2 Image Transceiver	40-1
40.1.3 Video Tape Recorder (VTR)	40-1
40.1.4 Interface Box	40-3
40.2 OPERATING INSTRUCTIONS	40-3
40.2.1 Powerup Sequence	40-3
40.3 RESETTING RCU AND IMAGE TRANSCEIVER	40-4
40.4 SETTINGS MENUS	40-5
40.4.1 Settings Menus' Format	40-5
40.4.2 Send-to-Call-Sign-Menu	40-6
40.4.3 Modify Call Sign Menu	40-6
40.4.4 Edit Call Sign Menu	40-6
40.4.5 Send/Delete Function Menu	40-6
40.4.6 Capture Rate Menu	40-6
40.4.7 Capture Time Menu	40-7
40.4.8 Max Key Time	40-7
40.4.9 Automatic Transmit Menu	40-7
40.4.10 Compression Method Menu	40-7
40.4.11 Compression Ratio Menu	40-8

	<i>Page No.</i>
40.4.12 PTAC Quick Start Menu	40-8
40.4.13 Local Call Sign Menu	40-8
40.4.14 Display Brightness Menu	40-9
40.4.15 Image Dimension menu	40-9
40.4.16 View Communications Cable Identification Menu	40-9
40.4.17 EIS Configuration Menu	40-9
40.4.18 Date and Time Menus	40-10
40.4.19 Format SRAM Card Menu	40-10
40.4.20 Waveburst Version Menu	40-10
40.5 POWER DOWN SEQUENCE	40-10
40.6 CAPTURING/COMPRESSING/SAVING/TRANSMITTING/RECEIVING IMAGES	40-10
40.6.1 Voice and Data Modes	40-10
40.6.2 Capturing Images	40-11
40.6.3 Compressing/Saving Images	40-12
40.6.4 Transmitting Images	40-13
40.6.5 Receiving Images	40-13
40.7 VIEWING IMAGES	40-14
40.8 CONTROLLING VTR FUNCTIONS	40-17
40.8.1 Function Operations	40-18
40.9 ERROR MESSAGES	40-19
40.9.1 DEW	40-19
40.9.2 COMMS ERROR	40-19
40.9.3 INTERNAL ERROR	40-19
40.9.4 COMMAND ERROR	40-19

LIST OF ILLUSTRATIONS

	<i>Page No.</i>
CHAPTER 1 — AIRCRAFT AND ENGINE	
Figure 1-1. Aircraft Dimensions	1-2
Figure 1-2. Characteristics and Limitations (Sheet 1 of 2)	1-3
Figure 1-3. Electronic Nomenclature	1-5
CHAPTER 2 — SYSTEMS	
Figure 2-1. Air Inlet Control System	2-2
Figure 2-2. AICS Control and Indicators (Sheet 1 of 2)	2-3
Figure 2-3. Variable-Geometry Inlet Configuration	2-5
Figure 2-4. AICS Normal Operating Mode	2-6
Figure 2-5. Fail-Operational Mode — No INLET Light	2-6
Figure 2-6. Fail-Safe Mode — INLET Light Illuminated	2-7
Figure 2-7. Ramp Monitor Logic	2-8
Figure 2-8. AICS Anti-Ice System	2-10
Figure 2-9. F110-GE-400 Engine	2-10
Figure 2-10. ENG MODE SELECT Panel and ENG SEC Lights	2-12
Figure 2-11. AFTC Functional Relationships	2-13
Figure 2-12. Rich Stability Cutback — F110-GE-400 Engine	2-15
Figure 2-13. Variable Area Exhaust Nozzle	2-17
Figure 2-14. FEMS Multifunction Display Configuration	2-18
Figure 2-15. Fatigue Engine Monitoring System Diagram	2-19
Figure 2-16. Flight Maintenance Indicator	2-20
Figure 2-17. Engine Fuel System	2-22
Figure 2-18. Afterburner Fuel Sequencing	2-24
Figure 2-19. Throttle Interlocks	2-25
Figure 2-20. Throttle Control	2-26
Figure 2-21. Autothrottle Controls and Indicators (Sheet 1 of 2)	2-28
Figure 2-22. Engine Bleed Air/Compartment Ventilation	2-30
Figure 2-23. Anti-Ice Control	2-31
Figure 2-24. Engine Start System	2-33
Figure 2-25. Engine Instruments (F110-GE-400)	2-36
Figure 2-26. MFD Engine Monitor Display	2-38
Figure 2-27. Fire Detection System	2-39
Figure 2-28. Fire Extinguishing Switches and Advisory Lights	2-41
Figure 2-29. Fuel Tanks	2-41
Figure 2-30. Fuel Controls and Indicators (Sheet 1 of 3)	2-44
Figure 2-31. Engine Fuel Feed	2-47
Figure 2-32. Aft Fuselage Fuel Transfer	2-49
Figure 2-33. Forward Fuselage Fuel Transfer	2-50
Figure 2-34. Wing and External Tank Fuel Transfer	2-52
Figure 2-35. Fuel Vent and Dump	2-56
Figure 2-36. Refueling System	2-57
Figure 2-37. Generator Panel	2-60
Figure 2-38. Circuit Breaker Alphanumeric Index (Sheet 1 of 5)	2-64
Figure 2-39. Hydraulic System Controls and Indicators (Sheet 1 of 2)	2-70
Figure 2-40. Outboard Spoiler System	2-74
Figure 2-41. Backup Flight Control System	2-75

	<i>Page No.</i>
Figure 2-42. Mission Computer System Architecture	2-78
Figure 2-43. CADC Functional Relationships	2-80
Figure 2-44. CADC Processor	2-80
Figure 2-45. CADC Processor Indicators	2-81
Figure 2-46. Wing-Sweep Controls and Indicators (Sheet 1 of 2)	2-84
Figure 2-47. Wing-Sweep Modes	2-86
Figure 2-48. Wing-Sweep Interlocks	2-88
Figure 2-49. Flap and Slat Controls and Indicators (Sheet 1 of 2)	2-90
Figure 2-50. Wing Control Surfaces	2-92
Figure 2-51. Maneuver Flap Envelope	2-94
Figure 2-52. Maneuver Slat/Flap Automatic Schedule for CADC	2-94
Figure 2-53. Speedbrakes	2-95
Figure 2-54. Speedbrake Control and Indicator	2-96
Figure 2-55. Control Surface Indicators (Sheet 1 of 2)	2-98
Figure 2-56. Longitudinal Control System	2-100
Figure 2-57. Longitudinal System Authority	2-100
Figure 2-58. Control Stick and Trim (Sheet 1 of 2)	2-101
Figure 2-59. Integrated Trim Schedules	2-103
Figure 2-60. Lateral Control System	2-103
Figure 2-61. Lateral System Authority	2-104
Figure 2-62. Spoiler Control System	2-105
Figure 2-63. Spoiler Gearing Schedule	2-106
Figure 2-64. Yaw Control System	2-108
Figure 2-65. Yaw System Authority	2-108
Figure 2-66. DFCS Rates and Authorities	2-110
Figure 2-67. DFCS Controls and Indicators (Sheet 1 of 3)	2-111
Figure 2-68. DFCS Up and Away ARI Functions	2-114
Figure 2-69. DFCS Pitch Interfaces and Control Functions (Sheet 1 of 3)	2-117
Figure 2-70. DFCS Failure Modes and Indications (Sheet 1 of 4)	2-121
Figure 2-71. DFCS DCP System Display Codes	2-131
Figure 2-72. Landing Gear Controls and Indicators (Sheet 1 of 2)	2-134
Figure 2-73. Wheelbrake Controls and Indicators	2-137
Figure 2-74. Antiskid BIT Box	2-139
Figure 2-75. Nosewheel Steering Controls	2-142
Figure 2-76. Launch Bar Controls	2-144
Figure 2-77. Nosewheel Strut and Launch Bar Positions	2-146
Figure 2-78. Arresting Hook Controls	2-147
Figure 2-79. Air-Conditioning and Pressurization Controls and Indicators (Sheet 1 of 2)	2-149
Figure 2-80. Avionic Equipment Liquid Cooling Controls and Lights (Sheet 1 of 2)	2-153
Figure 2-81. Cabin Pressure Schedule	2-155
Figure 2-82. Canopy Defog Controls and Windshield Air	2-156
Figure 2-83. Oxygen System Controls and Indicators (Sheet 1 of 2)	2-158
Figure 2-84. Backup Oxygen Duration Chart	2-161
Figure 2-85. Airstream Sensors	2-162
Figure 2-86. Display Systems Controls and Indicators (Sheet 1 of 4)	2-163
Figure 2-87. Display Format Groups (Sheet 1 of 2)	2-167
Figure 2-88. Heads-Up Display	2-170
Figure 2-89. Pilot Displays Control Panel (Sheet 1 of 3)	2-171
Figure 2-90. Multistatus Indicator Symbols/Meanings	2-174
Figure 2-91. Multifunction Display (Sheet 1 of 2)	2-175
Figure 2-92. Cursor Controls	2-177
Figure 2-93. Warning, Caution, Advisory Functions (Sheet 1 of 3)	2-179
Figure 2-94. Test Patterns	2-182

	<i>Page No.</i>
Figure 2-95. HUD TLN Basic Format (Sheet 1 of 4)	2-183
Figure 2-96. HUD Declutter Levels	2-187
Figure 2-97. HUD Added Symbology (Sheet 1 of 2)	2-189
Figure 2-98. HUD Symbology Available on TLN Formats (Sheet 1 of 2)	2-191
Figure 2-99. HUD A/A Search Formats (Sheet 1 of 2)	2-193
Figure 2-100. HUD Symbology Available on A/A Formats (Sheet 1 of 2)	2-195
Figure 2-101. HUD A/G Basic Format	2-198
Figure 2-102. HUD Symbology Available on A/G Formats (Sheet 1 of 2)	2-199
Figure 2-103. HUD Overlay Formats	2-201
Figure 2-104. HUD Manual Reticle Format	2-202
Figure 2-105. Slaved DEU Page Control	2-203
Figure 2-106. MFD MENU Displays	2-204
Figure 2-107. MFD Spin Indicator Display	2-206
Figure 2-108. MFD Warning/Caution/Advisory and Message Overlays (Sheet 1 of 2)	2-207
Figure 2-109. Computer and OBC Messages (Sheet 1 of 4)	2-209
Figure 2-110. Typical MFD Alphanumeric Format	2-213
Figure 2-111. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 1 of 9)	2-215
Figure 2-112. MFD VDI Symbology Available on TLN Formats (Sheet 1 of 2)	2-224
Figure 2-113. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 1 of 6)	2-226
Figure 2-114. MFD VDI Symbology Available on Air-to-Air and Air-to-Ground Formats (Sheet 1 of 2)	2-231
Figure 2-115. MFD VDI Air-to-Ground (A/G) Format	2-233
Figure 2-116. MFD VDI Recon Overlay Format	2-234
Figure 2-117. MFD VDI Radar and IRSTS Overlay Formats (Sheet 1 of 2)	2-235
Figure 2-118. MFD HSD Format (Sheet 1 of 4)	2-237
Figure 2-119. Plot Line and Course Line Displays (Sheet 1 of 2)	2-241
Figure 2-120. MFD SMS Format—CAP/Attack, Fighter Wingforms (Sheet 1 of 2)	2-243
Figure 2-121. MFD Engine Monitor Format (Sheet 1 of 2)	2-245
Figure 2-122. Data Entry Unit/Main Menu Page	2-247
Figure 2-123. Data Entry Parameters	2-249
Figure 2-124. Angle-of-Attack Conversion (Sheet 1 of 2)	2-252
Figure 2-125. Angle-of-Attack Displays	2-254
Figure 2-125A. Auxiliary Pneumatic Selector Valve Reset	2-256
Figure 2-126. Cockpit Canopy Control Handle and Indicator Lights	2-257
Figure 2-127. Ejection Seat (Sheet 1 of 2)	2-259
Figure 2-128. Survival Kit	2-262
Figure 2-129. Command Ejection Lever	2-264
Figure 2-130. Cockpit Light Controls (Sheet 1 of 3)	2-266
Figure 2-131. Pilot Indicator Lights (Sheet 1 of 5)	2-270
Figure 2-132. RIO Indicator Lights (Sheet 1 of 3)	2-275
Figure 2-133. Multistatus Indicator	2-279
Figure 2-134. Jettison Controls	2-281
Figure 2-135. ACM Jettison Selection and Display	2-282
Figure 2-136. Systems Test and System Power Ground Panel	2-283
Figure 2-137. CNU-188/A External Baggage Container	2-284

CHAPTER 3 — SERVICING AND HANDLING

Figure 3-1. Aircraft Servicing Locations	3-1
Figure 3-2. Aircraft Servicing Data (Sheet 1 of 2)	3-2
Figure 3-3. Aircraft Servicing (Sheet 1 of 3)	3-5
Figure 3-4. Runup Danger Areas — Exhaust Jet Wake Velocity and Temperature	3-9
Figure 3-5. Radar Radiation Hazard Areas (Sheet 1 of 4)	3-10
Figure 3-6. Noise Danger Areas	3-14

	<i>Page No.</i>
Figure 3-7. Towing Turn Radii	3-16
Figure 3-8. Towing	3-17
Figure 3-9. Tiedown Arrangement (Sheet 1 of 2)	3-18
 CHAPTER 4 — OPERATING LIMITATIONS	
Figure 4-1. Store Station Configuration	4-2
Figure 4-2. Instrument Markings	4-3
Figure 4-3. Engine Operating Limits	4-4
Figure 4-4. Maximum Allowable Airspeeds (Sheet 1 of 3)	4-6
Figure 4-5. Variation of Maximum Allowable Normal Load Factor With Gross Weight	4-9
Figure 4-6. Maximum Allowable Angle of Attack Rudder Deflections	4-11
Figure 4-7. Angle-of-Attack Limits	4-12
Figure 4-8. Maneuvering Limits — Cruise Configuration (Roll SAS Off or Degraded DFCS)	4-13
Figure 4-9. Maneuvering Limits — Rolling (Sheet 1 of 3)	4-14
Figure 4-10. Flap Limitations	4-17
 CHAPTER 7 — SHORE-BASED PROCEDURES	
Figure 7-1. Exterior Inspection	7-2
Figure 7-2. Ejection Seat Safe-and-Arm Module	7-7
Figure 7-3. Taxi Turn Radii (Maximum Nosewheel Steering 70°)	7-19
Figure 7-4. Field Carrier Landing Practice	7-38
 CHAPTER 8 — CARRIER-BASED PROCEDURES	
Figure 8-1. Catapult Launch Trim Requirements	8-5
Figure 8-2. Center-of-Gravity Variation With Fuel Loading	8-6
Figure 8-3. Carrier Landing Pattern	8-8
Figure 8-4. Carrier-Controlled Approach (Typical)	8-11
 CHAPTER 10 — FUNCTIONAL CHECKFLIGHT PROCEDURES	
Figure 10-1. Flight Profile	10-1
 CHAPTER 11 — FLIGHT CHARACTERISTICS	
Figure 11-1. Lateral-Control-Induced Departure Areas	11-8
Figure 11-2. Cross-Control-Induced Departure Areas	11-12
Figure 11-3. F-14 Departure Recovery Diagram	11-16
Figure 11-4. Spin Arrow Displays	11-18
Figure 11-5. MFD-1/PTID Right Spin Display (INS and SAHRS Failed)	11-19
Figure 11-6. Stall Speeds for Wing Rock at 25 Units AOA	11-23
Figure 11-7. Minimum Control Speed, Ground (V_{MCG})	11-24
Figure 11-8. Rudder Effectiveness	11-25
Figure 11-9. Landing Approach Airspeed (15 Units AOA)	11-28
Figure 11-10. Asymmetric Wing-Sweep Landing Approach	11-34
 CHAPTER 12 — GROUND EMERGENCIES	
Figure 12-1. Emergency Entrance	12-3

CHAPTER 14 — IN-FLIGHT EMERGENCIES

Figure 14-1. Airspeed Indicator Failure	14-2
Figure 14-2. External Stores Jettison	14-3
Figure 14-3. Airstart Envelope	14-9
Figure 14-4. Secondary Mode Thrust Levels	14-14
Figure 14-5. Emergency Generator Distribution (Sheet 1 of 2)	14-21
Figure 14-6. Failure of Both Transformer-Rectifiers Equipment Inoperative List	14-23

CHAPTER 15 — LANDING EMERGENCIES

Figure 15-1. Landing Gear Malfunction Emergency Landing Guide	15-7
Figure 15-2. Asymmetric Wing-Sweep Landing Approach Airspeed	15-12
Figure 15-3. Emergency Field Arrestment Guide (Sheet 1 of 2)	15-19

CHAPTER 16 — EJECTION

Figure 16-1. Minimum Ejection Altitude (Sheet 1 of 3)	16-2
Figure 16-2. Proper Ejection Position	16-6
Figure 16-3. Ejection Initiation	16-7
Figure 16-4. Life Preserver Assembly Inflation	16-8

CHAPTER 17 — INSTRUMENT PROCEDURES

Figure 17-1. Radar Beacon Panel (Sheet 1 of 2)	17-4
Figure 17-2. ACLS/ILS Steering (Sheet 1 of 3)	17-6
Figure 17-3. AN/ARA-63 Decoder Panel	17-9
Figure 17-4. ACLS Mode I and II Approaches	17-11
Figure 17-5. SPN-41 ILS Approach	17-14

CHAPTER 18 — EXTREME WEATHER OPERATIONS

Figure 18-1. Icing Danger Zone	18-2
Figure 18-2. Combined Viscous and Dynamic Tire Hydroplaning	18-3

CHAPTER 19 — COMMUNICATIONS

Figure 19-1. Communications and Associated Equipment	19-2
Figure 19-2. Antenna Select Panel	19-3
Figure 19-3. Intercommunication Controls (Sheet 1 of 2)	19-4
Figure 19-4. Glossary of Tones	19-6
Figure 19-5. Pilot TONE VOLUME/TACAN CMD Panel	19-8
Figure 19-6. AN/ARC-182 V/UHF Control Panel (Sheet 1 of 2)	19-9
Figure 19-7. Radio Frequency/Channel Indicator (Sheet 1 of 2)	19-11
Figure 19-8. Pilot VOLUME Control Panel	19-13
Figure 19-9. Common BIT Indications	19-14
Figure 19-10. Example of an ARC-182 Have Quick II MWOD Fill	19-14
Figure 19-11. Have Quick II Error Codes	19-18
Figure 19-12. KY-58 Controls (Sheet 1 of 2)	19-20
Figure 19-13. JTIDS Control Panels (Sheet 1 of 3)	19-24
Figure 19-14. In-Flight Communications (Sheet 1 of 4)	19-27
Figure 19-15. Deck/Ground Handling Signals	19-31

CHAPTER 20 — NAVIGATION SYSTEM

Figure 20-1. Navigation System	20-2
Figure 20-2. NAV MODE Select/Computer Reset Panel	20-4
Figure 20-3. DEU Navigation Formats	20-7
Figure 20-4. TACAN Controls and Indicators (Sheet 1 of 3)	20-9
Figure 20-5. Navigation System Data Distribution	20-13
Figure 20-6. HUD Navigation Outputs (TLN Basic)	20-14
Figure 20-7. MFD VDI (TLN Basic) Navigation Outputs	20-16
Figure 20-8. Own-Aircraft Basic Data Format	20-17
Figure 20-9. MFD HSD Format — Navigation Outputs	20-18
Figure 20-10. Navigation Data Display Summary (Sheet 1 of 2)	20-21
Figure 20-11. GPS Status Format (Sheet 1 of 3)	20-24
Figure 20-12. Crypto Loading Panel Location	20-27
Figure 20-13. Navigation Modes and Navigation Sensor Data	20-28
Figure 20-14. NAV System Aid Format	20-28
Figure 20-15. INS In-Flight Align Formats	20-32
Figure 20-16. Secondary Navigation Mode Manually Selected	20-33
Figure 20-17. IMU Backup Navigation Mode Selection	20-34
Figure 20-18. SAHRS Backup SLV and DG Modes (Sheet 1 of 2)	20-36
Figure 20-19. MFD MENU1 and MENU2 Displays	20-39
Figure 20-20. DEU Own-Aircraft Data Entry (Typical)	20-40
Figure 20-21. DD/PTID Own-Aircraft Data Entry	20-41
Figure 20-22. MFD Ground Alignment Formats	20-42
Figure 20-23. GPS On-Deck IFA Alignment	20-44
Figure 20-24. CV Alignment Formats — SINS	20-46
Figure 20-25. CV Alignment Formats — Manual (Sheet 1 of 2)	20-47
Figure 20-26. DD Align Data Entry	20-50
Figure 20-27. SAHRS Standalone Align MFD Format	20-50
Figure 20-28. Data Entry Unit Waypoint Pages (Typical)	20-53
Figure 20-29. MFD Waypoint Data Format	20-54
Figure 20-30. DD Waypoint Data Entry	20-54
Figure 20-31. Magnetic Variation Source Selection and DD Entry	20-56
Figure 20-32. Waypoint Numbering Scheme.	20-58
Figure 20-33. DEU Waypoint Type Format.	20-58
Figure 20-34. Waypoint Types and Associated Symbols.	20-59
Figure 20-35. MFD Flight Plan Format	20-60
Figure 20-36. MDL Reversionary Waypoint Format	20-61
Figure 20-37. Flight Plan Data Format	20-62
Figure 20-38. Flight Plan Format – Waypoint Add Page (Sheet 1 of 2)	20-64
Figure 20-39. Flight Plan Format – Waypoint Replacement Page (Sheet 1 of 2)	20-67
Figure 20-40. Flight Plan Format – Waypoint Transfer Page (Sheet 1 of 2)	20-69
Figure 20-41. MDL Reversionary Waypoint Format – MDL Waypoint Transfer	20-71
Figure 20-42. Flight Plan Format – Waypoint Delete Page (Sheet 1 of 2)	20-73
Figure 20-43. Steering Mode Summary	20-76
Figure 20-44. Destination Steering Displays (Sheet 1 of 2)	20-78
Figure 20-45. TACAN Steering Mode Formats (Sheet 1 of 2)	20-80
Figure 20-46. Typical GPS Steering Formats (Sheet 1 of 2)	20-82
Figure 20-47. Auto Waypoint Steering Displays (Sheet 1 of 2)	20-84
Figure 20-48. Commanded Ground Speed Indication	20-86
Figure 20-49. Manual Steering Mode Formats (Sheet 1 of 2)	20-87
Figure 20-50. Data-Link Steering Mode Formats (Sheet 1 of 2)	20-89
Figure 20-51. INS UPDATE MFD Formats (Sheet 1 of 4)	20-92

	<i>Page No.</i>
Figure 20-52. DD Control Panel With GND MAP Selected	20-96
Figure 20-53. MFD TSD Format	20-97
Figure 20-54. HUD/Designate Position Update	20-98
Figure 20-55. Navigation System Continuous Update MFD Format	20-100
Figure 20-56. Surface Waypoint Position MFD Formats (Sheet 1 of 2)	20-101
Figure 20-57. Cursor Controls	20-104
 CHAPTER 21 — IDENTIFICATION	
Figure 21-1. IFF Control Panels (Sheet 1 of 3)	21-2
Figure 21-2. Mode 4 Caution and Reply Light Logic	21-5
Figure 21-3. IFF Display Formats	21-8
 CHAPTER 22 — TARPS SUBSYSTEM	
Figure 22-1. Tactical Air Reconnaissance Pod System	22-1
Figure 22-2. TARPS Component Locations	22-3
Figure 22-3. Controller Processor Signal Unit (Sheet 1 of 5)	22-4
Figure 22-4. MFD MENU2 Format	22-9
Figure 22-5. MFD RECON DATA Status Format	22-10
Figure 22-6. TARPS Advisories	22-10
Figure 22-7. MFD OBC/Maintenance Failure Formats	22-12
Figure 22-8. HUD/VDI Reconnaissance Symbology (Sheet 1 of 2)	22-14
Figure 22-9. HUD Reconnaissance Display (Command Course Steering) (Sheet 1 of 2)	22-16
Figure 22-10. Dynamic Steering Point Display	22-18
Figure 22-11. MFD RECON WPT DATA 1 Format	22-19
Figure 22-12. MFD RECON WPT DATA 2 Format	22-19
Figure 22-13. DEU Reconnaissance Selection	22-20
Figure 22-14. KS-87D Serial Frame Camera Characteristics	22-23
Figure 22-15. KA-99A Panoramic Camera Characteristics	22-24
Figure 22-16. KS-153A Still Picture Camera Characteristics (610-Mm Standoff Configuration)	22-25
 CHAPTER 23 — NAVIGATION COMMAND AND CONTROL GRID	
Figure 23-1. DEU NAV GRID Data Entry — Typical	23-2
Figure 23-2. DD NAV GRID Data Entry	23-3
Figure 23-3. PTID NAV GRID Displays	23-4
Figure 23-4. TSD NAV GRID Display	23-5
 CHAPTER 38 — AIRCRAFT SELF TEST	
Figure 38-1. On-Board Checkout	38-2
Figure 38-2. Test Types	38-3
Figure 38-3. Master Test Panel (Sheet 1 of 2)	38-4
Figure 38-4. Subsystem BIT Mode Test Times (Sheet 1 of 2)	38-6
Figure 38-5. Definition of BIT Status Types	38-8
Figure 38-6. Equipment Subsystem BIT Status Types	38-9
Figure 38-7. BIT Interlocks Test Restrictions (Sheet 1 of 2)	38-11
Figure 38-8. OBC Display Format Types	38-13
Figure 38-9. OBC Failure Acronyms (Sheet 1 of 11)	38-14
Figure 38-10. DFCS Caution Lights and Acronyms (Sheet 1 of 2)	38-25
Figure 38-11. DFCS Fault Codes (Sheet 1 of 6)	38-27
Figure 38-12. OBC Basic Format	38-33

	<i>Page No.</i>
Figure 38-13. Format Examples	38-34
Figure 38-14. OBC Computer Messages	38-37
Figure 38-15. OBC/CSS Messages	38-38
Figure 38-16. OBC-Related Warning/Caution/Advisory Messages	38-39
Figure 38-17. DEU CSS Page	38-41
Figure 38-18. DEU Pages for Operator Code and Data Type	38-41
Figure 38-19. DEU Flycatcher Pages	38-42
Figure 38-20. MD CSS Display Format	38-43
Figure 38-21. Flycatcher Error Messages	38-44
Figure 38-22. DEU Block Address Pages	38-45
Figure 38-23. DEU Trap Pages	38-46
Figure 38-24. Block Address/Trap Error Messages	38-47
Figure 38-25. DD Radar Warning Maltese Cross	38-48
Figure 38-26. MFD/PTID ORT Abort Displays	38-50
Figure 38-27. Test-in-Progress Display	38-52
Figure 38-28. WRA Common Names and Designators	38-53
Figure 38-29. BIT Menu Display Format	38-54
Figure 38-30. Degraded Mode Assessment Format	38-54
Figure 38-31. Maintenance Display Format (Test Complete)	38-55
Figure 38-32. Maintenance Display (Test Complete)	38-55
Figure 38-33. Test Target Menu	38-56
Figure 38-34. Continuous Monitor Display	38-57
Figure 38-35. Radar Continuous Monitor Acronyms	38-58
Figure 38-36. OBC Continuous Monitor Acronyms	38-59
Figure 38-37. PTID Menu for TCS IBIT, In Progress	38-61
Figure 38-38. TCS BIT Prompts and RIO Responses	38-61
Figure 38-39. Initial C/D TEST Display	38-62
Figure 38-40. C/D TEST 1 Display (After Aging Is Completed)	38-62
Figure 38-41. C/D TEST 2 Display	38-63
Figure 38-42. C/D TEST 3 Display	38-63
Figure 38-43. DD Responses for SCU/SSP/DD Select Tests	38-64
Figure 38-44. DD Responses for SHC Select Tests	38-64
Figure 38-45. DD Responses for PTID Select Tests	38-64
Figure 38-46. BIT Static DD Display (ATTK Selected)	38-65
Figure 38-47. BIT Static PTID Display (ATTK Selected)	38-66
Figure 38-48. BIT Static DD Display (GND STAB or TV Selected)(Sheet 1 of 2)	38-67
Figure 38-49. BIT Static PTID Display (Non-ATTK Selection)	38-69
Figure 38-50. BIT DD Dynamic Display	38-70
Figure 38-51. BIT Dynamic PTID Display (ATTK Selected)	38-71
Figure 38-52. Special Test 80-Instrumentation Test	38-71

CHAPTER 40 — TACTICAL IMAGING SET

Figure 40-1. Tactical Imaging Set Controls and Indicators (Sheet 1 of 2)	40-2
Figure 40-2. Settings Menus Sequence	40-5

LIST OF ABBREVIATIONS AND ACRONYMS

A

A/A	Air-to-air.	AGR	Air-to-ground ranging.
AAA	Anti-aircraft artillery.	AIC	Air inlet control; air intercept control.
AAC	Aviation armament change.	AICS	Air inlet control system.
AAI	Air-to-air interrogator.	A/J	Antijam.
AAW	Anti-air warfare.	AM	Amplitude modulation.
AB	Afterburner.	A/N	Alphanumeric.
ac	Alternating current.	AOA	Angle of attack.
ACC	Aircrew system change.	AOB	Angle of bank.
ACL	Automatic carrier landing.	AON	Angle-off-the-nose.
ACLS	Automatic carrier landing system.	APC	Approach power compensator.
ACM	Air combat maneuver.	APCS	Approach power compensator system.
ACQ	Acquisition (TCS).	ARDP	Advance radar data processor.
ACS	Automatic channel select.	ARI	Automatic rudder interconnect.
A/D	Analog-to-digital.	ARSP	Advance radar signal processor.
ADAC	Airborne data acquisition computer.	ASC	Advanced signal converter.
ADF	Automatic direction finder.	ASE	Allowable steering error.
ADI	Altitude director indicator.	ASH	Automatic stored heading.
ADL	Armament datum line.	ASPJ	Airborne self-protection jammer.
ADRL	Automatic distribution requirements list.	ASR	Air surveillance radar.
AEC	Automatic exposure control.	ATDC	Airborne tactical data control.
AFB	Airframe bulletin.	ATDS	Airborne tactical data system.
AFC	Airframe change.	ATLS	Asymmetric thrust limiting system.
AFTC	Augmenter fan temperature control.	AVB	Avionic bulletin.
A/G	Air-to-ground.	AVC	Avionic change.
AGI	Armament gas ingestion.	AVIA	TID AOA, VV, ILS, and ACLS.
AGL	Above ground level.	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.
BLD 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.
CATM Captive air training missile.
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.
CCTVS Color cockpit television sensor.
CDI Course deviation indicator.
CDIR Camouflage detection infrared.
cg Center of gravity.
CGTL Command ground track line.
Charlie time Expected time over ramp.
CIC Combat information center.
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.
CNO Chief of Naval Operations.
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.

CV Aircraft carrier.

CVA Aircraft carrier approach.

CVIC Aircraft carrier intelligence center.

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.

DFCS Digital flight control system.

DFM Dogfight mode.

DG Directional gyro.

D/L Data link.

DLC Direct lift control.

DLS Data-link system.

DMA Degraded mode assessment.

DME Distance measuring equipment.

DP Decision point.

DPG Data processor group.

DPGS Data processing ground station.

DR Dead reckoning.

DRO Destructive readout.

DROT Degraded range on target.

DSPT Dynamic steering point.

DSS Data storage set.

DSU Data storage unit.

DTM Data transfer module.

E

EAC Expected approach clearance time.

EAS Equivalent airspeed.

ECA Expanded chaff adapter.

ECCM Electronic counter-countermeasures.

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

FAM Familiarization.

FCF Functional checkflight.

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.

FLOLS Fresnel lens optical landing system.

FLRP Fighter link reference point.

FMC Fighter mode command; forward 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.

GPU Generator control unit; gun control unit.

GPS Global positioning system.

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.

HPRF High pulse repetition frequency.

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 systems.

IDG Integrated-drive generator.

IF Intermediate frequency.

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.

IRT Infrared test.

IRW Infrared wide.

ITER Improved triple ejector track.

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 equivalent 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.

LCU Load control unit.

LE Leading edge.

LOROP Long-range oblique photography.

LOS Line of sight.

LOX Liquid oxygen.

LPA Life preserver assembly.

LPRF Low pulse repetition frequency.

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.

MCF Motion compensation factor.

MCM Monitor control message.
MCS Mission computer system.
MCT Memory confidence test.
MDL Mission data loader.
meatball Glideslope image of mirror landing system.
MEC Main engine control.
MER Multiple ejector rack.
MFD Multifunction display.
MFT Mission flight trainer.
MHz Megahertz.
MIL Military.
MITS Missile interface test set.
MLC Mainlobe clutter.
MLG Main landing gear.
MMGS Multiple mode gunsight.
MOAT Missile on aircraft test.
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.
NAVRIT Naval airborne video recorder and image transceiver.
NDRO Nondestructive readout.
NECT Net entry control terminal.
NFL Notch filter let.
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.
NVIS Night vision imaging system.
NWP Naval warfare publication.
NWPM Non-write-protected memory.
NWS Nosewheel steering.
N₁ Low-pressure compressor rotor speed.
N₂ High-pressure compressor rotor speed.

O

OAT Outside air temperature.
OBC On-board check.
OBCCM On-board check continuous monitor.
OBOGS On-board oxygen generating system.
OFT Operational flight trainer.
OFPP Operational flight plan.
ORT Operational readiness test.
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.
PID Positive identification.
PIO Pilot-induced oscillation.
PLM Pilot lock-on mode.
POL Petroleum, oil, lubricants.
PP Peak power.

PPC Powerplant change.
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.
PTID Programmable tactical information display.
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.
RATS Reduced arrestment thrust system.
RDO Recovery duty officer.
RDP Radar data processor.
RDR Radar.
RDSCU Radar sensor control unit.
RECON Reconnaissance.
RF Radio frequency.
RFCI Radio frequency/control indicators.
RGSTT Range-gated single target track.

RHA Recording head assembly.
RIO Radar intercept officer.
RNAV Area navigation.
ROE Rules of engagement.
ROM Read-only memory.
ROT Range on target.
rpm High-pressure compressor rotor speed (N₂).
RRC Rounds remaining counter.
R/T Receiver-transmitter.
RTF Return to force.
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.
SEAD Suppression of enemy air defense.
SEAM Sidewinder expanded acquisition mode.
SEAWARS Seawater-activated release system.

SEC Secondary.
SHC Sensor hand control.
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.
SOP Standard operating procedures.
SP Sparrow missile.
SPAM Special aid to maintenance.
SPS Solenoid power supply.
SRA Shop replaceable assembly.
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.
TAMPS Tactical aviation mission planning system.
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.
TDC Throttle designator controller.
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.
TIS Tactical imaging set.
TIT Turbine inlet temperature.
TLN Takeoff, landing, navigation.
TMA Target under missile attack.
TMN True Mach number.
TOD Time of day.
TOF Time of fall.
TOMS Terminal output messages.
TOT Time on target.
T/R Transformer-rectifier.
T_S Static temperature.
TSD Tactical situation display.
TSEC Transmission security.
T_{T2} Compressor inlet temperature.
T_{T4} Compressor discharge temperature.
TTG Time to go.
TV Television.
TVS Television search.

TVT Television track.
TWS Track while scan.

U

UHF Ultra high frequency.
UHT Unit horizontal tail.
UTM Universal test message.

V

V_c Closing velocity rate.
v_C Computed MAG VAR.
VDI Vertical display indicator.
VDIG Vertical display indicator group.
VEC Vector.
VERT Vertical.
VFR Visual flight rules.
V_{g/H} Velocity/height.
V/H Velocity altitude factor (V_{g/H}).
VHF Very high frequency.
VID Visual identification.
VLA Vertical lever arm.
v_M Manual MAG VAR.
V_{m_{cg}} Minimum control groundspeed.
VMCU Voltage monitor control unit.
V_R Rotation speed.
VSL Vertical scan lock-on.
VSV Variable stator vane.
VSWR Voltage standing wave ratio.
VTR Videotape recorder.
VV Vertical velocity.
V₁ 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.

Z

ZTOD Zulu time of day.

ZTOT Zulu time on target.

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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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
NAS Oceana
Virginia Beach, VA 23460-5220

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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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.



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



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

FROM (originator)			Unit		
TO (Model Manager)			Unit		
Complete Name of Manual/Checklist	Revision Date	Change Date	Section/Chapter	Page	Paragraph

Recommendation (be specific)

CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title
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Address of Unit or Command

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

FROM	DATE
------	------

TO

REFERENCE

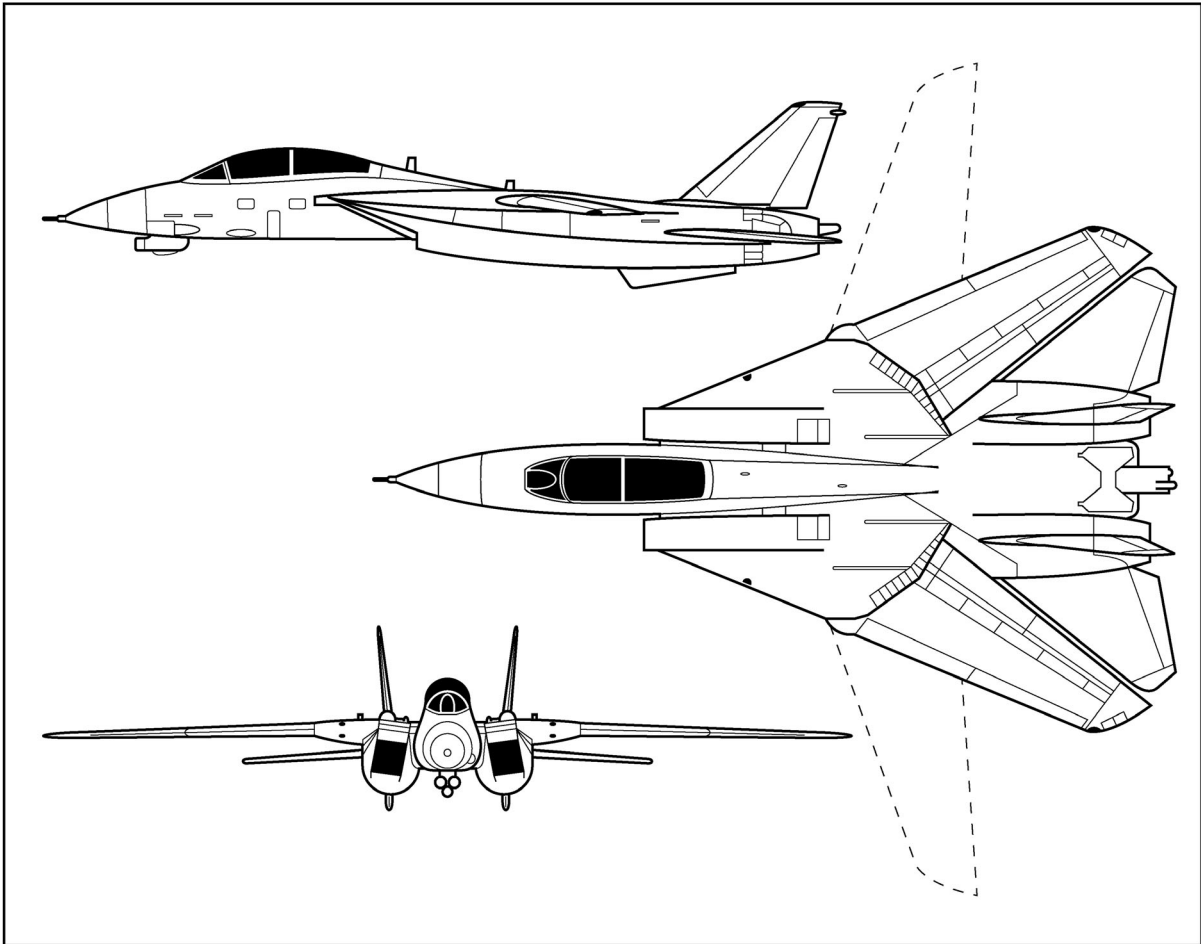
(a) Your Change Recommendation Dated _____

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

Your change recommendation is reclassified URGENT and forwarded for approval to _____ by my DTG _____.

/S/ _____ MODEL MANAGER	_____ AIRCRAFT
-------------------------	----------------

F-14D TOMCAT



CSC-F14D-1-P-001

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 (general purpose and precision 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 on operating limitations.

1.1.1 Aircraft Weight

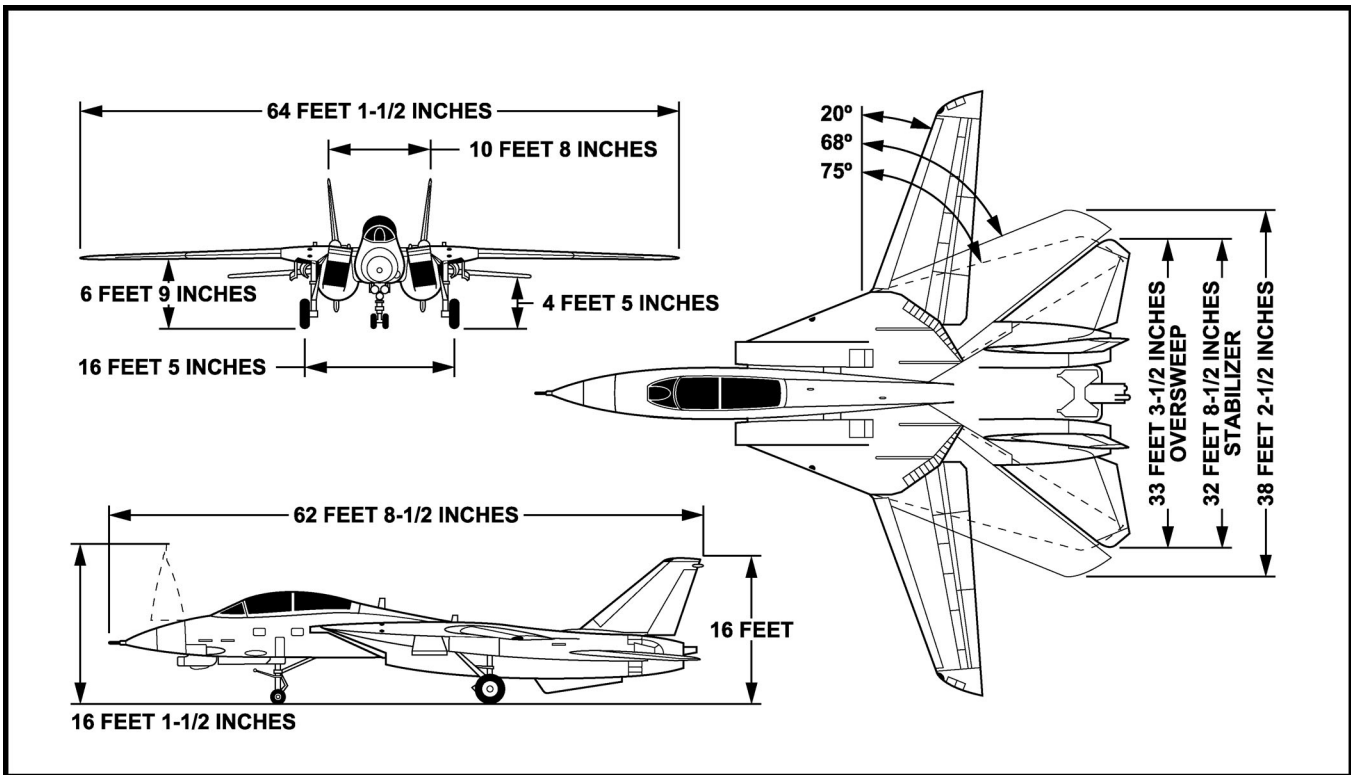
The basic weight of the aircraft is approximately 43,735 pounds, which includes trapped fuel, oil, gun, and pylons. Consult the applicable Handbook of Weight and Balance (NAVAIR 01-1B-40) for the exact weight of any series aircraft.

1.1.2 Cockpit

The aircraft accommodates a 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. 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, thereby necessitating two aircrew for safe 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.



CSC-F14D-1-1-001B

Figure 1-1. Aircraft Dimensions

1.1.2.2 RIO Cockpit

The aft station of the cockpit is equipped for the RIO (FO-4). This instrument panel 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, lighting controls, 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 in the aircraft while it is still on the production line. Check the Technical Directives Section of the Aircraft Log Book for applicable modifica-

tions. The following are types of technical directives used in this manual:

- AAC 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 include the indicated aircraft serial numbers (BuNo). Selected aircraft in blocks 85 and 110 have been updated to create the F-14D/block 170 configuration.

Block No.	Serial No. (BuNo)
160	163412 - 163418
165	163893 - 163904
170	164341 - 164351 and 164599 - 164604
85	159592, 159595, 159600, 159603, 159610, 159613, 159618, 159619, 159628 - 159630
110	161159, 161163, 161166.

F-14D AIRCRAFT CHARACTERISTICS AND LIMITATIONS			
Aircraft Dimensions		Starter Cranking Limits	
Length	62'	8.5"	Cross bleed 2 min continuous then 10 min off
Height (Tail)	16'	0"	Start Cart 5 min continuous then 10 min off
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		Idle	
Empty A/C (w/crew & trapped fuel)	43,735 lbs		RPM = 62 - 78% OIL PRESS = 15 - 45 psi
Catapult	76,000 lbs		EGT = 350 - 650°C NOZ POS = 100%
Field takeoff	72,000 lbs		FF = 950 - 1400 PPH HYD PRESS = 3000 psi
Min descent rate landing (350 fpm)	72,000 lbs		
Field landing (<i>max</i> 500 fpm ROD)	60,000 lbs		
Carrier/FCLP land	54,000 lbs		
T/O & Land Flap/Slat Transition Limits		MIL (and above)	
AOB < 45°		RPM = 95 - 104% OIL PRESS = 25 - 65 psi	
ROLL SAS ON		EGT = 780 - 935°C NOZ POS INFLIGHT:	
Min 200' AGL for flaps/slats up on takeoff		MIL = 3 - 10%	
Min 800' AGL for dirty-up		Min AB = 5 - 12%	
Min 180 kts for retraction of flaps		Max AB = 60 - 90%	
12 units AOA for all transitions			
225 kts <i>max</i> flap/slat speed			
280 kts <i>max</i> landing gear speed			
Landing & Braking		Ground Start Malfunctions	
15 kts <i>min</i> speed for antiskid operation		HOT START: 890°C (will normally peak @ 30 - 40% RPM)	
145 kts <i>max</i> wheel braking (51.0 k A/C)		HUNG START: Hung RPM below 63% with rising EGT	
165 kts <i>max</i> wheel braking (46 k A/C)		WET START: No lightoff within 20 sec of throttle to IDLE	
190 kts <i>max</i> tire speed			
145 kts <i>max</i> E-5 engagement speed (69.8 k A/C)			
175 kts <i>max</i> E-28 engagement speed			
20 kts <i>max</i> 90° crosswind component			
60 kts <i>max</i> canopy open			
Engine Speeds (RPM)		INST Test	
10%	Ignition system becomes operative		RPM = 96%
30 - 46%	Engine crank switch will not engage		EGT = 950 ± 10°C
20%	<i>Min</i> RPM with throttle at idle		(initiates engine overtemp alarm)
30%	<i>Max</i> RPM with pneumatic starter		FF = 10,500 pph
30%	RPM must fall below for generator auto-reset		AOA = 18 ± 0.5 UNITS
50%	Engine crank switch automatically shuts off		W/S = 45 ± 2.5°
60%	Generator comes on line		FUEL = 2,000 ± 200# (all tapes and windows)
50%	Generator light illuminates (if RPM falling)		LIGHTS: L and R FUEL LOW
60%	Ensure engine crank off (osp/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)		
		Oil System	
		Normal Range	25 - 65 psi
		<i>Min</i> (stabilized idle)	15 psi
		Oil pressure light	on @ 11 psi decreasing off @ 14 psi increasing
		Pneumatic Pressure	
		<i>Min</i> auxiliary canopy (3000 psi)	800 psi
		<i>Min</i> normal canopy (3000 psi)	1200 psi
		CHS accumulator	1800 psi
		FHS accumulator	1800 psi
		<i>Min</i> emergency gear preflight	3000 psi
		<i>Min</i> emergency gear extension	1800 psi
		Wheel brake accumulator (2 gages)	1900 ± 50 psi
		Arresting hook dashpot	800 ± 10 psi

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

F-14D AIRCRAFT CHARACTERISTICS AND LIMITATIONS (CONTINUED)			
Fuel System		In-Flight Refueling	
Aft-Left Tank Group Capacity	5900 - 6200 lbs	170 - 200	Approach configuration
Fwd-Right Tank Group Capacity	6300 - 6600 lbs	200 - 300/0.8 TMN	Cruise configuration
Max split between cockpit totals	300 lbs	400/0.8 TMN	Max IFR probe speed
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		SAS Stability Augmentation System	
Normal Hyd. system operating press	3000 ± 100 psi	FCS CAUTION:	Airspeed < 600 kts/1.3 TMN
BIDI activates when one system is	< 2100 psi		> 0.5 TMN/10 units No cross controls
BIDI output w/3000 psi on good side	2400 - 2600 psi		> 0.6/15 units AOA coordinate all lateral stick
BIDI shuts off when failed system is	< 500 psi for 10 sec	PITCH SAS:	No Limitations
Emer. Flt. Hyd. on if both systems	< 2100 psi	ROLL DGR/YAW DGR and/or ARI DGR	Airspeed <1.0 TMN
Outb'd Spoiler Module electrically inhibited @	62° W/S	ARI/SAS OUT:	Airspeed <1.0 TMN, AOA - max 15 units
Outb'd Spoiler Module depressurized @	65° W/S		No aggressive maneuvering
Miscellaneous		Prohibited Maneuvers	
450	Windmill airstart airspeed required	1. Intentional Spins.	
300	Spooldown airstart airspeed required	2. During AB operations; sustained 0 to -0.5 g flight; -0.5 g to -2.4 g's for more than 10 seconds.	
250	With RUDDER AUTH, limit inputs to <10°	3. At MIL power or less; zero or negative g flight for more than 20 seconds.	
400	Rudder authority limits inputs to < 9.5°	4. AIM-9 launch with flaps/slats extended.	
400/0.9	With HZ TAIL AUTH, limit lateral stick<1/4 throw	5. Fuel dump while in AB or with S/Bs extended.	
400	Speedbrake blowback	6. Dual eng AB takeoff, waveoffs, bolters or cat launches.	
300	Hook blowback in transit	7. Single eng MAX AB takeoff, waveoff, bolter, or cat launches.	
300/0.8 TMN	Max speed w/ airsource off (overwing fairing)	8. Rolling maneuvers with bank angle changes in excess of 360 degrees.	
350/1.5 TMN	Max ramdoor open 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		G Limits	
Zero - 250 KIAS	Ejection Safe	Gear Down Symmetric Limit	0 - 2.0
250 - 600 KIAS	Ejection Hazardous	Gear Down Rolling (coordinated turns only 225 - 280 KTS)	0 - 2.0
> 600 KIAS	Ejection Extremely Hazardous	Flaps/Slats Down	0 - 2.0
External Tank Limits		68,000 lb aircraft symmetric limit	4.6
650	Max below 12,000 ft	58,000 lb aircraft symmetric limit	5.5
700	Max 12 - 25,000 ft	53,000 lb aircraft symmetric limit	6.0
650	Max 25 - 34,000 ft	50,000 lb aircraft symmetric limit	6.5
1.75 TMN	Max above 34,000 ft		
1.6 TMN	Max with ROLL SAS OFF		

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

TACTICAL

CHAFF DISPENSING SET	AN/ALE-39
DIGITAL DATA LINK	AN/ASW-27B/C
ELECTRONIC COUNTERMEASURES SET	AN/ALQ-165
FUZE 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)
INTERFERENCE BLANKER	MX-10666/A
IRSTS	AN/AAS-429XN-1
JOINT TACTICAL INFORMATION DISTRIBUTION SYSTEM	AN/URC-107
MISSILE LAUNCHER/BOL CHAFF DISPENSER	LAU-138A/A
MISSILE POWER SUPPLY	PP-8043/A
MISSION COMPUTERS	AN/AYK-14 9XN-60 PMM
PANORAMIC CAMERA	KA-99A
RADAR SYSTEM	AN/APG-71 (XN-1)
RADAR WARNING SET	AN/ALR-67(V)
SERIAL FRAME CAMERA	KS-87B
STANDARD CENTRAL AIR DATA COMPUTER	CPU-175/A
STORES MANAGEMENT SET	AN/AYQ-15
TARPS POD	LA-610
TELEVISION CAMERA SET	AN/AXX-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
INERTIAL NAVIGATION SYSTEM	AN/ASN-139
MAGNETIC AZIMUTH DETECTOR SET	DSU-4A/A
MINIATURIZED AIRBORNE GPS RECEIVER	R-2512
MISSION DATA LOADER	MU-1053/A
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
STANDARD ATTITUDE HEADING REFERENCE SYSTEM	AN/USN-2(V)
TACTICAL NAVIGATION SET	AN/ARN-118(V)

FLIGHT CONTROL AND INSTRUMENTS

AIR INLET CONTROL PROGRAMMER	C-8684B/A
APPROACH POWER COMPENSATOR SET	AN/ASN-146
DIGITAL FLIGHT CONTROL SET	AN/ASW-59
BEARING DISTANCE HEADING INDICATOR	ID-663D/U
STANDBY AIRSPEED INDICATOR	AVU-30/A
STANDBY COCKPIT ALTIMETER	AAU-39/A
STANDBY COMPASS	AQU-5/A
VERTICAL VELOCITY INDICATOR	AAU-8/A

Figure 1-3. Electronic Nomenclature

CHAPTER 2

Systems

2.1 AIR INLET CONTROL SYSTEM (AICS)

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 separated 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.

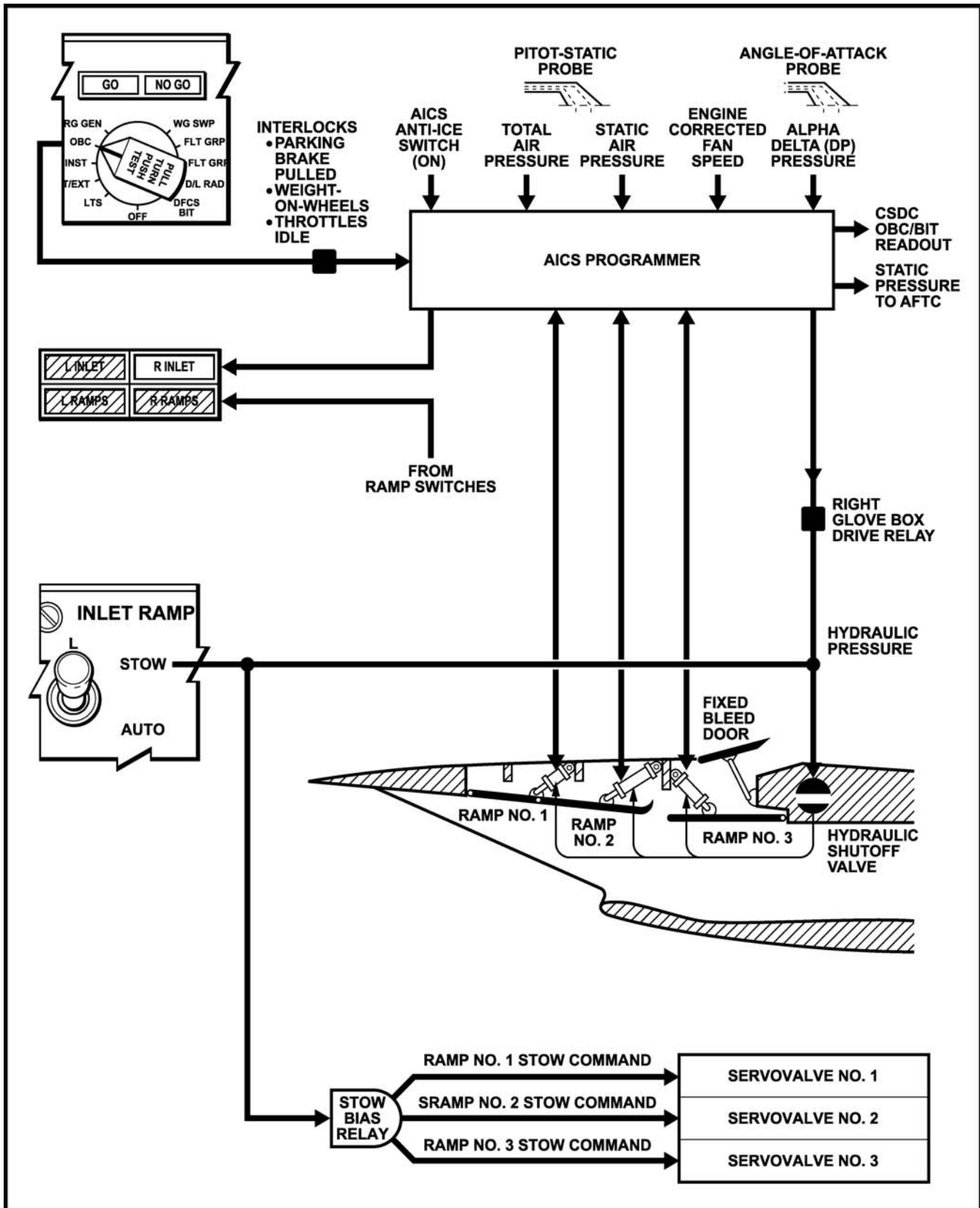
At supersonic speeds, four shock waves compress and decelerate the inlet air. The bleed slot removes boundary layer air and stabilizes the shock waves. This design results in substantially higher performance above Mach 2 than simpler inlet designs.

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.

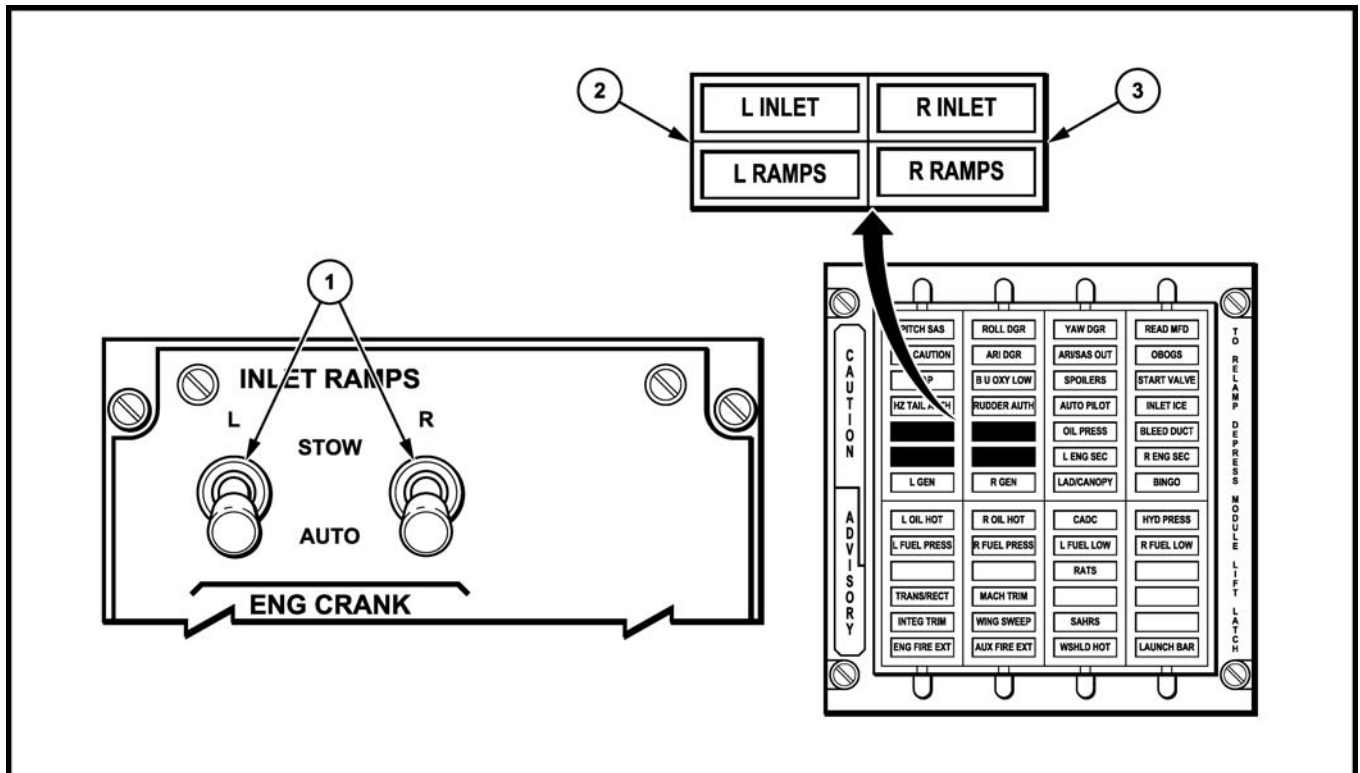
2.1.2.1 AICS Built-In Test

BIT in the AICS computer programmer is automatically and continually initiated within the programmer to check AICS components when the programmer is energized.



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Figure 2-1. Air Inlet Control System



CSC-F14D-1-2-002

NOMENCLATURE	FUNCTION
<p>① INLET RAMPS switches</p> <p>② RAMPS caution light</p>	<p>AUTO - Inlet ramp position is determined by the AICS programmer.</p> <p>STOW - Electrically commands the respective inlet ramp actuator to the stow position; opens the appropriate hydraulic shutoff valve.</p> <div style="text-align: center; border: 2px solid black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>WARNING</p> </div> <ul style="list-style-type: none"> 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. <p style="text-align: center;">Note</p> <p>Cycling either AICS circuit breaker while airborne may result in DFCS air data failures, illuminating the FCS CAUTION and ARI DGR lights, and cause degraded control system capability. MASTER RESET should restore normal operation once the cb(s) are reset.</p> <p>Indicates ramps not positioned in either stow or trail locks during critical flight conditions (see Figure 2-5).</p>

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

NOMENCLATURE	FUNCTION
<p>③ INLET caution light</p>	<p>Indicates AICS programmer/system failure: Reduce airspeed to Mach 1.2 and check AICS acronym for failure indication.</p> <p>AICS failure</p> <p>Less than Mach 0.5: Ramps should be restrained by actuator stow locks.</p> <p>Greater than Mach 0.5: Ramp movement is restrained by trapped hydraulic pressure and mechanical locks, depending on Mach when INLET light illuminates.</p> <p>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.</p>

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

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.

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 programmable tactical information display (Figure 2-5 and Figure 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 pseudo-pneumatic 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 AICS acronyms or AIC acronym(s) with associated INLET caution light(s) displayed after completion of OBC.

Note

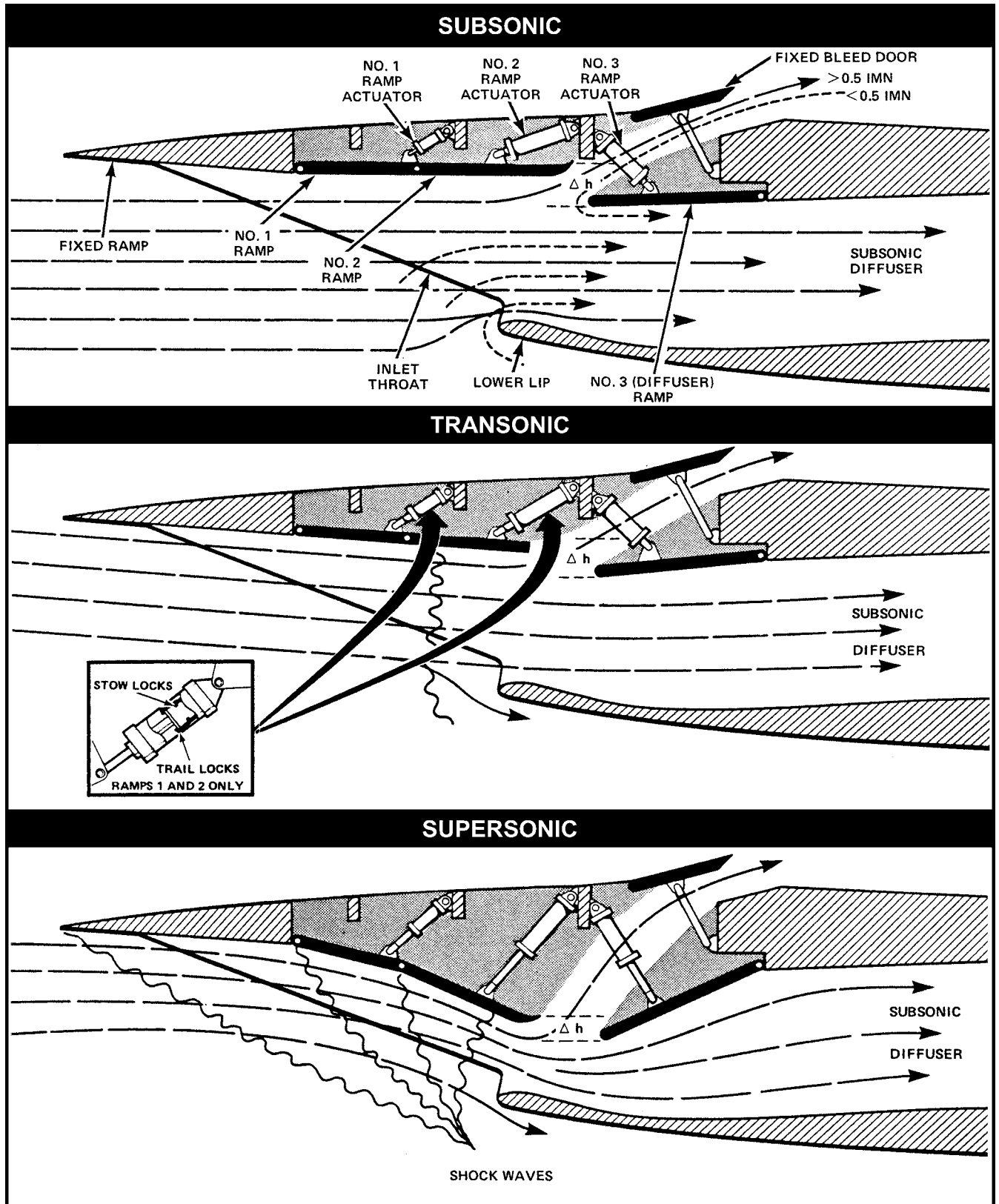
- With INLET RAMP switches in STOW, AICS OBC will fail test and INLET lights will illuminate.
- If the engine enters secondary mode during OBC, the ramps will stow and fail OBC. To reinitiate OBC, select primary mode and reset the AICS.
- An S4 acronym indicates the AICS programmers may be operating 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.



0-F50D-2-0

Figure 2-3. Variable-Geometry Inlet Configuration

FLIGHT CONDITION	HYDRAULIC POWER RAMP ACTUATORS	ACTUATOR 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

PTID 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.	<ul style="list-style-type: none"> • Substitutes +2° angle-of-attack value until reset. • Substitutes 7,300 rpm.
AIC A4	Open wire	Open wire	None
<p>Note</p> <p>AIC symbol has L or R appended (AICL, AICR) to identify on which side failure was detected.</p>			

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

FAILURE MAINTENANCE READOUT ACRONYM	DETECTED FAILURE	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 aerodynamic 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 N₁ 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.

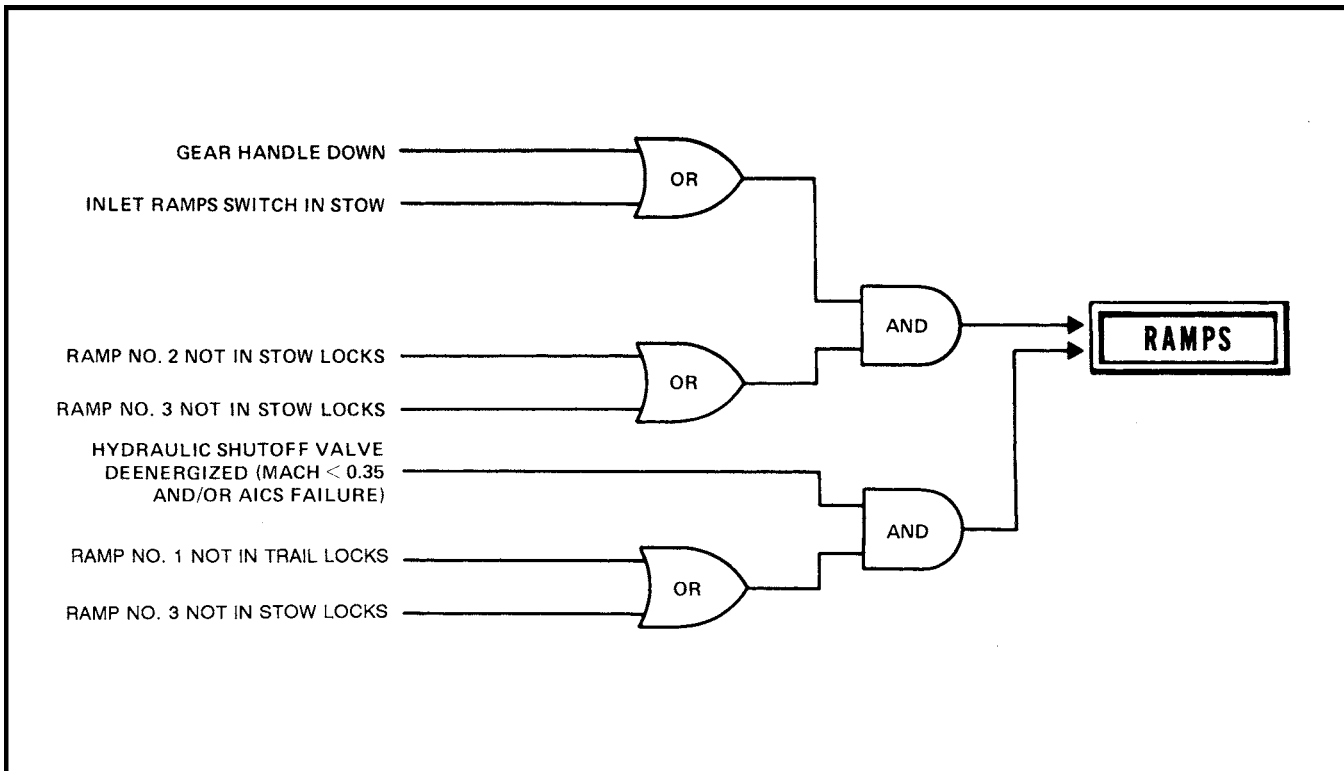
If the hydraulic shutoff valve closes above Mach 0.9, the ramps are normally in an unsafe configuration and the appropriate RAMPS caution light will accompany the INLET caution light (Figure 2-7). Above Mach 0.9, the No. 3 ramp normally begins programming below the actuator stow lock. When the fail-safe 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.



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



1-F50D-149-0

Figure 2-7. Ramp Monitor Logic

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.

Note

Cycling either AICS circuit breaker while airborne may result in DFCS air data failures, illuminating the FCS CAUTION and ARI DGR lights, and cause degraded control system capability. MASTER RESET should restore normal operation once the cb(s) are reset.

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 is 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 2-7](#). 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 stowed position. The programmers are disabled by pulling the affected AICS circuit breaker and returning the INLET RAMPS switch to AUTO.
- Cycling either AICS circuit breaker while airborne may result in DFCS air data failures, illuminating the FCS CAUTION and ARI DGR lights, and cause degraded control system capability. MASTER RESET should restore normal operation once the cb(s) are reset.

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 RAMPS light does illuminate, then the ramps should be stowed and the AICS programmer reset. (Depressing MASTER RESET following an AICS programmer reset should restore normal DFCS operation.)
3. If hydraulic pressure is greater than zero and airspeed is greater than .35 Mach, then the ramps should be stowed and, if time allows, 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

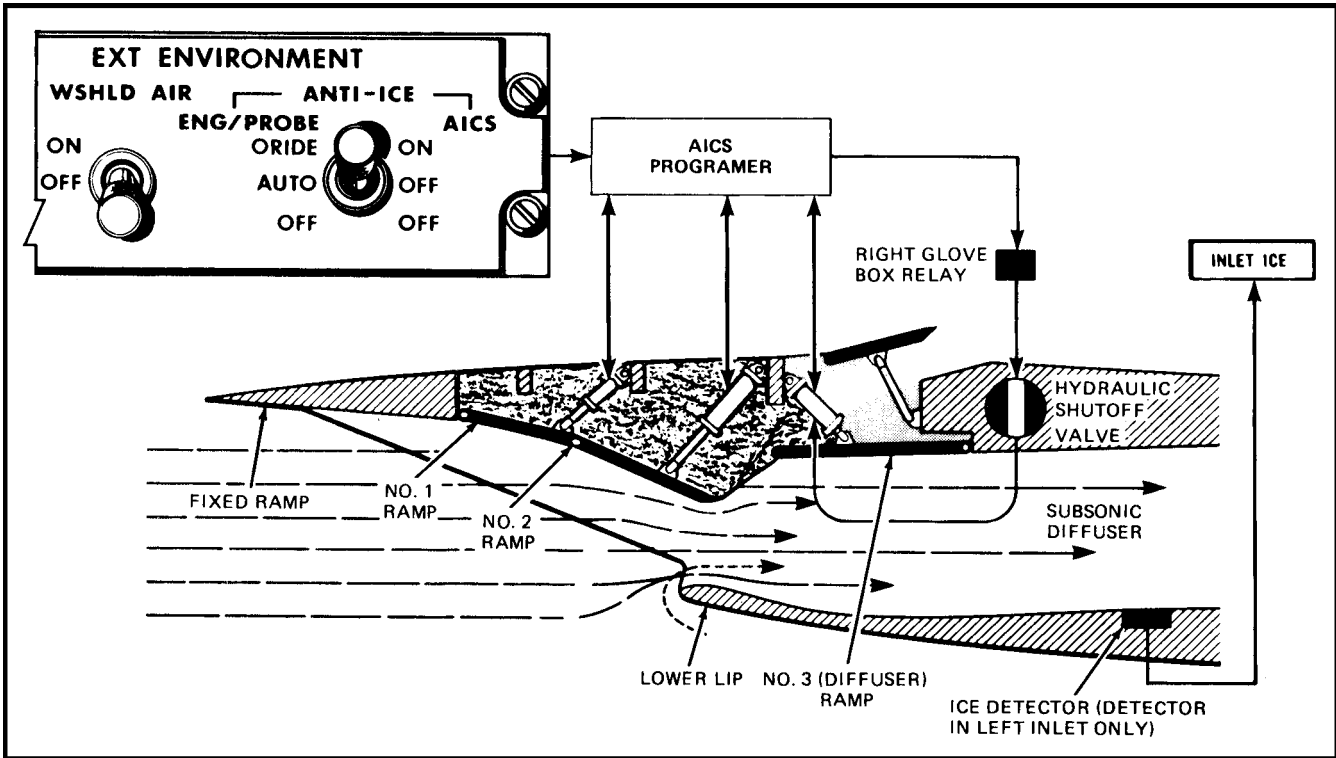
AICS anti-ice is activated only by selecting ORIDE/ON with the AICS ANTI-ICE switch and airspeed between 0.35 to 0.9 Mach (hydraulic power is available at 0.3 Mach). Above and below these airspeeds the AICS anti-ice is disabled. When the ENG/PROBE anti-ice switch is in AUTO, the AICS anti-ice is off. 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 augments fan temperature control unit and by throttle inputs to the main engine control.

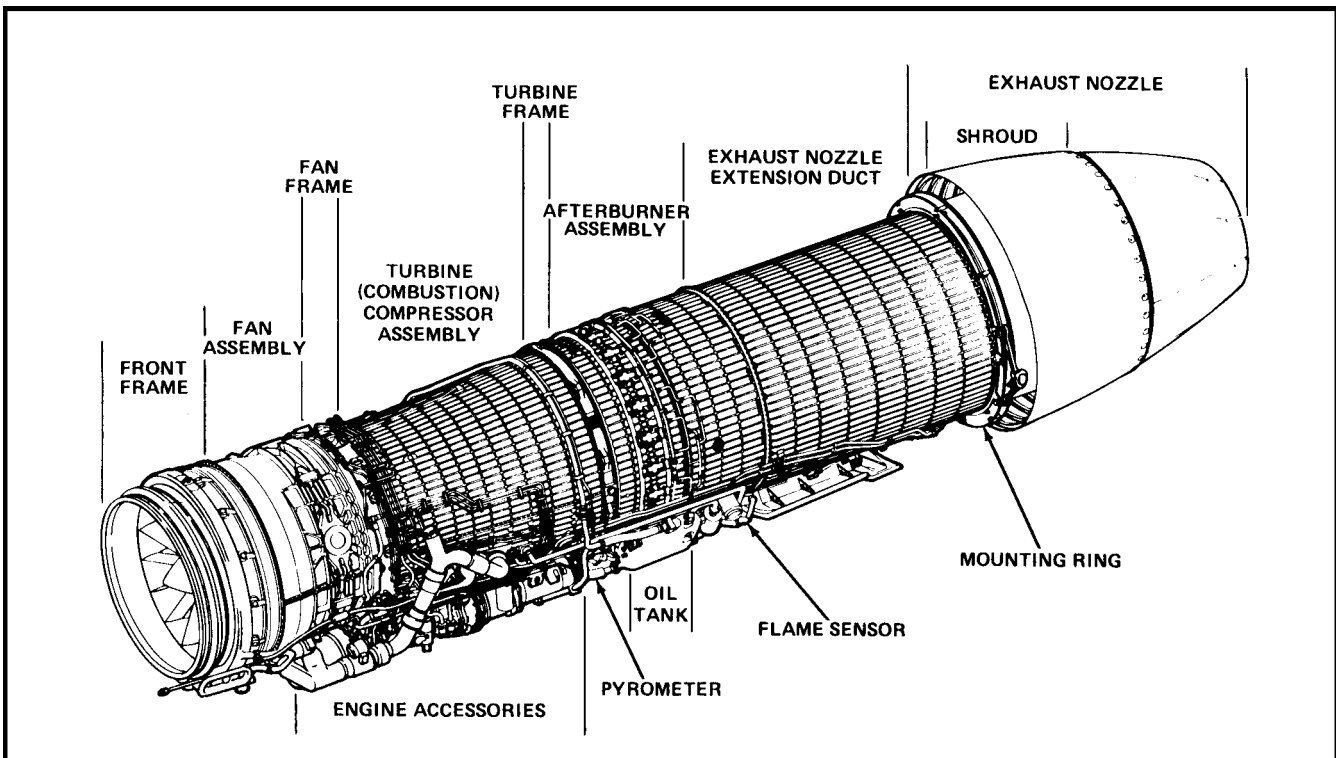
Each engine is slung in a nacelle with the thrust axis laterally offset approximately 4½ feet from the aircraft centerline. The installed static engine thrust at military power is 13,800 pounds and, at maximum AB power, thrust is 23,600 pounds. Installed engine thrust at maximum AB at 0.9M at sea level 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 compresses 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 fuel from the fuel nozzles. This fuel-air



0-F50D-30-0

Figure 2-8. AICS Anti-Ice System



0-F50D-24-0

Figure 2-9. F110-GE-400 Engine

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 afterburner 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. In addition, 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 hydro-mechanical main engine control, the electronic augments 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

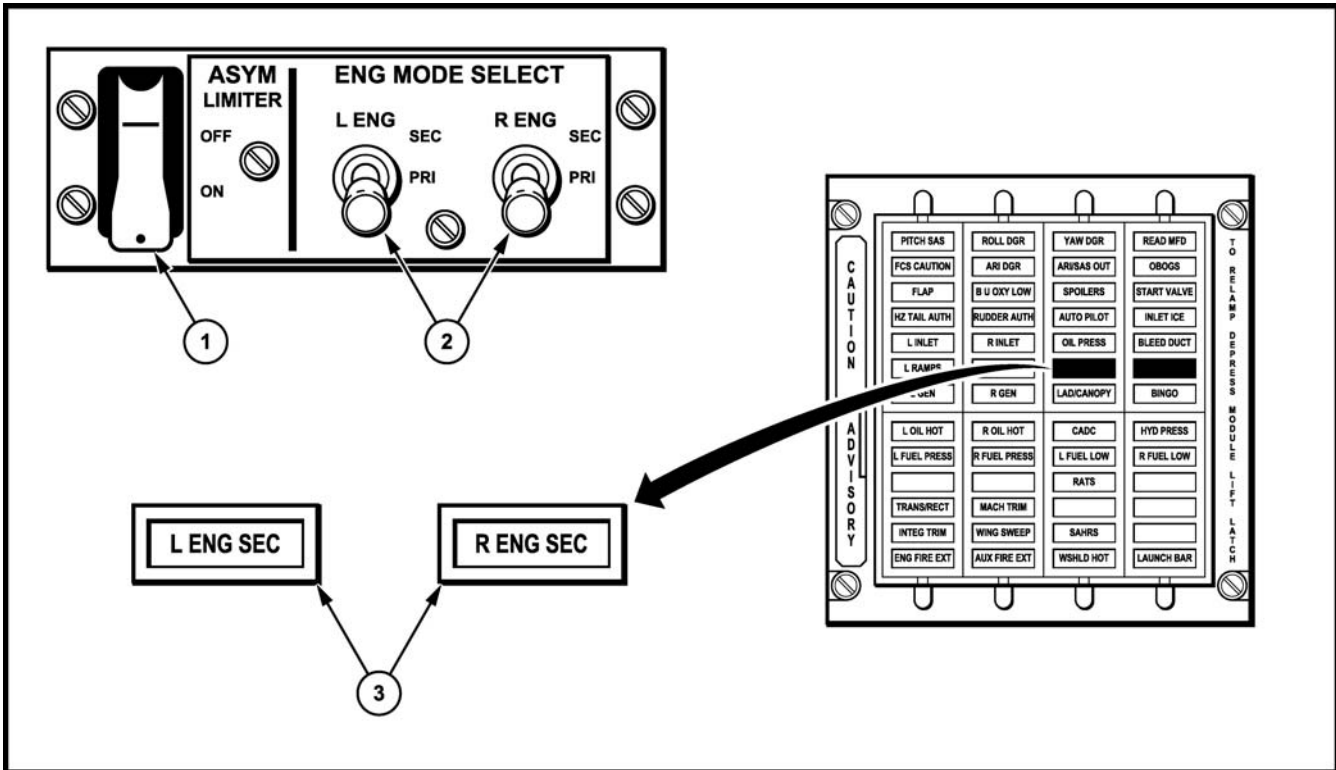
The MEC is a hydromechanical control that provides fuel shutoff, variable stator vane scheduling, and main fuel metering in both primary and secondary modes. The MEC controls fuel flow until 59-percent rpm and provides high-pressure compressor rotor overspeed protection automatically by securing fuel 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 $110 \pm .5$ percent. EGT and FF indicators will continue to function normally.

2.2.1.2 Augments Fan Temperature Control

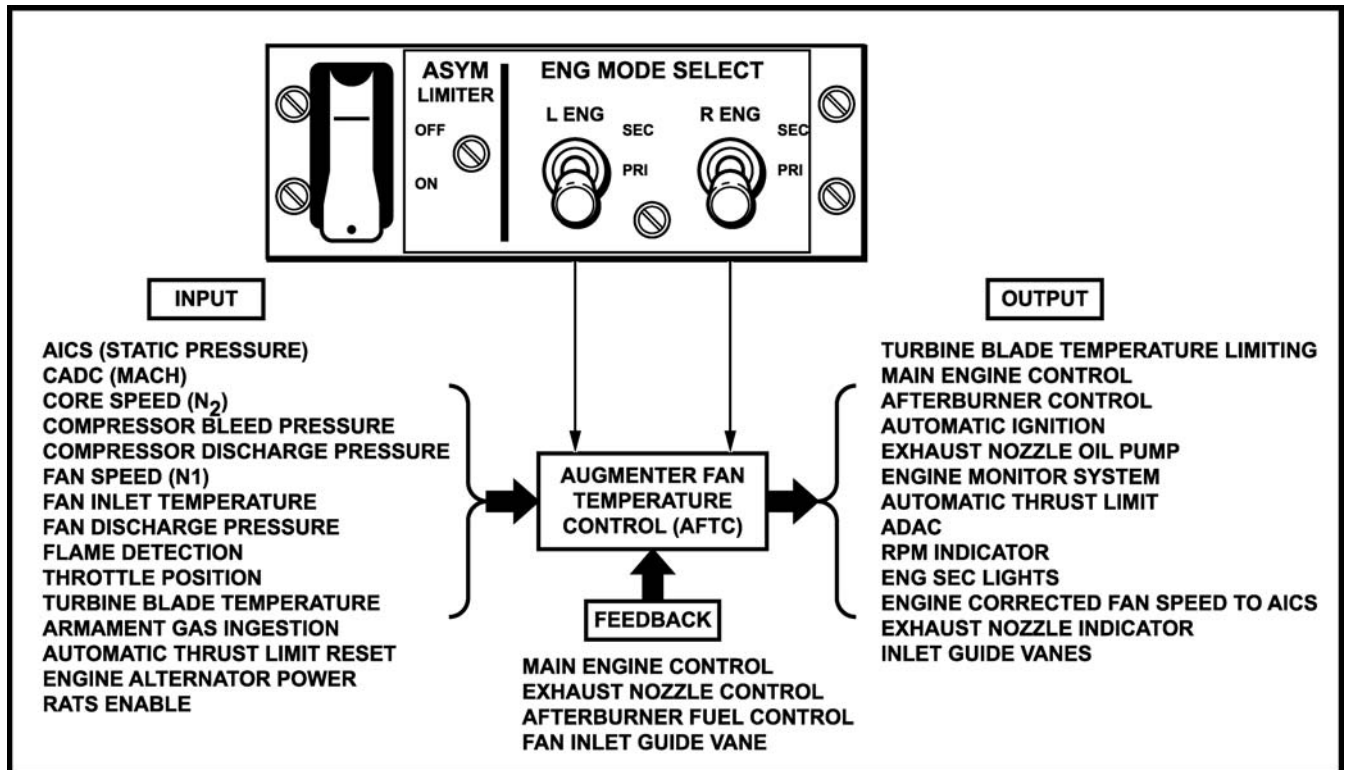
The AFTC is a modular solid-state electronic device that performs control schedule computations, integration and logic functions, limit control, failure detection, and provides engine core speed (N_2) signal for instrument display and engine fan speed (N_1) signal to the AICS. It also controls the distribution 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.



CSC-F14D-1-2-005

NOMENCLATURE	FUNCTION
<p>① ASYM LIMITER switch</p>	<p>ON — 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.</p> <p>OFF — Either engine may operate at any AB power setting independently of the other engine.</p>
<p>② L/R ENG MODE SELECT switch</p>	<p>PRI — Primary mode, AFTC controls main and AB fuel flow, fan inlet guide vanes, nozzle area, and ignition.</p> <p>SEC — Secondary mode, main fuel flow is scheduled hydromechanically by the MEC. AB is inhibited.</p>
<p>③ L/R ENG SEC caution light</p>	<p>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.</p>

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



CSC-F14D-1-2-024

Figure 2-11. AFTC Functional 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 while supersonic on a cold day, or at high power settings, or at idle. Inlet buzzing may also result at high power settings. If occurring while supersonic and at high power settings, decelerate at 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, IG, 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, nozzle full open when engine is not at idle or maximum AB, AFTC power deviations, fuel flow demand mismatch with throttle settings, fan speed greater than 800 rpm 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. An AFTC automatic “rich stability cutback” feature reduces or limits maximum AB fuel flow at high altitudes and low airspeeds 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. SEC mode is manually selected via the ENG MODE SELECT switch or the autopilot emergency disengage paddle switch, or via automatic default. In SEC MODE, 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 when in secondary mode. This vibration/rumble has no adverse affect on the engine and disappears when the throttle is advanced slightly (5-percent rpm increase or less). Maximum thrust available at military power in SEC mode is depicted in Chapter 14, [Figure 14-4](#).



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

Note

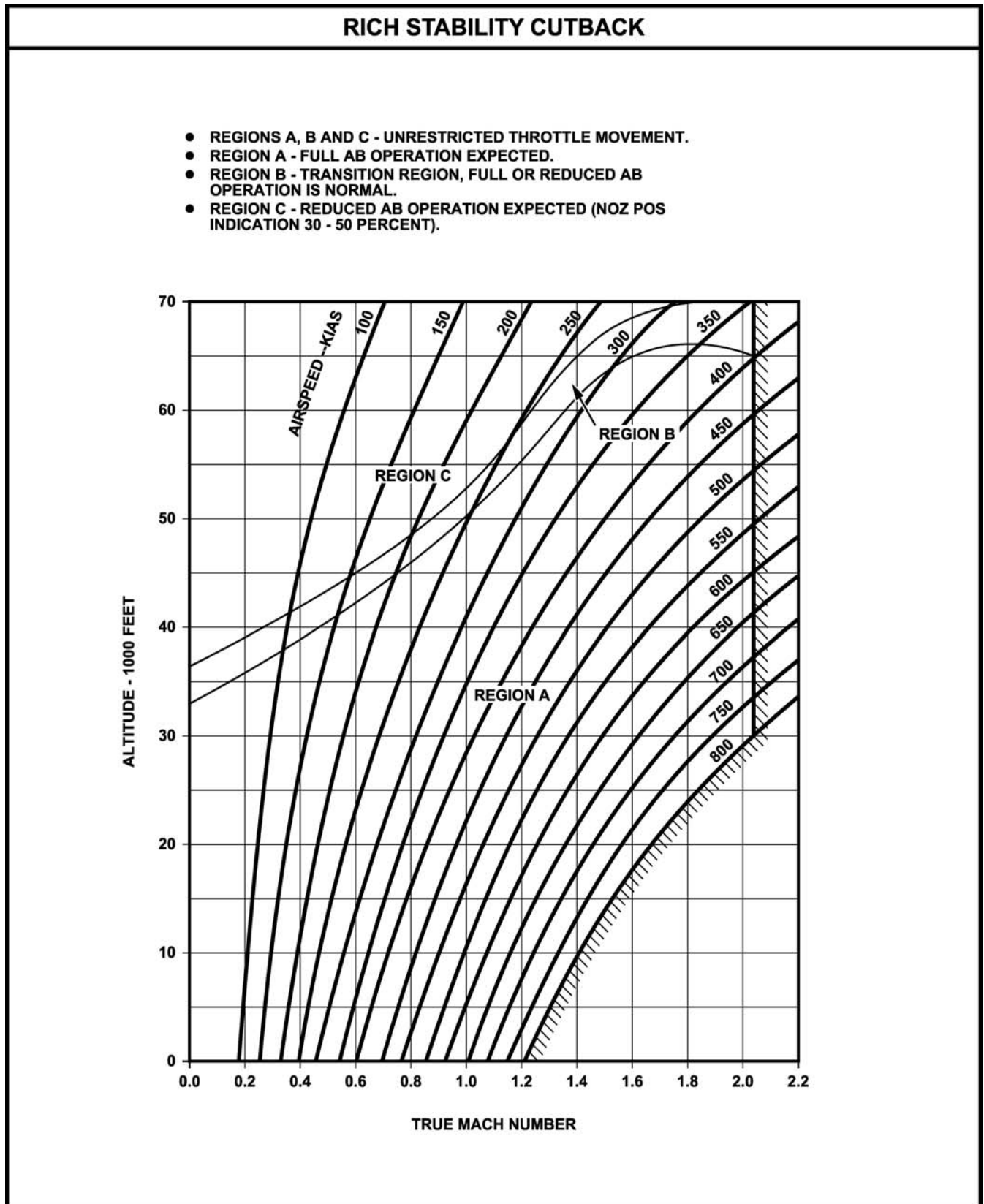
- SEC mode transfer from AB may result in pop stalls. Nonemergency manual selection of SEC mode on the ground should be performed in basic engine. Nonemergency manual selection of SEC mode airborne should be performed in basic engine with power set above 85-percent rpm.
- If the fan speed limiter circuit 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 are 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.



CSC-F14D-1-2-062

Figure 2-12. Rich Stability Cutback — F110-GE-400 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 engine 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.



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 (N₂) 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

gear with the hook handle down or the hook out of the stowed position. The RATS light, located on the pilot's 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

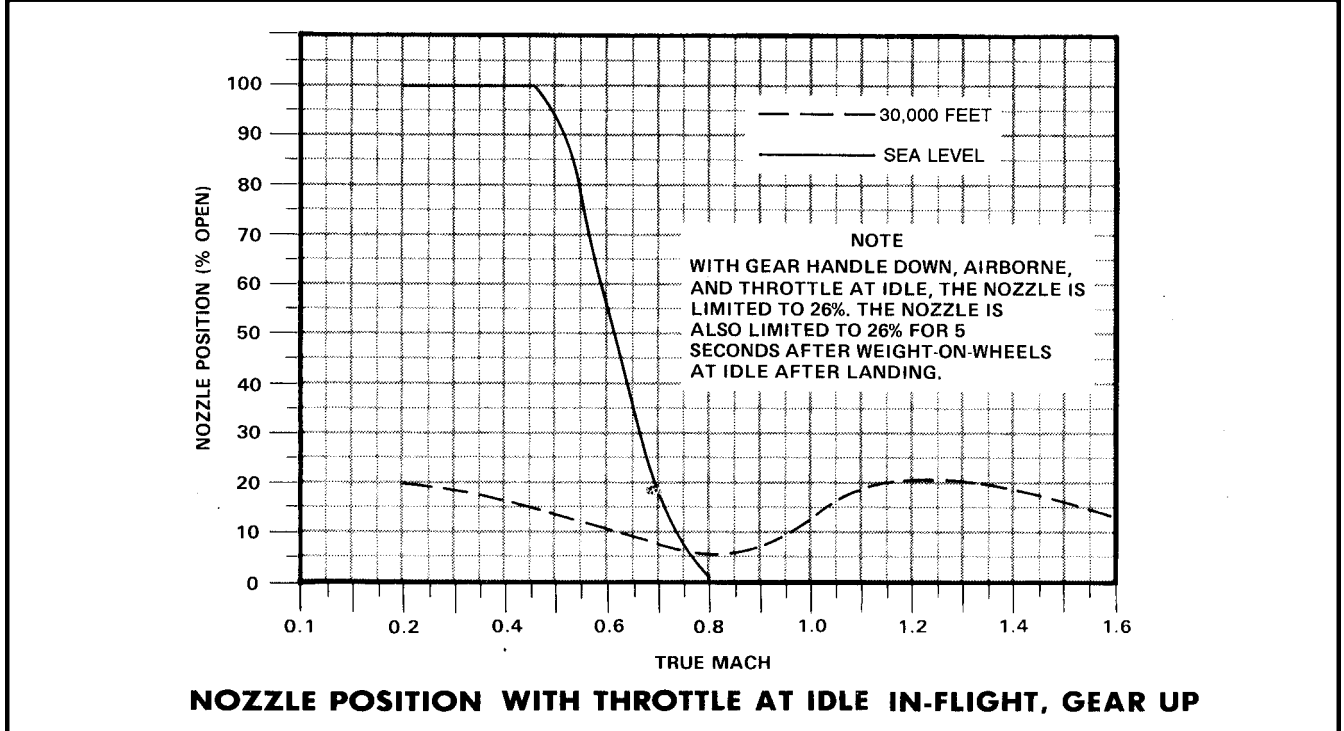
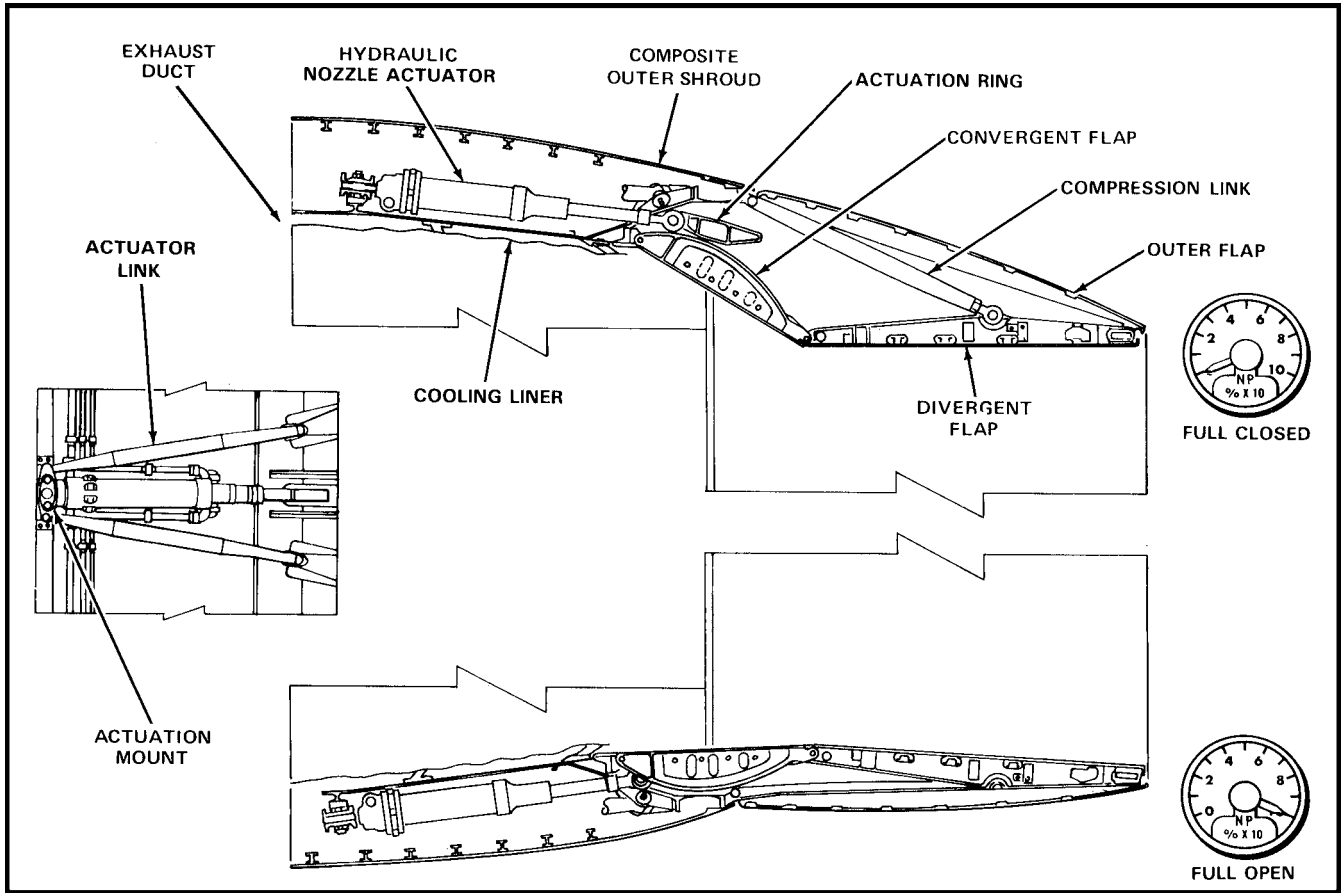
Engine exhaust gases at higher thrust settings are discharged through the nozzle throat at sonic velocity and are accelerated to supersonic velocity by the controlled expansion of the gases. Varying nozzle throat area controls fan stall margin, which optimizes performance.

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

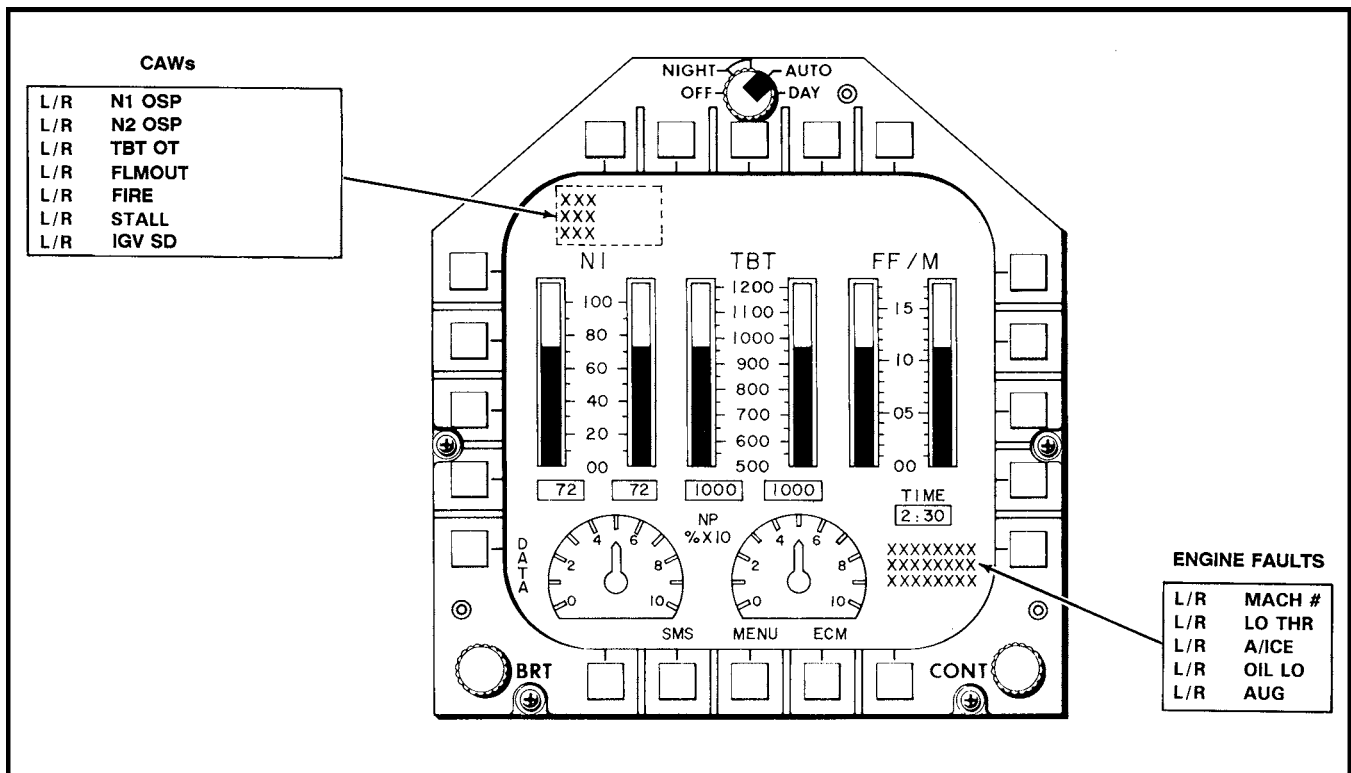
When AFTC is operating in secondary mode, the nozzle is commanded closed and the exhaust nozzle indicator is inoperative.

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.



1-F50D-005-0

Figure 2-13. Variable Area Exhaust Nozzle



1-F50D-301-0

Figure 2-14. FEMS Multifunction Display Configuration

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 relevant engine performance data, both in flight and on deck, from the engine monitoring system processors. Engine faults 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

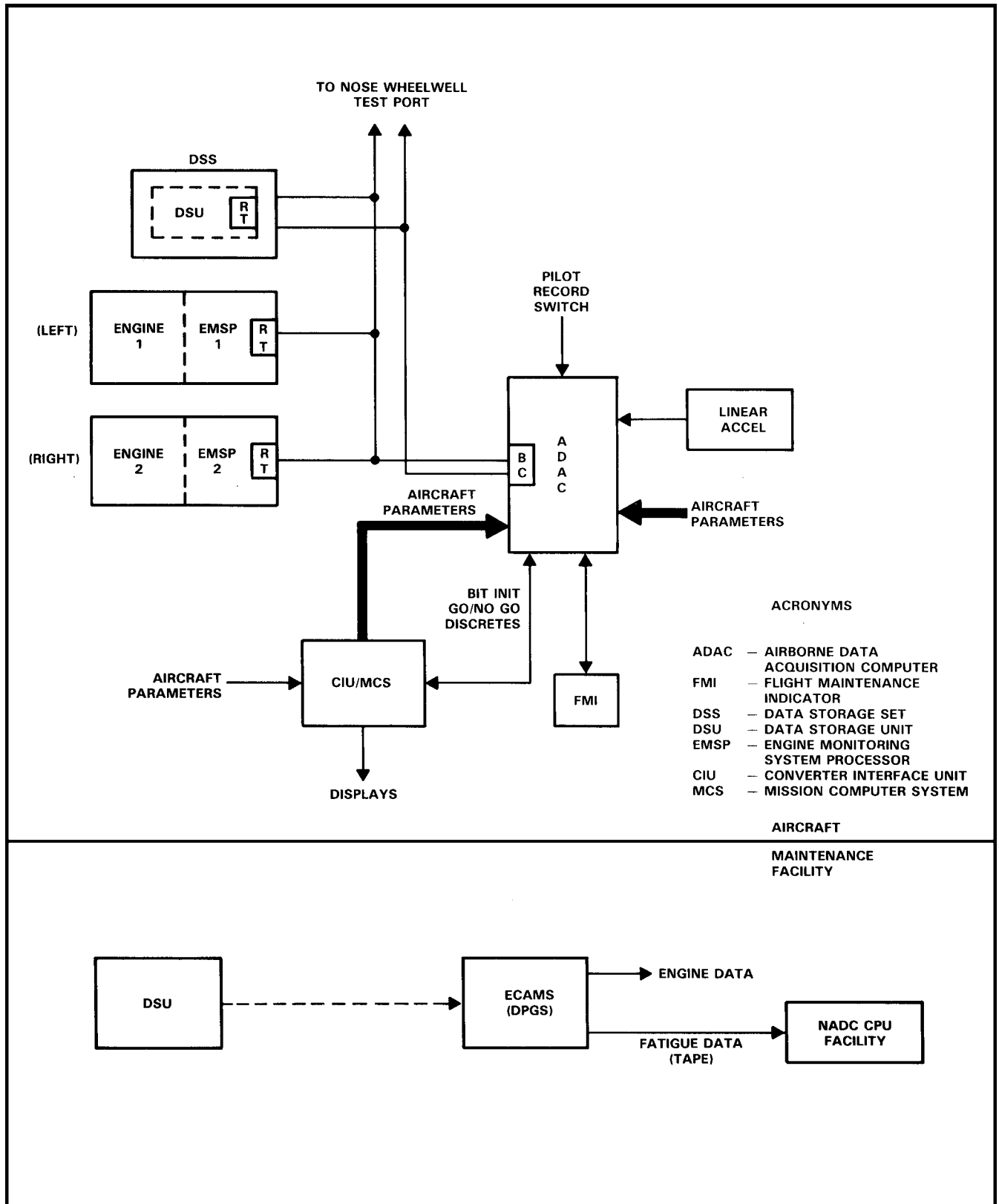
The EMSP is engine-mounted, engine-powered, and converts control system electrical signals from the AFTC into digital format for transmission to the ADAC. It also receives and digitizes other noncontrol system-related data such as anti-icing system status, lube oil level, and lube temperature data for 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.

Note

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.



0-F50D-90-0

Figure 2-15. Fatigue Engine Monitoring System Diagram

2.3.1.3 Data Storage Set

The DSS, located in the nosewheel well has a removable DSU that provides in-flight recording of engine and CSS data for analysis. 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

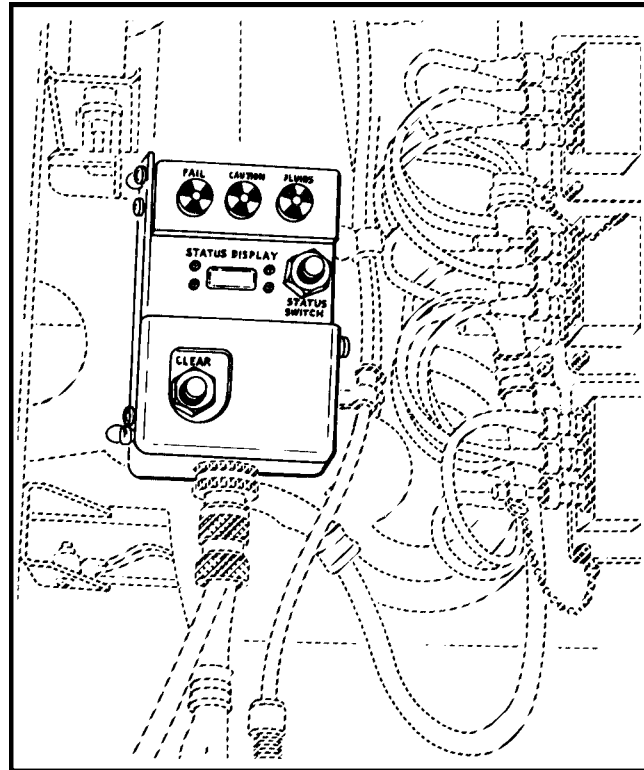
The FMI (Figure 2-16) displays to the maintenance crew ADAC data for engine/airframe status. It is mounted in an easily accessible location on the forward bulkhead in the nose wheelwell. After each flight, the FMI FAIL, CAUTION, and/or FLUIDS fault trip indicators will be either black, signifying the 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



0-F50D-16-0

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

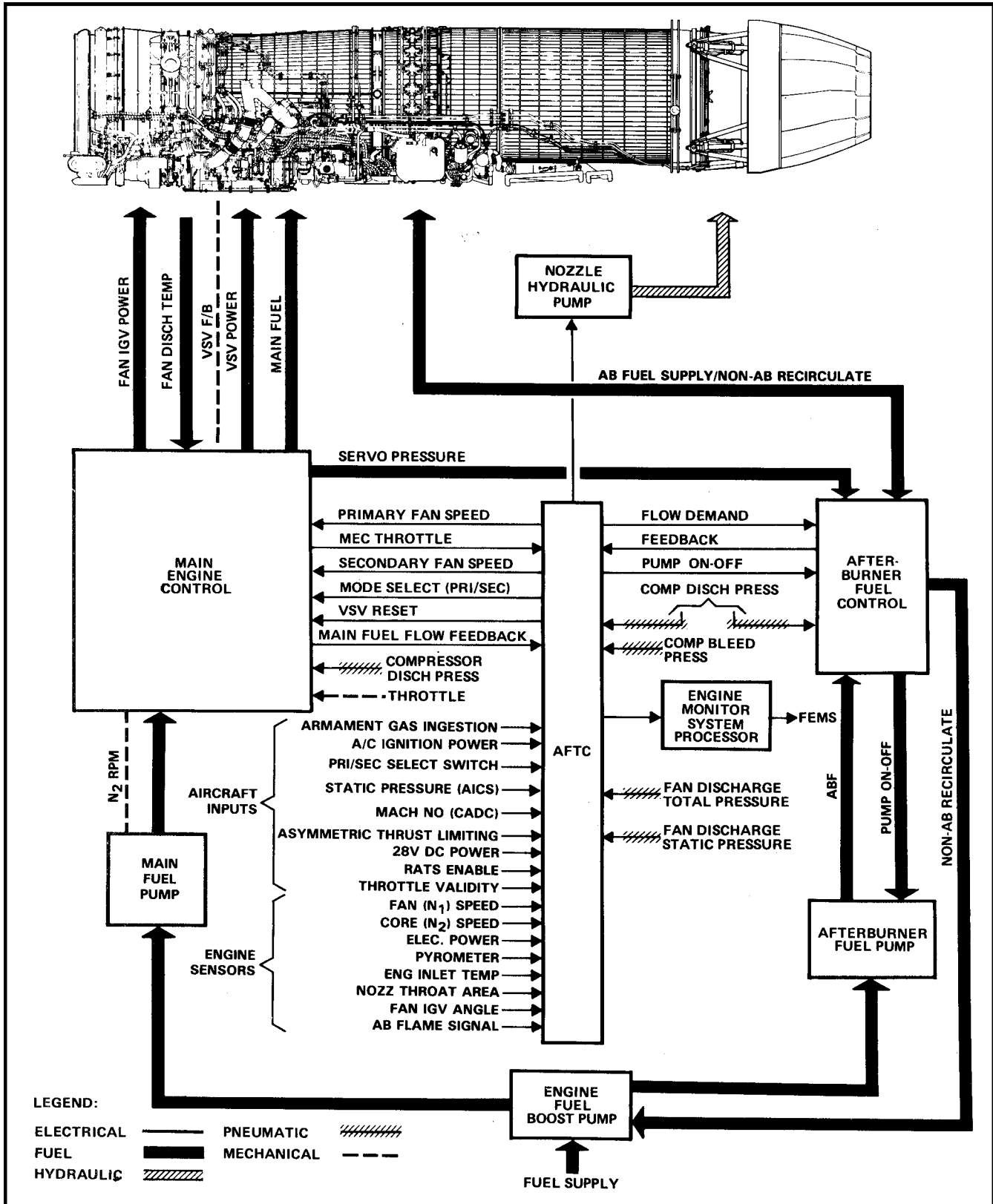
The engine (total flow) fuel boost pump is an engine-driven centrifugal pump on the aft accessory gearbox that provides boosted pressure and flow from the fuel supply system to meet main and AB fuel requirements. The pump receives fuel at aircraft boost pressure and boosts fuel pressure to levels adequate 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 N₂ speed based on pilot throttle commands and provides basic engine control except for AFTC fan speed limiting.



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Figure 2-17. Engine Fuel System

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.

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, electrohydro-mechanical 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.

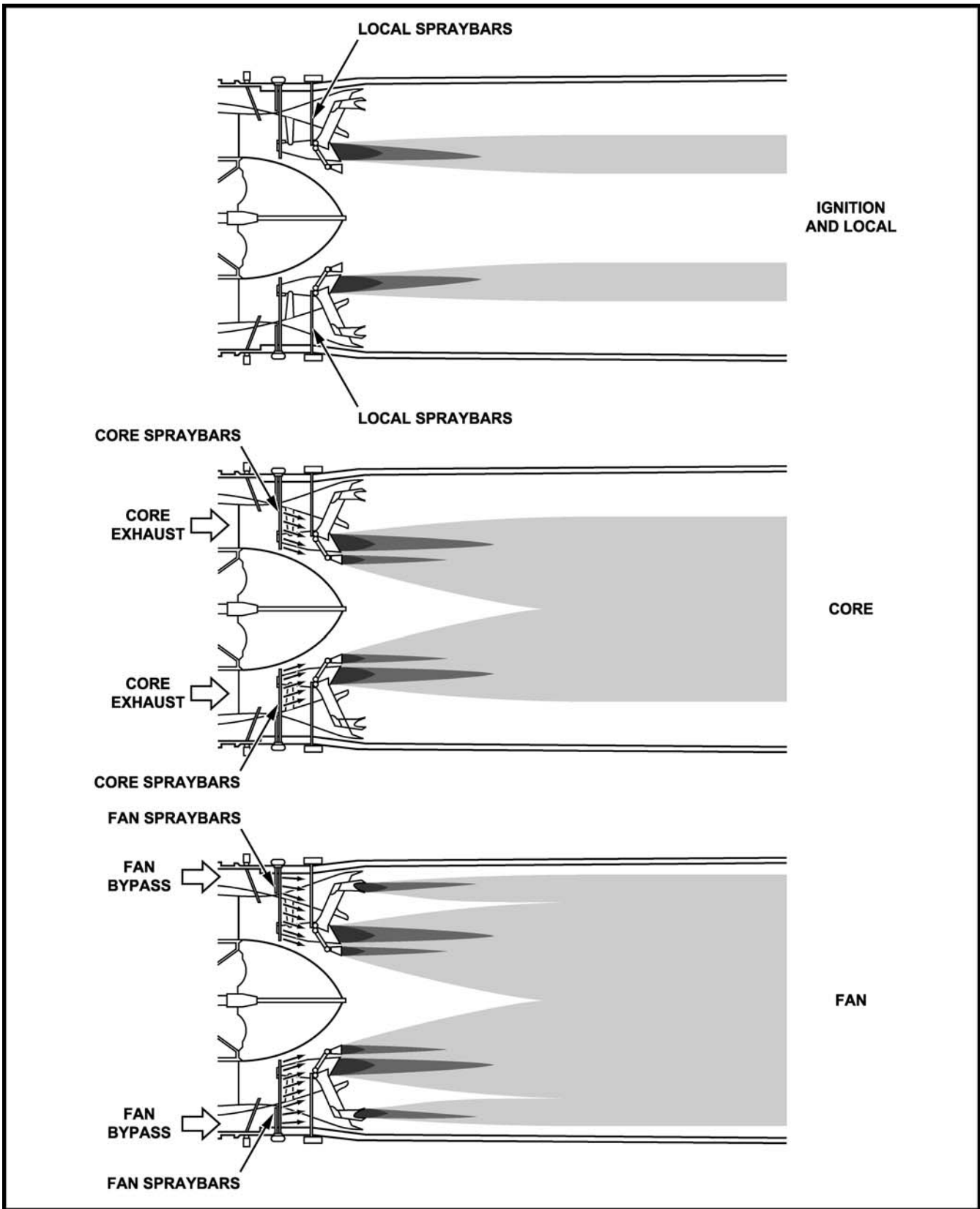
2.5 THROTTLES

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.

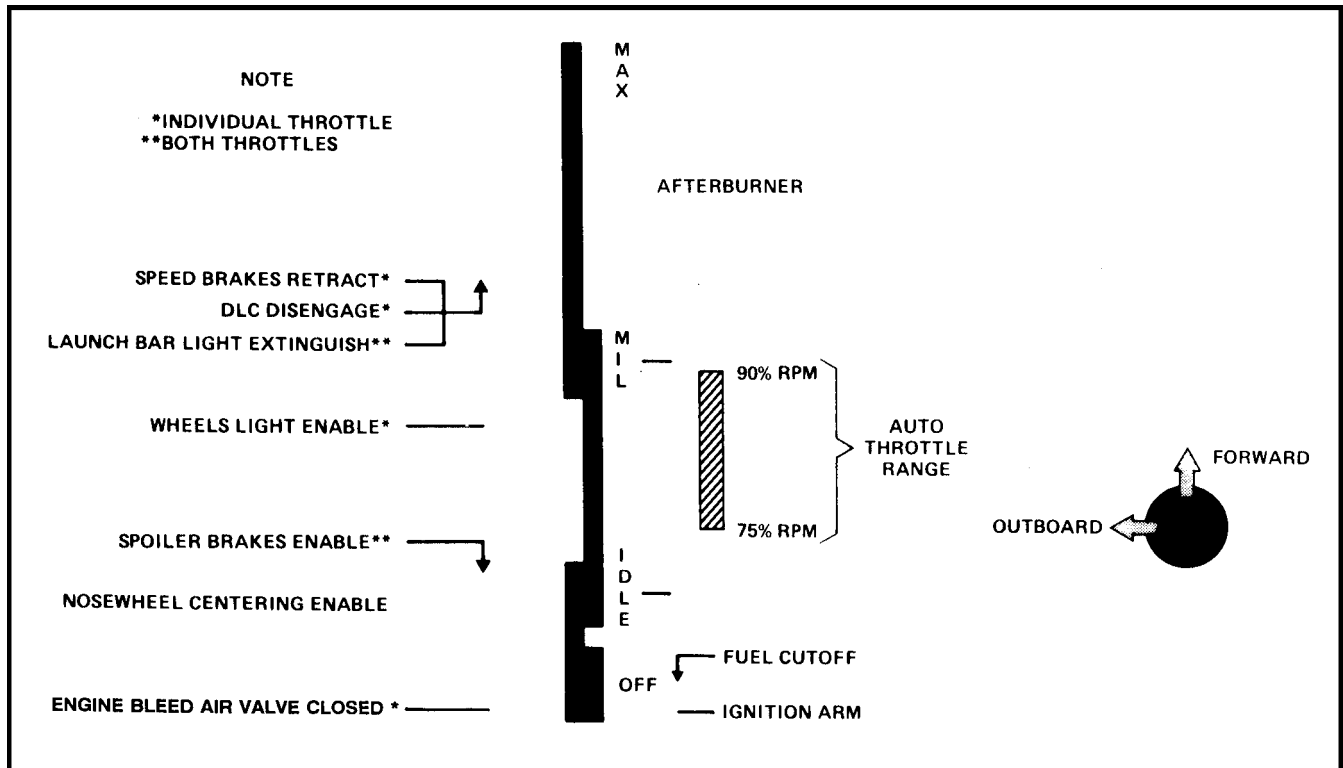
2.5.1 Throttle Control Modes

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.



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Figure 2-18. Afterburner Fuel Sequencing



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Figure 2-19. Throttle Interlocks

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 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.



- 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

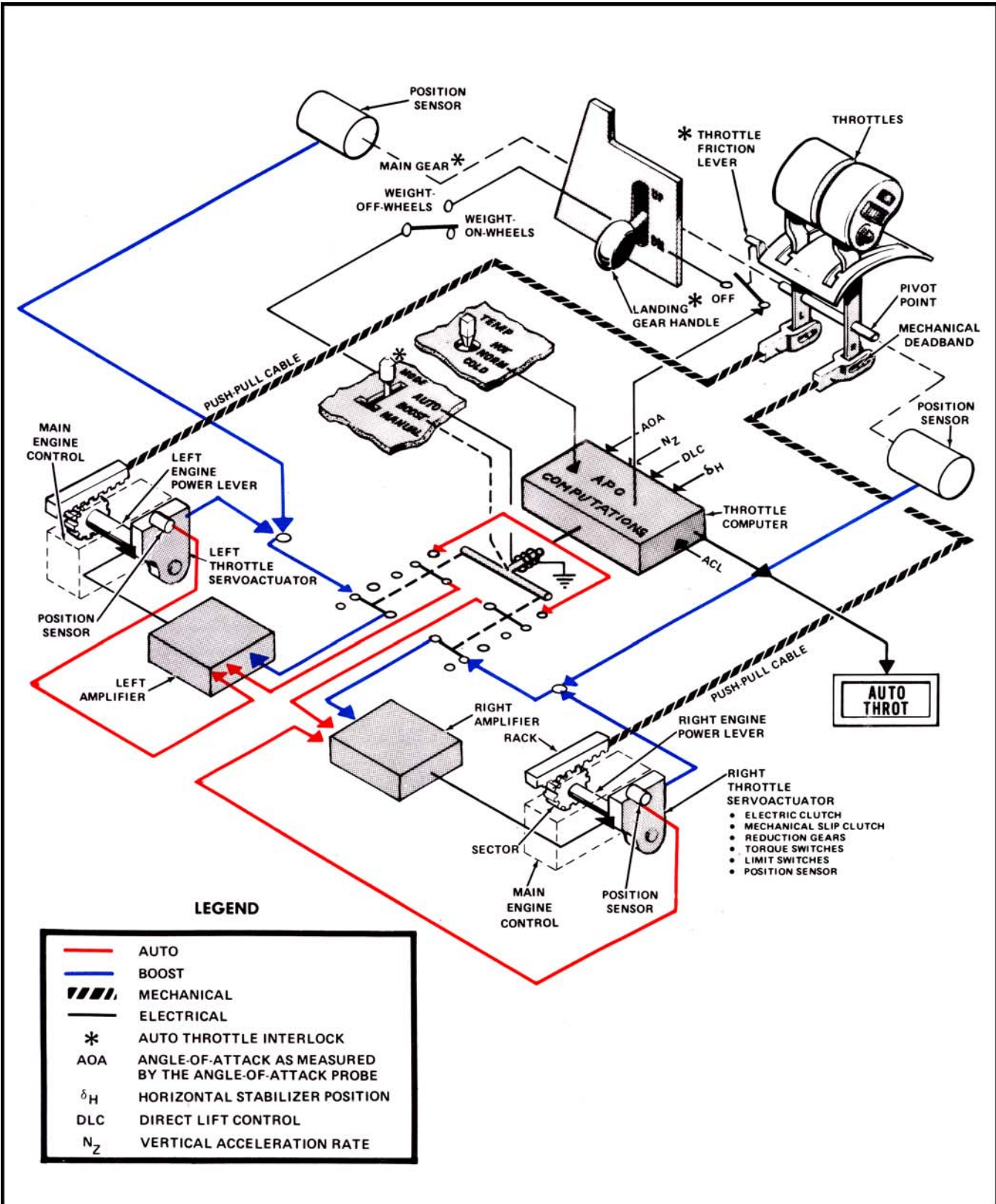
electric clutch in the throttle servoactuator, which is also mounted to the power lever shaft, is disengaged in the manual mode to reduce operating forces.

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



1-F50D-14-0

Figure 2-20. Throttle Control

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 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 15 units 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.



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.

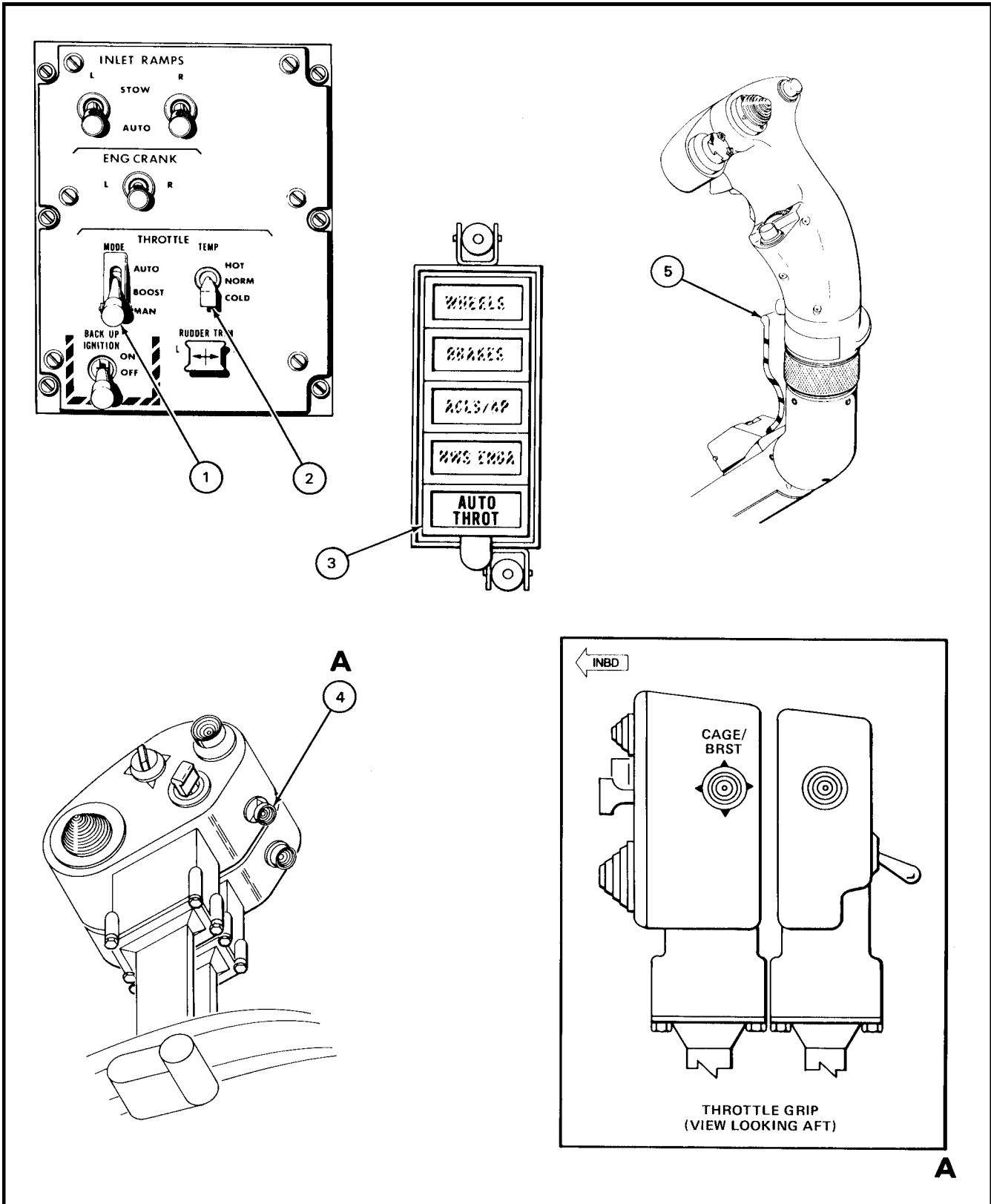
Depressing and holding the autopilot emergency disengage paddle switch with weight on wheels causes the throttle control system to be placed in the manual mode. If the automatic mode was selected before depressing the paddle switch, the THROTTLE MODE switch will automatically move to BOOST. The THROTTLE 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 hot, high pressure 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 dislodgment of ice, which can damage the compressor. The engine anti-icing system is designed to prevent the formation of ice rather than de-ice 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
<p>① THROTTLE MODE switch</p>	<p>AUTO — Engine thrust is automatically regulated by the throttle control computer to maintain optimum angle of attack for landing.</p> <p>BOOST — Normal operating mode. Reduces effort required to move throttles manually with friction control aft.</p> <p>MAN — Movement of each throttle is mechanically transmitted to the respective engine cross-shaft by a push-pull cable.</p>
<p>② THROTTLE TEMP switch</p>	<p>Used with the AUTO throttle mode to effect throttle computer gain changes to compensate for air temperature.</p> <p>HOT — Increases normal throttle computer gain.</p> <p>NORM — Normal throttle computer gain.</p> <p>COLD — Decreases normal throttle computer gain.</p>
<p>③ AUTO THROT caution light</p>	<p>Auto throttle mode is disengaged. During preflight check, remains illuminated for 10 seconds, then goes off and throttle mode switch automatically returns to BOOST.</p> <p style="text-align: center;">Note</p> <p style="text-align: center;">If the auto throttle is disengaged by deselecting the throttle mode switch, the AUTO THROT light will not illuminate.</p>
<p>④ CAGE/SEAM switch</p>	<p>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.</p>
<p>⑤ Autopilot emergency paddle</p>	<p>Reverts throttle system from AUTO or BOOST mode to MAN mode only while disengage depressed and with weight on wheels.</p>

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).

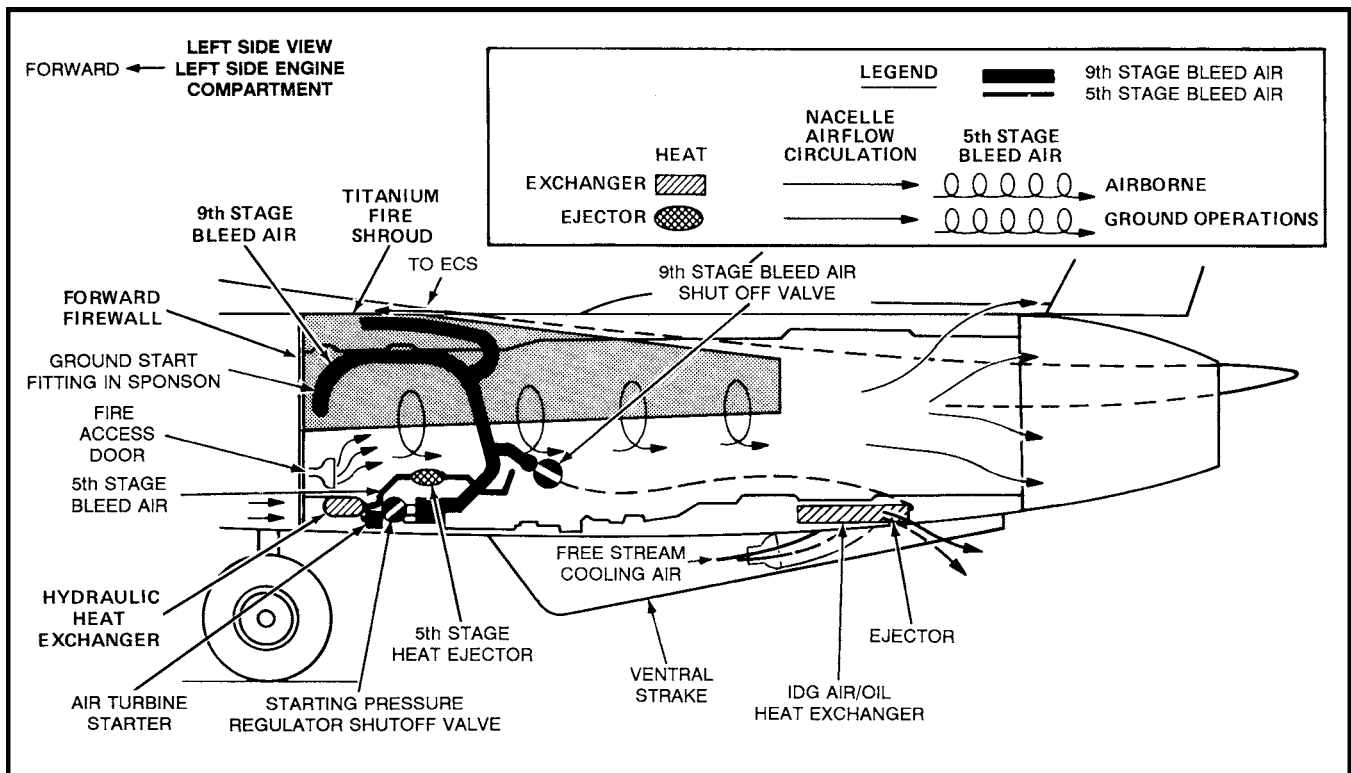
2.6.2 Environmental Control System Leak Detection

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 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.



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Figure 2-22. Engine Bleed Air/Compartment Ventilation

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 application 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

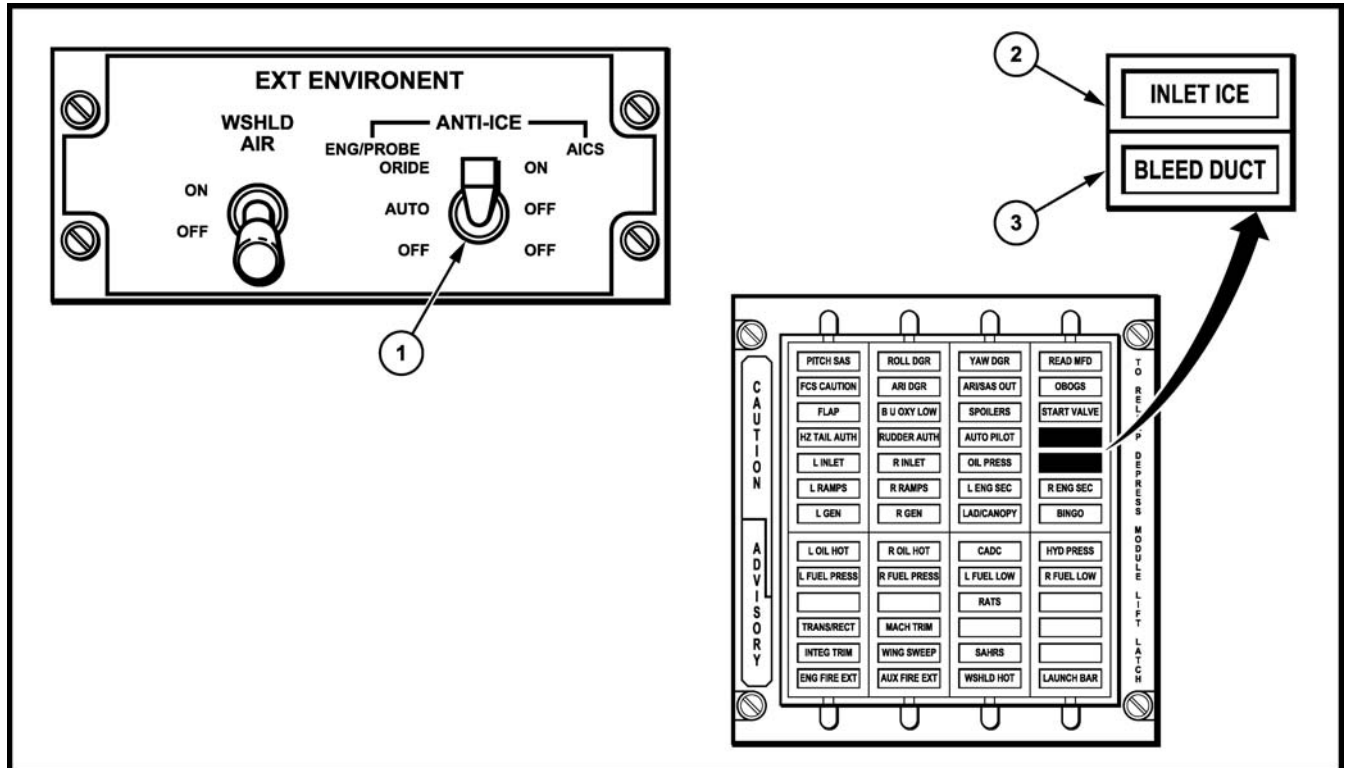
With weight on wheels, cooling airflow through the engine compartment is induced by the hydraulic heat exchanger ejector in the forward end of the compartment. Air enters through the nacelle ram-air scoop on the left side, passes through the hydraulic heat exchanger and is discharged into the engine 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 igniter, for each engine: main high energy, afterburner, and backup.

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 N₂ rpm is 10 percent or greater and is automatically provided from 10-to 59-percent rpm when the throttle is above cutoff. Ignition



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NOMENCLATURE	FUNCTION
<p>① ANTI-ICE switch</p>	<p>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.</p> <p>AUTO/OFF — When icing is sensed, ice detector activates engine anti-ice system, turns on INLET ICE caution light, activates external probe heaters with weight off wheels, and disables anti-ice mode to AICS programmers.</p> <p>OFF/OFF — Engine anti-ice system and probe heaters shut off. INLET ICE caution light disabled. Disables anti-ice mode to AICS programmers.</p>
<p>② INLET ICE caution light</p>	<p>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.</p>
<p>③ BLEED DUCT caution light</p>	<p>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. Also illuminates when an additional sensor detects temperatures of 255° or greater from the right diverter area, along the 400° manifold and into the bootstrap turbine compartment.</p>

Figure 2-23. Anti-Ice Control

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 ignites AB fuel flow for AB light-offs and relights (in the event of an AB blowout). The AB ignition 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.



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. Maximum engine motoring speed with the pneumatic starter is approximately 30-percent rpm.

2.9.2 Engine Crank

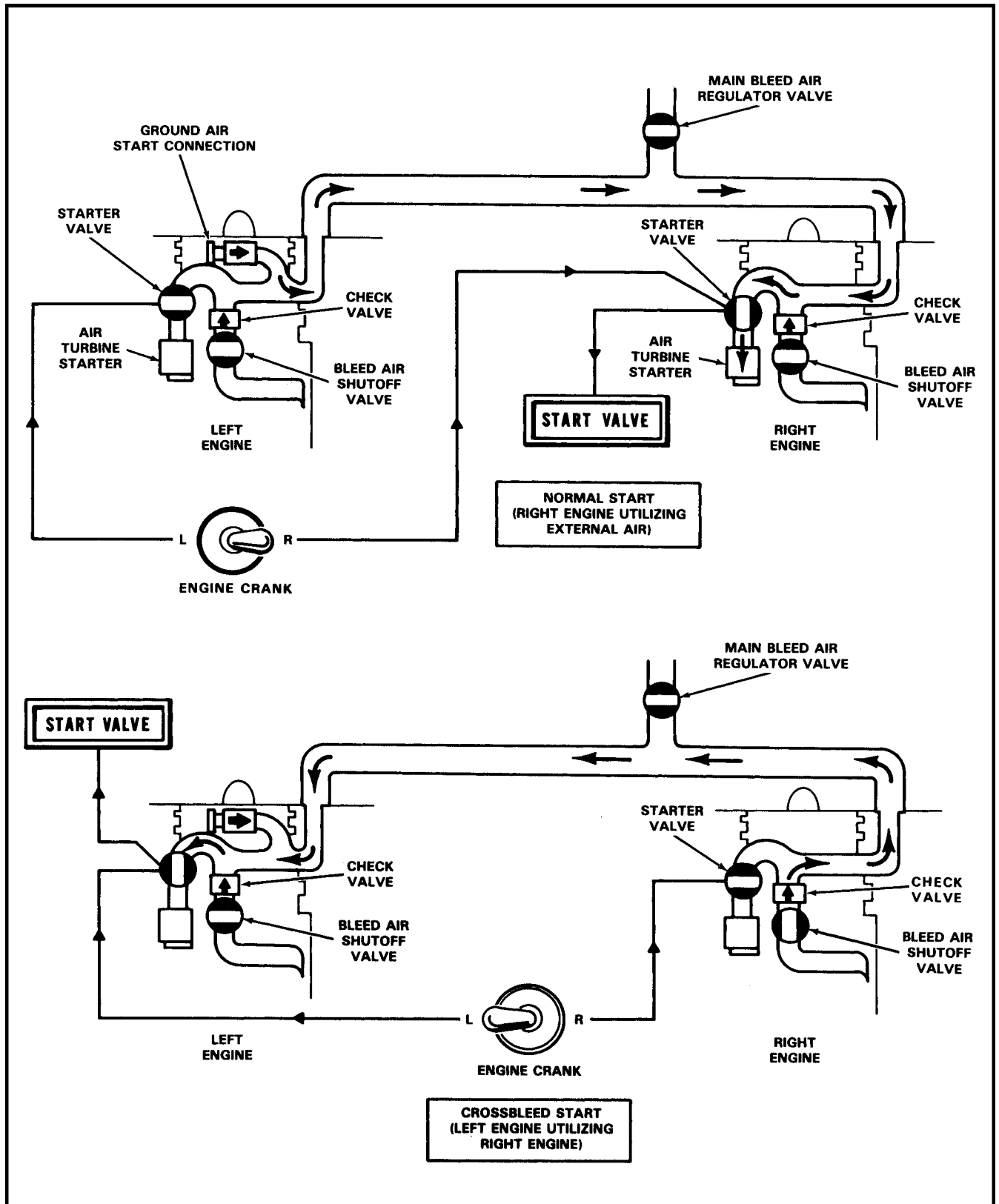
Placing the ENG CRANK switch in either L or R opens the corresponding starter pressure shutoff valve to allow pressurized air to drive the turbine. The ENG CRANK switch energizes the appropriate shutoff valves to configure the bleed manifold for starting.

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 switch 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.



- If the starter valve does not close during engine acceleration to idle rpm, continued air-flow 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

Return of the ENG CRANK switch to the center or off position 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 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 bearings, 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 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 the engine must be run 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 transducer 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 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 backlit for night operations. Left and right engine compressor speed (rpm), EGT, and fuel flow are displayed on the EIG. Adjacent to the EIG are circular instruments for both engines' 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

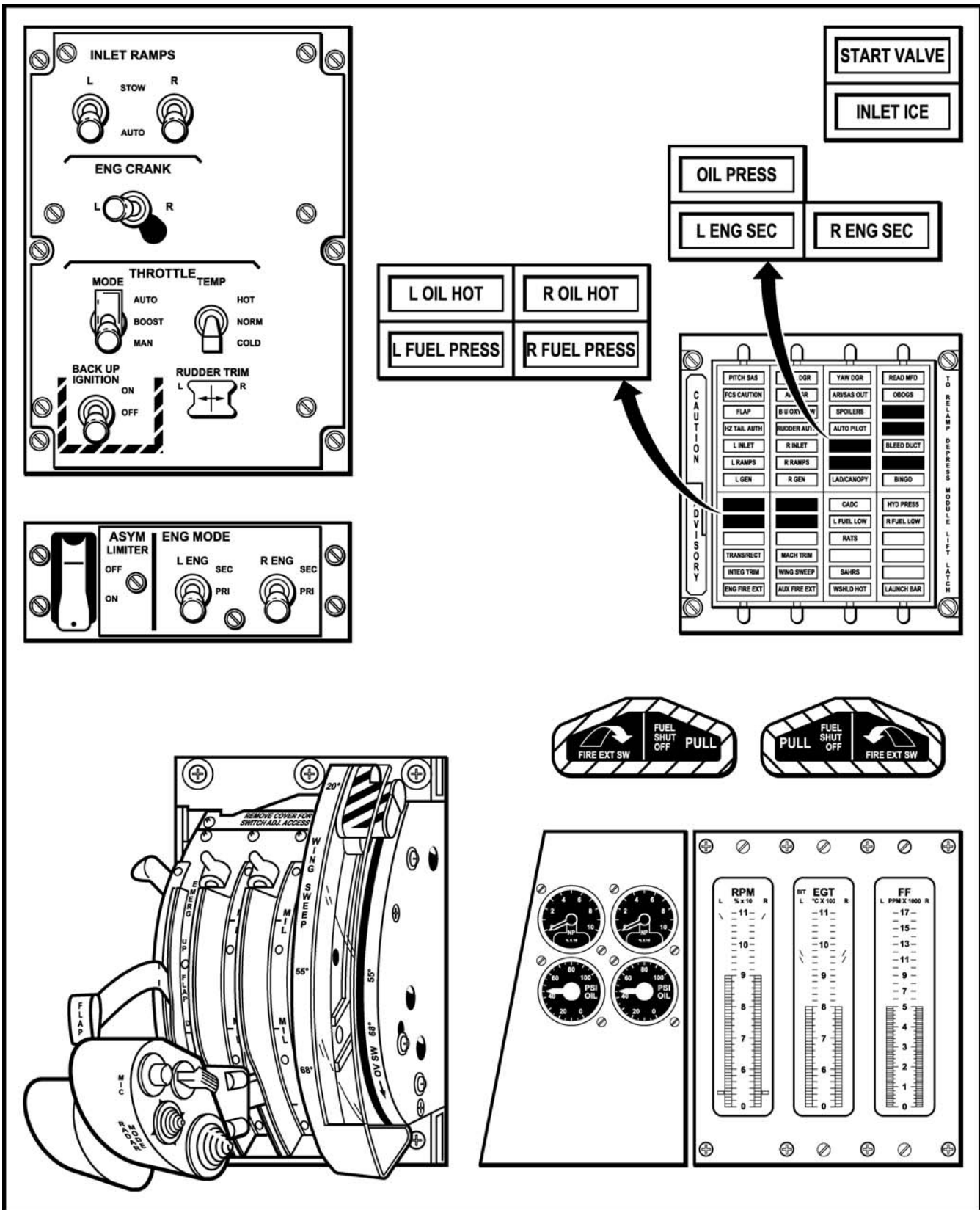
The RPM indicators (Figure 2-25) have a range of 0 to 110 percent. The tape display steps in 5-percent increments and the upper segment flashes to indicate rpm increasing at more than 0.4 percent per second from 0 to 60-percent rpm. The tape steps in 1-percent increments when greater than 60-percent 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 fuel flow 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



CSC-F14D-1-2-007

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

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 over-temperature condition. The tone is present for a maximum of 10 seconds unless the fault clears sooner. There is an EGT reading for each engine.

2.11.3 Fuel Flow Indicator

The fuel flow 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 fuel flow. 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 $950 \pm 10^\circ \text{C}$. 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.

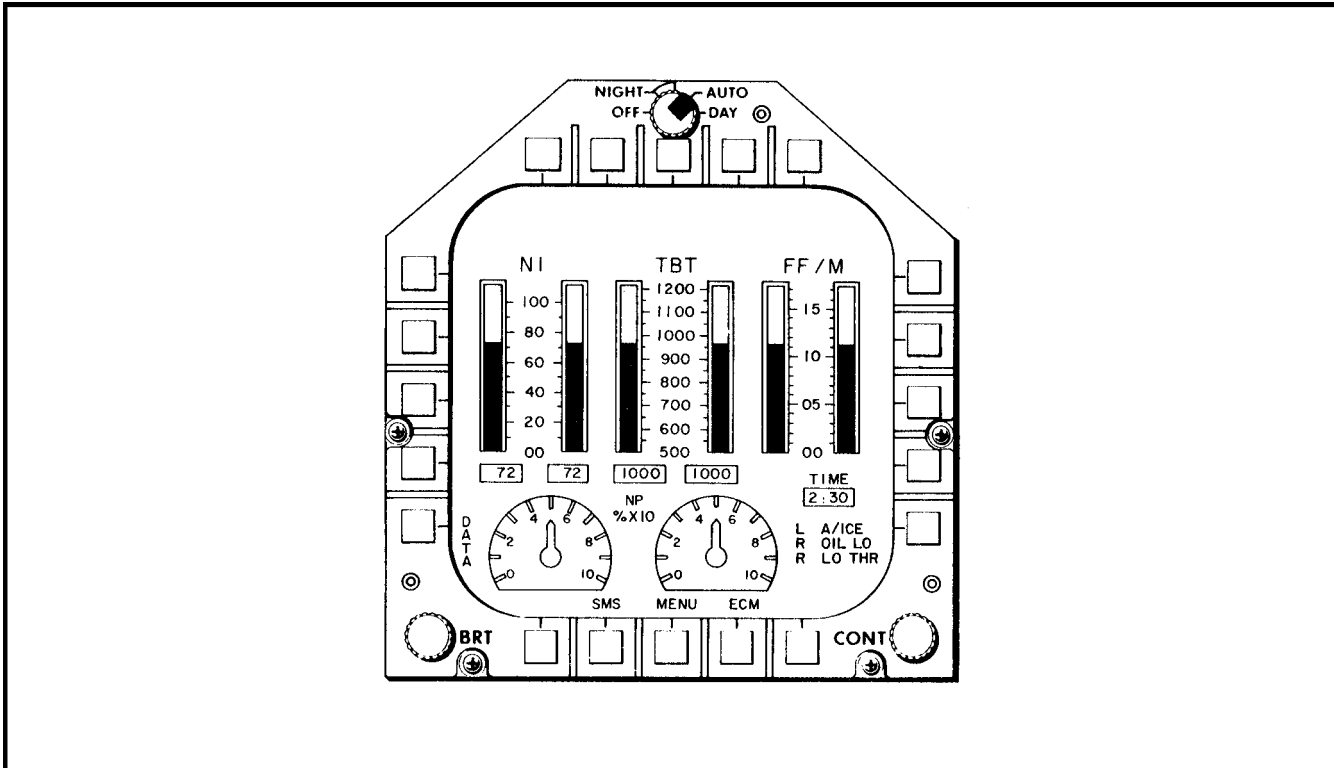
Note

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.



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Figure 2-26. MFD Engine Monitor Display

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.

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 N₂ overspeed condition.
2. L N1 OSP or R N1 OSP — Designated engine N₁ 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 IGVS or R IGVS — 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

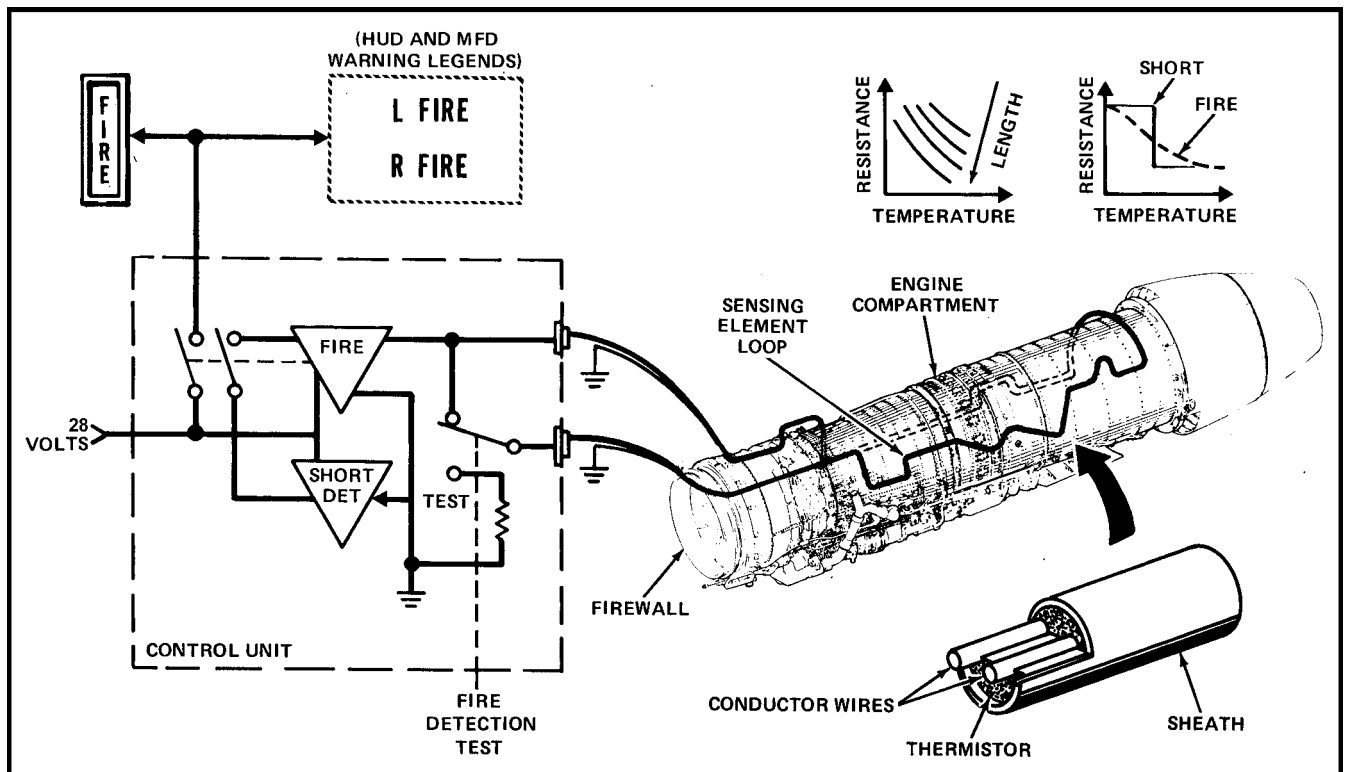
The fire detection system provides a cockpit indication of fire or overheating in either engine compartment. There is a separate system for each engine compartment, each consisting of a thermistor-type sensing loop monitored by a transistorized control unit. The system is powered by 28 volts from the 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.



CSC-F14D-1-2-035

Figure 2-27. Fire Detection System

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 signal 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 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 below 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

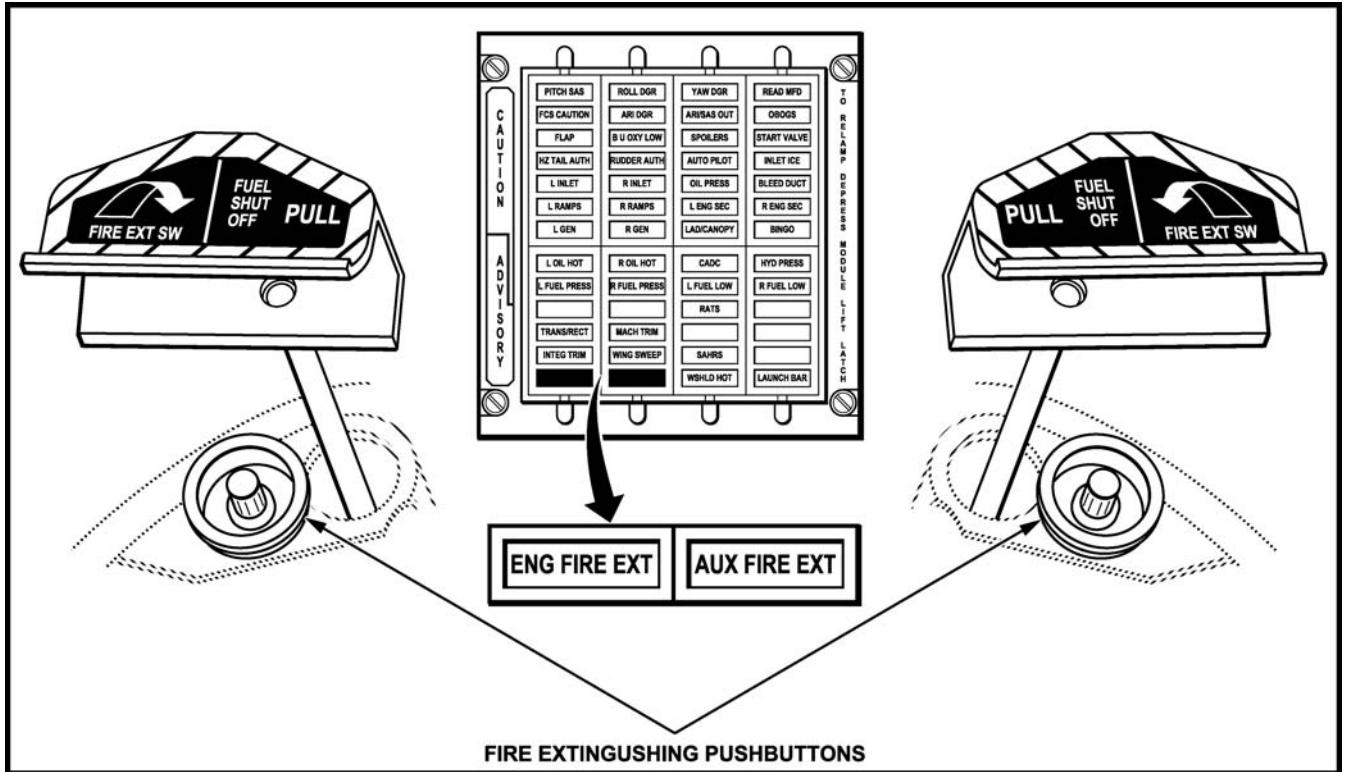
The fire extinguishing system is tested by raising and rotating the MASTER TEST switch to FIRE DET/EXT and depressing the knob. If the fire extinguisher test passes, the GO light illuminates; if the NO GO light illuminates or if both or neither GO and NO GO lights illuminate, the system has not tested 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 selectable 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 flame-out occurs from fuel starvation. However, with complete motive flow failure, engine fuel starvation can occur with usable fuel aboard.

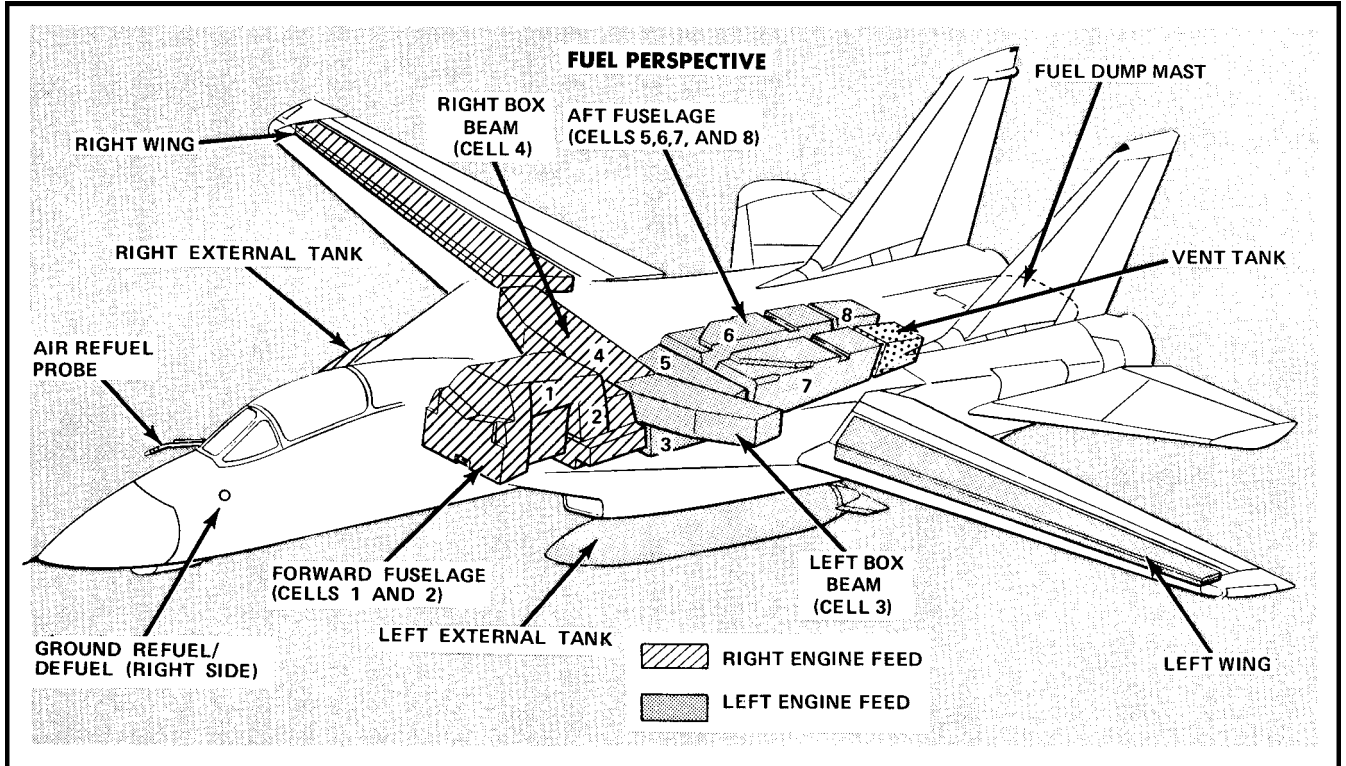
Note

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.



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Figure 2-28. Fire Extinguishing Switches and Advisory Lights



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Figure 2-29. Fuel Tanks

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, spans 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 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 0 to -0.5 -g 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 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 wingsweep 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 locations are designated as armament stations 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 indicating system, independent of the capacitance 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 $1,000 \pm 200$ 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

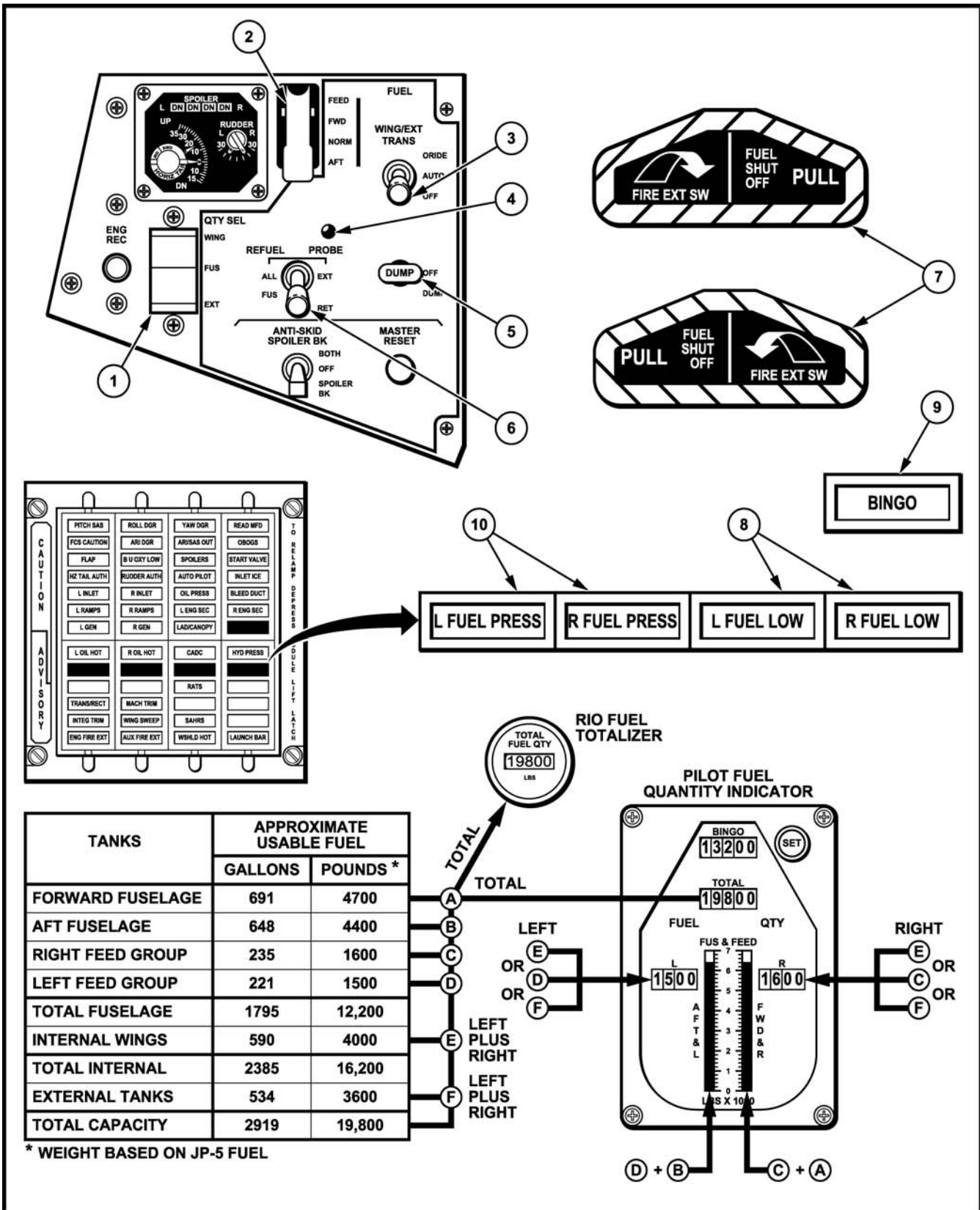
- If the thermistors in either cell No. 2 or No. 5 remain covered during a fuel transfer failure, it is possible to partially deplete the sump tank without illuminating the respective FUEL LOW caution light.
- When both FUEL LOW caution lights illuminate, less than 1 minute of fuel is available if both 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



CSC-F14D-1-2-009

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

NOMENCLATURE	FUNCTION
<p>① QTY SEL switch</p>	<p>WING — Fuel quantity in each wing is displayed on L and R counter of pilot's fuel quantity indicator.</p> <p>FEED — Spring-loaded rocker switch 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</p> <p>EXT — Fuel quantity in each external tank displayed on L and R counter of pilot's fuel quantity indicator.</p>
<p>② FEED switch</p>	<p>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.</p> <p>NORM — (guarded position) Right engine feeds from forward and right tanks. Left engine feeds from aft and left tanks.</p> <p>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.</p>
<p>③ WING/EXT TRANS switch</p>	<p>ORIDE — <i>Airborne</i> - 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. <i>Weight on Wheels</i> -Allows transfer of wing and external tank fuel.</p> <p>AUTO — <i>Airborne</i> - 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. <i>Weight on Wheels</i> -Automatic transfer of wing and external tank fuel cannot be accomplished; switch must be set to ORIDE for wing fuel transfer.</p> <p>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.</p>
<p>④ In-flight refueling probe transition light</p>	<p>Illuminates whenever probe cavity forward door is open during retraction or extension of probe.</p>
<p>⑤ DUMP switch</p>	<p>OFF — Dump valve closed.</p> <p>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.</p>

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

NOMENCLATURE	FUNCTION
<p>⑥ REFUEL PROBE switch</p>	<p>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.</p> <p>FUS EXTD — Extends refueling probe. Normal transfer and feed. Used for practice plug-ins, fuselage-only refueling, or flight with damaged wing tank.</p> <p>RET — Retracts refueling probe.</p>
<p>⑦ Left and right FUEL SHUT OFF PULL handles</p>	<p>Pulling respective handle manually shuts off fuel to that engine. Push forward resets engine fuel feed shutoff valve to open.</p>
<p>⑧ L and R FUEL LOW caution lights (Also single light on RIO CAUTION panel.)</p>	<p>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.</p>
<p>⑨ BINGO caution light</p>	<p>Illuminates when total fuel quantity indicator reads lower than BINGO counter value.</p>
<p>⑩ L and R FUEL PRESS caution lights</p>	<p>Indicates insufficient discharge pressure (less than 9 psi) from respective turbine-driven boost pump.</p> <p style="text-align: center;">NOTE</p> <p style="text-align: center;">If fuel pressure light is illuminated an engine overtemp warning tone will sound.</p>

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

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.

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:

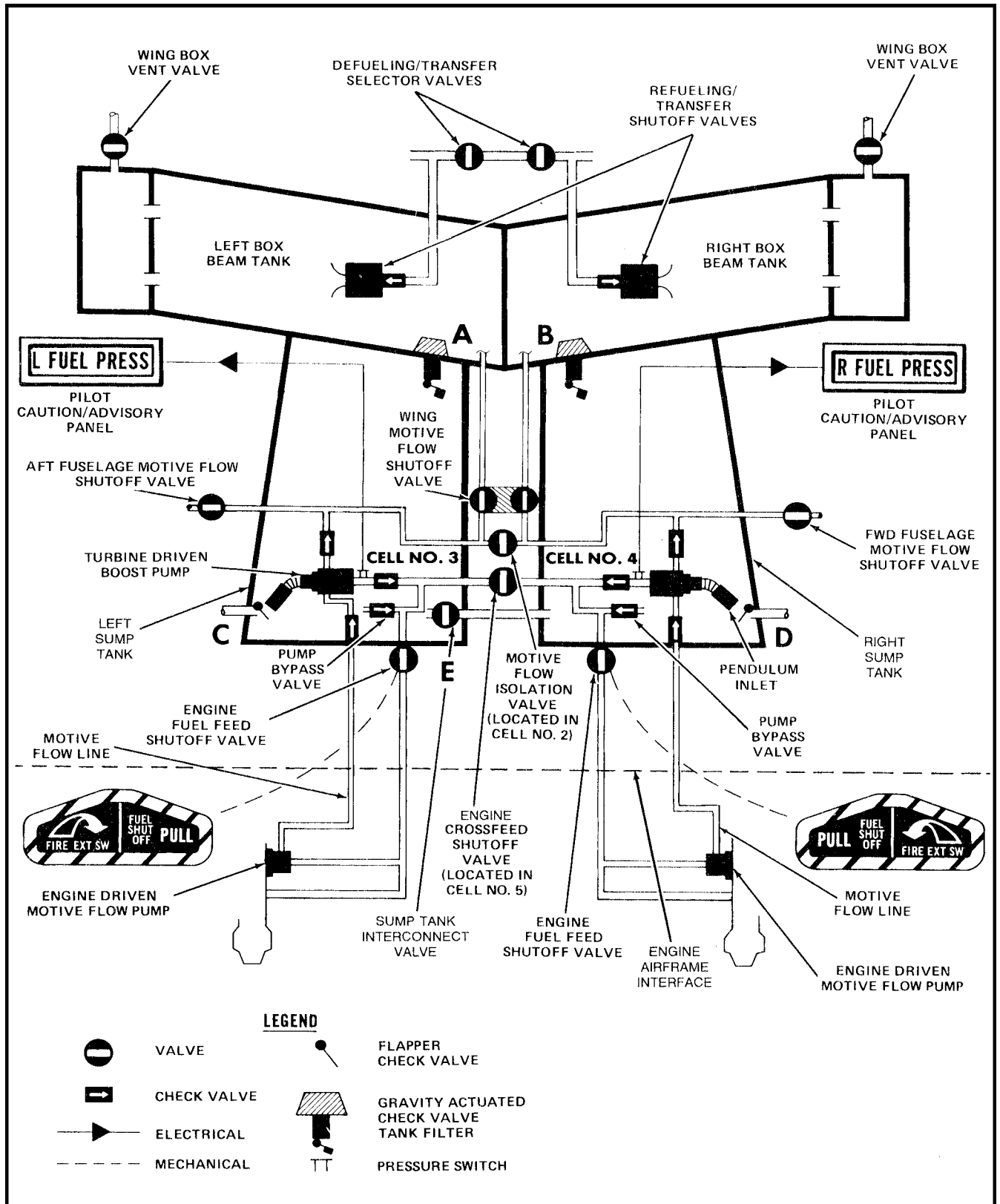
1. Situation 1
 - a. Fuel in cell Nos. 2 and 5
 - b. FEED switch in NORM
 - c. Normal engine fuel flow (MIL thrust or less).

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 tanks 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 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.



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Figure 2-31. Engine Fuel Feed

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.



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 both motive flow pumps are 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:

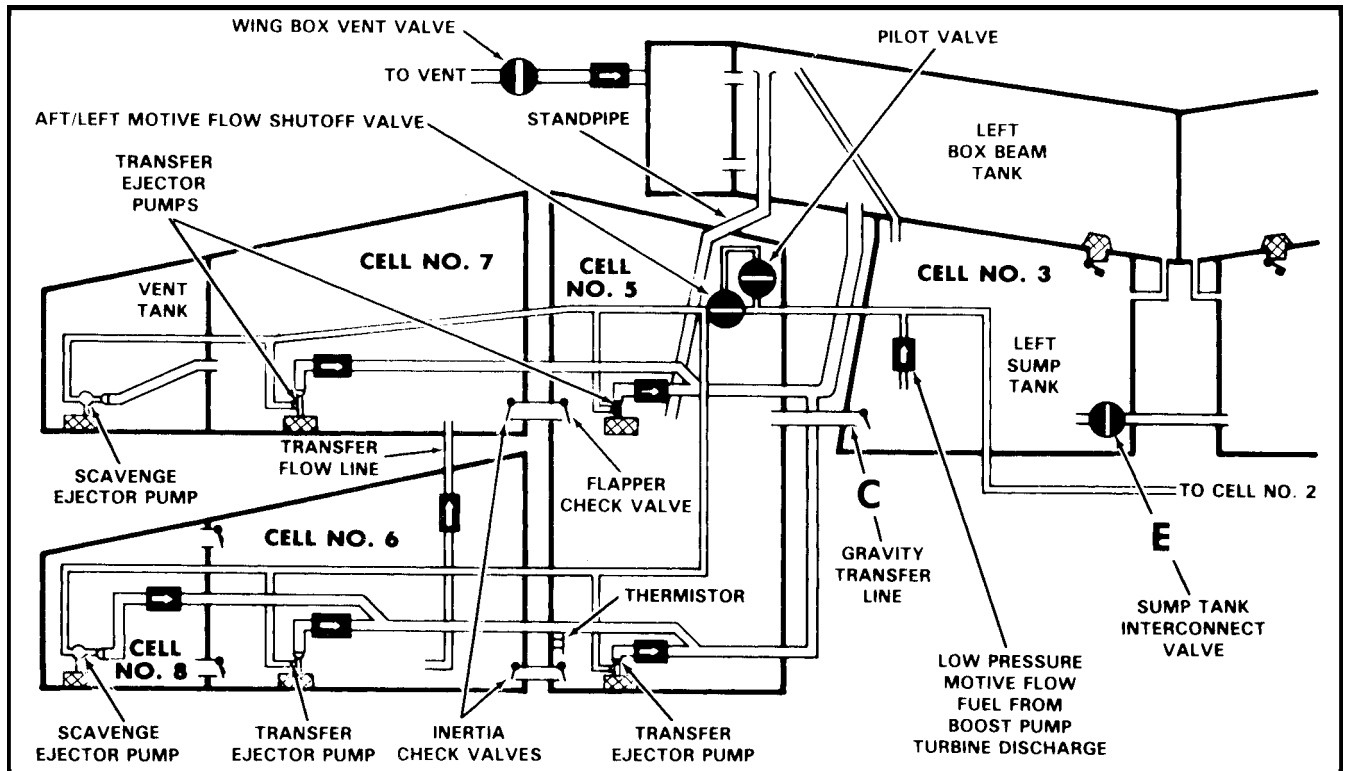
1. Wing fuel transfer
2. With the FEED switch in FWD or AFT and no transfer of external fuel
 - a. The feed group of the selected side remains full.
 - b. Fuel migration from one side to the other.

NOTE

If fuel pressure light is illuminated an engine overtemp warning tone will sound.

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 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



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Figure 2-32. Aft Fuselage Fuel Transfer

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.

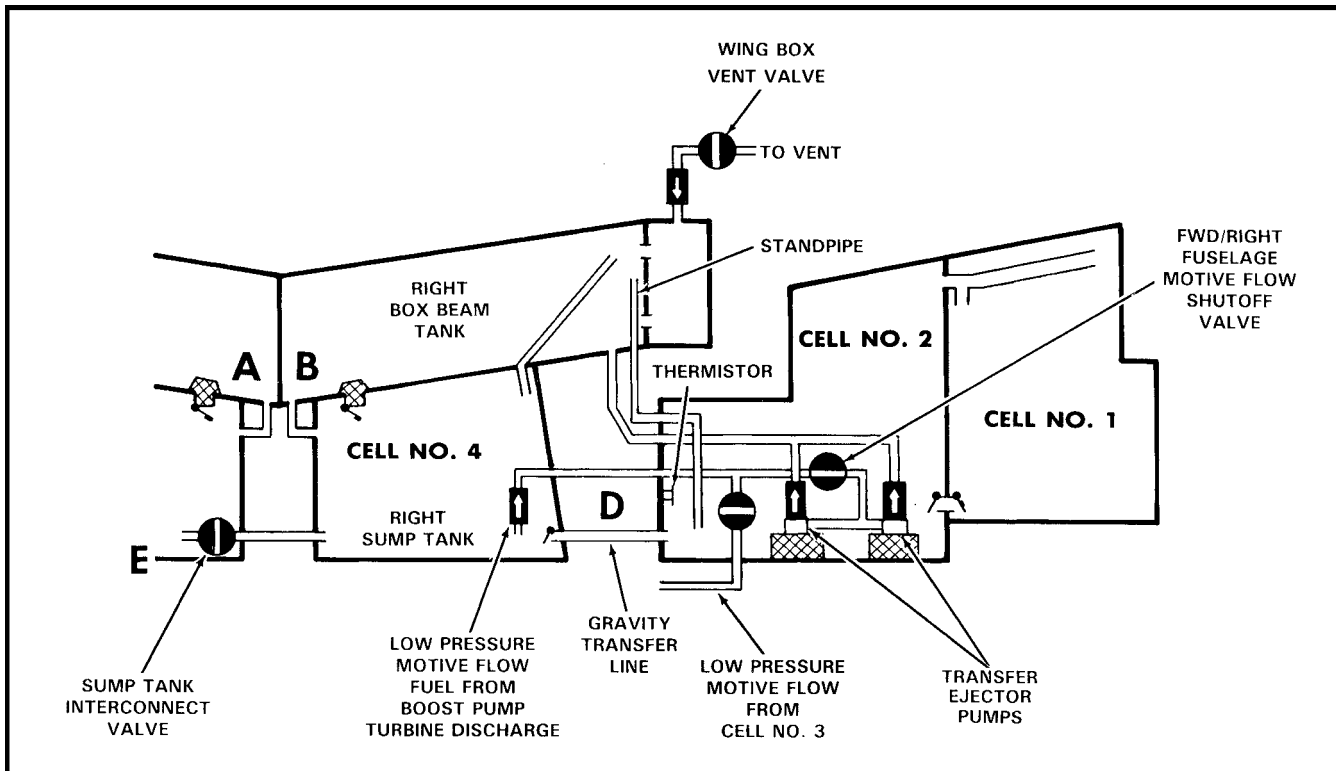
- In the presence of a fuel pressure light, fuel demand must be reduced and positive g restored to prevent possible engine flameout.

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.



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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 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 fuse-

lage, 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 cells are 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.

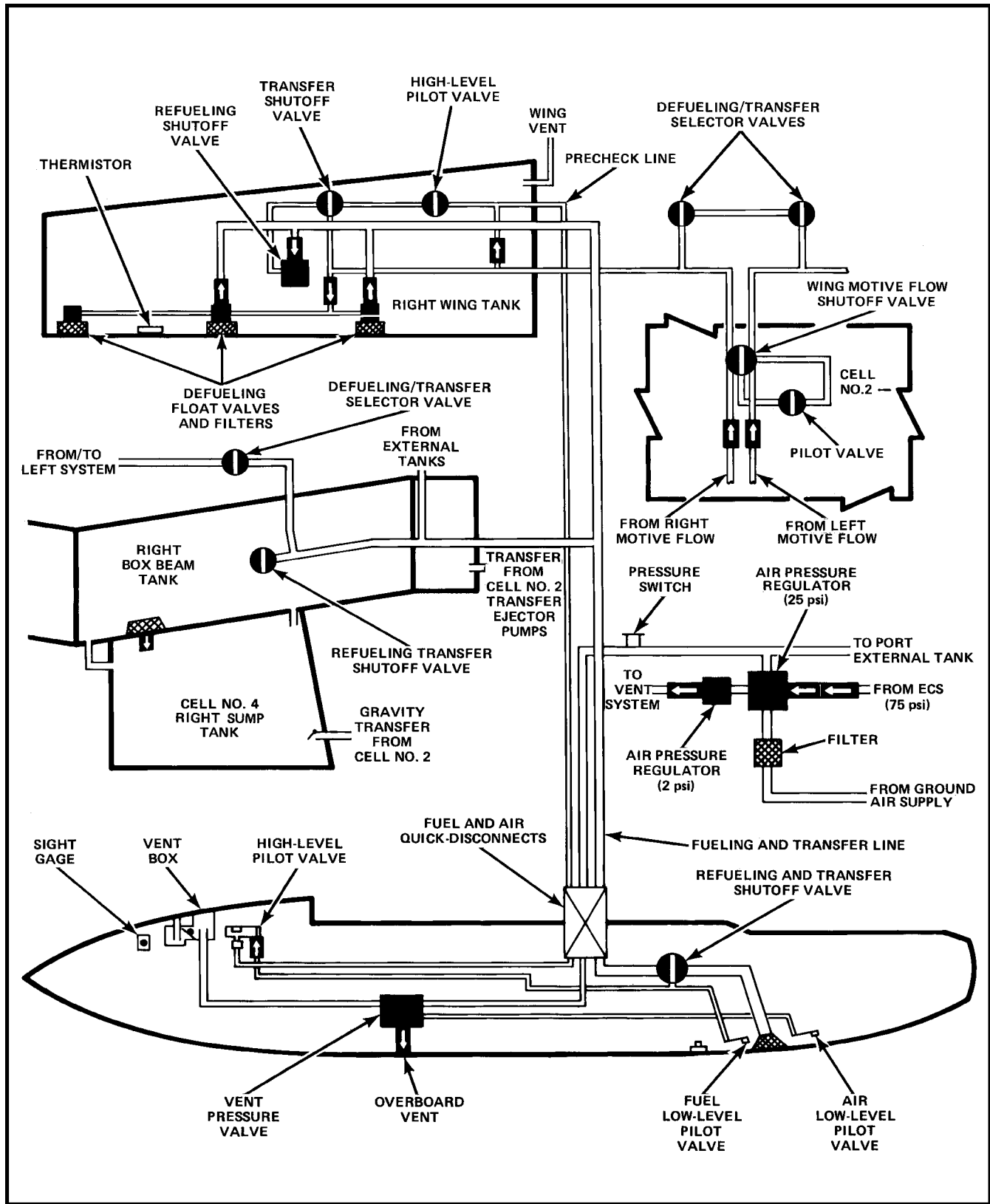
2.14.4.4 Wing Transfer

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 re-enable 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 shutoff 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 a path for the 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.



- 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.

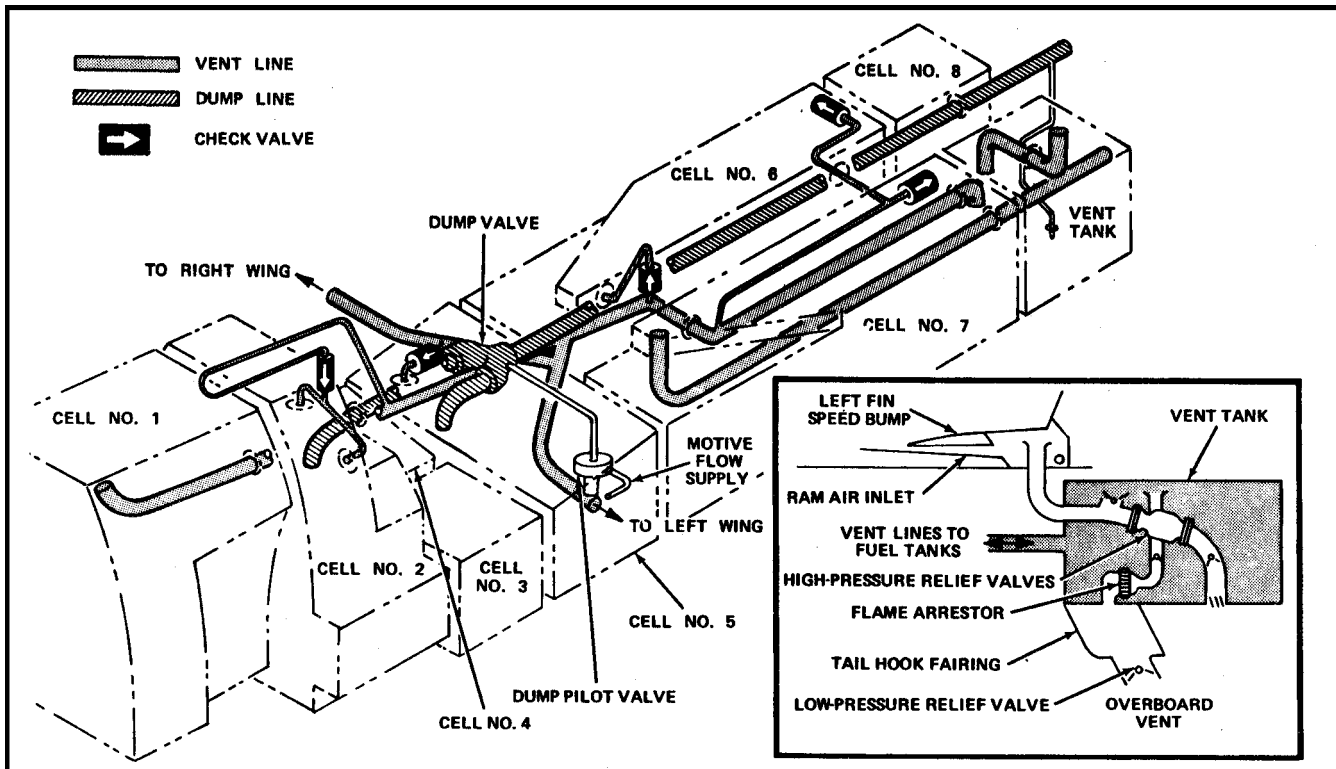


The speedbrake/fuel dump interlock does not prevent speedbrakes from being deployed if fuel dump is activated. It only prevents the dumping of fuel if the speedbrakes are already extended.

Note

- The FUEL FEED/DUMP circuit breaker (RE1) 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 fuel dump level in the tanks, which, under normal operations (feed group full), is approximately 4,000 pounds.



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Figure 2-35. Fuel Vent and Dump

2.14.8 Internal Tank Pressurization and Vent

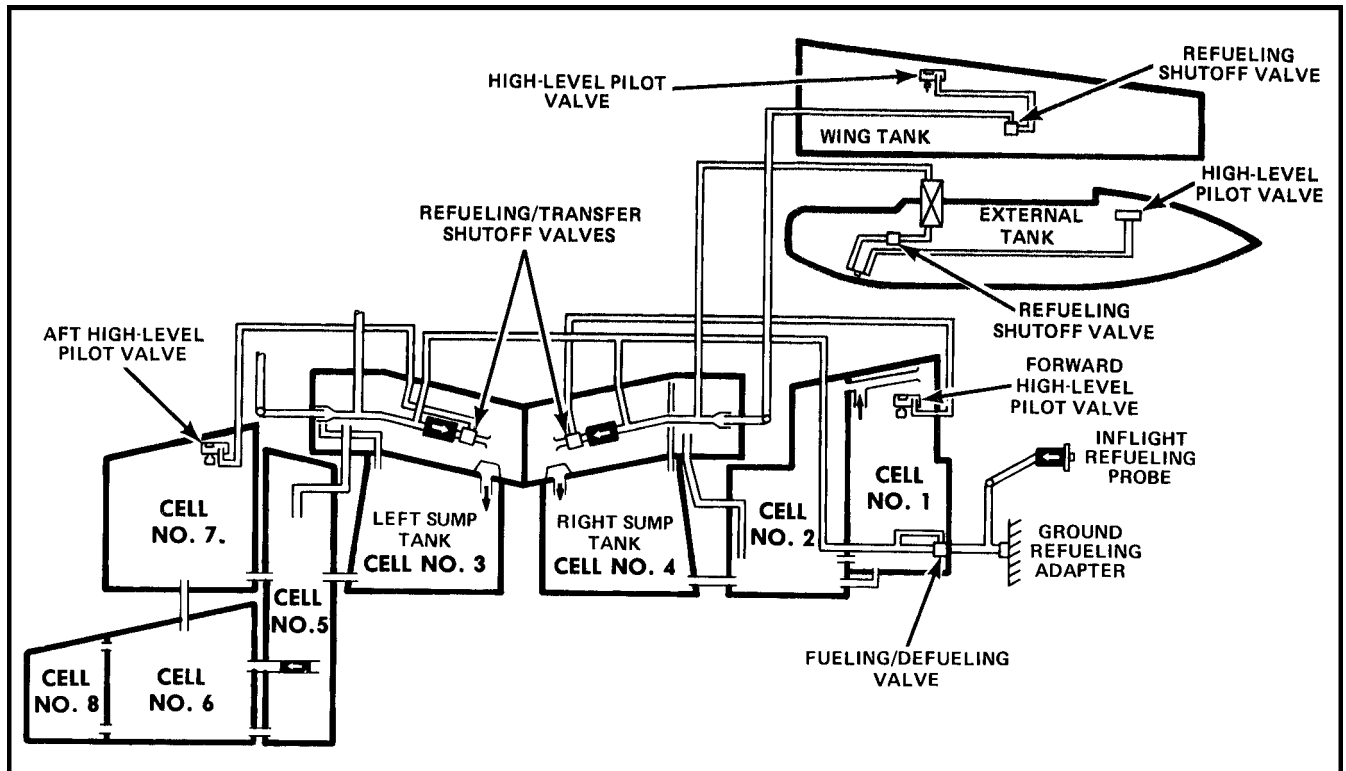
The internal fuel vent system is shown in Figure 2-35. It is an open-vent-type system, pressurized by ram air and engine bleed air from the 25-psi external tank pressure system that is reduced to 1.75 psi by a fuselage pressure regulator and distributed to all tanks through the fuselage vent system. 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.



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Figure 2-36. Refueling System



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).



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 gallons per minute (3,000 lbs per minute depending on fuel type) at a pressure of 57 psi.

WARNING

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

CAUTION

- 57 psi limitation could be exceeded when refueling from some aircraft operating more than one transfer pump. Damage to fuel system can result.
- Maximum airspeed for extension or retraction 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 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

- Extension or retraction of the refueling probe using the hydraulic hand pump 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, by placing the landing gear handle 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 in-flight 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 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.

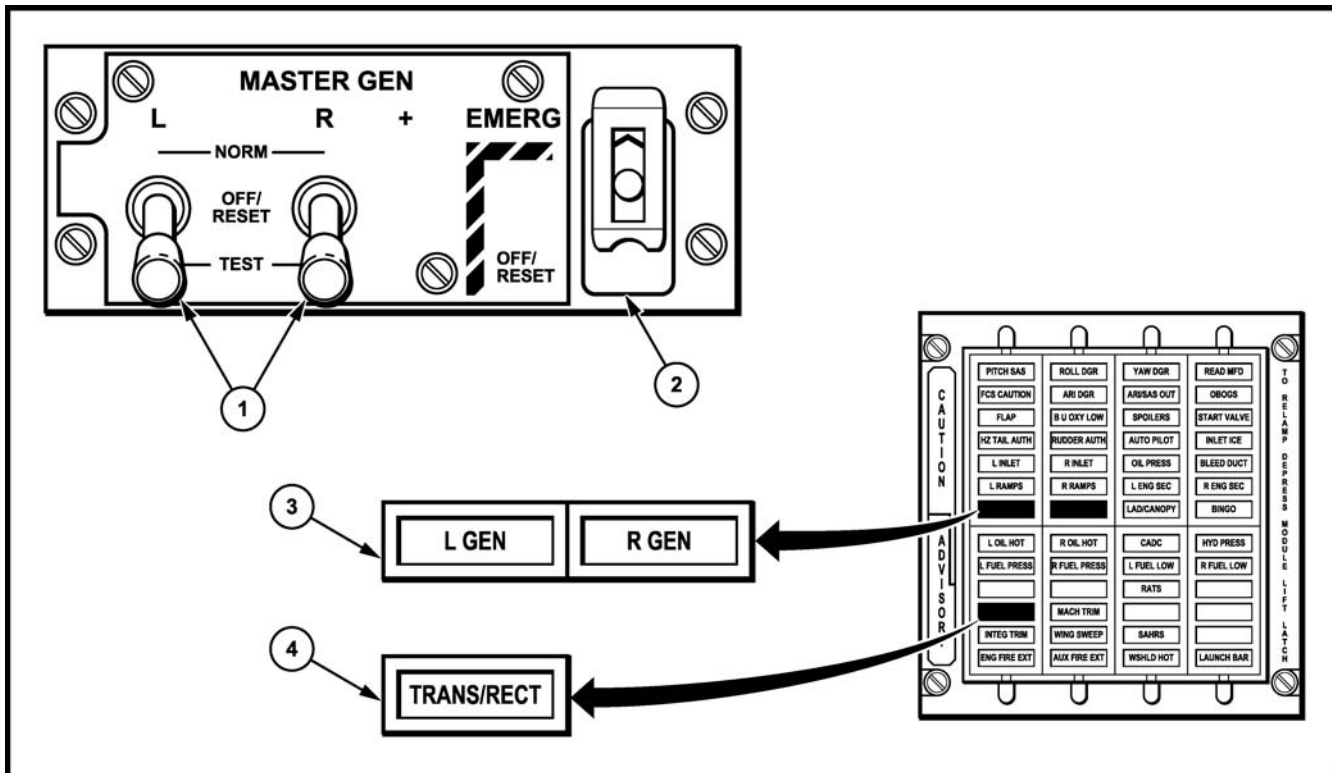
2.15.1 Normal Electrical Operation

2.15.1.1 Main Generators

Two engine-driven, oil cooled, integrated drive generators (IDG) produce the normal 115-volt, 400 Hz, three-phase ac electrical power. The normal rated output of each generator is 75 kVA, which is sufficient to individually assume the complete electrical load of the aircraft. 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 (CSD) 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.

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.



CSC-F14D-1-2-010

NOMENCLATURE	FUNCTION
<p>① MASTER GEN switch (lock lever)</p>	<p>NORM — Connects the generator to the main buses through the line contactor.</p> <p>OFF/RESET — Disconnects generators from the buses. Resets the generator if tripped by an overvoltage, undervoltage, or fault condition.</p> <p>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.</p>
<p>② EMERG generator switch</p>	<p>NORM — Safety guard down. Electrically controlled by a solenoid control valve energized by the left main dc bus. Operation is automatically initiated, connecting to the essential buses, with the loss of the left main dc bus, regardless of other sources of ac or dc power. Total loss of ac or dc power will result in the loss of the left main dc bus and, therefore, activation of the emergency generator.</p> <p>OFF/RESET — Safety guard must be lifted. Disconnects the emergency generator from the essential buses. Resets the generator if tripped by an undervoltage or under-frequency condition.</p>
<p>③ L GEN and R GEN caution lights</p>	<p>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.</p>
<p>④ TRANS/RECT advisory light</p>	<p>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.</p>

Figure 2-37. Generator Panel

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-line at approximately 50-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 rpm.

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-line, the relight of the engine will not automatically reset the generator unless the engine speed decreased below about 30-percent N₂ 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, under-frequency, 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 DFCS bus is normally supplied from the interruption-free dc bus; however, with an output failure from both transformer-rectifiers, the DFCS bus load is automatically transferred to the essential No. 2 bus. Loss of main dc power automatically activates the emergency generator. The emergency generator is electrically

inhibited by a solenoid control valve energized by the left main dc bus. Operation of the generator is automatically initiated, connecting to the essential buses, with the loss of the main dc bus, regardless of other sources of ac or dc power. Total loss of ac or dc power will consequently result in the loss of the left main dc bus and, therefore, activation of the emergency generator. This, in turn, trips power transfer relays to change essential ac & 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.



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 a popped breaker is readily visible to the flightcrew. 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. 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 that 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 normal combined hydraulic system operation, the emergency generator powers the essential ac and dc No. 1 and No. 2 buses and the DFCS dc bus in the 5 kVA mode. 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. This delay will force the DFCS computers into a power-up BIT sequence, requiring a MASTER RESET to regain SAS and ARI functions.



The spoiler actuators are mechanically biased to the retracted position in order to cause the spoilers to retract in the event that the command signal from the DFCS is lost (i.e., DFCS power failure).

If this bias is reversed, the affected spoiler will extend instead of retracting when the command signal is lost. A DFCS power failure coupled with a reverse spoiler bias will result in a fully deployed spoiler. All unaffected spoilers will remain retracted and will not respond to flight control inputs until the DFCS command signals are restored.

Note

- DFCS synchronization can take up to two 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.
- Do not press and hold the MASTER RESET pushbutton. Pressing and holding the MASTER RESET pushbutton during the synchronization time will have no effect since the DFCS computers only recognize the leading edge of the pulse from the MASTER RESET pushbutton, and not the fact that the button is continuously depressed.

Pilot control of the emergency generator is through the guarded EMERG switch on the MASTER GEN control panel. The emergency generator is electrically inhibited by a solenoid control valve energized by the left main dc bus.

With the switch in NORM, operation of the generator is automatically initiated, connecting to the essential buses, with the loss of the left main dc bus, regardless of other sources of ac or dc power. Total loss of ac or dc power will consequently result in the loss of the left main dc bus and activation of the emergency generator. The OFF/RESET switch position 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, the control unit disconnects the essential ac and dc essential No. 2 and the dc DFCS buses from the emergency generator (1 kVA mode). 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 5 kVA mode, restoring power to the essential No. 2 and DFCS buses. The DFCS computers will respond with a power up BIT sequence, requiring a MASTER RESET to regain SAS and ARI functions.

The exact hydraulic 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 ac essential No. 2 and dc essential No. 2 and dc DFCS buses can be powered with lower hydraulic pressure securing nonessential equipment in order to reduce the electrical load and to maintain DFCS functionality.

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 DFCS 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 the maximum airspeed.
- In the event of L and R generator failure, an attempt should be made to reduce unnecessary electrical loads to maintain DFCS SAS and ARI functionality.

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 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.

Note

During the emergency generator test the essential ac No. 2 bus is switched between the left main and emergency generator. The DFCS computers detect this as a loss of ac power and perform a power-up BIT sequence when the emergency generator test is completed. A MASTER RESET is required to regain SAS and ARI functions.

NAVAIR 01-F14AAD-1

3F6	26 VAC BUS FDR	8E6	APN-154
3F7	AC ESS BUS NO. 2 FDR PH A	4D6	APX-100 AC
4F1	AC ESS BUS NO. 2 FDR PH B	7F7	APX-100 DC
4F2	AC ESS BUS NO. 2 FDR PH C	7C2	ARC-182 NO. 1
2I4	ACM LT/SEAT ADJ/STEADY POS LT	7C1	ARC-182 NO. 2
3C6	ADF AC	8A5	ARMT GAS/L ENG AFT CONT/RAT IND
8D6	ADF DC	9A4	ASC
RC2	AFCS/NOSE WHEEL STEER	1D2	ASC PH A
LF1	AICS L	1D5	ASC PH B
2I5	AICS L HTR	1D6	ASC PH C
8E2	AICS L LKUP PWR/EMER GEN TST	1F1	ASPJ AUG PH A
7A6	AICS L RAMP STOW	1F3	ASPJ AUG PH B
LG1	AICS R	1F6	ASPJ AUG PH C
2I8	AICS R HTR	1F2	ASPJ BASIC PH A
8E1	AICS R LKUP PWR/ANTI SKID	1F4	ASPJ BASIC PH B
7A5	AICS R RAMP STOW	1F5	ASPJ BASIC PH C
RD2	AIR SOURCE CONTROL	9G5	ASPJ DC
8C2	AIR/ANTI ICE CONTR HOOK CONT/WSHLD	9G6	ASW-27
9B6	ALE-47 CHAFF/FLARE DISP	1J2	ASW-27 AC
9B5	ALE-47 SEQ 1 & 2 SQUIBS	LA3	AUTO PITCH DRIVE TRIM
RB1	ALPHA COMP/PEDAL SHAKER	1J1	AUTO THROT AC
4F4	ALPHA HTR	9B7	AUTO THROT DC
2H1	ALR-67 CMPTR	8G3	AUX FLAP/FLAP CONTR
9F5	ALR-67 CONTR		
2H3	ALR-67 RCVR PH A	7D3	BARO ALT/TURN SLIP
2H6	ALR-67 RCVR PH B	3D4	BDHI INST PWR/JTIDS/DPG
2H9	ALR-67 RCVR PH C	8E7	BDHI/JTIDS DPG
7B6	ALT LOW WARN	1B3	BEAM PS
9D1	AMC BIT/R DC, TEST	8F6	BINGO CAUTION
7A3	ANGLE OF ATTACK IND DC	8F2	BLEED AIR/L OIL HOT
3F3	ANGLE OF ATTK IND AC	4B4	BLEED DUCT AC
4F5	ANL ATTK/TOTAL TEMP HTR	7A4	BOS CONTR/B/U OXY LOW
9C2	ANN PNL DIM CONTR	9D5	BRAKE ACCUM SOV
8C1	ANN PNL PWR	7A2	B/U OXY PRESS IND
9A6	ANT LOCK EXCIT		
1C2	ANT SVO HYD PH A	8A1	CABIN PRESS
1C4	ANT SVO HYD PH B	8C5	CAN/LAD CAUTION/EJECT CMD IND
1C6	ANT SVO HYD PH C	LA2	CHAN 1 CADC PH A
8C2	ANTI-ICE CONTR HOOK CONT/ WSHLD/AIR	LB2	CHAN 1 CADC PH B
8E1	ANTI SKID/R AICS LKUP PWR	LC2	CHAN 1 CADC PH C
2I1	ANTICOLL/SUPP POS/POS LT	LD2	CHAN 2 CADC
RG2	ANTI-ICE/ENG/PROBE	3E7	CIU PH A
6C3	AN/AWW 4 PH A	4E1	CIU PH B
6C2	AN/AWW 4 PH B	4E2	CIU PH C
6C1	AN/AWW 4 PH C	3B3	COMB HYD PRESS IND
9A2	APG-71 ANT	9F4	COOLING INTLK/GND PWR
2G3	APG-71 PUMP PH A	8D8	CURSOR CONT/SNSR
2G6	APG-71 PUMP PH B		
2G7	APG-71 PUMP PH C	7B5	DC ESS NO. 1 FDR
1I1	APG-71 XMTR AC	8A2	DC ESS NO. 2 FDR
9A3	APG-71 XMTR DC		

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

7A7	DC L TEST/RUDDER TRIM	RF2	FLT CONTR AUTH DC
9D1	DC R TEST/AMC BIT	2A1	FLT HYD BACKUP PH A
9B2	DD ENABLE/RDP	2C1	FLT HYD BACKUP PH B
9I6	DEKI	2E1	FLT HYD BACKUP PH C
8B1	DFCS BUS FDR	3B4	FLT HYD PRESS IND
3F4	DP 1 PH A	3A2	FORM LT/TAXI
4F3	DP 1 PH B	RE1	FUEL FEED/DUMP
4F6	DP 1 PH C	8F7	FUEL LOW CAUTION
1G2	DP 2 PH A	RD1	FUEL MGT PNL
1G4	DP 2 PH B	8F1	FUEL PRESS ADVSY
1G6	DP 2 PH C	RG1	FUEL P/MOTIVE FLOW ISOL V
9G2	DSS	3C3	FUEL QTY IND AC
RE1	DUMP/FUEL FEED	7D1	FUEL QTY IND DC
9E7	DYHR UNIT	8E4	FUEL TRANS ORIDE
		8F9	FUEL VENT VALVE
8D4	ECS TEMP CONTR DC	8F5	GEN L CAUTION
9H3	ELECT COOLING	8F4	GEN R CAUTION
7B2	EMER FLT HYD AUTO	9F4	GND PWR/COOLING INTLK
7B1	EMER FLT HYD MAN	8G1	GND ROLL BRAKING/SPOILER POS IND
9I2	EMER GEN CONTR	9D6	GND TEST
8E2	EMER GEN TEST/L AICS LKUP PWR	3E2	GPS
7E3	EMER JETT #1	8E9	GPS ANT AMPL
7E2	EMER JETT #2	6A1	GUN CONTRL PWR AC
RC1	ENG ANTI-ICE VALVES	5D2	GUN PWR NO. 1
7D5	ENG INST NO. 1	5C2	GUN PWR NO.2
7D4	ENG INST NO. 2	1H1	HUD CAMERA PH A
8A5	ENG L AFT CONT/ARMT GAS/RATS IND	1H5	HUD CAMERA PH B
3A3	ENG L BACKUP IGN	1H7	HUD CAMERA PH C
3B1	ENG L OIL PRESS	3C1	HUD PH A/MFD 1
8A4	ENG R AFT CONT/EXHAUST NOZZLE	4C5	HUD PH B/MFD 1
3A4	ENG R BACKUP IGN	4C6	HUD PH C/MFD 1
3B2	ENG R OIL PRESS	1A1	HV PWR SUP PH A
8D1	ENG OIL COOL	1A3	HV PWR SUP PH B
8D3	ENG SEC	1A5	HV PWR SUP PH C
8F10	ENG STALL TONE	7B3	HYD PRESS IND
RF1	ENG START	8G11	HYD PUMP SPOILER CONTR
RG2	ENG/PROBE/ANTI-ICE	8E5	HYD VALVE CONTR
8A4	EXHAUST NOZZLE/R ENG AFT CONT	LE3	ICE DET
8G10	EXT LT CONTR	7F3	ICS NFO
9D2	FEMS	7F2	ICS PILOT
7C7	FIRE L DET LT	1J7	IFF A/A AC
7C5	FIRE L EXT	9F6	IFF A/A DC
7C6	FIRE R DET LT	8C7	ILS ARA-63 DC
7C4	FIRE R EXT	3E5	ILS ARA-63 PH A
8G3	FLAP CONTR/AUX FLAP	4E3	ILS ARA-63 PH B
3D6	FLAP IND/TAIL/RUDDER	4E4	ILS ARA-63 PH C
RA2	FLAP/SLAT CONTR SHUT-OFF	8G9	INBD SPOILER CONTR
9B6	FLARE DISP/ALE-39 CHAFF	1I7	INS BATT PWR
LC1	FLT CONTR AUTH AC		

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

3C7	INS PH A	LE2	MACH TRIM AC
4C1	INS PH B	RE2	MACH TRIM DC
4C2	INS PH C	1A8	MAIN L XFMR RECT
3E4	INS SYNC	2F4	MAIN R XFMR RECT
3A1	INST LTS	LE1	MANUV FLAP/WG SWP DR NO. 2
3F5	INSTR BUS FDR	5A2	MASTER ARM
1I2	INTEG TRIM AC	9H4	MASTER TEST
9F3	INTEG TRIM DC	9G3	MDL
9I5	INTRF BLANKER	9G4	MFA
9I1	INTRPT FREE DC BUS FDR NO. 1	3C1	MFD 1/HUD PH A
9C6	INTRPT FREE DC BUS FDR NO. 2	4C5	MFD 1/HUD PH B
9D4	IRST DC	4C6	MFD 1/HUD PH C
2G2	IRST PH A	1G1	MFD 2/MFD 3 PH A
2G5	IRST PH B	1G3	MFD 2/MFD 3 PH B
2G8	IRST PH C	1G5	MFD 2/MFD 3 PH C
1J4	JTIDS BATT HEATER	1G1	MFD 3 PH A/MFD 2
1J3	JTIDS DPG PH A	1G3	MFD 3 PH B/MFD 2
1J5	JTIDS DPG PH B	1G5	MFD 3 PH C/MFD 2
1J6	JTIDS DPG PH C	8G5	MLG HANDLE RLY NO. 1
8E7	JTIDS DPG/BDHI	8G4	MLG HANDLE RLY NO. 2
3D5	JTIDS RT PH A	7F5	MLG SAFETY RLY NO. 1
4D3	JTIDS RT PH B	7F4	MLG SAFETY RLY NO. 2
4D4	JTIDS RT PH C	9D3	MONITOR BUS CONTR
3D4	JTIDS/DPG/BDHI INST PWR	RG1	MOTIVE FLOW ISOL V/FUEL P
7C3	KY-58/Z-AHP	5B2	MPRU DC PWR
LF1	L AICS	6D3	MPRU PH A/SMP
2I5	L AICS HTR	6D2	MPRU PH B/SMP
8E2	L AICS LKUP PWR/EMER GEN TST	6D1	MPRU PH C/SMP
7A6	L AICS RAMP STOW	8C8	MSL PWR HUD TEST
7A7	L DC TEST/RUDDER TRIM	6B3	MSL PWR SUP PH A
8A5	L ENG AFT CONT/ARMT GAS/RATS IND	6B2	MSL PWR SUP PH B
3A3	L ENG BACKUP IGN	6B1	MSL PWR SUP PH C
3B1	L ENG OIL PRESS	3C5	MSN CMPTR NO. 2 PH A
7C7	L FIRE DET LT	4C3	MSN CMPTR NO. 2 PH B
7C5	L FIRE EXT	4C4	MSN CMPTR NO. 2 PH C
8F5	L GEN CAUTION	1D1	MSN CMPTR NO. 1 PH A
1A8	L MAIN XFMR RECT	1D3	MSN CMPTR NO. 1 PH B
8F2	L OIL HOT/BLEED AIR	1D7	MSN CMPTR NO. 1 PH C
3B7	L PH A TEST/P-ROLL TRIM	8A3	NLG STRUT LCH BAR ADVSY
4B1	L PH B TEST/P-ROLL TRIM	RC2	NOSE WHEEL STEER/AFCS
4B2	L PH C TEST/P-ROLL TRIM	2I2	NFO CONSOLE LT
4E5	L PITOT STATIC HTR	3C4	OBOGS CONC
8C5	LAD CAUTION/EJECT CMD IND/CAN	7A1	OBOGS CONTR
9E1	LANTIRN POD CONT/RECON ECS	8F2	OIL L HOT/BLEED AIR
9E2	LANTIRN POD PWR/RECON CONTR	8D2	OIL R HOT
2C3	LANTIRN PWR/RECON HTR 3 PH	9C5	OUTBD SPOILER CONTR
2H10	LIQUID COOLING CONTR AC	2B3	OUTBD SPOILER PUMP
9B4	LIQUID COOLING CONTR DC		

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

2H5	OXY CONC HTR	9B1	RDP
8F6	OXY/BINGO CAUTION	1E4	RDP PH A
		1E5	RDP PH B
3B7	P-ROLL TRIM/L PH A TEST	1E6	RDP PH C
4B1	P-ROLL TRIM/L PH B TEST	9B2	RDP/DD ENABLE
4B2	P-ROLL TRIM/L PH C TEST	2G4	RECON ECS CONT AC
4A6	PANEL FLOOD LTS	9E1	RECON ECS/LANTIRN POD CONT
RB1	PEDAL SHAKER/ALPHA COMP	9E2	RECON CONTR/LANTIRN POD PWR
3B7	PH A L TEST/P-ROLL TRIM	2C3	RECON HTR/LANTIRN PWR 3 PH
4B1	PH B L TEST/P-ROLL TRIM	1E2	RECON POD
4B2	PH C L TEST/P-ROLL TRIM	9E4	RECON POD DC PWR NO. 1
2H2	PH A R TEST	9E3	RECON POD DC PWR NO. 2
2H4	PH B R TEST	1A8	RECT/L MAIN XFMR
2H8	PH C R TEST	5H1	REL PWR/STA 1 TYPE I DCDR
4A5	PILOT CONSOLE LTS	5G1	REL PWR/STA 1 TYPE II DCDR
4A3	PILOT LCD INST LTS	5F1	REL PWR/STA 3 DCDR
LB1	PITCH A AC	5E1	REL PWR/STA 4 DCDR
8B7	PITCH A DC	5D1	REL PWR/STA 5 DCDR
LH1	PITCH B AC	5C1	REL PWR/STA 6 DCDR
8B3	PITCH B DC	5B1	REL PWR/STA 8 TYPE I DCDR
4E5	PITOT STATIC HTR L	5A1	REL PWR/STA 8 TYPE II DCDR
4E6	PITOT STATIC HTR R	LB3	ROLL A/YAW M
8F3	PLT ANN PNL AUX PWR/TR ADVSY	8B4	ROLL A DC
2I1	POSTL/ANTICOLL/SUPP POS	LA1	ROLL B AC
4A4	PROBE LT	8B2	ROLL B DC
RG2	PROBE/ANTI-ICE/ENG	9A7	RSP
		1B2	RSP PH A
LG1	R AICS	1B5	RSP PH B
2I8	R AICS HTR	1B8	RSP PH C
8E1	R AICS LKUP PWR/ANTI SKID	3D7	RUDDER TRIM PH A
7A5	R AICS RAMP STOW	4D1	RUDDER TRIM PH B
8A5	RAT IND/L ENG AFT CONT/ARMT GAS	4D2	RUDDER TRIM PH C
9D1	R DC TEST/AMC BIT	7A7	RUDDER TRIM/L DC TEST
8A4	R ENG AFT CONT/EXHAUST NOZZLE	3D6	RUDDER/TAIL/FLAP IND
3A4	R ENG BACKUP IGN		
3B2	R ENG OIL PRESS	9I3	SAHRS DC
7C6	R FIRE DET LT	1I3	SAHRS A
7C4	R FIRE EXT	1I5	SAHRS B
8F4	R GEN CAUTION	1I6	SAHRS C
2E4	R MAIN XFMR RECT	2I4	SEAT ADJ/STDY POS LT
8D2	R OIL HOT	RA2	SLAT CONTR SHUT-OFF/FLAP
2H2	R PH A TEST	7E5	SMP ESS
2H4	R PH B TEST	6D3	SMP/MPRU PH A
2H8	R PH C TEST	6D2	SMP/MPRU PH B
4E6	R PITOT STATIC HTR	6D1	SMP/MPRU PH C
4B3	RADAR ALTM	8D8	SNSR/CURSOR CONT
1C3	RADAR DD PH A	1B1	SOL PWR SUP PH A
1C5	RADAR DD PH B	1B4	SOL PWR SUP PH B
1C7	RADAR DD PH C	1B7	SOL PWR SUP PH C

Figure 2-38. Circuit Breaker Alphanumeric Index (Sheet 4 of 5)

NAVAIR 01-F14AAD-1

RB2	SPD BK P-ROLL TRIM ENABLE	6F6	STA 8B PWR PH A
8G1	SPOILER POS IND/GND ROLL BRAKING	6F5	STA 8B PWR PH B
5D3	STA 1 AIM-9 COOL	6F4	STA 8B PWR PH C
2I10	STA 1 BOL PWR	8F8	STARTER VALVE LT
5I3	STA 1 IFOL	3A7	STBY ATTD IND PH A
5H1	STA 1 TYPE I DCDR/REL PWR	4A1	STBY ATTD IND PH B
5G1	STA 1 TYPE II DCDR/REL PWR	4A2	STBY ATTD IND PH C
6A3	STA 1A AIM-9 PWR AC	2I1	SUPP POS/ANTICOLL/POS LT
5B3	STA 1A AIM-9 PWR DC	2I6	STORM FLOOD LTS
5J2	STA 1B NO. 1/2 DC		
6A6	STA 1B PWR PH A	3D6	TAIL/RUDDER/FLAP IND
6A5	STA 1B PWR PH B	3A2	TAXI/FORM LT
6A4	STA 1B PWR PH C	1H2	TCS PH A
5F1	STA 3 DCDR/REL PWR	1H3	TCS PH B
5I2	STA 3 NO. 1/2 DC	1H6	TCS PH C
6B6	STA 3 PWR PH A	9C3	TCS SEL
6B5	STA 3 PWR PH B	4B5	TEMP CONT AC
6B4	STA 3 PWR PH C	4F5	TOTAL TEMP HTR/ANL ATTK
5H3	STA 3/6 IFOL	8F3	TR ADVSY/PLT ANN PNL AUX PWR
5E1	STA 4 DCDR/REL PWR	7D3	TURN SLIP/BARO ALT
5H2	STA 4 NO. 1/2 DC		
6C6	STA 4 PWR PH A	7F6	UHF CONTR/VHF
6C5	STA 4 PWR PH B	3A6	UTILITY LTS
6C4	STA 4 PWR PH C		
5G3	STA 4/5 IFOL	7F6	VHF/UHF CONTR
5D1	STA 5 DCDR/REL PWR		
5G2	STA 5 NO. 1/2 DC	LE1	WG SWP DR NO. 2/MANUV FLAP
6D6	STA 5 PWR PH A	7D6	WHEELS POS IND
6D5	STA 5 PWR PH B	3F2	WING POS IND AC
6D4	STA 5 PWR PH C	7D2	WING POS IND DC
5C1	STA 6 DCDR/REL PWR	LD1	WING SWEEP DRIVE NO. 1
5F2	STA 6 NO. 1/2 DC	8C3	WSHLD DEFOG CONTR
6E6	STA 6 PWR PH A	8C2	WSHLDAIR/ANTI ICE CONTR/ HOOK CONT
6E5	STA 6 PWR PH B		
6E4	STA 6 PWR PH C	8B6	YAW A DC
5C3	STA 8 AIM-9 COOL	8B5	YAW B DC
2I9	STA 8 BOL PWR	LD3	YAW A AC
5F3	STA 8 IFOL	LC3	YAW B AC
5B1	STA 8 TYPE I DCDR/REL PWR	LB3	YAW M/ROLL A
5A1	STA 8 TYPE II DCDR/REL PWR		
6F3	STA 8A AIM-9 PWR AC	3F6	26 VAC BUS FDR
5A3	STA 8A AIM-9 PWR DC		
5E2	STA 8B NO. 1/2 DC		

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

2.16 HYDRAULIC POWER SUPPLY SYSTEMS

The aircraft employs two main, independent, engine-powered hydraulic systems, supplemented by two electro-hydraulic power modules, a bi-directional 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 in 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 \pm 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 (Bi-Directional 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

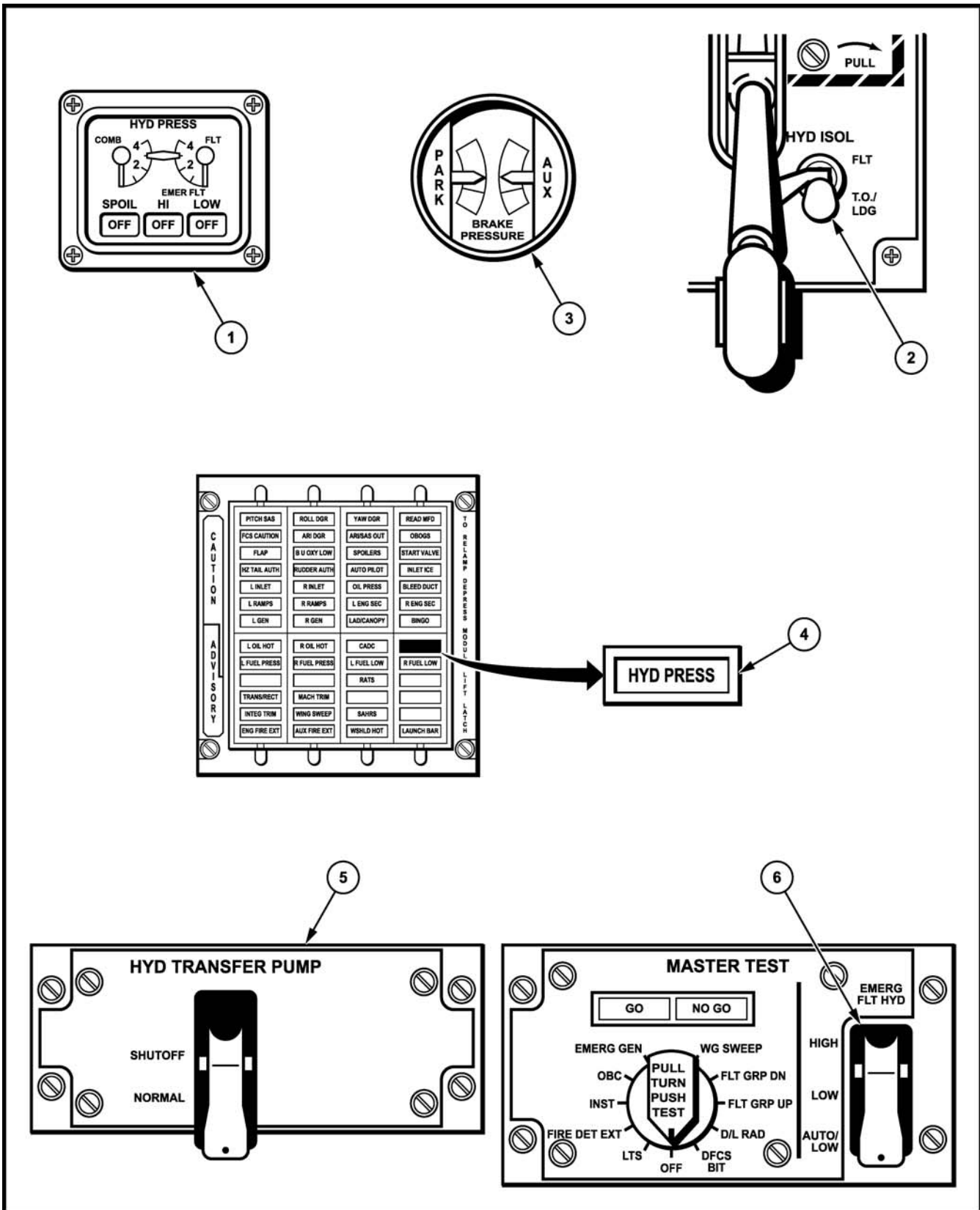
transfer pump. This unit consists of two hydraulic pumps, one in each of the main hydraulic systems, interconnected by a common mechanical shaft. Thus, a pressure deficiency in one system is automatically augmented using pressure in the other system as the motive power. The result is bi-directional transfer 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.



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. In addition, the HYD PRESS caution light will also illuminate. 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.



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Figure 2-39. Hydraulic System Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>① HYD PRESS indicator</p>	<p>COMB and FLT — Indicates pump discharge pressure on each engine, normally 3,000 psi, or hydraulic transfer pressure approximately 2,400 psi.</p> <p>SPOIL — When the outboard spoiler hydraulic module is pressurized (1,950 to 2,050 psi) the ON flag appears. If pressure drops below 1,900 to 1,800 psi, the OFF flag appears.</p> <p>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.</p>
<p>② HYD ISOL switch</p>	<p>FLT — Combined system hydraulic pressure is shutoff to landing gear, nosewheel steering, antiskid, and wheel brakes.</p> <p>T.O./LDG — Hydraulic pressure is available to all combined system components.</p>
<p>③ BRAKE PRESSURE gage</p>	<p>AUX — Green segment indicates hydraulic pressure ($2,150 \pm 50$ 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).</p> <p>PARK — Green segment indicates hydraulic pressure ($2,150 \pm 50$ 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.</p>
<p>④ HYD PRESS caution light</p>	<p>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.</p>
<p>⑤ HYD TRANSFER PUMP switch</p>	<p>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.</p> <p>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.</p>
<p>⑥ EMERG FLT HYD switch</p>	<p>HIGH — Guard must be lifted. Activates the power module (high speed mode) bypassing flight and combined 2,100-psi switches.</p> <p>LOW — Guard must be lifted. Activates the backup power module (low-speed mode) bypassing flight and combined 2,100-psi switches.</p> <p>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.</p>

Figure 2-39. Hydraulic System Controls and Indication (Sheet 2 of 2)

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 extendable 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. With the gear handle up, 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 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 to 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 due to 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.

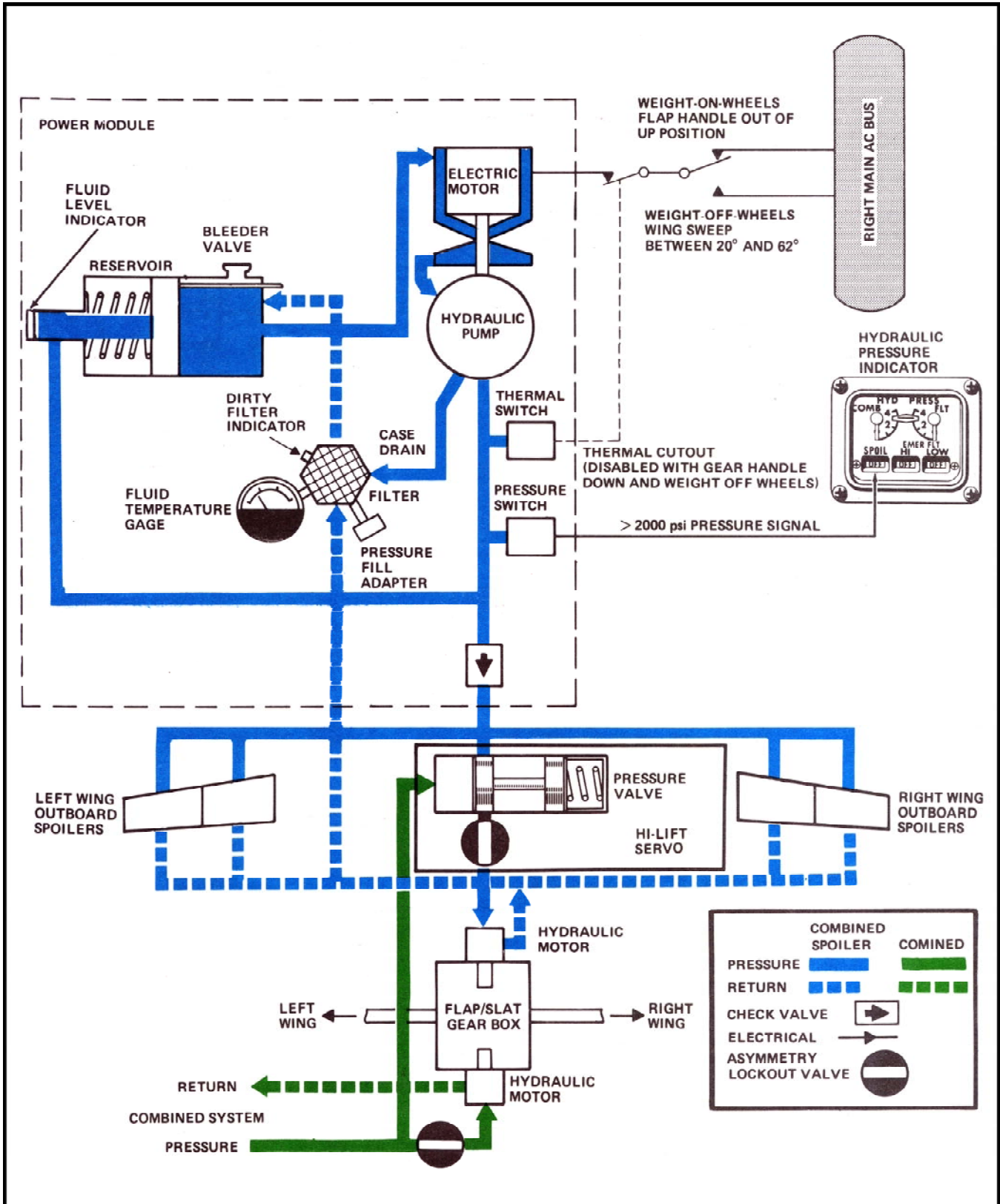
2.16.4.1 Backup Flight Control Operation

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.



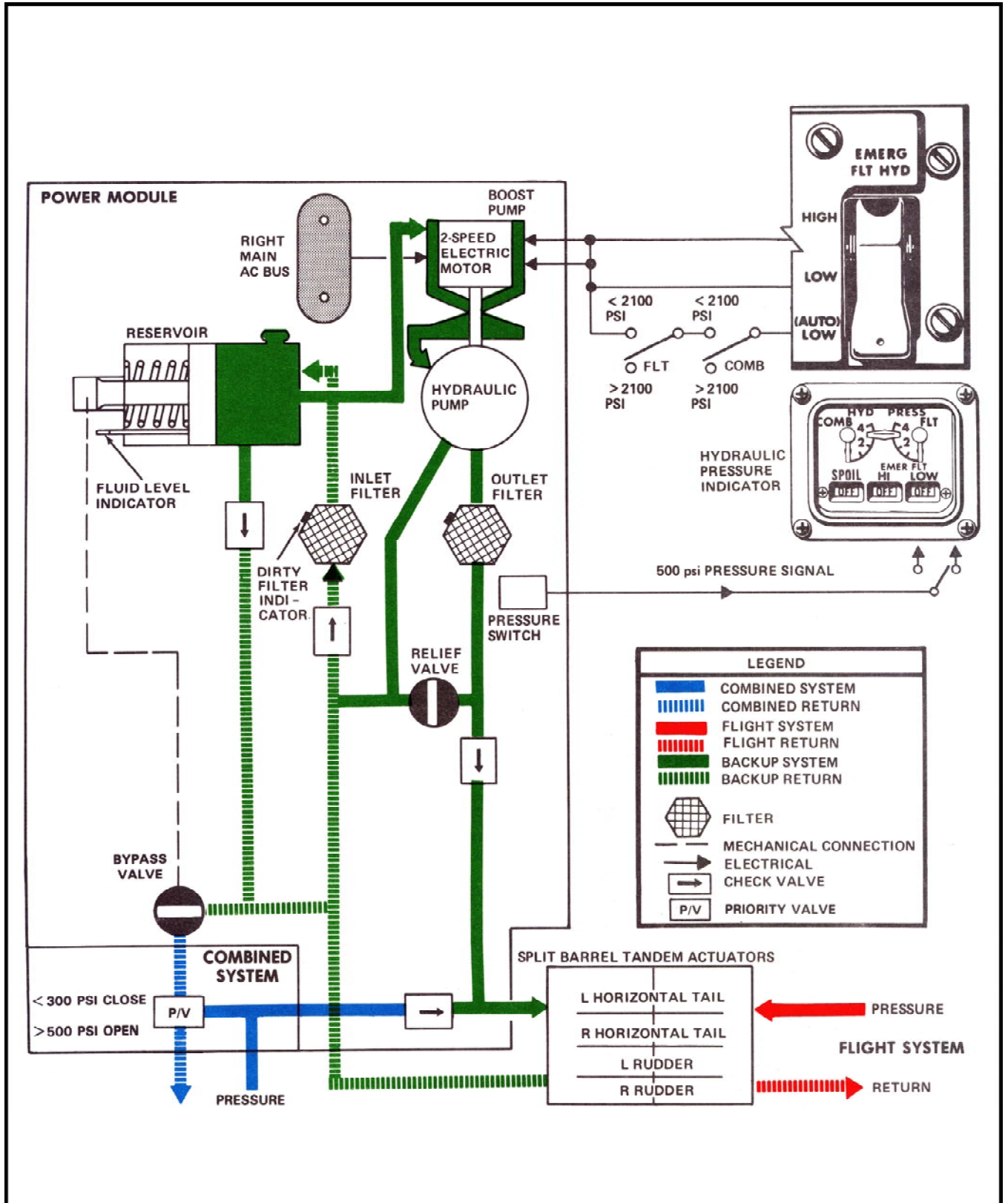
Never use the three-phase circuit breakers (PH A, PH B, and PH C) to start or shut off the BFCM as damage to the motor may result. These circuits must be engaged prior to any system test.

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



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Figure 2-40. Outboard Spoiler System



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Figure 2-41. Backup Flight Control System

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.

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.



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.



- 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.
- Prolonged use (approximately 8 minutes cumulative time) of the BFCM in the high mode may result in a failure of the BFCM.

2.16.4.2 Ground Operations

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.

Ground checks of the BFCM are performed by the pilot using the EMERG 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 (@ 1 qt.) when full, but will decrease in volume to 500 cc (@ ½ qt.) when the aircraft is not in use. Below 500 cc (@ ½ qt.), 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.



- 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.



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.

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 N₂ 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.

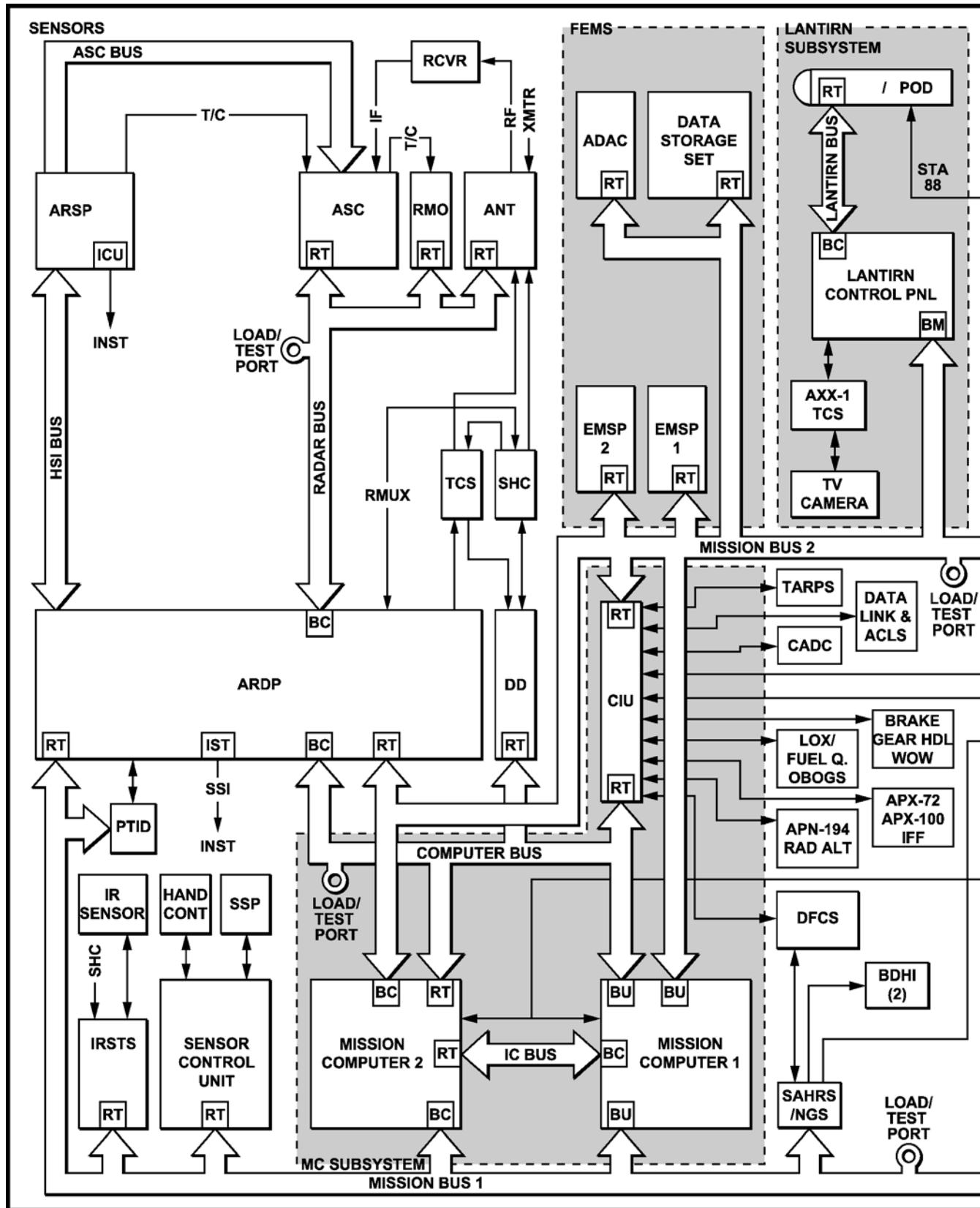
2.18 MISSION COMPUTER SYSTEM

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.

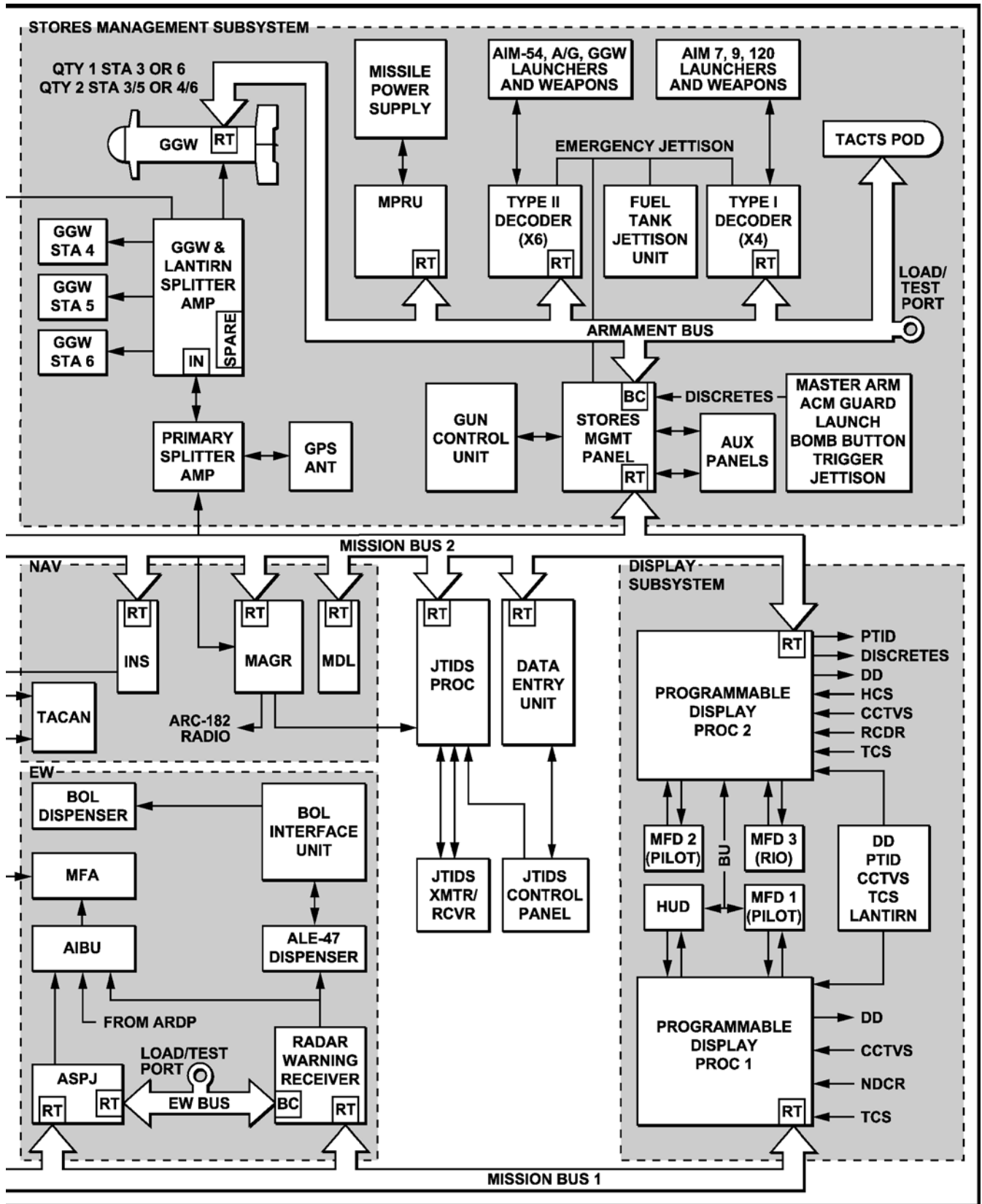
2.18.1 Aircrew Interface

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.



CSC-F14D-1-2-027C

Figure 2-42. Mission Computer System Architecture (Sheet 1 of 2)



CSC-F14D-1-2-066

Figure 2-42. Mission Computer System Architecture (Sheet 2 of 2)

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 the Supplemental NATOPS, 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. In aircraft prior to AFC 793 (CADC 1166B/A), aircrew should refer to performance charts, 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 SCADC 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 SCADC 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](#).

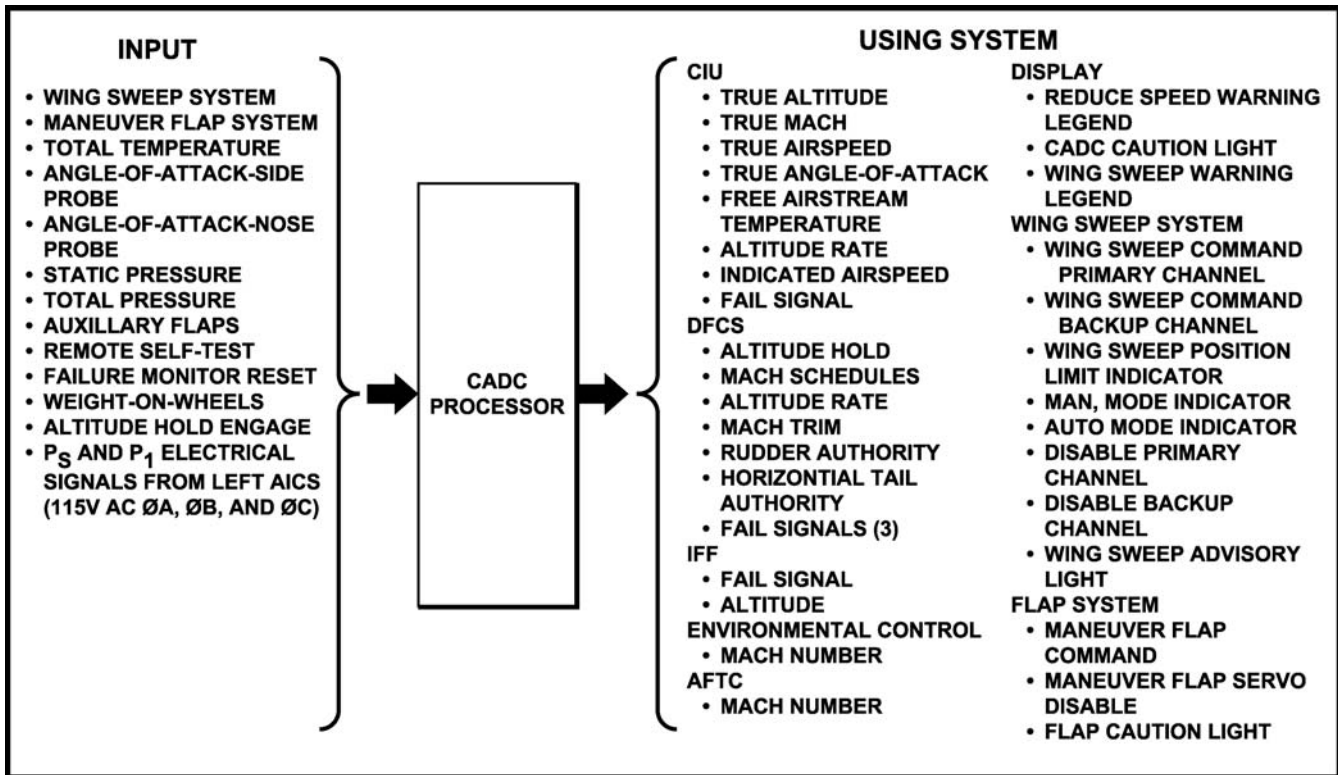
The following legends appear on the MFD when activated by the CADC:

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 Standard Central Air Data Computer Tests

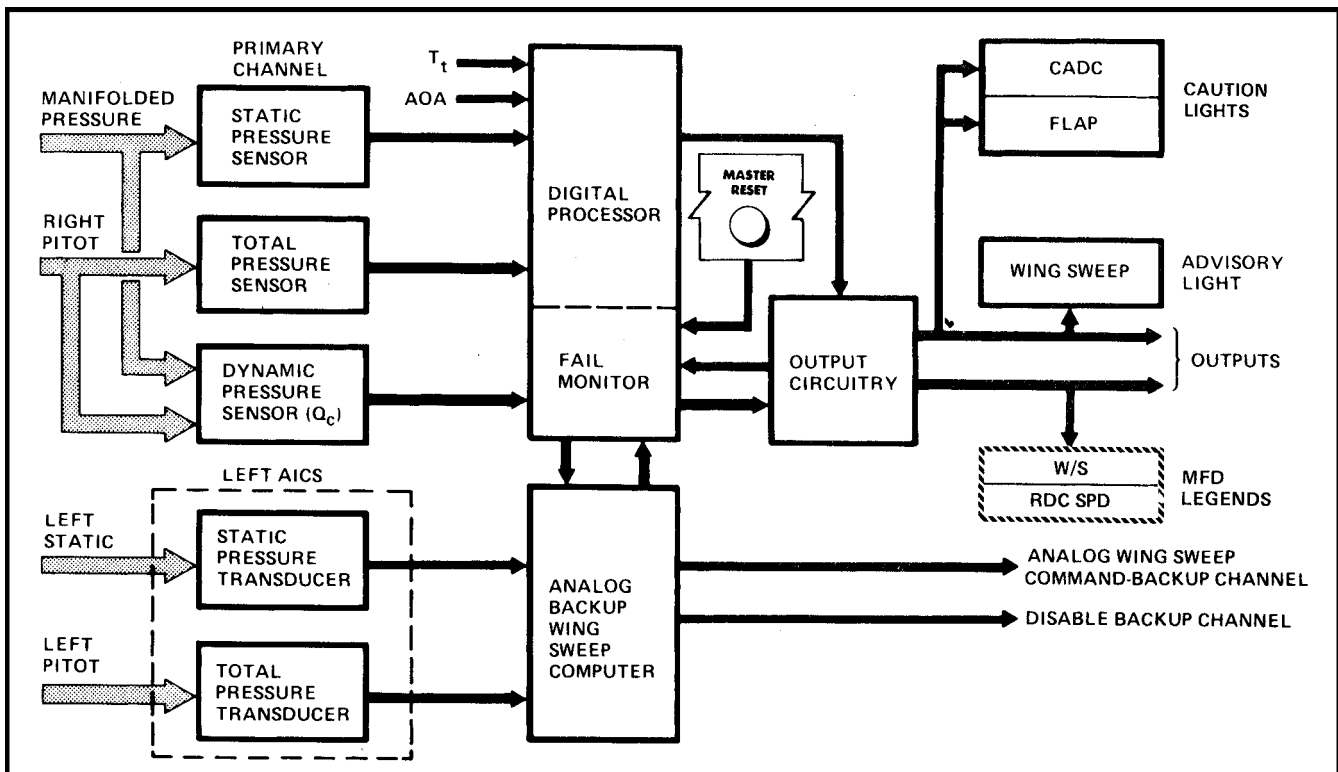
2.19.1.1 Built-In Test

BIT capabilities provide continuous monitoring of the SCADC and its inputs and outputs. The failure indicator matrix ([Figure 2-45](#)) tabulates the functions that are monitored and associated fail indications.



CSC-F14D-1-2-028

Figure 2-43. CADCC Functional Relationships



0-F50D-366-0

Figure 2-44. CADCC Processor

<div style="text-align: center;">INDICATION</div> <div style="text-align: center;">FAILURE</div>	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 ₃ /P ₁ 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 MANEUVER FLAP MISCOMPARE				●					
AUXILIARY FLAP ASYMMETRY				●					
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 IMR/TOTAL TEMPERATURE ABOVE 388° F.									

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 SCADC:

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 SCADC fail signals drive the DFCS failure detection circuits. If these signals exist, the DFCS 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. (FCS CAUTION and ARI DGR lights will also be illuminated.)

Note

If autopilot is engaged the AUTOPILOT light will illuminate when any of the three fail signals exist. If ACL is engaged the AUTOPILOT and ACLS/AP lights will illuminate when any of the three fail signals exist.

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 screw-jack 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 sweep angle. On the deck, the range is extended aft to 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 contoured 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.



Slower than normal wing sweep cycling times may also be indicative of a failed hydraulic wing sweep motor or an impending failure. With aircraft on the ground and both FLT and COMB hydraulic power, the time to sweep the wings from 68° to 20° should not exceed 9 seconds.

Note

- The overwing fairings and flaps are susceptible to a high frequency (60 cycles per second), low-amplitude oscillation that can be felt in the cockpit. This overwing fairing and flap

buzz is normal and is influenced by the 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

The emergency wingsweep handle can be moved independent of the wings and wingsweep indicators when no hydraulic power and/or electrical power are on the aircraft. Care must be taken to accurately determine the position of the emergency wingsweep handle prior to application of hydraulic power. Inadvertent wingsweep to the position selected by the emergency wingsweep handle may occur anytime hydraulic power is on, resulting in potential damage to the aircraft. When positioning the wings during ground operation other than pilot poststart or post-landing checklist procedures, use the emergency wingsweep 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 exist 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

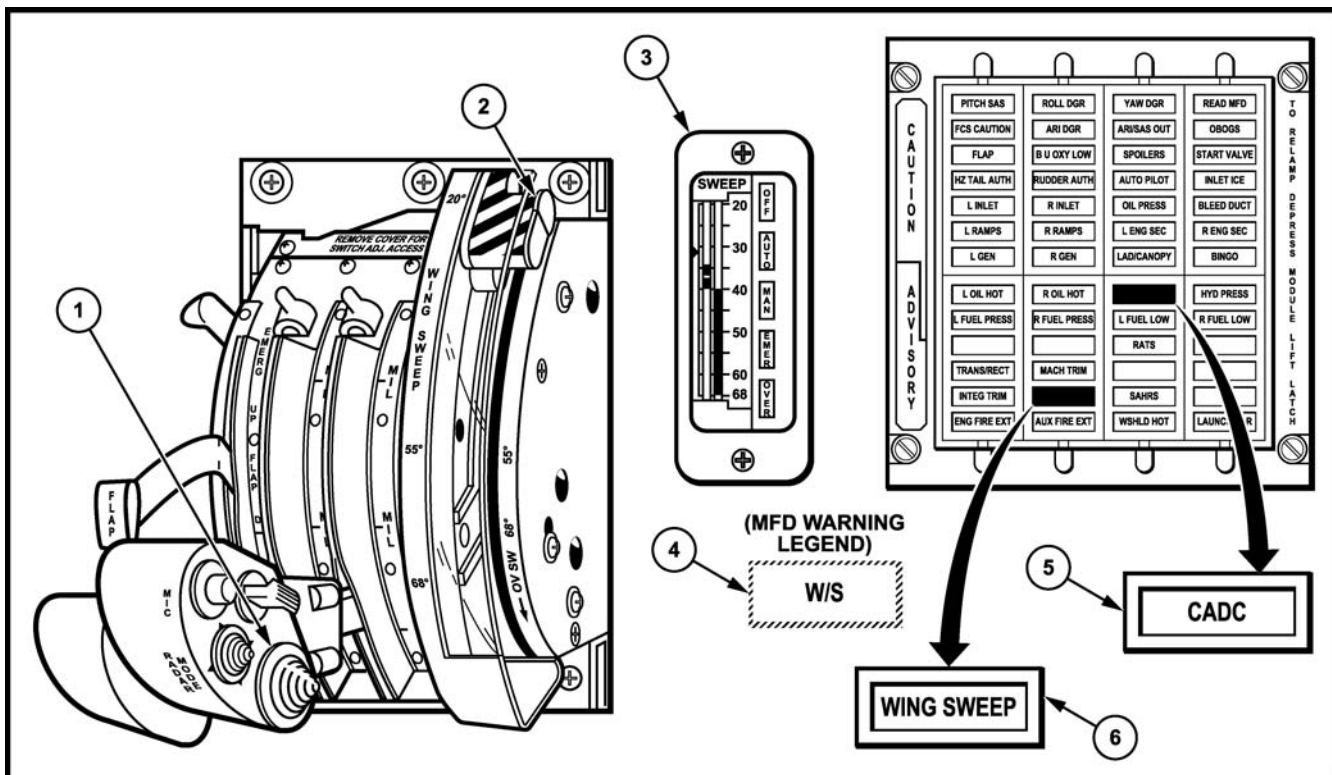
Bomb mode is selected by moving the wing-sweep switch to the down (BOMB) position. With the switch in BOMB, the following occurs:

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 system (CADC and control drive servo loop).



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NOMENCLATURE	FUNCTION
<p>① Wing sweep switch</p>	<p>AUTO — Wing sweep angles are determined by CADAC according to wing sweep program. Detented switch position.</p> <p>BOMB — Wings are positioned at 55° or further aft if commanded by the CADAC program. Detented switch position.</p> <p>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.</p>
<p>② Emergency WING SWEEP handle</p>	<p>Provides a mechanical means of wing sweep control that overrides the CADAC 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.</p>
<p>③ Wing SWEEP indicator</p>	<p>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 attitude. Indicator windows show the operating mode.</p>
<p>④ W/S caution legend on MFD</p>	<p>Indicates failure of both wing sweep channels and/or disengagement of spider detent. Wing sweep positioning requires using the emergency wing sweep handle.</p>

Figure 2-46. Wing-Sweep Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>5 CADC caution light</p>	<p>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.</p>
<p>6 WING SWEEP advisory light</p>	<p>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.</p>

Figure 2-46. Wing-Sweep Controls and Indicators (Sheet 2 of 2)

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.

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 the 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.



- Except for wing flap (main and auxiliary) and oversweep interlocks in the control box, the emergency mode does not prevent pilot mis-positioning of 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°
5. 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.

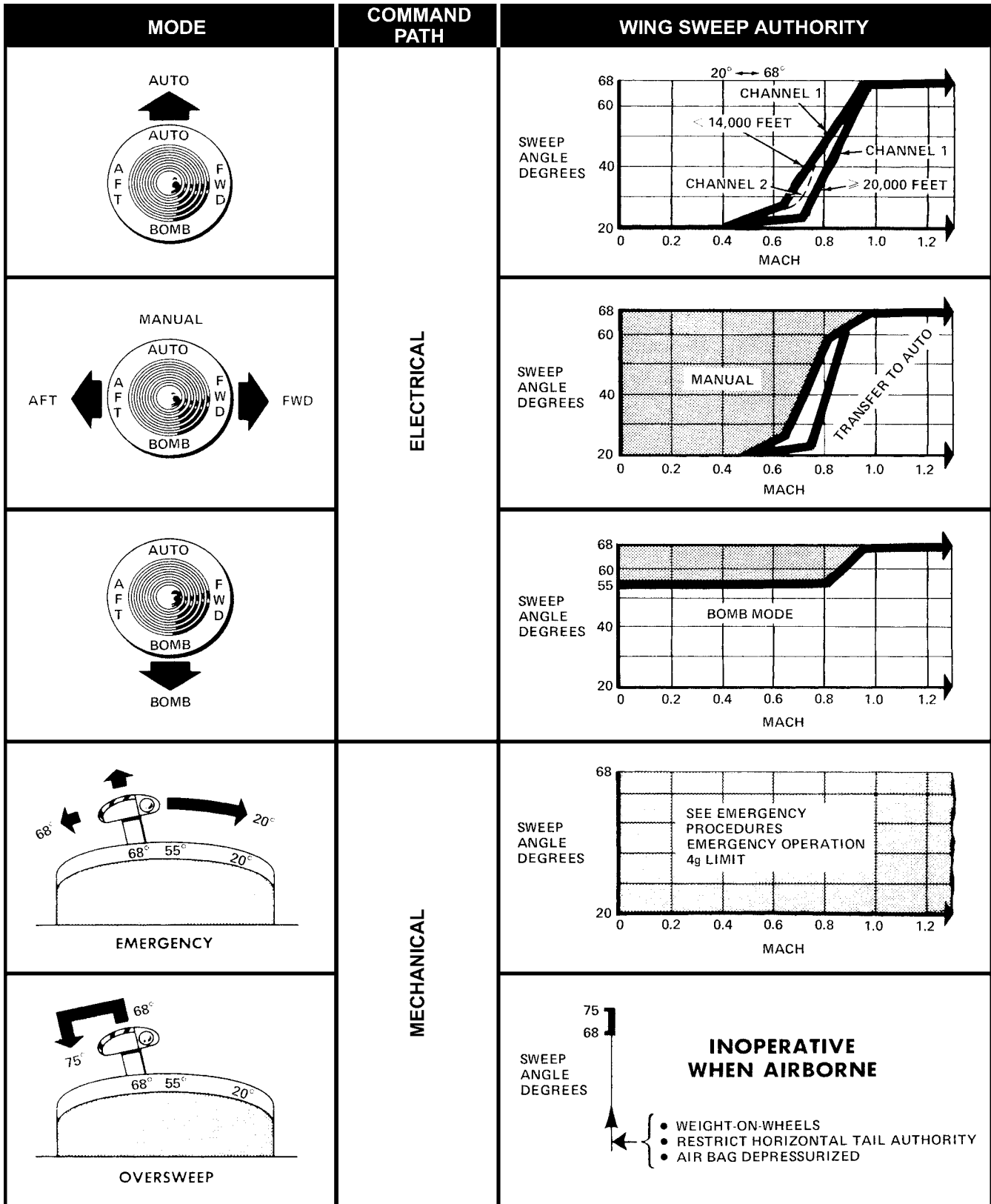
2.20.2.5 Oversweep Mode (75°)

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.



If the “over” flag is not displayed in the wing-sweep indicator with the wings in oversweep, the stick should remain centered.

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



0-F50D-61-0

Figure 2-47. Wing-Sweep Modes

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 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 flags on the wing-sweep indicator will be visible.



- 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.

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.



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 -0.5 g.

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 non-interference 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.

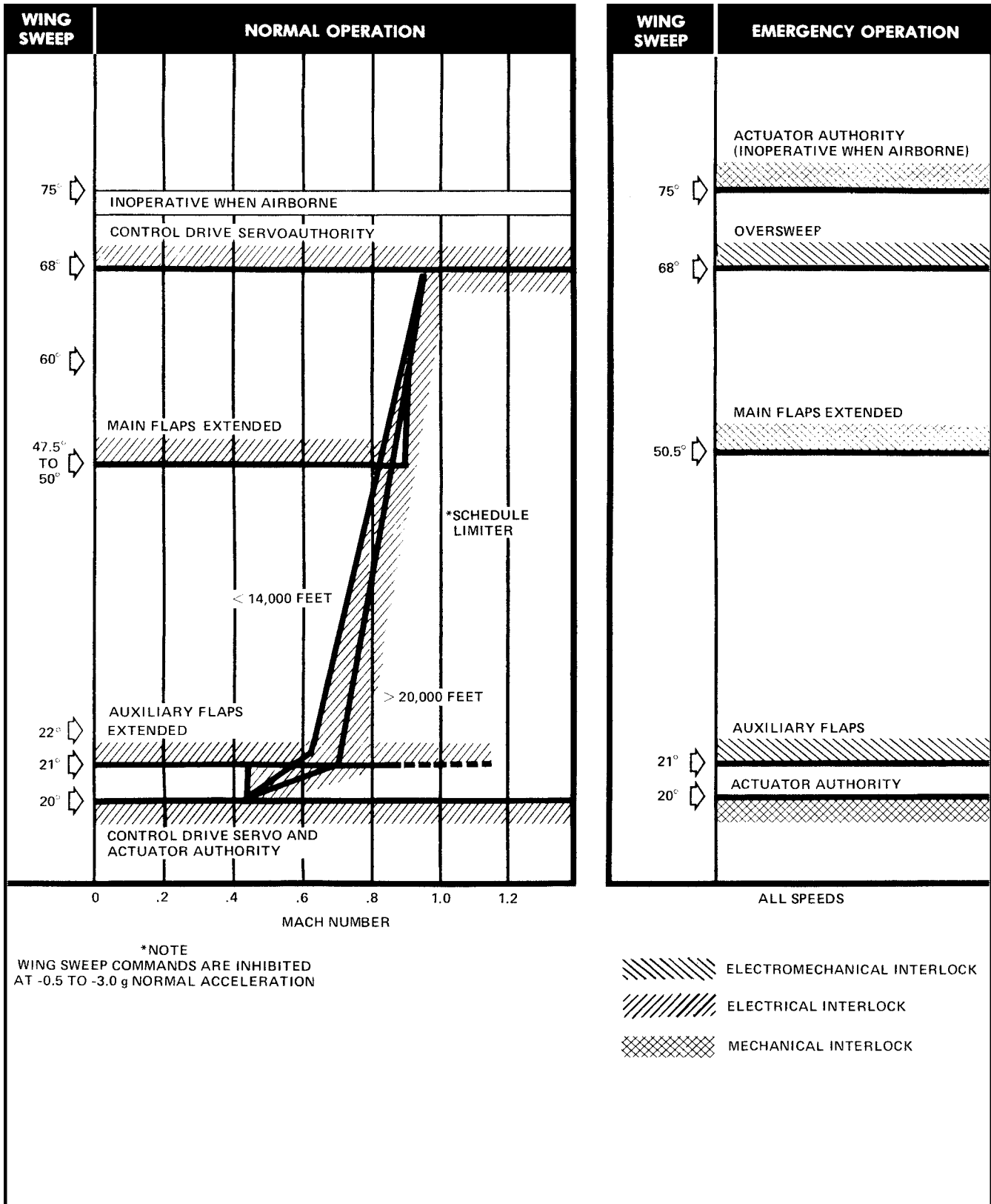
2.20.4.2 Preflight Check

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.



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Figure 2-48. Wing-Sweep Interlocks

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.

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 electro-mechanical 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.



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.

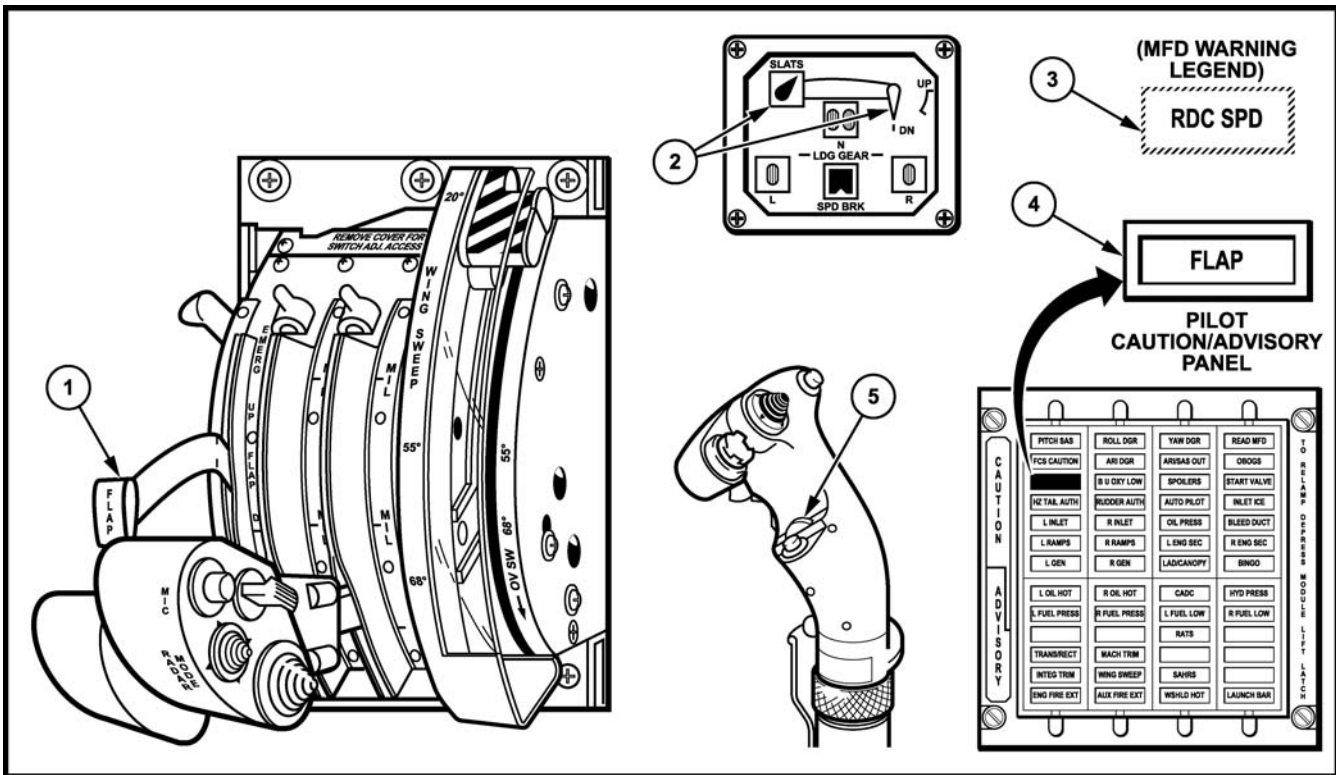
2.21.1.2 Maneuver Flap and Slat Thumbwheel

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 DFCS depresses the spoilers to -4½° 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.



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NOMENCLATURE	FUNCTION
<p>① FLAP handle</p>	<p>UP — Normal retraction of main and auxiliary flaps.</p> <p>DN — Normal extension of main and auxiliary flaps.</p> <p>EMER UP — Emergency retraction of main flaps to full up overriding any electromechanical command faults.</p> <p>EMER DN — No function.</p>

Figure 2-49. Flap and Slat Controls and Indicators (Sheet 1 of 2)







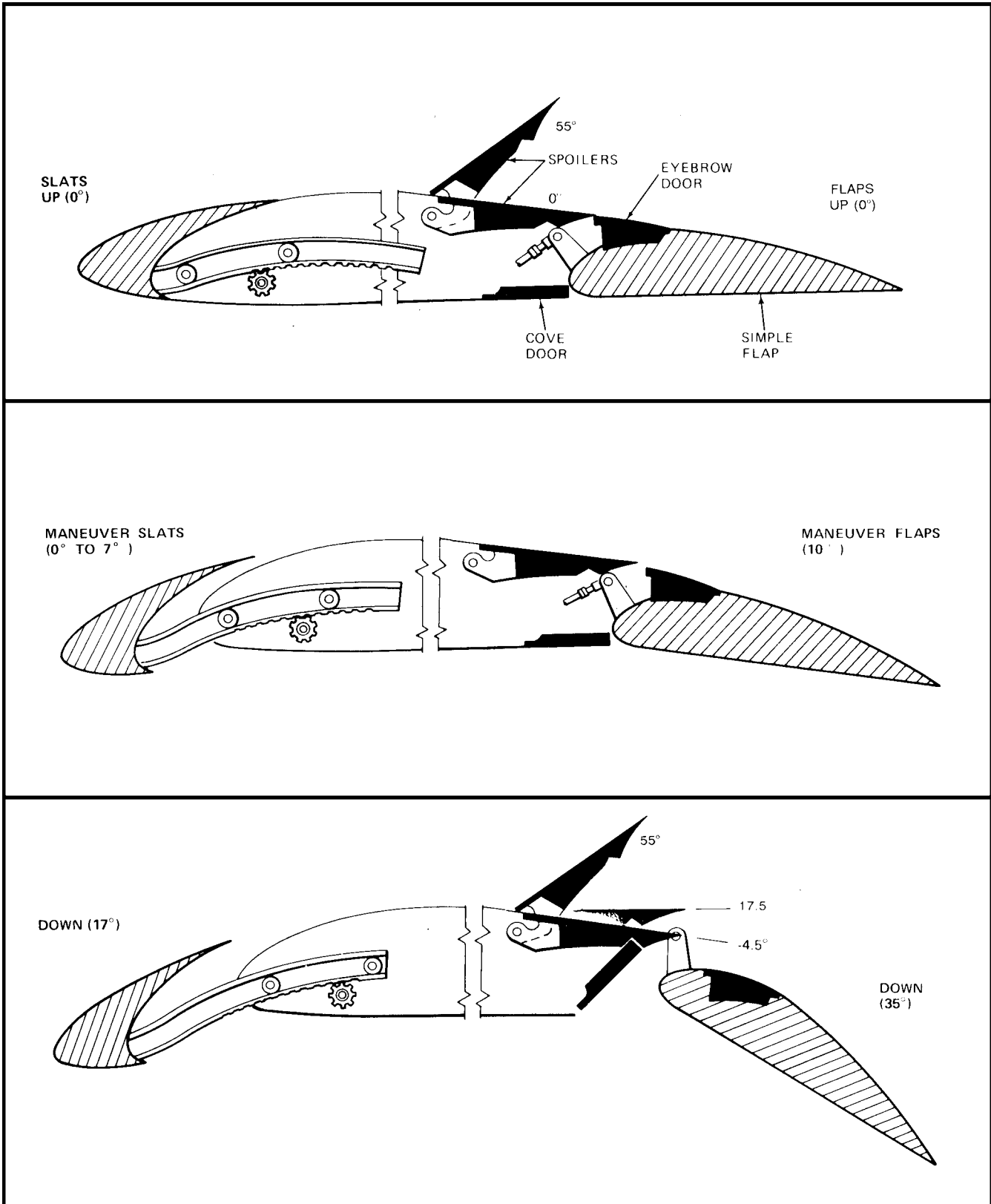
NOMENCLATURE	FUNCTION
<p>② Flaps and Slats Indicator</p>	<p> — Power off; maneuver slats extended.</p> <p> — Slats extended (17°). } Slats position is an electrical pickoff of right slat position only.</p> <p> — Slats retracted (0°).</p> <p> — Flaps full up (0°). } Flap position is pickoff from hydraulic motor for main flaps only.</p> <p> — Maneuver flaps down (10°).</p> <p> — Flaps full down (35°).</p>
<p>③ RDC SPD legend on MFD and HUD</p>	<p>Main flap comparator failures with flaps not retracted and airspeed >225 KIAS (see Figure 2-43).</p> <p>Maximum safe Mach exceeded (2.4 M).</p> <p>Total temperature exceeds 388°F.</p>
<p>④ FLAP caution light</p>	<p>Disagreement between main and/or AUX flap position (10 second light) or asymmetry lockout (3 second light).</p> <p>CADC failure. WG SWP DR NO. 2/MANUV FLAP (LE1) circuit breaker pulled.</p>
<p>⑤ Maneuver flap and slat thumbwheel</p>	<p>Forward — Commands maneuver flaps and slats to retract.</p> <p>Neutral — Automatic CADC program.</p> <p>Aft — Commands maneuver flaps and slats to extend.</p>

Figure 2-49. Flap and Slat Controls and Indicators (Sheet 2 of 2)



1-F50D-62-0

Figure 2-50. Wing Control Surfaces

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 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 servo-loop 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.



- 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 over-travel protection, 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

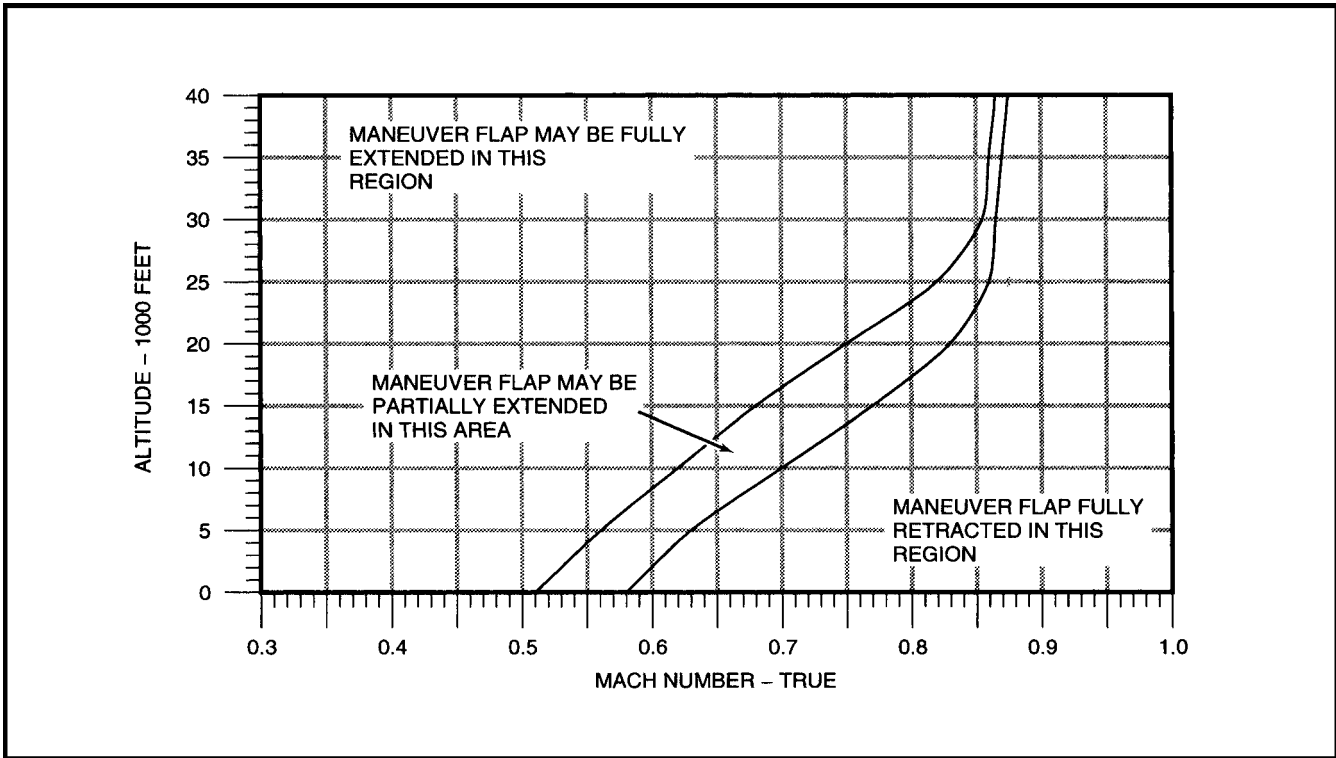
The main flaps can be extended to 10° with the slats extended to 7° within the altitude and Mach envelope shown in [Figure 2-51](#).

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

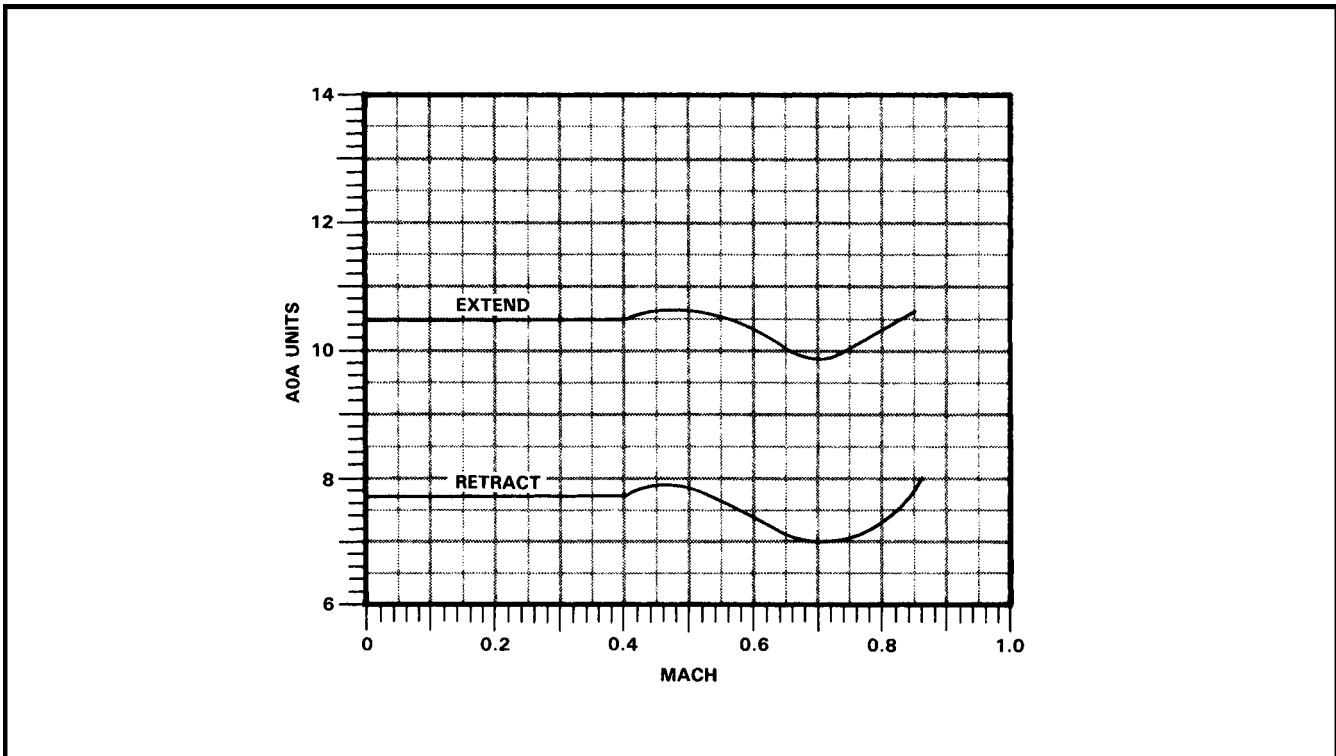
CADC maneuver flap commands are automatically reset when the flap handle is placed down greater than 2° , wing-sweep BOMB mode is selected, or maneuver flaps are commanded to less than 1° by the CADC because of dynamic pressure.

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.



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Figure 2-51. Maneuver Flap Envelope



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Figure 2-52. Maneuver Slat/Flap Automatic Schedule for CADC



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).

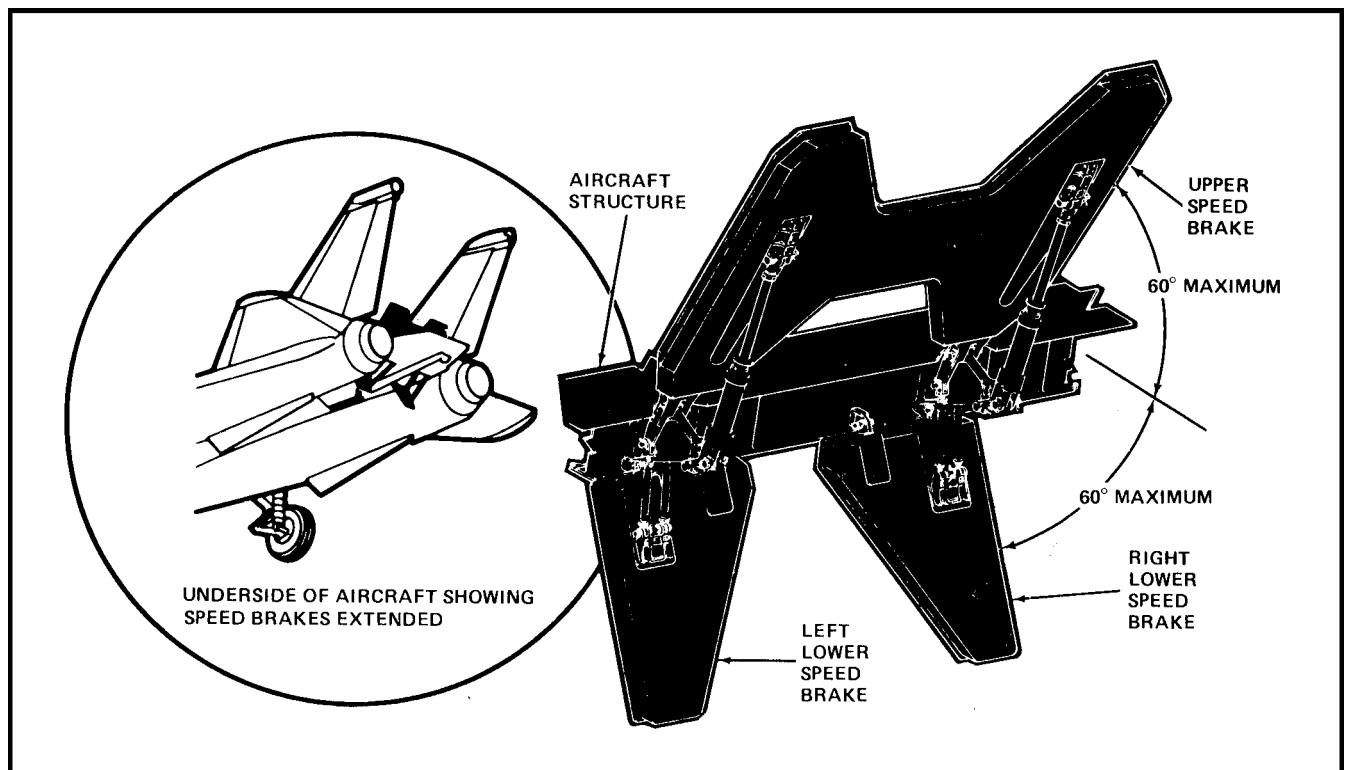
2.22.1 Speedbrake Operation

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.

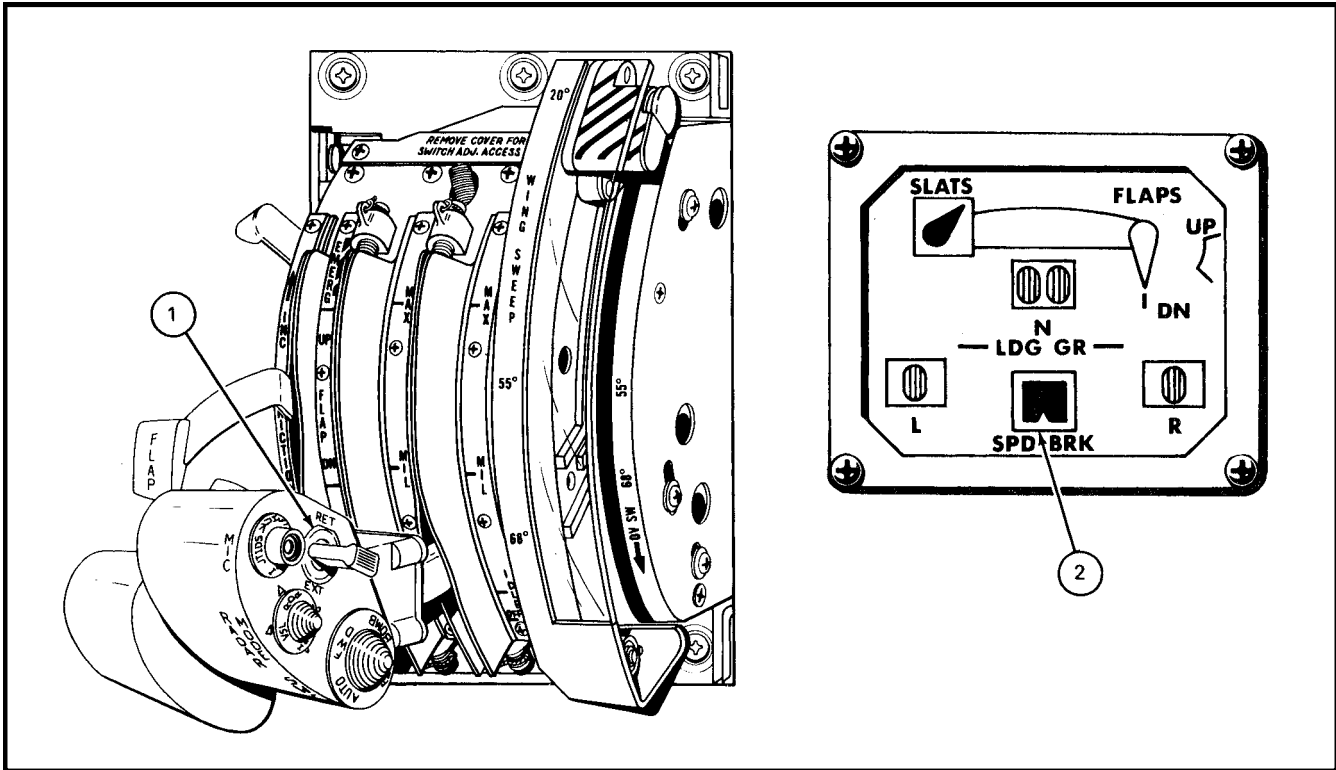
Note

- 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.



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Figure 2-53. Speedbrakes



0-F50D-161-0





NOMENCLATURE	FUNCTION
<p>① Speed brake switch</p>	<p>EXT — Momentary position used for partial or full extension. When released, switch returns to center (hold) position.</p> <p>RET — Normal position of switch. Retracts and maintains speed brakes closed.</p>
<p>② SPEED BRAKE indicator</p>	<p> — Partial extension (hold).</p> <p> — Full extension (60°).</p> <p> — Full retracted position.</p> <p> — Speed brakes power off.</p> <p style="text-align: center;">Note</p> <p>Automatic retraction of speed brakes occurs when either or both throttles are at MIL.</p>

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 DFCS 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 bob-weights. 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 cam and roller feel assembly with an electro-mechanical 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 DFCS 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.

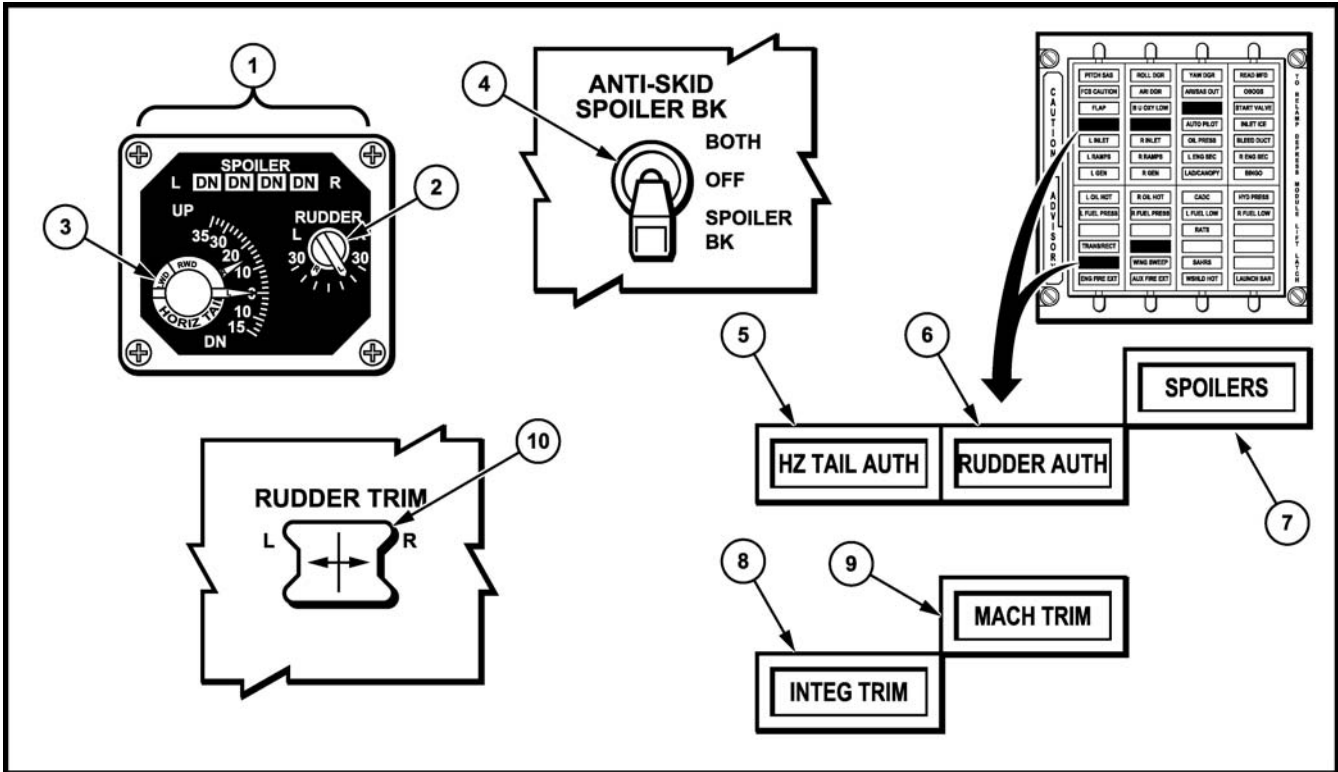
The manual and DFCS automatic trim and Mach trim actuator is installed in parallel with the flight control system. Trim actuation produces a corresponding stick and control surface movement.

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](#).



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 2 g nose-down trim change when the speedbrake is extended. Under these conditions with the PITCH SAS engaged, maximum trim change is reduced to approximately 1 g.



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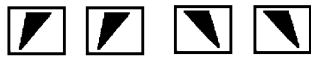
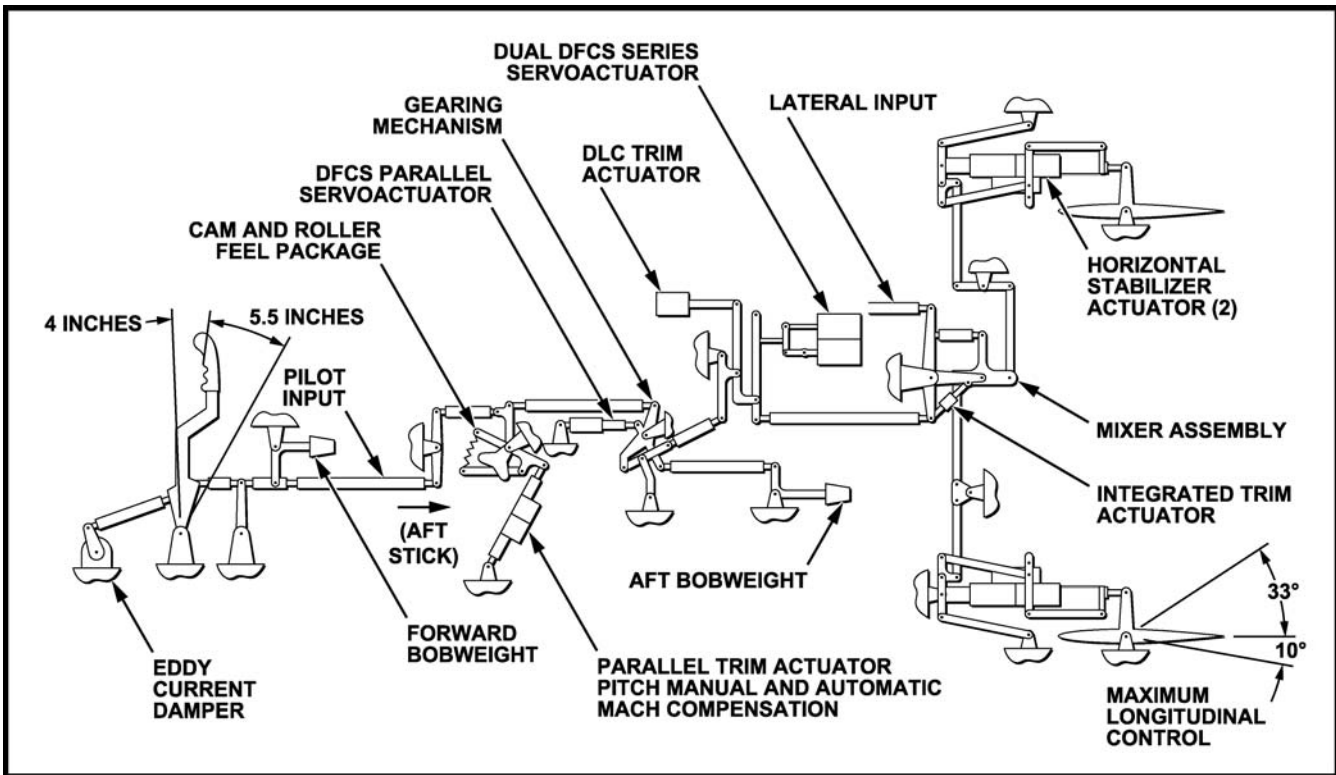
NOMENCLATURE	FUNCTION
<p>① SPOILER position indicators</p> <p>Note</p> <p>A right inboard or outboard spoiler position indicator showing one position higher than the corresponding spoilers actual position indicates a possibility of ground roll braking in flight and loss of spoiler asymmetry protection due to a failed zero degree switch.</p> <p>② RUDDER position indicator</p>	<p>DN DN DN DN — Spoilers down (flush with wing surface).</p> <p> — Either spoiler of the appropriate pair is extended more than 0°.</p> <p> — Both spoilers of the appropriate pair at a dropped position (0-4½° below wing surface)</p> <p>Individual rudder pointers marked R (right) and L (left) display the trailing-edge position of the rudders in degrees (0 to 30).</p>

Figure 2-55. Control Surface Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>③ HORIZONTAL tail stabilizers position</p>	<p>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).</p>
<p>④ ANTI SKID SPOILER BK switch</p>	<p>BOTH — Antiskid activated. Spoiler brakes operate with weight on wheels and throttle at IDLE.</p> <p>OFF — Antiskid and spoiler brakes inoperative with weight on wheels.</p> <p>SPOILER BK — Spoiler brakes operate with weight on wheels and both throttles at IDLE. Antiskid is deactivated.</p>
<p>⑤ HZ TAIL AUTH caution light</p>	<p>Failure of lateral tail authority actuator to follow schedule or CADC failure.</p>
<p>⑥ RUDDER AUTH caution light</p>	<p>Disagreement between command and position, failure of rudder authority actuators to follow schedule, or CADC failure.</p>
<p>⑦ SPOILERS caution light</p>	<p style="text-align: center;">Note</p> <p>The RUDDER AUTH caution light may illuminate when the in-flight refueling probe is extended. Press the MASTER RESET button to reset the light.</p>
<p>⑧ SPOILERS caution light</p>	<p>Spoiler system failure, causing a set of spoilers to be locked down.</p> <p style="text-align: center;">Note</p> <p>SPOILERS caution light will not illuminate with SPOILER FLR ORIDE switches in ORIDE position.</p>
<p>⑧ INTEG TRIM advisory light</p>	<p>Discrepancy between input command signal and actuator position or an electrical power loss within the computer.</p>
<p>⑨ MACH TRIM advisory light</p>	<p>Failure of Mach trim actuator to follow schedule.</p>
<p>⑩ RUDDER TRIM switch</p>	<p style="text-align: center;">Note</p> <p>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.</p>
<p>⑩ RUDDER TRIM switch</p>	<p>Controls the electromechanical actuator that varies the neutral position of the mechanical linkage for rudder trim.</p>

Figure 2-55. Control Surface Indicators (Sheet 2 of 2)

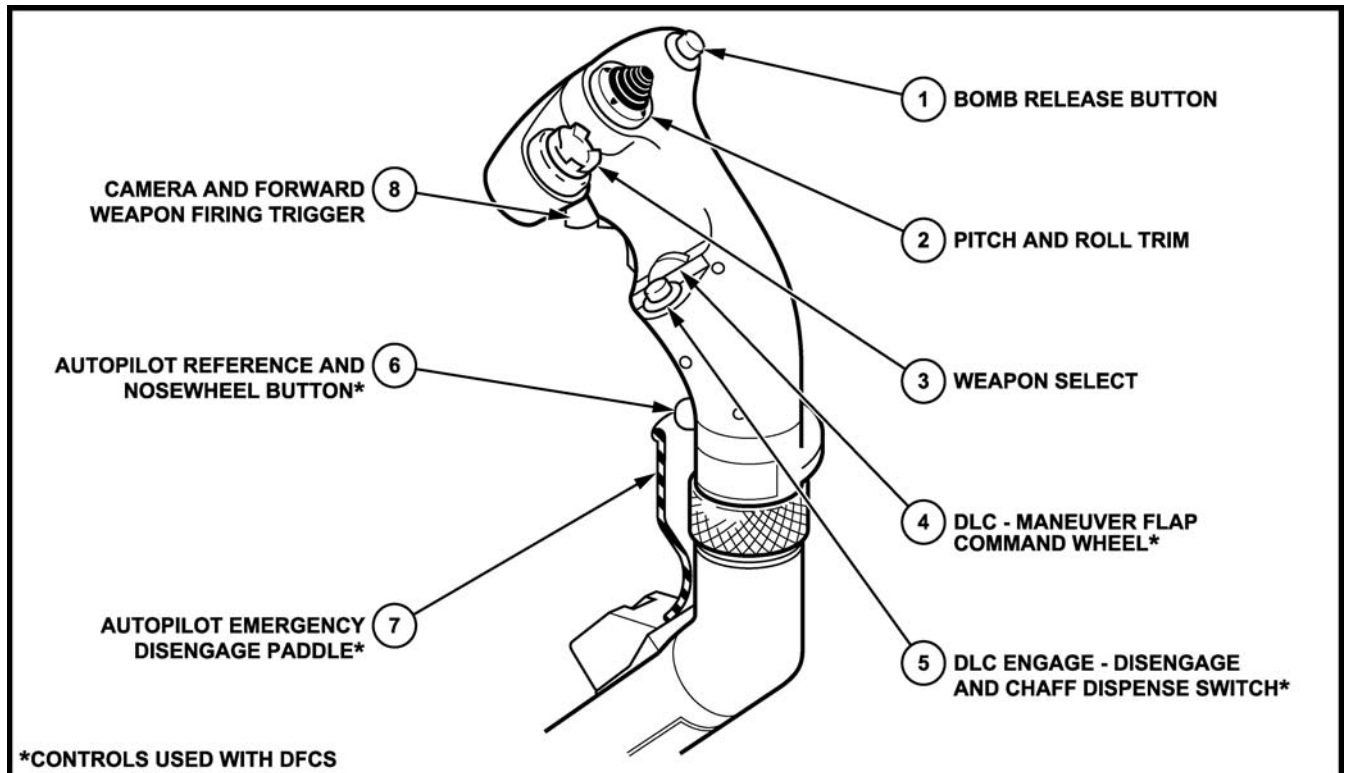


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Figure 2-56. Longitudinal Control System

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
DFCS	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



CSC-F14D-1-2-030

NOMENCLATURE	FUNCTION
<p>① Bomb release button</p>	<p>Pilot control for release of stores. In aircraft with the weapons rail defensive electronic countermeasures (DECM) chaff adapter, the bomb release button is used to dispense chaff.</p>
<p>② Pitch and roll trim button</p>	<p>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.</p>
<p>③ Weapon Selector switch</p>	<p>LR — Selects Phoenix missiles. MR — Selects Sparrow missiles. SR — Selects Sidewinder missiles. GN — Selects gun.</p>
<p>④ Maneuver flap, slat, and DLC command</p>	<p>Spring-loaded to a neutral position.</p> <p>With DLC engaged: Forward rotation extends spoilers (aircraft down); aft rotation retracts spoilers (aircraft up).</p> <p>With gear and flaps up: Forward rotation retracts maneuvering flaps/slots; aft rotation extends maneuvering flaps/slots.</p>

Figure 2-58. Control Stick and Trim (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>5 DLC engage, disengage, and chaff switch</p>	<p>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.</p>
<p>6 Autopilot reference and nosewheel steering pushbutton</p>	<p>With weight on wheels, nosewheel steering can be engaged by depressing switch momentarily. Weight off wheels and autopilot engaged; switch engages compatible autopilot modes. The switch also disengages ACL mode.</p>
<p>7 Autopilot emergency disengage paddle</p>	<p>Disengages all autopilot modes and DLC. Releases all autopilot switches. Depressing the paddle switch reverts throttle system from AUTO or BOOST mode to MAN mode and reverts engines to SEC MODE only while depressed and with weight on wheels.</p>
<p>8 Camera and forward weapon firing trigger</p>	<p>Pilot control of CCTVS, gun camera, and/or forward firing weapons. First detent of trigger starts gun camera and color cockpit television sensor (CCTVS).</p>

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 wingsweep positions of less than 62°. With gear handle up, 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 spoiler in the 0° position. Lateral stick commands are transmitted by pushrods and bell-cranks 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

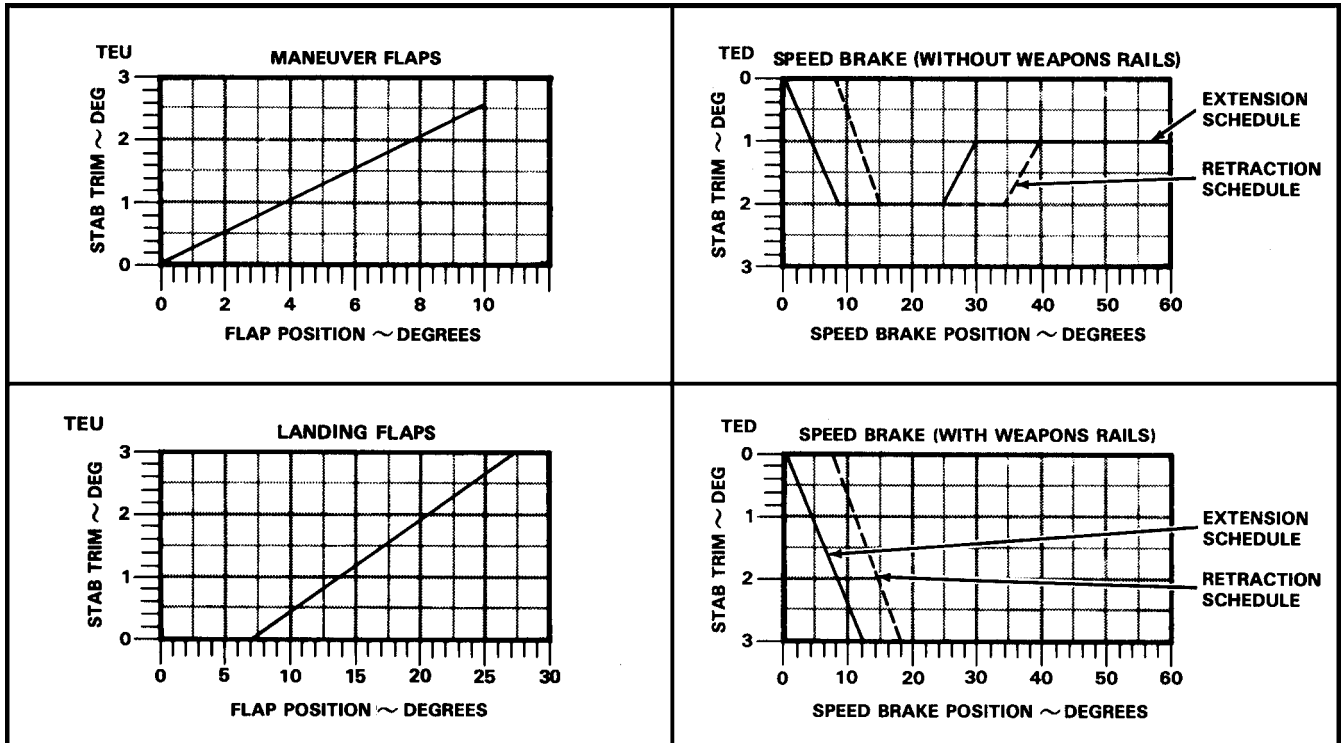
Lateral trim is by differential deflection of the horizontal stabilizers. The wing spoilers are not actuated for lateral trim control. Trim is provided by adjusting the neutral position of the spring roller-cam-feel assembly with an electromechanical screwjack. Left or right deflection of the roll trim 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.

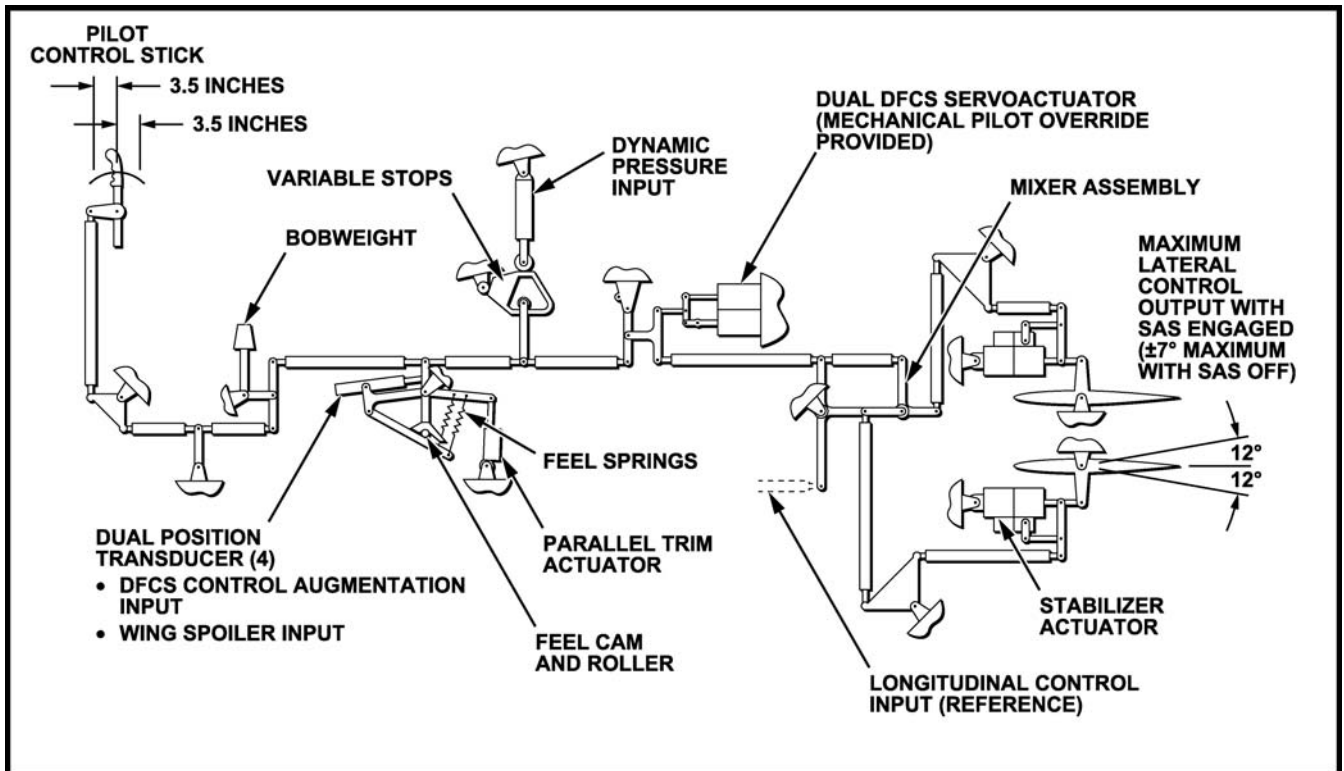
2.23.3.3 Lateral Control Stops

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.



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Figure 2-59. Integrated Trim Schedules



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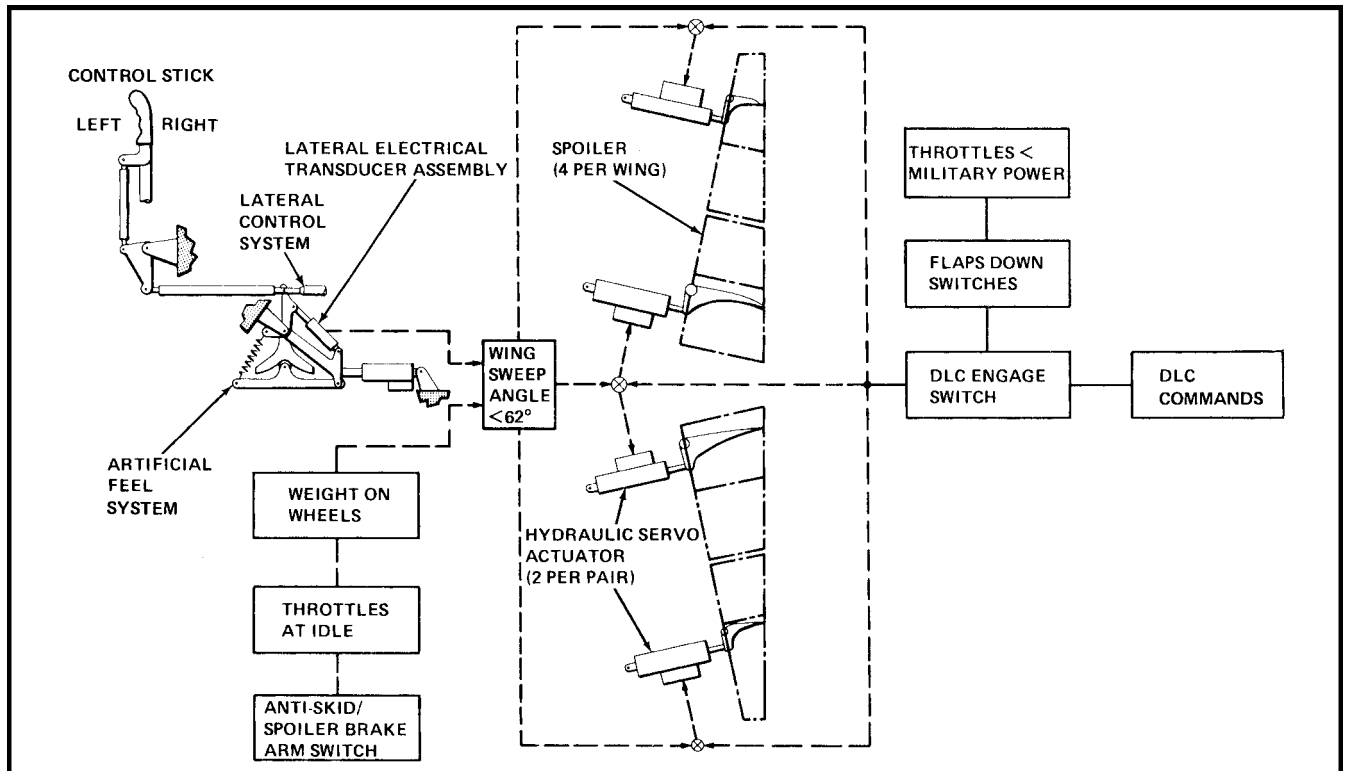
Figure 2-60. Lateral Control System

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
	DFCS	Series	None	± 5°	33° per second	—	—
Inboard and Outboard Spoilers	Control Stick	Manual for $\Omega \leq 62^\circ$	3.5 inches left 3.5 inches right	± 55°	250° per second	None	None
	DFCS (ACL) (inboard only)	Series	None	15° maximum 8° neutral	250° per second	None	None
	DLC/ Maneuver Flap (inboard only)	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	± 3½° 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



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Figure 2-62. Spoiler Control System

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 also provide DLC. The inboard and outboard spoilers are powered and controlled by separate hydraulic and electrical command systems. The DFCS monitors each spoiler panel individually. 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 digital flight control system in FO-12.)

The inboard spoilers are controlled and monitored by the ROLL A and PITCH A computer segregations respectively. The outboard spoilers are controlled and monitored by the PITCH B and YAW B computer segregations respectively. Hydraulic actuation of the servo actuators is controlled by electric servo valves 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). The power approach spoiler gearing schedule is modified to provide predictable roll response with lateral stick deflection. To provide the appropriate spoiler gearing

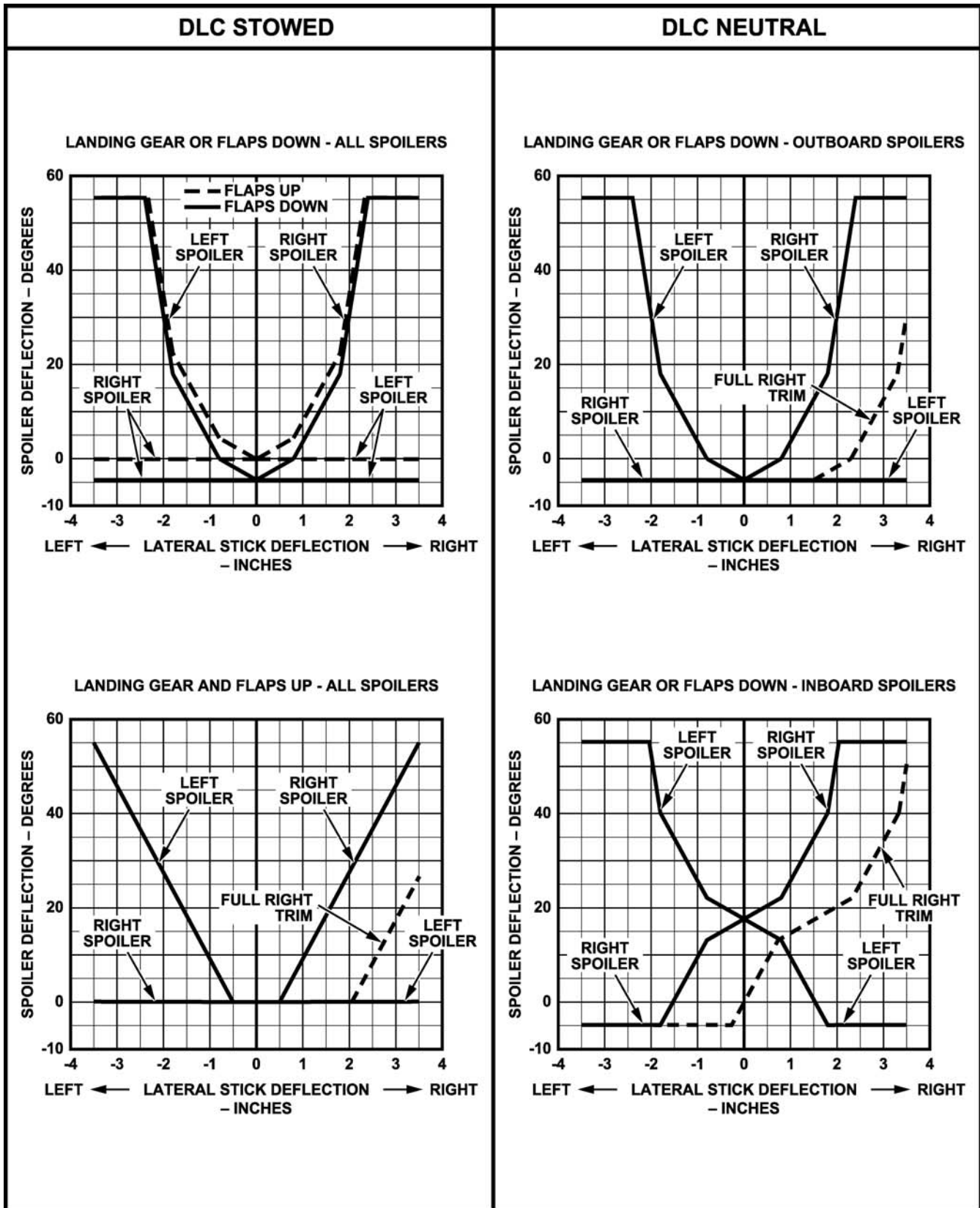
for all landing configurations, the DFCS uses the power approach spoiler gearing whenever the landing gear or main flaps are down. With DLC engaged in the power approach mode, the inboard spoilers are positioned from normal -4.5° to $+17.5^\circ$ position. Lateral stick inputs result in the spoilers extending on one side in the direction of stick displacement and depressing toward the landing flaps down drooped (-4.5°) stowed 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 and Spoiler Deflection

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 neutral trim position, maximum spoiler deflection is reduced in the same direction (right trim – less right wing spoiler deflection).

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.



CSC-F14D-1-2-019

Figure 2-63. Spoiler Gearing Schedule

Full lateral trim in the same direction as lateral stick displacement will still provide approximately 25° to 35° 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.

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 left vertical console. The three-position switch allows optional selection of BOTH (spoiler brake and wheel antiskid braking), SPOILER BK (spoiler brake only), or OFF where neither spoilers nor antiskid is armed. With SPOILER BK or BOTH selected, two conditions are required to actuate the spoilers:

1. Weight on wheels
2. Both throttles at idle.

Failure to satisfy any one of the above conditions will cause the spoilers to return to the down position.



Ground-roll braking may fail to extend spoilers on touchdown due to a momentary miscompare of the weight-on-wheels switches. MASTER RESET should restore normal ground-roll braking operation.

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

Spoiler monitoring is accomplished by directly comparing the commanded spoiler position with the actual spoiler position. When a miscompare is detected, the affected individual spoiler panel and the corresponding spoiler panel on the opposite wing are commanded to - 4½° and the SPOILERS caution light illuminated. Transient spoiler failures can be reset by depressing the MASTER RESET pushbutton. If the affected spoiler panel is mechanically stuck-up, the DFCS automatically restores normal operation of the opposite spoiler panel within 2 seconds.



The spoiler actuators are mechanically biased to the retracted position in order to cause the spoilers to retract in the event that the command

signal from the DFCS is lost (i.e., DFCS power failure). If this bias is reversed, the affected spoiler will extend instead of retracting when the command signal is lost. A DFCS power failure coupled with a reverse spoiler bias will result in a fully deployed spoiler. All unaffected spoilers will remain retracted and will not respond to flight control inputs until the DFCS command signals are restored.

Note

- DFCS synchronization can take up to two 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.
- Do not press and hold the MASTER RESET pushbutton. Pressing and holding the MASTER RESET pushbutton during the synchronization time will have no effect since the DFCS computers only recognize the leading edge of the pulse from the MASTER RESET pushbutton, and not the fact that the button is continuously depressed.
- On deck, when the flap handle is cycled to UP, the outboard spoiler module is shut down. This will cause the outboard spoilers to remain extended if activated. If this occurs, position the flap handle to DN and deactivate the spoilers. This may also cause the spoiler indicators to inaccurately indicate a droop or down position. If this occurs, position the flap handle to DN and move the control stick laterally to correct spoiler indicators.

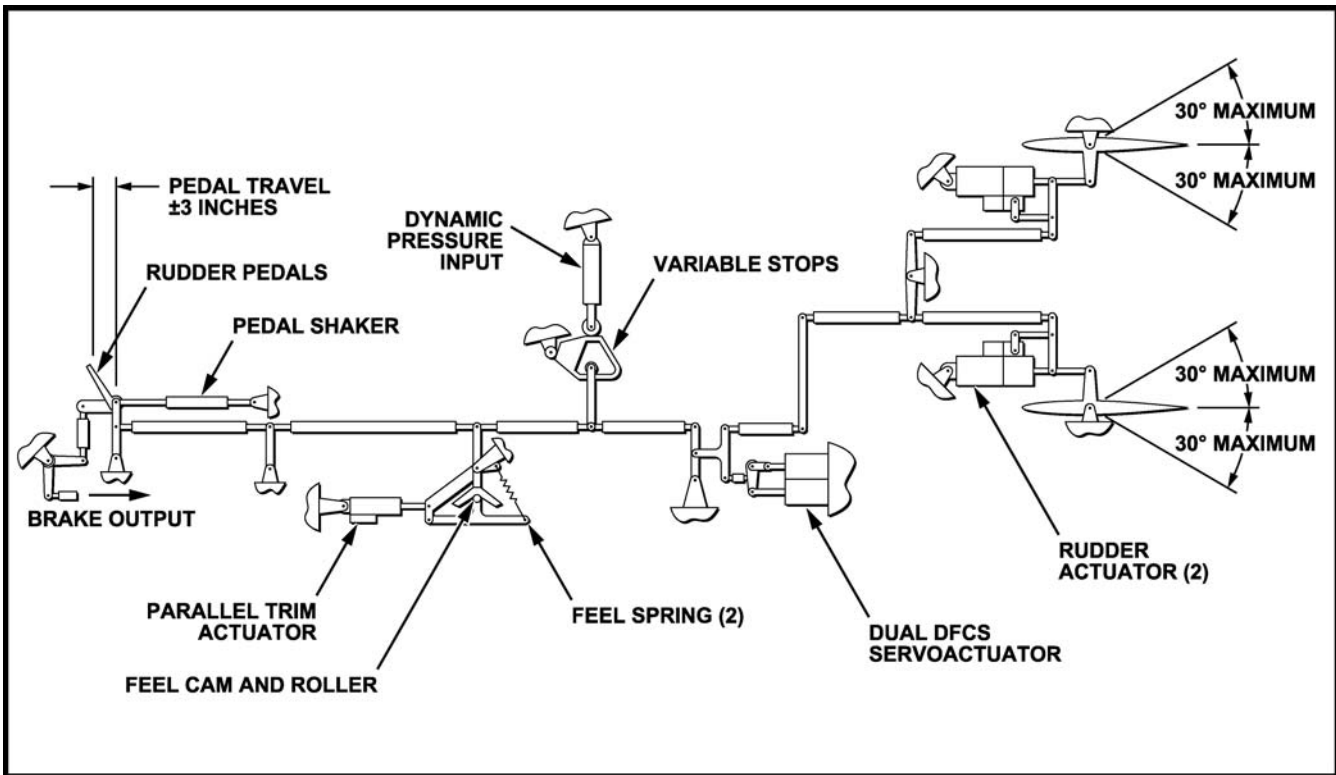
2.23.4.4 Spoiler Test

Proper spoiler operation is verified when IBIT is run during startup if wings are at 20 degrees and flaps are down. See Chapters 7 and 38.

2.23.5 Yaw Control

Yaw control ([Figure 2-64](#)) 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 2-65](#).



CSC-F14D-1-2-032

Figure 2-64. 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 inch left, 1 inch right	± 9.5° minimum	106° per second	7°	1.13° per second
DFCS	Series	None	* ± 19°	80° per second	—	—

*Stops programmed by CADC (rudder authority) as a function of dynamic pressure.

Figure 2-65. Yaw System Authority

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.

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.



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. Nose-wheel steering authority is greatly reduced with the 9.5° stops engaged.

2.23.5.4 Rudder Pedal Shaker

The rudder pedal shaker operates during IBIT and in flight when the landing gear is extended and angle of attack is above ~20 units. Rudder pedal shaker will deactivate once the angle of attack is reduced below ~19 units.

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. Only the inboard spoilers are used for DLC.

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 B, and yaw B 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. Absolute spoiler deflection is dependent upon lateral stick position (see [Figure 2-63](#)). DLC is provided by the yaw computer.

Upon engagement of DLC, the roll computer extends the inboard spoilers from the landing flaps down drooped (- 4½°) 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 DIGITAL FLIGHT CONTROL SYSTEM

The DFCS (FO-12) augments the aircraft natural damping characteristics and provides automatic commands for control of attitude, altitude, heading, and approach modes selected by the pilot. All DFCS functions are integrated into the primary flight control system.

The DFCS also provides an Up and Away Automatic Rudder Interconnect (UA-ARI) to enhance departure resistance, spin recovery and high angle of attack flying qualities, and a Power Approach Automatic Rudder Interconnect (PA-ARI) to enhance the landing approach flying qualities. The DFCS consists of three computers, one computer for each axis (pitch, roll, and yaw). Each computer has two distinct and independent processors called channels or segregations (one "A" and one "B" channel per axis), each controlling one of the dual series servoactuators. All channels share data through cross channel data links.

A BIT capability is provided to exercise in-flight monitoring and to conduct an automatic operational readiness test for preflight checks. DFCS rates and authorities are tabulated in [Figure 2-66](#).

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 2-66. DFCS Rates and Authorities

2.24.1 Stability Augmentation System

Stability augmentation is provided for all three aircraft axes (pitch, roll, and yaw) and is controlled by the three STAB AUG switches on the upper half of the DFCS control panel (DCP) (Figure 2-67). SAS is engaged by placing these switches to ON during normal poststart procedures. The PITCH, ROLL, and YAW STAB AUG switches are manually operated toggle switches mechanically held in the selected ON or OFF position.

The PITCH SAS incorporates a pitch rate feedback function that is reduced as airspeed is increased above 650 KIAS. This is necessary to maintain adequate control system stability and is not noticeable. The ROLL SAS is independent with the landing gear up, at low angle of attack (less than 15 units), and at supersonic flight conditions. At all other conditions, the ROLL SAS is part of the UA-ARI and PA-ARI. Similar to the PITCH SAS, the roll rate feedback is reduced as airspeed is increased above 300 KIAS. With the landing gear down, the YAW SAS becomes part of the PA-ARI.

All SAS switches should remain ON during flight. Deselection of either the ROLL or YAW SAS switch will disable the affected SAS axis and all ARI functions, and illuminate the ARI/SAS OUT caution light. Deselection of the PITCH SAS switch will disable the PITCH SAS, but no caution light will illuminate since no restriction exists for PITCH SAS OFF.



Maneuvering with YAW SAS OFF or inoperative shall not be conducted above 15 units AOA with landing gear retracted.

Note

Depressing the paddle switch does not disable the PITCH and ROLL SAS. If problems are suspected with any SAS axis, the appropriate STAB AUG switch must be manually selected OFF. Depressing the paddle switch will disengage the autopilot and DLC inflight, revert the throttles to MANUAL mode on deck, and revert fuel control to SEC mode.

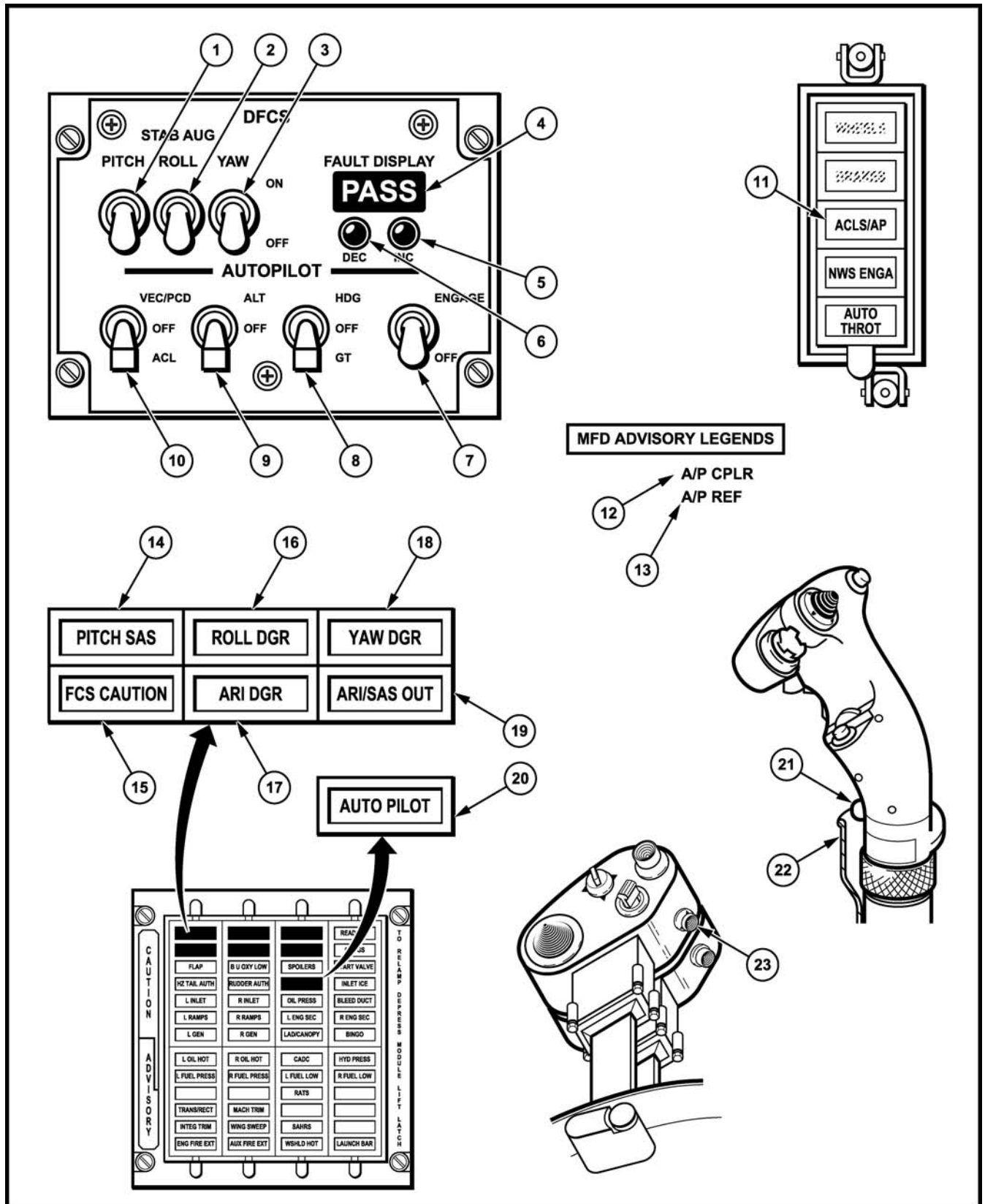
2.24.1.1 DFCS Control Panel/Fault Display

The DFCS control panel (Figure 2-67), located on the pilot’s left side console, includes all the controls for the DFCS and an LED alphanumeric fault display with the associated INC and DEC pushbuttons to control display operation. This fault display is intended for ground use only to assist in the troubleshooting and repair of the DFCS and related components.

2.24.1.2 Up and Away Automatic Rudder Interconnect (UA-ARI)

The UA-ARI is selected when the landing gear handle is up and provides several functions designed to improve high angle of attack flying qualities and departure resistance (Figure 2-67). These include:

- Differential Stabilizer Fadeout
- Lateral Stick-to-Rudder Interconnect (LSRI)
- Low airspeed/high angle of attack cross control (LSXC)
- Wing Rock Suppression
- Spin Recovery Function.



CSC-F14D-1-2-015

Figure 2-67. DFCS Controls and Indicators (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
1 PITCH STAB AUG engage switch	Engages dual-channel pitch stability augmentation.
2 ROLL STAB AUG engage switch	Engages dual-channel roll stability augmentation.
3 YAW STAB AUG engage switch	Engages dual-channel yaw stability augmentation.
4 DFCS fault display	With weight on wheels, the DFCS fault display yields three categories of fault codes including: currently existing failures (FAIL), in-flight detected failures (FLT), and IBIT detected failures (IBIT).
5 INC pushbutton	With weight on wheels, depressing the INC pushbutton scrolls forward through logged DFCS fault codes.
6 DEC pushbutton	With weight on wheels, depressing the DEC pushbutton scrolls backward through logged DFCS fault codes.
7 AUTOPILOT ENGAGE-OFF switch	<p>ENGAGE — Engages autopilot. PITCH, ROLL, and YAW SAS switches must be engaged. No warmup required. Engages attitude hold. Requires weight off wheels.</p> <p>OFF — Disengages autopilot.</p>
8 HDG-OFF-GT switch	<p>HDG — Autopilot will lock on constant aircraft heading when aircraft is less than ± 5 roll.</p> <p>OFF — Disengages heading hold and ground track.</p> <p>GT — Selects autopilot ground tracking computed at time of engagement using inertia navigation system (INS) data. Engaged by nosewheel steering pushbutton.</p>
9 ALT-OFF switch	<p>ALT — Autopilot will maintain barometric altitude. Engaged by nosewheel steering pushbutton.</p> <p>OFF — Disengages altitude mode.</p>
10 VEC/PCD-OFF-ACL switch	<p>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.</p> <p>OFF — Disengages VEC/PCD and ACL modes.</p> <p>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 and disengaged by nosewheel steering pushbutton.</p>
11 ACLS/AP caution light	Autopilot and automatic carrier landing system (ACLS) mode disengaged.
12 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 displayed in conjunction with the CMD CTRL legend after coupling is accomplished.
13 A/P REF advisory legend on MFD	Autopilot mode is selected but is not engaged. (Except attitude and heading hold.)

Figure 2-67. DFCS Controls and Indicators (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
14 PITCH SAS caution light	Indicates inoperative pitch channel or PITCH SAS failure.
15 FCS CAUTION light	Indicates DFCS failure has occurred. If no other lights are illuminated, indicates loss of redundancy only (subsequent failure may result in loss of significant DFCS functionality).
16 ROLL DGR caution light	Indicates inoperative roll channel and degraded roll authority.
17 ARI DGR caution light	Indicates degraded ARI performance. If caused by loss of a Mach number signal, LSXC and wing rock suppression functions will be inoperative.
18 YAW DGR caution light	Indicates inoperative yaw channel and degraded yaw authority.
19 ARI/SAS OUT caution light	Indicates loss of either ROLL or YAW SAS and all ARI functions. Will be illuminated if either the ROLL STAB AUG or YAW STAB AUG switches are selected off.
20 AUTOPILOT caution light	Indicates failure of one or more of pilot relief modes.
21 Autopilot reference and nosewheel steering pushbutton	Engages the ALT, GT, ACL or VEC/PCD autopilot mode selected. Autopilot must be engaged and compatible autopilot modes selected. Also disengages ACL mode. Requires weight off wheels.
22 Autopilot emergency disengage paddle	Disengages all autopilot modes and releases all autopilot switches.
23 PLM pushbutton	With the A/P CPLR legend and the VEC/PCD ACL switch latched in the ACL position, depressing the PLM pushbutton engages and disengages the ACL mode and autopilot.

Figure 2-67. DFCS Controls and Indicators (Sheet 3 of 3)

These functions are active throughout the subsonic flight envelope and are scheduled with Mach number and angle of attack (Figure 2-68). The effects of these functions on flight characteristics are discussed in Chapter 11.

Note

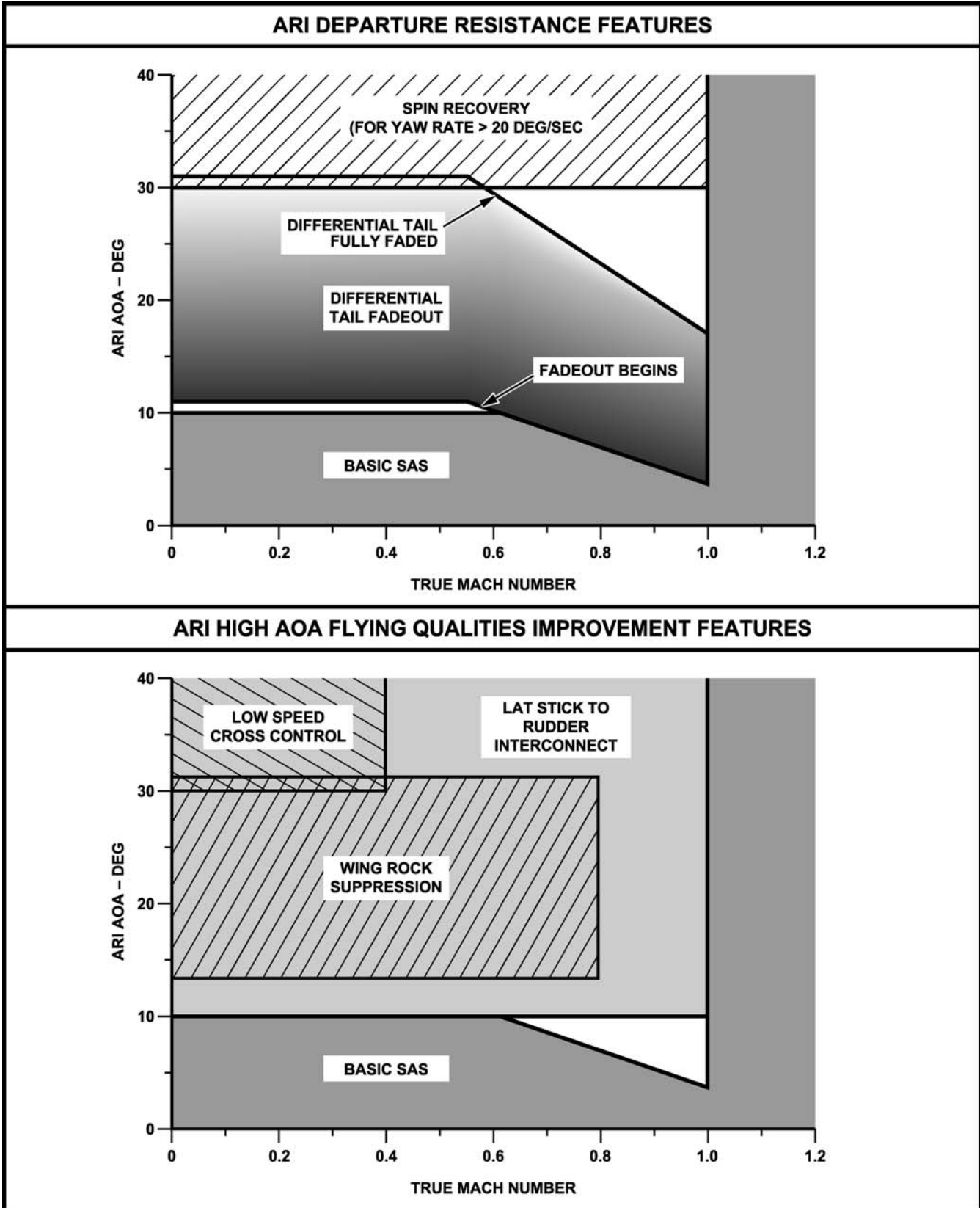
The primary AOA input for control law scheduling is based on degrees AOA provided by the ARI alpha nose-probe vice units AOA as displayed on the cockpit AOA indicator provided by the ADD AOA side-probe. Descriptions of control law functions are written in units AOA, but it should be noted that the correlation between units and degrees AOA is a function of Mach number.

The differential stabilizer fadeout function reduces the amount of differential stabilizer the pilot can command as angle of attack and Mach number are increased. Below ~15 units angle of attack, the pilot can command up to the maximum +/-12 deg differential stabilizer authority. Above ~30 units angle of attack, the differential stabilizer is limited to a maximum of +/-2 deg deflection (except when overridden

by activation of LSXC or spin recovery functions). As Mach number is increased, the differential stabilizer is faded out at a lower AOA. This reduces the effects of kinematic coupling and results in less adverse sideslip with lateral stick deflection as angle of attack is increased and reduces the tendency for lateral control induced departures.

The LSRI function gradually applies coordinating rudder with lateral stick as angle of attack is increased above ~15 units AOA. A maximum of +/-19 deg coordinating rudder is provided by the LSRI above ~23 units AOA. This results in the desired roll response with lateral stick input alone at elevated AOA.

The LSXC function provides a means to override the differential stabilizer fadeout and LSRI functions when CADC Mach number is below 0.4 and angle of attack is above ~30 units. At these conditions, the pilot can command up to +/-10 deg differential stabilizer deflection in the direction of lateral stick and up to +/-30 deg rudder deflection in the direction of commanded rudder. Because rudder



CSC-F14D-1-2-020A

Figure 2-68. DFCS Up and Away ARI Functions

effectiveness is diminished above 30 units angle of attack, the LSXC function is necessary to provide adequate roll/ yaw maneuvering capability at extreme angles of attack. When LSRI is no longer effective, the aircraft can still be rolled through LSXC by manually applying greater than 1.75 inch of rudder pedal in the direction of the desired roll, and greater than 1 inch lateral stick in the opposite direction. This will create an adverse yaw response causing the aircraft to roll/yaw in the same direction as the rudder input.

The wing rock suppression function uses roll rate feedback to command the differential stabilizer and rudder to damp lateral-directional oscillations from between 20 to 30 units AOA. This results in smoother tracking capability for the majority of the maneuvering flight envelope. Wing rock suppression is disabled when a pedal input greater than 2 inches is applied or CADC Mach number is above 0.77 to prevent the system from applying inadvertent cross control inputs and allow the pilot to roll the aircraft with rudder inputs alone.

The spin recovery function applies full SAS authority of up to +/-19 deg rudder and up to +/-5 deg differential stabilizer to oppose yaw rate during a departure. The spin recovery function is activated when angle of attack is above ~30 units and yaw rate is above 20 deg/sec. The spin recovery inputs are in addition to the pilot's mechanical inputs, providing full control surface authority for departure recovery (+/-30 deg rudder opposite roll/yaw and +/-12 deg differential stabilizer into roll/yaw). Misapplied pilot recovery inputs are limited to +/-11 deg pro-spin rudder and +/-2 deg pro-spin differential stabilizer.

2.24.1.3 Power Approach ARI

The PA-ARI is selected when the landing gear handle is down and provides roll rate command, LSRI, Dutch roll damping, and spiral mode stabilization functions. In addition, the spoiler gearing has been modified for 0.1 inch lateral stick spoiler breakout to improve roll sensitivity and predictability.

The roll rate command function tailors differential stabilizer to maintain a constant lateral stick to roll rate relationship. This is achieved by comparing the roll rate command (based upon lateral stick position as measured from trimmed position) to the actual roll rate, then increasing or decreasing the differential stabilizer deflection to maintain the commanded roll rate. The control gains are designed to provide approximately 20 deg/sec roll rate per inch of lateral stick deflection from trim.

Note

The PA-ARI will perceive a lateral trim offset as an uncommanded roll rate and will attempt to reduce roll rate to zero with the stick in the trimmed position. As a result, it is possible to have the stick offset due to lateral trim with zero

roll rate. Because the pilot's roll rate command is based upon lateral stick position from a trimmed position, it may be necessary to select ROLL SAS OFF, trim the airplane, and then reselect the ROLL SAS ON. The same procedure may be necessary to trim an airplane with a lateral store asymmetry, trapped wing fuel, etc.

The LSRI function gradually fades in coordinating rudder with lateral stick as angle of attack is increased above ~10 units AOA. This minimizes adverse yaw response from lateral stick only inputs, greatly enhancing heading and centerline capture during lineup corrections. At normal approach conditions (15 units angle of attack, flaps down), up to +/- 19 deg coordinating rudder is provided by the LSRI. Raising the flaps decreases the amount of coordinating rudder available.

The Dutch roll damping function provides sideslip rate feedback to the rudder to reduce directional nose wandering during approach. Airplane roll rate, yaw rate, lateral acceleration, Mach number, and angle of attack are used to calculate sideslip rate. At normal approach conditions, the sideslip rate feedback to rudder provides a deadbeat Dutch roll response.

The spiral mode stabilization function provides yaw rate feedback to the differential stabilizer to reduce bank angle excursions during stabilized turns. At normal approach conditions, the yaw rate feedback to differential stabilizer provides an essentially neutral spiral mode.

2.24.1.4 Aircraft Sensors

The DFCS uses the aircraft sensor inputs distributed to the various computer channels as shown in [Figure 2-69](#). The DFCS distributes sensor inputs to all computer channels through cross channel data link (CCDL) communication. Each computer channel compares like sensor data (for example, yaw rate A, B, and M) to determine validity of each input and then consolidates the good inputs. The consolidated sensor inputs are then used to generate output commands. This provides an additional level of monitoring and redundancy.

Note

Loss of a computer segregation or individual cross channel data link will result in loss of sensor information provided by the affected segregation or link and illuminate the appropriate caution/advisory lights.

The aircraft sensors are supplemented by a pitch/roll voter monitor and air data redundancy management algorithm to provide a fail-operational capability following a single sensor failure. Following a second sensor failure, the DFCS reverts to a fail-safe configuration.

2.24.1.4.1 Pitch/Roll Voter Monitor

The pitch/roll voter monitor (PQVM) algorithm provides triple redundancy for the existing duplex pitch and roll rate gyro sensors. The PQVM operates by calculating aircraft pitch and roll attitudes from three axis rate information and comparing this against pitch and roll attitudes supplied by the IMU/INS. If a pitch or roll rate sensor miscompare occurs, the PQVM algorithm is used to select the remaining good sensor signal. The monitor does not provide additional rate information for averaging with the sensor signals. Since only pitch and roll attitude are available from the IMU/INS, the effectiveness of the monitor depends on aircraft attitude. The monitor is incapable of detecting pitch rate failures with the wings near vertical (± 90 deg bank angle) or roll rate failures with the fuselage near vertical (± 90 deg pitch angle).

Note

Transient IMU/INS attitude failures will result in a PQVM miscompare. This will be indicated by an FCS CAUTION light accompanied by PS and RS acronyms. Depressing the MASTER RESET pushbutton will restore normal PQVM operation and clear the failure indications. Failed velocity information from the IMU/INS does not affect operation of the PQVM function.

2.24.1.4.2 Angle of Attack / Mach Redundancy Management

The primary angle of attack (AOA) input is provided by the ARI alpha nose-probe (AOA range 0° to $+37^\circ$). The fuselage-mounted ADD AOA side-probe (AOA range -4° to $+24^\circ$ for Mach < 0.4) is used for comparison and as a backup AOA source in the event of a detected failure of the ARI AOA input. Although two AICS AOA inputs are available (AOA range 0° to $+30^\circ$ for Mach > 0.5), significant sideslip-induced errors distort these measurements as a function of their locations on either side of the fuselage. Location of sensor probes is discussed in paragraph 2.32 (Pitot Static System). A sideslip estimation routine, based upon lateral acceleration, differential stabilizer, and rudder position, is implemented to select the upwind AICS AOA source. This AICS AOA is utilized as a triplex monitor to vote out a failed ARI or ADD AOA (1st AOA fault), but is not of sufficient accuracy to be used as a primary source for control law gain scheduling. In the event of a subsequent miscompare between the remaining AOA sources (2nd AOA fault), the ARI control laws are reverted to fail-safe fixed values for AOA. First AOA miscompares are indicated by an FCS CAUTION light and PS acronym. Second AOA miscompare are indicated by FCS CAUTION, ROLL DGR, ARI DGR, and ARI/SAS OUT caution lights and PS acronym with the landing gear handle up and FCS CAUTION, ARI DGR caution lights and PS acronym with the landing gear handle down.



Pulling the Alpha computer circuit breaker will result in loss of the primary AOA source. This may degrade DFCS performance as the backup ADD AOA is subject to sideslip-induced errors. For the DFCS to operate properly, the Alpha computer should not be disabled.

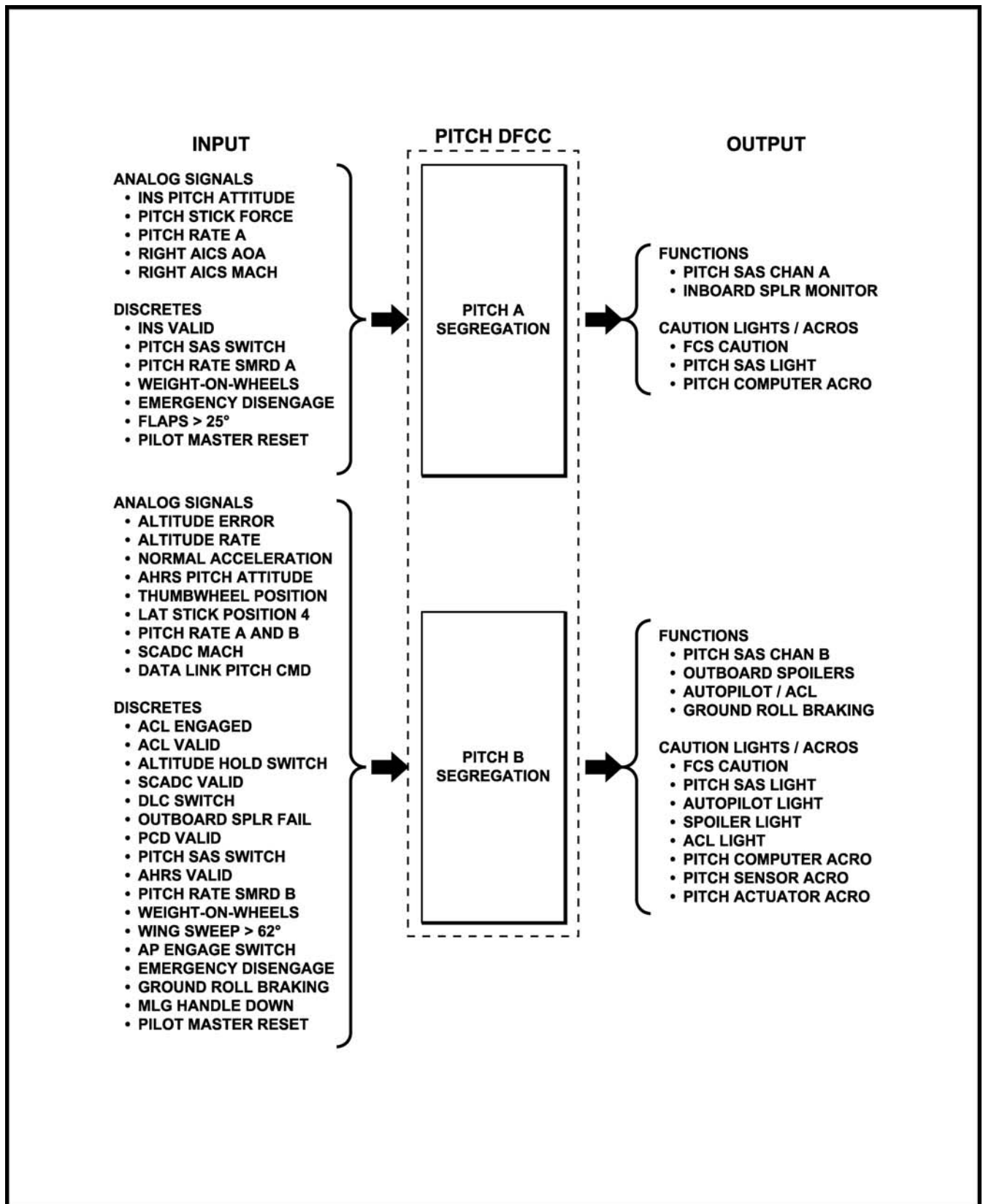
The primary Mach number input is provided by the CADC calculated from the left and right pitot-static probe inputs. Total and static pressure data (Mach number) inputs from the left and right AICS programmers are used for comparison. Similar to the AOA implementation, the upwind AICS Mach number is selected based upon estimated sideslip and is compared with the CADC Mach number. When the estimated sideslip angle is less than 2 deg, the Mach calculations from both the left and right AICS programmers are cross checked to determine pressure validity. An AICS cross check miscompare (1st Mach fault) results in a loss of Mach redundancy and is indicated by an FCS CAUTION light and PS acronym. Mach scheduling functions are still being performed using the CADC Mach number. A single Mach miscompare between the CADC Mach number and the upwind AICS Mach number results in a default Mach number being set and is indicated by FCS CAUTION, ARI DGR caution lights and PS acronym. Any subsequent Mach failure (2nd Mach fault) results in the UA control laws configuring to a fail-safe degraded mode and is indicated by PITCH SAS, FCS CAUTION, ROLL DGR, ARI DGR, and ARI/SAS OUT caution lights and PS acronym with the landing gear handle up. Subsequent Mach failures do not further degrade the PA control laws and are indicated by an FCS CAUTION, ARI DGR lights and PS acronym with the landing gear handle down.



Pulling either AICS programmer circuit breakers (LF1 or LG1) will result in DFCS air data failures and degraded control system capability. This will be indicated by one or more of the following caution lights depending on flight condition: FCS CAUTION, PITCH SAS, ROLL DGR, and ARI DGR. Once the AICS circuit breaker is reset, depressing MASTER RESET should restore normal operation and clear the failure indications.

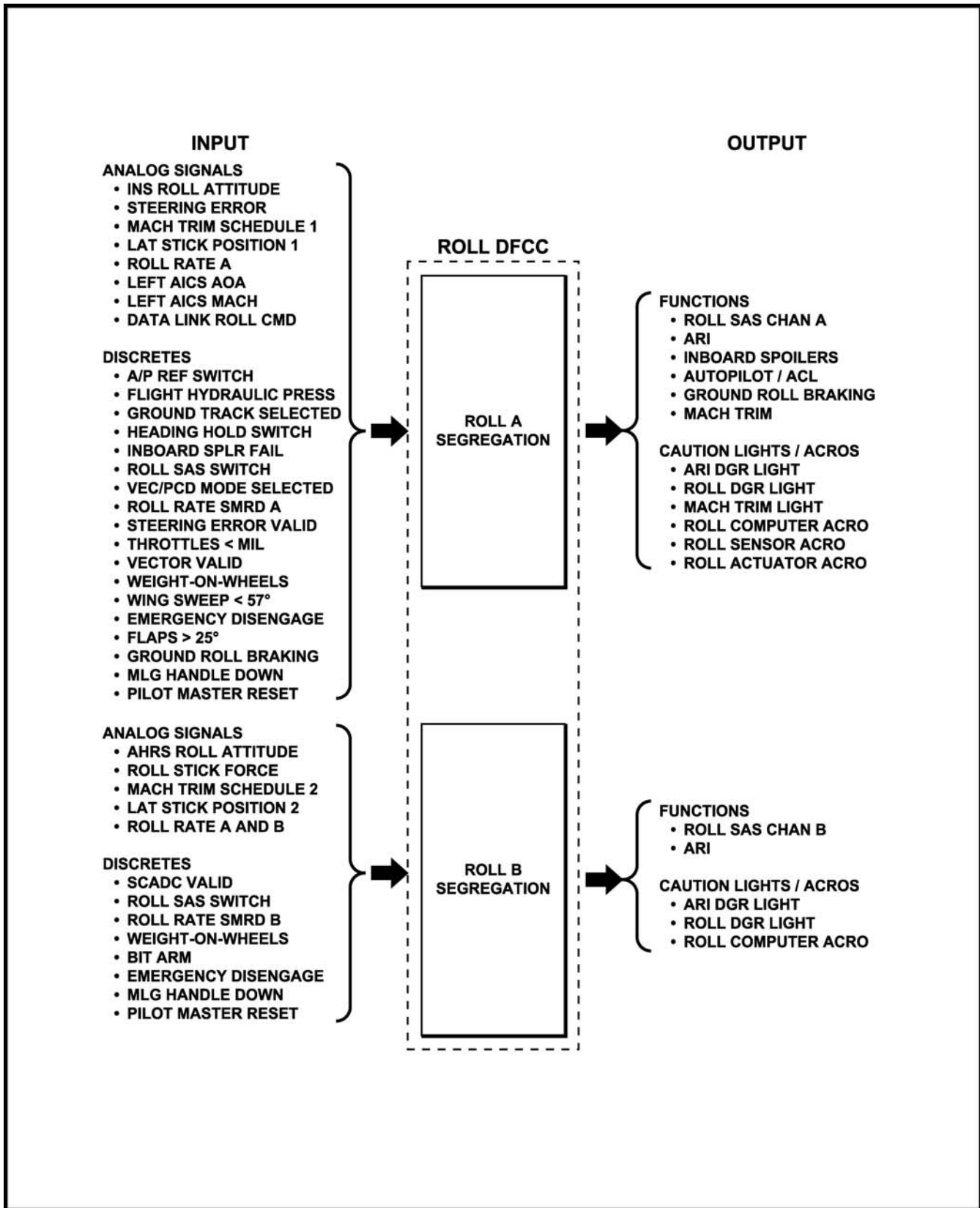
Note

- Extremely aggressive maneuvering at high AOA or intermittent CADC problems may result in a transient AOA or Mach miscompare. Depressing the MASTER RESET



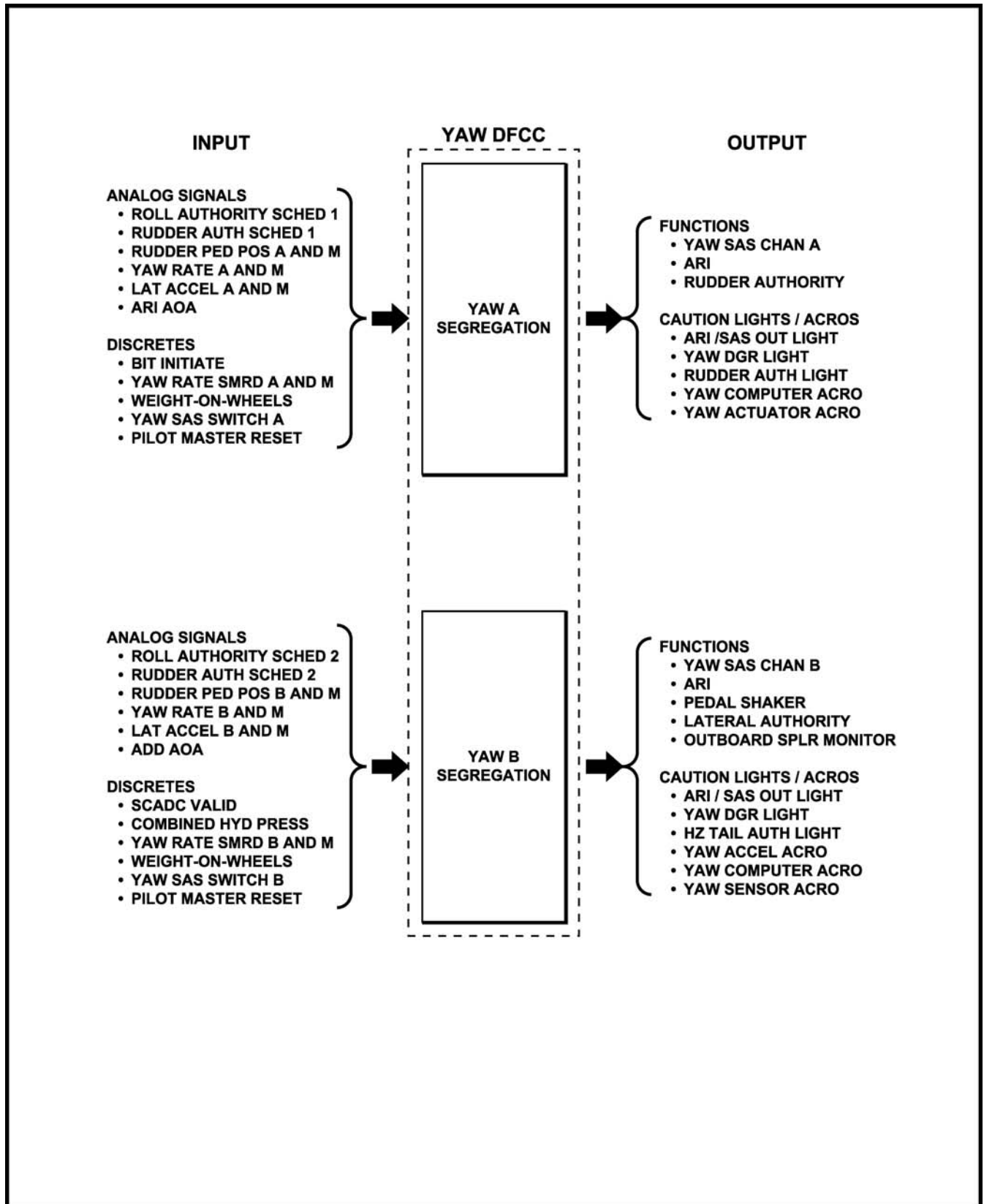
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Figure 2-69. DFCS Pitch Interfaces and Control Functions (Sheet 1 of 3)



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Figure 2-69. DFCS Pitch Interfaces and Control Functions (Sheet 2 of 3)



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Figure 2-69. DFCS Pitch Interfaces and Control Functions (Sheet 3 of 3)

pushbutton will restore normal operation and clear the failure indications for all single failure situations. Dual failure of either the Mach or AOA inputs is not resettable with MASTER RESET.

- With a dual AOA or Mach failure set, lowering the landing gear handle will result in the PITCH SAS (Mach only), ROLL DGR, and ARI/SAS OUT lights extinguishing. This does not imply the dual failure is no longer present, only that the impact of the dual failure on PA control functions are less severe than on the UA control functions due to the more confined operational flight envelope.

2.24.1.5 Sensor Failures

First sensor input failures are indicated by the FCS CAUTION light and the appropriate acronym (PS, RS, YS, or AM). An FCS CAUTION light with no other lights indicates a loss of sensor redundancy with no loss of functionality. The only single sensor failure to light more than the FCS CAUTION light is a single Mach miscompare that is indicated by FCS CAUTION, ARI DGR caution lights and PS acronym. With a single Mach miscompare, the LSXC and wing rock suppression functions will be lost. Depressing the MASTER RESET pushbutton should clear transient first sensor failures and failure indications. Second sensor failures result in loss of functions in the affected axis. The affected axis will be indicated by a PITCH SAS, ROLL DGR, or YAW DGR caution light. For failures affecting either the roll or yaw axis, all ARI functions may be lost. Partial loss or degrade of the ARI is indicated by an ARI DGR caution light. Complete loss of the ARI is indicated by the ARI/SAS OUT light. For second AOA, Mach, or roll rate sensor failures the spin recovery function is retained even though the ARI/SAS OUT light is illuminated.

DFCS failure indications and effects are summarized in [Figure 2-70](#). The DCP fault codes are listed in alphanumeric order followed by their classification to the IBIT and/or OFP fault group(s). The IBIT fault group includes fault codes generated by the IBIT self-test and will be identified in the DCP FAULT DISPLAY following the “IBIT” group header. The OFP fault group includes fault codes generated by the PBIT and/or ABIT self-test(s) and will be identified in the DCP FAULT DISPLAY following the “FAIL” and/or “FLT” group header. The failure indication and potential functions lost are listed for each individual fault code. The associated caution lights and maintenance file acronyms are listed for each fault code in addition to any applicable notes. In certain cases, potential functions lost for multiple failures (also known as a dual faults or 2nd faults) have been identified.

2.24.1.6 Digital Flight Control Computers

The DFCS consists of three computers, one for each axis (pitch, roll, and yaw) ([Figure 2-69](#)). Each computer has two distinct channels/segregations (A and B), each in turn controlling one of the dual series servoactuators in the respective axis. The DFCS uses cross channel data link communication to provide redundancy management so that a miscompare between the A and B channels of a given axis cannot result in a loss of the entire axis. Each A channel (for example, pitch A) is monitored by every B channel (pitch B, roll B, and yaw B) and conversely each B channel is monitored by every A channel. As a result of this monitoring structure, loss of a single channel will only result in loss of functions controlled by that channel and the corresponding series servoactuator, rather than the entire axis (sensor information provided by the affected channel will also be lost). Loss of a second channel will significantly degrade DFCS performance or result in a complete loss of all DFCS functions. Computer failure effects and cockpit indications are summarized in [Figure 2-70](#).

2.24.1.6.1 Flight Control Computer Reset

Each computer channel is independently powered and can be disabled by pulling the appropriate DC or AC circuit breaker. In general, there should be no need to cycle DFCS circuit breakers. If power is removed from a channel and then restored, the pilot must depress MASTER RESET to restore full DFCS functionality. If power is removed from two or more of the “same letter” channels/segregations, most or all of the DFCS functions will be lost. Restoring power will cause the DFCS to execute a “power on reset” (POR) and the system will re-initialize interpreting the current sensor information as valid. This can create a potentially hazardous situation under conditions where a dual sensor failure occurred prior to restoring power. When the DFCS re-initializes it is possible for the failed signals to be interpreted as valid and the remaining good signal to be interpreted as invalid. Therefore, careful consideration should be given before executing a POR airborne, since it can result in erroneous DFCS commanded control deflections.

WARNING

If a dual failure has been declared, performing a “power on reset” to clear the failure can result in erroneous DFCS commanded control deflections.

When performed on deck, the DC breakers (ROLL A DC, YAW B DC, and YAW A DC - 8B4, 8B5, 8B6) are generally used to avoid inadvertently inducing additional faults. A MASTER RESET is required to extinguish the resulting DFCS caution lights following restoration of power.

FAILURE	CAUTION LIGHTS											ACRONYM	DCP CODE	FUNCTIONS LOST	
	PITCH SAS	FCS CAUTION	ROLL DGR	ARI DGR	YAW DGR	ARI/SAS OUT	SPOILERS	MACH TRIM	HZ TAIL AUTH	RUDDER AUTH	AUTOPILOT				ACLS A/P
SENSOR FAILURES															
PITCH RATE 1F		X											PS	PGYx	REDUNDANCY LOSS ONLY.
PITCH RATE 2F	X	X											PS	PGY7	PITCH SAS OFF.
ROLL RATE 1F		X											RS	RGYx	REDUNDANCY LOSS ONLY.
ROLL RATE 2F		X	X	X		X							RS	RGY7	ROLL SAS/ARI OFF. SPIN RECOVERY RETAINED.
YAW RATE 1F		X											YS	YGYx	REDUNDANCY LOSS ONLY.
YAW RATE 2F (PA MODE)		X		X	X	X							YS	YGYx	YAW SAS/ARI OFF. ALSO GENERATES PQVM FAULT.
YAW RATE 2F (UA MODE)		X	X	X	X	X							YS	YGYx	ROLL AND YAW SAS/ARI OFF. ALSO GENERATES PQVM FAULT.
LATERAL ACCELERATION 1F		X											AM	LATx	REDUNDANCY LOSS ONLY.
LATERAL ACCELERATION 2F (PA MODE)		X		X	X	X							AM	LATx	YAW SAS/ARI OFF.
LATERAL ACCELERATION 2F (UA MODE)		X	X	X	X	X							AM	LATx	ROLL AND YAW SAS/ARI OFF.
LATERAL STICK POSITION 1F		X											RS	RCPx	REDUNDANCY LOSS ONLY.
LATERAL STICK POSITION 2F		X	X	X		X	X						RS	RCPx	ROLL SAS/ARI OFF. NO SPOILERS.
RUDDER PEDAL POSITION 1F		X											YS	RPPx	REDUNDANCY LOSS ONLY.
RUDDER PEDAL POSITION 2F (PA MODE)		X		X									YS	RPPx	NO PEDAL FADEOUT (NO SLIPPED APPROACHES).
RUDDER PEDAL POSITION 2F (UA MODE)		X		X									YS	RPPx	NO LSXC OR WING ROCK SUPPRESSION.
ANGLE OF ATTACK 1F		X											PS	NOTE(1)	REDUNDANCY LOSS ONLY.
ANGLE OF ATTACK 2F (PA MODE)		X		X									PS	NOTE(1)	SLIGHTLY DEGRADED PA-ARI FUNCTIONS.

Figure 2-70. DFCS Failure Modes and Indications (Sheet 1 of 4)

FAILURE	CAUTION LIGHTS										ACRONYM	DCP CODE	FUNCTIONS LOST		
	PITCH SAS	FCS CAUTION	ROLL DGR	ARI DGR	YAW DGR	ARI/SAS OUT	SPOILERS	MACH TRIM	HZ TAIL AUTH	RUDDER AUTH				AUTOPILOT	ACLS A/P
ANGLE OF ATTACK 2F (UA MODE)		X	X	X		X							PS	NOTE(1)	ROLL SAS/ARI OFF. SPIN RECOVERY RETAINED.
MACH NUMBER 1F		X		X							+		PS	AD02	NO LSXC OR WING ROCK SUPPRESSION.
MACH NUMBER 1F OR 2F (PA MODE)		X		X							+		PS	NOTE(2)	SLIGHTLY DEGRADED DUTCH ROLL DAMPING.
MACH NUMBER 2F (UA MODE)	X	X	X	X		X					+	+	PS	NOTE(2)	PITCH AND ROLL SAS/ARI OFF. SPIN REC. RETAINED.
AICS MACH CROSS CHECK		X											PS	AICX	REDUNDANCY LOSS ONLY.
AICS MACH CROSS CHECK (QBAR>1230)	X	X	X										PS	AICX	PITCH SAS OFF. SLIGHTLY DEGRADED ROLL SAS.
INS ATTITUDE (PQVM ATTITUDE MONITOR)		X									+	+	PS, RS	IMUx	REDUNDANCY LOSS ONLY.
SCADC VALID TO PITCH COMPUTER											+	+		AD03	NO AUTOPILOT.
SCADC VALID TO ROLL COMPUTER		X		X			X				+	+	PS	AD04	NO AUTOPILOT OR MACH TRIM. MACH FAULT SET.
SCADC VALID TO YAW COMPUTER								X	X					AD05	NO AUTOPILOT OR AUTHORITY STOPS.
MAIN LANDING GEAR 1F													RS	LDGx	REDUNDANCY LOSS ONLY.
MAIN LANDING GEAR 2F (PA MODE)						X							RS	LDGx	DEFAULTS TO UA-ARI (SAME AS AFCS AT 15U).
MAIN LANDING GEAR 2F (UA MODE)													RS	LDGx	REMAINS IN UA-ARI.

Figure 2-70. DFCS Failure Modes and Indications (Sheet 2 of 4)

FAILURE	CAUTION LIGHTS											ACRONYM	DCP CODE	FUNCTIONS LOST			
	PITCH SAS	FCS CAUTION	ROLL DGR	ARI DGR	YAW DGR	ARI/SAS OUT	SPOILERS	MACH TRIM	HZ TAIL AUTH	RUDDER AUTH	AUTOPILOT				ACLS A/P		
COMPUTER FAILURES																	
PITCH A CHANNEL	X	X	X	X			X						+	+	PS, PC, PA, RA, RS	PC05	HALF AUTHORITY PITCH SAS. NO INBOARD SPOILERS, DLC, OR AUTOPILOT.
PITCH B CHANNEL	X	X		X			X						X		PS, PC, PA, RS	PC06	HALF AUTHORITY PITCH SAS. NO OUTBOARD SPOILERS, DLC, OR AUTOPILOT. MACH FAULT SET.
ROLL A CHANNEL		X	X	X			X	X					+	+	PS, RS, RC, RA	RC05	HALF AUTHORITY ROLL SAS/ARI. NO INBOARD SPOILERS, DLC, MACH TRIM, OR AUTOPILOT.
ROLL B CHANNEL		X	X	X			X								RS, RC,	RC06	HALF AUTHORITY ROLL SAS/ARI. NO MACH TRIM OR AUTOPILOT.
YAW A CHANNEL		X		X	X			X	X						PS, YS, YC, YA, AM	YC05	HALF AUTHORITY YAW SAS/ARI. NO AUTHORITY STOPS.
YAW B CHANNEL		X		X	X		X	X	X				+	+	PS, PA, YS, YA(4), YC, AM	YC06	HALF AUTHORITY YAW SAS/ARI. NO OUTBOARD SPOILERS, DLC, OR AUTHORITY STOPS.
ACTUATOR FAILURES																	
ROLL OR YAW STAB AUG SWITCH OFF						X									—	—	INDICATES ROLL OR YAW SAS/ARI SELECTED OFF.
PITCH SERIES SERVO 1F	X														PA	PSA1 OR PSA2	HALF AUTHORITY PITCH SAS.
PITCH SERIES SERVO 2F	X												+	+	PA	PSA1 AND PSA2	PITCH SAS OFF.
ROLL SERIES SERVO 1F			X	X											RA	RSA1 OR RSA2	HALF AUTHORITY ROLL SAS/ARI.

Figure 2-70. DFCS Failure Modes and Indications (Sheet 3 of 4)

FAILURE	CAUTION LIGHTS											ACRONYM	DCP CODE	FUNCTIONS LOST			
	PITCH SAS	FCS CAUTION	ROLL DGR	ARI DGR	YAW DGR	ARI/SAS OUT	SPOILERS	MACH TRIM	HZ TAIL AUTH	RUDDER AUTH	AUTOPILOT				ACLS A/P		
ACTUATOR FAILURES (continued)																	
ROLL SERIES SERVO 2F			X	X		X							+	+	RSA1 AND RSA2	RSAA/B	ROLL SAS/ARI OFF
YAW SERIES SERVO 1F				X	X										YSA1 OR YSA2	YSAA/B	HALF AUTHORITY YAW SAS/ARI (GAINS DOUBLED).
YAW SERIES SERVO 2F (PA MODE)				X	X	X							+	+	YSA1 AND YSA2	YSAA/B	YAW SAS/ARI OFF.
YAW SERIES SERVO 2F (UA MODE)			X	X	X	X							+	+	11	YSAA/B	ROLL AND YAW SAS/ARI OFF.
INBOARD SPOILER ACTUATOR							X						+	+	SP1/2 L/R	SP1/2/ L/R	AFFECTED SPOILER PANEL INOPERATIVE.
OUTBOARD SPOILER ACTUATOR							X						+	+	SP3/4 L/R	SP3/4/ L/R	AFFECTED SPOILER PANEL INOPERATIVE.
RUDDER AUTHORITY ACTUATOR										X						RUDA	FROZEN AT LAST COMMANDED POSITION.
HORIZONTAL TAIL AUTHORITY ACTUATOR									X							HZTA	FROZEN AT LAST COMMANDED POSITION.
MACH TRIM ACTUATOR								X								MTRM	FROZEN AT LAST COMMANDED POSITION.
PITCH PARALLEL ACTUATOR (ACL ENGAGED)													X	X	PA	PPA	NO ACLS.
DLC TRIM ACTUATOR							X						+	+	PA	DLT1	NO DLC.
PITCH AUTOTRIM ACTUATOR													X	+	PA	PTRM	NO AUTOPILOT.
+ Lights will illuminate only if autopilot or ACL mode engaged when failure occurs. "x" or "xx" in fault code depicts multiple numeral possibilities.																	
NOTE: 1. DCP CODES MAY INCLUDE AOAC, AOAT, DPSR, DPSL, AOAL, AOAR, AC28. 2. DCP CODES MAY INCLUDE AD01, AD02, AD04, CAD7, SPSR, SPSL, TPSR, TPSL, MACL, MACR, AICX. 3. DCP CODES MAY INCLUDE SPSR, SPSL, TPSR, TPSL, LAIC, RAIC																	

Figure 2-70. DFCS Failure Modes and Indications (Sheet 4 of 4)

Note

- DFCS synchronization can take up to two 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.
- Do not press and hold the MASTER RESET pushbutton. Pressing and holding the MASTER RESET pushbutton during the synchronization time will have no effect since the DFCS computers only recognize the leading edge of the pulse from the MASTER RESET pushbutton, and not the fact that the button is continuously depressed.

An IBIT must always be run following POR on deck to ensure full system capability is restored.

Note

Both pitch rate gyros are powered through the Pitch A AC circuit breaker (LB1), while both roll rate gyros are powered through the ROLL B AC circuit breaker (LA1). Removing DFCS Pitch A or Roll B computer channel AC power via one of these circuit breakers for more than ~15 seconds either on deck or airborne can result in latched dual rate sensor faults requiring a POR to clear.

The only situation in which an airborne power on reset should be considered is when a DFCS failure has resulted in unsuitable controllability for landing approach (i.e., complete loss of spoilers and asymmetric load condition). In this case, the risk of potential uncommanded SAS inputs is outweighed by the risk of attempting landing with marginal or uncontrollable flying qualities at approach speed. Refer to Chapter 14.12.1 – Controllability Check.

2.24.2 Voltage Monitoring

The DFCS monitors voltage levels internally and no longer requires the VMCU. When a low voltage condition of 88.5 volts ac or less or a high voltage condition of 126.5 volts ac or more is detected, the computer channel detecting the abnormal voltage will be isolated and its associated functions will be lost. Failure indications for an isolated computer channel are shown in [Figure 2-70](#). Depressing MASTER RESET will restore normal system operation once the voltage is within allowable limits.

Similar to the ac power, when dc voltage drops below 11.0 volts, the affected computer channel will be isolated and the associated functions will be lost. Depressing MASTER RESET will restore normal system operation once the voltage is within allowable limits.

2.24.3 Autopilot

The autopilot is controlled by four switches on the lower half of the DFCS control panel ([Figure 2-67](#)) 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 $\pm 30^\circ$ in pitch and $\pm 60^\circ$ in roll, the autopilot will automatically return the aircraft to these limits. Normally, IMU/INS is the prime reference and SAHRS a backup.

2.24.3.1 DFCS Series Actuator

The series actuator is a dual-channel servoactuator that is controlled and commanded by the DFCS 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. The remaining functional channel will continue to provide half authority in the affected axis. In the yaw axis, the output command is doubled to provide normal YAW SAS response up to the authority of the remaining yaw series servoactuator ($\pm 9.5^\circ$). Autopilot modes may be engageable but will have reduced authority. A dual pitch series servoactuator failure results in loss of the PITCH SAS. A dual roll or yaw series servoactuator failure results in loss of the affected SAS and all ARI functions. With landing gear retracted, the ROLL SAS will be disabled whenever ARI functions are lost. This is to minimize risk of departure if a dual failure occurs during aggressive maneuvering.

Pitch series servoactuator failures are indicated by the PITCH SAS caution light and PA acronym. Roll series servoactuator failures are indicated by the ROLL DGR, ARI DGR caution lights and RA acronym for a first failure and ROLL DGR, ARI DGR, ARI/SAS OUT caution lights and RA acronym for a second failure. Yaw series servoactuator failures are indicated by the YAW DGR, ARI DGR caution lights and YA acronym for a first failure and YAW DGR, ARI DGR, ARI/SAS OUT caution lights and YA acronym for a second failure. With landing gear handle up, the ROLL DGR caution light will also be illuminated indicating inhibited UA ROLL SAS. Series servoactuator failure effects and cockpit indications are summarized in [Figure 2-70](#).

Note

Taxiing with one engine shut down and the HYD TRANSFER PUMP off may illuminate the PITCH SAS, ROLL DGR, ARI DGR, and YAW DGR caution lights.

2.24.3.2 DFCS Pitch Parallel Actuator

The DFCS 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 DFCS 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.



- 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 DFCS attitude and altitude hold engaged to utilize the DFCS automatic pitch trim system.
- Commencement of OBC with longitudinal trim set below zero units with flaps up or 3 units nose up with the flaps down will likely result in a force link disconnect when the control stick hits the forward stop during DFCS 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 Autopilot Emergency Disengage

Operation of the autopilot emergency disengage paddle on the control stick (Figure 2-58), disengages the autopilot and DLC. Depressing the paddle with weight on wheels reverts throttle system from the auto or boost mode to the manual mode; reverts the engines to SEC mode only while depressed.

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 DFCS 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 $\pm 30^\circ$ and bank angles up to $\pm 60^\circ$. Inertial measurement unit failure will cause mode disagreement and the engage switch will return off. The mode may be reengaged using 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 $\pm 5^\circ$. The autopilot will then hold the aircraft on the desired heading. Heading reference is obtained from the SAHRS via the CIU.

2.24.4.4 Ground Track

To engage ground track, set the HDG-OFF-GT switch to GT. When the A/P REF legend appears, press the nosewheel steering pushbutton on the control stick grip. When the A/P REF legend goes out, the mode is engaged.

Disengagement will occur if more than $1\frac{1}{2}$ 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 weapon system 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 $\pm 30^\circ$. Failure of the INS or SAHRS will cause loss of ground-track steering.

Note

Performing a system reset with ground track (GT) engaged will cause the DFCS AUTO PILOT caution light to illuminate, which may cause the ground-track mode to disengage.

2.24.4.5 Altitude Hold

Altitude hold mode is engaged by setting the ALT-OFF switch to ALT. When the A/P REF 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 to go out. 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 out. 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.
- Altitude hold performance in the landing configuration with cg forward of 12% will be degraded due to rapid limiting of servoactuator authority. Aircrew should avoid aggressive power or bank angle changes in this condition or undesirable pitch attitudes may result (without decoupling of AUTOPILOT switch).

2.24.4.6 Data-Link Vector — Precision Course Direction

This mode is engaged by placing the VEC/PCD switch to VEC/PCD and pressing the nosewheel steering pushbutton. Mode engagement is evidenced by the A/P REF legend going out.

Disengagement of the mode is accomplished by application of stick forces of $7\frac{1}{2}$ pounds lateral or 10 pounds longitudinal, or by placing the VEC/PCD 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 DFCS pitch and

roll computers in response to inputs from the data-link converter and IMU. 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 $\pm 30^\circ$.

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

The DFCS incorporates ACLS software with control laws provide a vertical rate (h-dot) command system with integrated direct lift control (DLC). These control laws provide corrections for glidepath deviations commanded directly by horizontal stabilizer and DLC through altitude rate “h-dot” feedback. Since the F-14 DFCS does not have a direct altitude rate input from the IMU/INS, the DFCS has incorporated the normal accelerometer (Nz) sensor to derive a pseudo vertical rate feedback signal by sensing motion in the vertical axis. This normal accelerometer is the same sensor used in the autothrottle approach power compensator (APC) system and the autopilot altitude hold mode.

ACLS control of the aircraft is achieved through the autopilot by pitch parallel servo actuator and DLC commands in pitch and spoiler commands in roll. The pitch parallel actuator is utilized to command the control stick and horizontal stabilizers to provide a large amplitude, low frequency control response. The integrated “blended” DLC is utilized to provide a small amplitude, high frequency control response. This system is significantly more capable than previous versions of compensating for varying engine response, winds, and/or deck motion. The DFCS continues to provide roll control through the spoilers only and does not capitalize on the full benefits of the automatic rudder interconnect (ARI). The lateral axis is the primary limitation of the F-14 DFCS ACLS and must be closely monitored for any unacceptable course deviations during the approach.

Note

If the pitch parallel actuator force link is mechanically disconnected, the A/P REF legend indicating ACL mode engagement may go out when coupling is attempted, but the aircraft will not respond to SPN-46 commands and the autopilot will then uncouple from the ACLS when the first pitch commands are received.

The F-14 DFCS ACLS control laws require the incorporation of a software upgrade in the AN/SPN-46 Automatic Carrier Landing System.

Note

ACLS mode I/IA approaches are authorized for F-14 DFCS aircraft incorporating OFP 4.4 or subsequent only.



DFCS software OFP 4.4 is not compatible with AN/SPN-42 systems. ACLS mode I/IA approaches are only authorized with AN/SPN-46 systems.

2.24.4.7.1 ACL Operation

Prior to ACLS engagement, the aircraft should be in the landing gear down, full flaps, speedbrakes extended approach configuration with direct lift control (DLC), autothrottle approach power compensator (APC), and autopilot altitude hold mode engaged.



ACLS mode I/IA approaches are not authorized with the THROTTLE MODE switch in MANUAL.

Note

The APG-71 should be in STBY to avoid beacon interference problems.

With a valid ACLS coupler discrete (A/P CPLR legend), the autopilot can be armed in the ACL mode with the A/P REF advisory legend displayed, indicating that a pilot relief mode (in this case, ACL) has been selected, but not engaged (altitude hold mode will automatically disengage). The pilot can then couple the autopilot ACL mode to the data link by means of the autopilot reference pushbutton on the control stick, at which time, if the DFCS is functioning properly and the ACL mode interlocks are satisfied, the AP REF light will be extinguished. The pilot should report coupled and the controller will then send a discrete command control message that illuminates the CMD CONTROL light. The Naval Tactical Data System (NTDS) begins transmitting ACLS data-link pitch and bank commands to the aircraft. The autopilot actuates the appropriate control surface to execute the desired command, while the autothrottle APC maintains approach angle of attack by controlling the throttle setting.

Note

- Application of more than 2 to 3 pounds of stick force while attempting to couple will cause the AUTOPILOT caution light to illuminate and coupling cannot be accomplished. It is imperative that any stick force be avoided while depressing the autopilot reference pushbutton to preclude illumination of the AUTOPILOT caution light.
- In the autopilot ACL mode, the ACLS control laws utilize DLC to augment glideslope control. DLC engaged is an interlock requirement for

the ACL mode. DLC disengagement during an approach will result in automatic downgrade.

- When the ACL mode is engaged, the DLC neutral spoiler position is shifted from 17.5° to 8°. In the event of a downgrade, the DLC neutral spoiler position will return to 17.5°. This slight transient will occur over a 1 sec fade-in schedule so as not to result in any perceptible change in aircraft energy and/or rate of descent during the approach.
- Between the time the autopilot ACL mode is engaged (A/P REF legend goes out) and transition to command control (CMD CONTROL legend appears), the aircraft may experience a slight altitude deviation of less than 100 feet. Normal system operation should correct for this deviation prior to tip-over.
- Care should be taken not to couple above glideslope. If above glideslope or reference altitude when initial pitch commands are sent, the resulting nose down correction may cause a force link disconnect resulting in automatic decouple and an inability to perform mode I/IA approaches until maintenance action is performed.
- Care should be taken not to couple after tip over or prior to tip over with greater than 500 foot per minute rate of climb or descent. If coupling is attempted after tip over, degraded system performance should be expected, possibly requiring a PTO no later than 200 feet or ½ mile on final. If excessive climb/descent rate is established prior to coupling, system control authority may be insufficient to arrest the trend and capture reference altitude.

The ACL mode (and autopilot) will be automatically disengaged by loss of any aircraft autopilot or ACL mode interlock requirement, if the information stored in the data link is not updated within any 2-second period, or the aircraft exceeds the flightpath control envelope. The DFCS will revert to basic stability augmentation and the pilot can continue the descent in mode II or mode III.



If the autopilot/ACLS uncouples after approach commencement, do not attempt to recouple with the CMD CONTROL light illuminated. 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 CONTROL

light should go out. The ACL RDY and A/P CPLR legends must be displayed prior to any attempt at recoupling.

Until 12.5 seconds from touchdown, the landing system commands the aircraft to follow a stabilized glide-slope. Inside of 12.5 seconds, the landing system commands the aircraft to follow the vertical movement of the intended touchdown point. As a result, some deviations from the SLOLS glideslope will be noted with large pitching deck motions.

Between 12.5 and 1.5 seconds from touchdown, the approach controller sends an automatic waveoff discrete if any part of the carrier-based equipment fails and up to 5 seconds from touchdown if the aircraft exceeds the AN/SPN-46 flightpath control envelope. Waveoff signals may also 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 precision approach weather minimums if the pilot cannot see the meatball.

At 1.5 seconds from touchdown, the landing system freezes the vertical rate command and sends a bank command to return the aircraft to a wings-level attitude. The DFCS follows these commands to touchdown, unless the pilot elects to disengage from the ACL mode via pilot takeover.



If the pilot and/or LSO recognizes a course drift immediately prior to or at command freeze, the pilot will be required to make a lateral correction to prevent unacceptable deviation from centerline.

Pilot takeovers (PTO) may be desired/required during ACLS approaches. In the case of an ACLS mode IA approach the PTO shall be executed prior to 200-foot altitude and ½-mile. All approaches must be waved off at precision approach weather minimums if the pilot cannot see the meatball. The recommended method for a PTO is via the autopilot reference pushbutton located on the control stick to disengage the ACL mode and the CAGE/SEAM pushbutton on the throttle to disengage autothrottle APC. An alternative method to disengage the ACL mode is via the PLM pushbutton. Another method to disengage the ACL mode is via the manual deselection of the ACL or AUTOPILOT switches. Manual deselection of the THROTTLE MODE switch will disengage the autothrottle APC. Manual deselection of these switches may be difficult to accomplish, especially during the final stages of the approach. The paddle switch will disengage the ACL mode and autopilot, but will also disengage DLC. As a last resort, overriding the control stick with 10 pounds longitudinal or 7 pounds lateral control stick force will disengage the ACL mode and 11 pounds of force per throttle will disengage the autothrottle APC. If the

aircraft bolters or if the pilot decides to go around, the autopilot/ACL mode is disengaged automatically by weight-on-wheels or overriding the control stick, as the pilot enters the bolter/waveoff pattern. If the aft longitudinal stick force method is used at or inside the in-close position, the pilot must avoid over-rotation. The waveoff technique described in Chapter 8 applies.

WARNING

A PTO initiated by autothrottle APC disengagement with large power additions prior to uncoupling from ACLS will result in large nose down commands. A force link disconnect may occur if the control stick hits the forward stop.



The paddle switch will disengage the autopilot. Use of the paddle switch to disengage DFCS for mode IA landing is not recommended since DLC will also be disengaged. The PITCH and ROLL SAS switches will remain engaged.

Note

- The paddle switch will revert throttles to MANUAL mode with weight-on-wheels.
- The paddle switch, control stick forces, or loss of any aircraft ACL mode interlock will illuminate the MASTER CAUTION light, AUTOPILOT caution light, and ACLS/AP caution ladder light.

ACL mode disengagement via the autopilot reference pushbutton or PLM pushbutton will illuminate the ACLS/AP caution ladder light, but not the MASTER CAUTION and AUTOPILOT caution lights. The PLM pushbutton commands the radar to pilot lock-on mode when the A/P CPLR legend is not displayed. However, when the A/P CPLR legend is displayed, selection of the PLM pushbutton disengages the ACL mode. ACL mode disengagement via control stick forces or the emergency disengage paddle will illuminate the MASTER CAUTION light, the AUTOPILOT caution light, and the ACLS/AP caution ladder light. Manually disengaging the ACL mode and/or AUTOPILOT switches will illuminate the ACLS/AP caution ladder light, but not the MASTER CAUTION and AUTOPILOT caution lights.

2.24.5 DFCS Test

The DFCS has several self-test modes. These include power-up BIT (PBIT), initiated BIT (IBIT), and automatic BIT (ABIT). The results of these tests are indicated by the

illumination of applicable caution lights, maintenance file acronyms, and DFCS control panel (DCP) fault display codes.

2.24.5.1 DFCS Power-up BIT (PBIT)

A DFCS power-up BIT is an automatic function of the DFCS that is initiated when power is initially applied to the aircraft. Power-up BIT is completed in approximately 2 seconds. Following a successful power-up BIT, the flight control computers will synchronize and enter the operational flight program mode following depression of the MASTER RESET pushbutton. Failure of power-up BIT will result in illumination of caution lights and DCP fault display codes (Figure 2-71) associated with the failed computer(s) that will not reset with MASTER RESET. The failed computer(s) will remain isolated and will not enter the operational flight program mode.

2.24.5.2 DFCS Initiated BIT (IBIT)

A DFCS Initiated BIT is a thorough preflight indication of DFCS performance and can be obtained during poststart OBC or a DFCS BIT. All SAS switches must be engaged, weight-on-wheels, flaps extended greater than 25° or wings swept aft of 62°, and ANTI-SKID SPOILER BK switch OFF. If one of these interlocks is not satisfied the DFCS will not enter the IBIT ARM state. The AUTOPILOT switch must be engaged to test autopilot functions and can only be engaged in the IBIT ARM state.

Longitudinal trim should be greater than 0° for flaps up and greater than 3° for flaps down. The MASTER TEST switch must be selected to "IBIT ARM" by raising and rotating to the "OBC" or "DFCS BIT" position. The DCP fault display will alternate between an "IBIT" and "ARM" indication to confirm that IBIT is in the armed state. The AUTOPILOT switch can be engaged at this time in order to test autopilot functions during IBIT. If the INC or DEC pushbuttons are depressed in the IBIT ARM state the DCP will indicate any existing fault display codes. In this case, the DFCS is still in the IBIT ARM mode and the depression of a MASTER RESET will restore the IBIT ARM codes to the fault display, but is not required. A DFCS IBIT test sequence will commence upon depression of the MASTER TEST switch in the "DFCS BIT" position, or a complete OBC encompassing all aircraft functions may be subsequently initiated by the RIO with the MASTER TEST switch in the "OBC" position.

The DFCS IBIT sequence will commence with the following: The DCP fault display will alternate between an "IBIT" and "RUN" during the entire IBIT run sequence. All ten DFCS caution lights (including the HZ TAIL AUTH, RUD AUTH, and SPOILERS lights) will illuminate and the ACLS/AP and AP REF lights will flash once per second to

serve as an indication that IBIT is running. The IBIT sequence will continue with the pitch trim check (slow longitudinal stick motion), PITCH SAS actuator check (no longitudinal stick motion), the pitch parallel actuator check (rapid longitudinal stick motion), the individual spoiler operation check (from right to left), and the ROLL and YAW SAS actuator checks. DFCS IBIT concludes with disengagement of the AUTOPILOT switch, activation of the rudder pedal shaker check, and illumination of an alternating test pattern to test all pixels of the DCP LED fault display.

Premature termination of the IBIT sequence will cause the ACLS/AP and AP REF lights to stop flashing and leave all other DFCS caution lights illuminated. The DCP fault display will indicate "ABRT" when IBIT is terminated prematurely.

Following completion of a successful IBIT, all DFCS caution lights will be extinguished, the AUTOPILOT switch will be OFF, and the DFCS will automatically enter the operational flight program mode. The DCP will display a "PASS" indication in the DCP fault display.

Following an IBIT with one or more failures, caution lights and acronyms for the detected failures will be displayed. The DCP fault display will indicate "NO GO" and fault codes for the specific failed WRAs can be viewed using the INC and DEC pushbuttons. The DFCS will automatically enter the operational flight program, even though IBIT has detected failures. Depression of the MASTER RESET pushbutton will extinguish caution lights and acronyms, but will not clear DCP IBIT fault codes. Any discrepancies detected by IBIT may still exist even though caution lights have been extinguished with MASTER RESET. Another IBIT must be completed to ensure proper system operation.



Following an IBIT, a MASTER RESET will clear the IBIT caution/advisory light failure indications, but will not clear the FAULT DISPLAY IBIT codes. This does not indicate that the failures detected during IBIT are resolved. The DFCS should not be considered fully operational. Only the successful completion of another IBIT can verify proper system operation.

Note

Spoiler actuator IBIT tests are run only with the wings forward and flaps down. During IBIT, spoilers are deflected individually, one at a time starting with the right no. 4 spoiler.

CODE	REMARKS
ARM	IBIT is armed awaiting BIT initiate (alternates between "IBIT" and "ARM").
RUN	Indication that IBIT is running (alternates between "IBIT" and "RUN").
ABRT	IBIT has aborted before it completed.
PASS	IBIT passed without any failures.
NOGO	IBIT completed with failures.
GO	No current, in-flight, or IBIT failures have been logged.
FAIL	Failures following this code are current fault indications.
FLT	Failures following this code were logged during flight.
IBIT	Failures following this code were logged during the most recent IBIT run.
END	Failure list end has been reached.
CLR	Failure clearing sequence has been started.
----	Indicates completion of clearing sequence.

Figure 2-71. DFCS DCP System Display Codes

If the pitch parallel actuator is functioning properly, large longitudinal control stick deflections should be observed during IBIT. An IBIT with the flaps down requires a longitudinal trim of 3 or more noseup; an IBIT with the wings at 68 requires not less than 0 noseup. A pitch parallel actuator force link disconnect during IBIT is indicated by illumination of the AUTOPILOT caution light, a PA 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 AUTOPILOT caution light or PA acronym may be absent after IBIT, but no large stick deflection will be observed. The implications of this condition are the same as for a total disconnect (no ACL capability).

2.24.5.3 DFCS Automatic BIT (ABIT)

A DFCS Automatic BIT provides continuous failure monitoring of the DFCS. Test coverage for ABIT is not as extensive as IBIT and should not be used as a replacement for performing a pre-flight IBIT. ABIT failures will be recorded in a maintenance data store and are listed on the DCP fault display following the "FAIL" and "FLT" headers. Depending on the severity of the problem detected, functionality may be lost and the appropriate caution/advisory lights illuminated and acronyms displayed.

2.24.6 DFCS Control Panel Fault Reporting

The DFCS control panel (DCP) incorporates an LED alphanumeric fault display. This fault display is intended for ground use only to assist in the troubleshooting and repair of the DFCS and related components. The DCP will not display any fault data with weight off wheels. DFCS operational DCP system display codes are listed in [Figure 2-71](#). The fault display will group faults into three categories: currently existing faults (FAIL), faults detected in flight (FLT), and faults that are detected during initiated BIT (IBIT). Fault codes will be displayed in order by repeated depression of the INC pushbutton. Current failures will be displayed first followed by in-flight detected failures, and any IBIT detected failures. This will be indicated by "FAIL" followed by any current failures, then "FLT" followed by any in-flight logged failures, and finally by "IBIT" followed by failures detected during the last executed IBIT. If there are no failures in a particular group that group's header will not be displayed. When all faults have been displayed, "END" will be displayed. The INC or DEC pushbuttons may be used to scroll forward or backward through the fault codes. If no failures have been logged, depression of the INC or DEC pushbutton will display a "GO" indication.

2.24.6.1 Current Faults

On the ground, currently existing faults are indicated by a combination of caution/advisory lights and acronyms. After momentary depression of the INC or DEC pushbutton, the current fault codes will be listed following the “FAIL” header. The current faults are logged in volatile memory and will be lost following removal of system power. If faults exist when the aircraft goes weight off wheels, they are added to the in-flight fault listing.

2.24.6.2 In-Flight Detected Faults

In-flight faults will be logged and stored in chronological order. During the normal startup or shutdown sequence, depressing the INC or DEC pushbuttons will indicate if any in-flight faults were logged. In-flight faults will be listed following the “FLT” header. Each particular fault code will only be displayed once regardless of the number of failures recorded during the flight, unless a POR is recorded in which case the sequence is allowed to repeat previously listed codes. In-flight faults remain in memory until manually cleared by the pilot or ground crew. To avoid confusion, in-flight faults should be cleared just prior to each flight. Loss of system power does not remove FLT faults from memory to enable reference by maintenance personnel during post-flight troubleshooting.

2.24.6.3 IBIT Detected Faults

Successful completion of IBIT is indicated by the absence of caution/advisory lights and acronyms. A “PASS” indication will also be displayed on the DCP. Depressing MASTER RESET will then blank the display (or will return to alternating “IBIT” and “ARM” if all IBIT interlocks are still valid). IBIT detected faults are indicated by the appropriate caution/advisory lights and acronyms, and a “NOGO” indication on the DCP. After momentary depression of the INC or DEC pushbutton, fault codes from the most recent IBIT run will be listed following the “IBIT” header. The IBIT faults are logged in volatile memory and will be lost following removal of system power.

2.24.6.4 Clearing Fault Indications

Simultaneous and continuous depression of the INC and DEC pushbuttons for 7 sec will clear any logged FLT fault codes. This will be indicated by a steady “CLR”

message for 3 seconds followed by a flashing “CLR” message for 4 seconds. Once all FLT fault codes are cleared, all center segments “----” will be illuminated and the INC and DEC pushbuttons can then be released. IBIT faults can only be cleared by the completion of a successful IBIT “PASS,” a power on reset, or loss of system power. Current FAIL faults can be cleared from the display by depressing MASTER RESET once the fault no longer exists or loss of system power.



Following an IBIT, a MASTER RESET will clear the IBIT caution/advisory light failure indications, but will not clear the FAULT DISPLAY IBIT codes. This does not indicate that the failures detected during IBIT are resolved. The DFCS should not be considered fully operational. Only the successful completion of another IBIT can verify proper system operation.

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. Design limit landing sink speed for the aircraft is 1,520 feet per minute (nominal landing sink speed is about 650 feet per minute).

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.

Normal and emergency controls and displays associated with operation of the landing gear are shown in [Figure 2-72](#).

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 25 inches. A hard stop (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 (jackknives 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, 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.



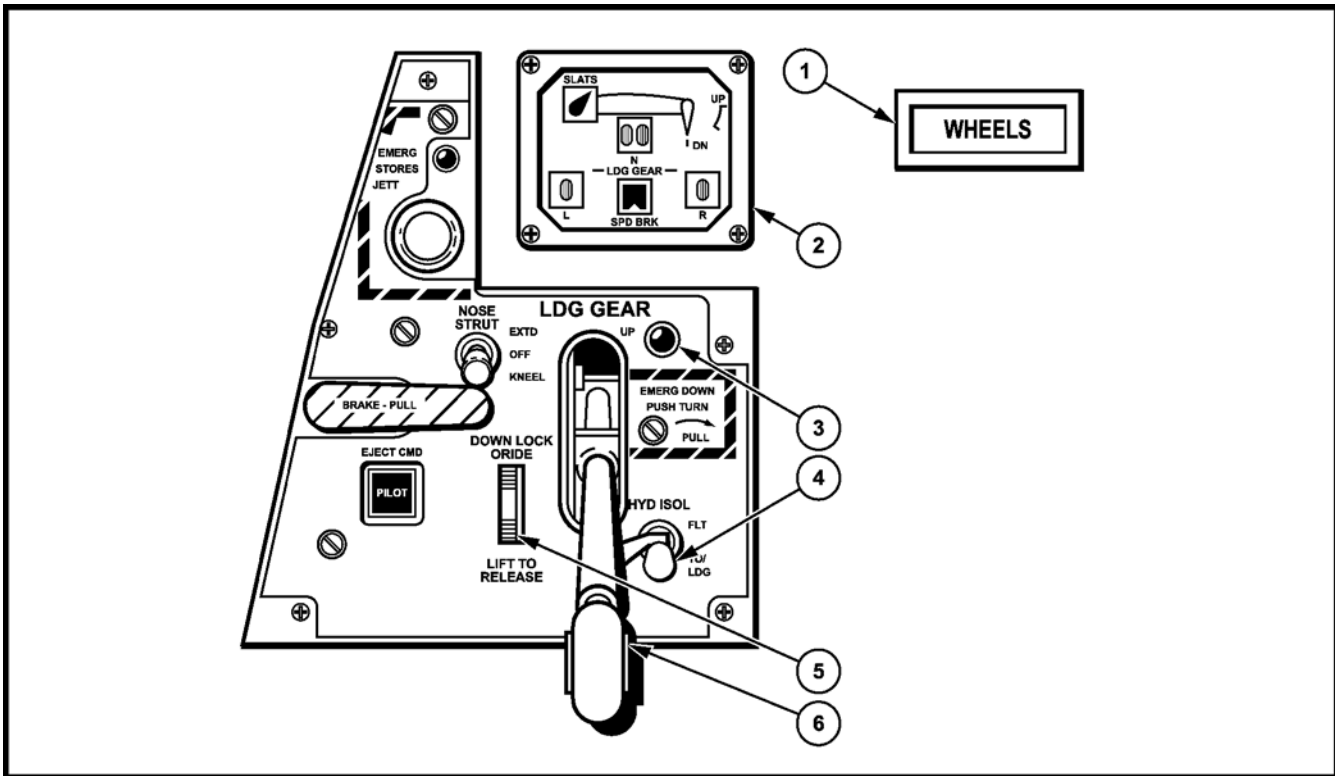
- Illumination of indexer lights does not indicate that the main landing gear are clear of the runway. Raising the gear before a positive rate of climb is established will result in blown main tires.
- Illumination of indexer and approach lights is not an indication of gear down and locked.

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 (see [Figure 2-77](#)). 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



CSC-F14D-1-2-025A




NOMENCLATURE	FUNCTION
<p>① WHEELS warning light</p>	<p>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.</p>
<p>② LDG GR indicator</p>	<p>  — Landing gear down and locked (except main landing gear sidebrace actuator).  — Landing gear retracted and doors closed.  — Unsafe gear or power off indication. </p>
<p>③ Landing gear transition light</p>	<p>On whenever gear and door positions (including main landing gear sidebrace actuators) do not correspond to handle position. Off when gear and doors are locked in position selected by handle.</p>

Figure 2-72. Landing Gear Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE		FUNCTION	
④	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.
⑤	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.
⑥	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.

Figure 2-72. Landing Gear Controls and Indicators (Sheet 2 of 2)

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 (see Figure 2-77). 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 .



Restrict nosewheel deflection to ±90 to prevent structural damage to the nosewheel 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.



- 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 over-center 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 480 feet per minute. 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.



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.

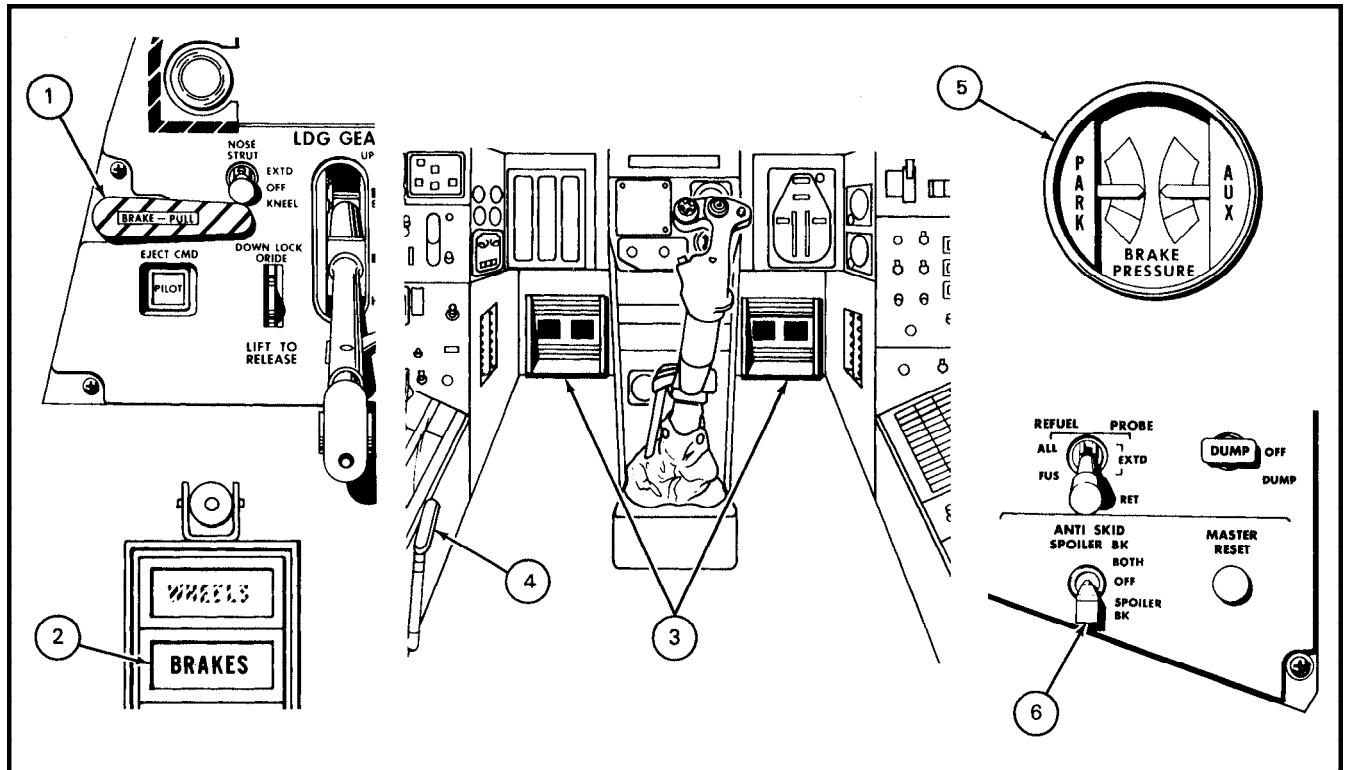


- Emergency extension of the landing gear shall be logged in the Maintenance Action Form (OPNAV Form 3760-2).
- To facilitate in-flight refueling probe extension when the landing gear has been blown down, raise the landing gear handle to give priority to the refueling probe system.

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 2-73](#).

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 fluid 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.



0-F50D-123-0

NOMENCLATURE	FUNCTION
<p>① Parking brake handle</p>	<p>Forward — Parking brake released. Modulated braking action available with brake pedal depression.</p> <p>Aft — Parking brake set. No modulation of control, locks both main wheel brakes.</p>
<p>② BRAKES warning light</p>	<p>Indicates parking brake handle is pulled, antiskid has failed, or operation is in auxiliary brake mode when brake pedals are depressed.</p>
<p>③ Brake Pedals</p>	<p>Press top of rudder pedals to command normal or auxiliary braking.</p>
<p>④ Hand pump</p>	<p>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.</p>
<p>⑤ BRAKE PRESSURE gage</p>	<p>Provides pilot indication of brake accumulator pressure remaining which is indicative of auxiliary and emergency brake cycles remaining.</p>
<p>⑥ ANTI SKID SPOILER BK switch</p>	<p>BOTH — Antiskid activated. Spoiler brakes operative with weight on wheels and both throttles in IDLE.</p> <p>OFF — Antiskid deactivated, spoiler brakes inoperative.</p> <p>SPOILER BK — Spoiler brakes operate with weight on wheels and both throttles IDLE. Antiskid is deactivated.</p>

Figure 2-73. Wheelbrake Controls and Indicators

Four thermal relief plugs are mounted in each main wheel assembly to relieve tire pressure and thus avert a blow-out 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.

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.



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.



- 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 2-73). 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 touch-down 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.

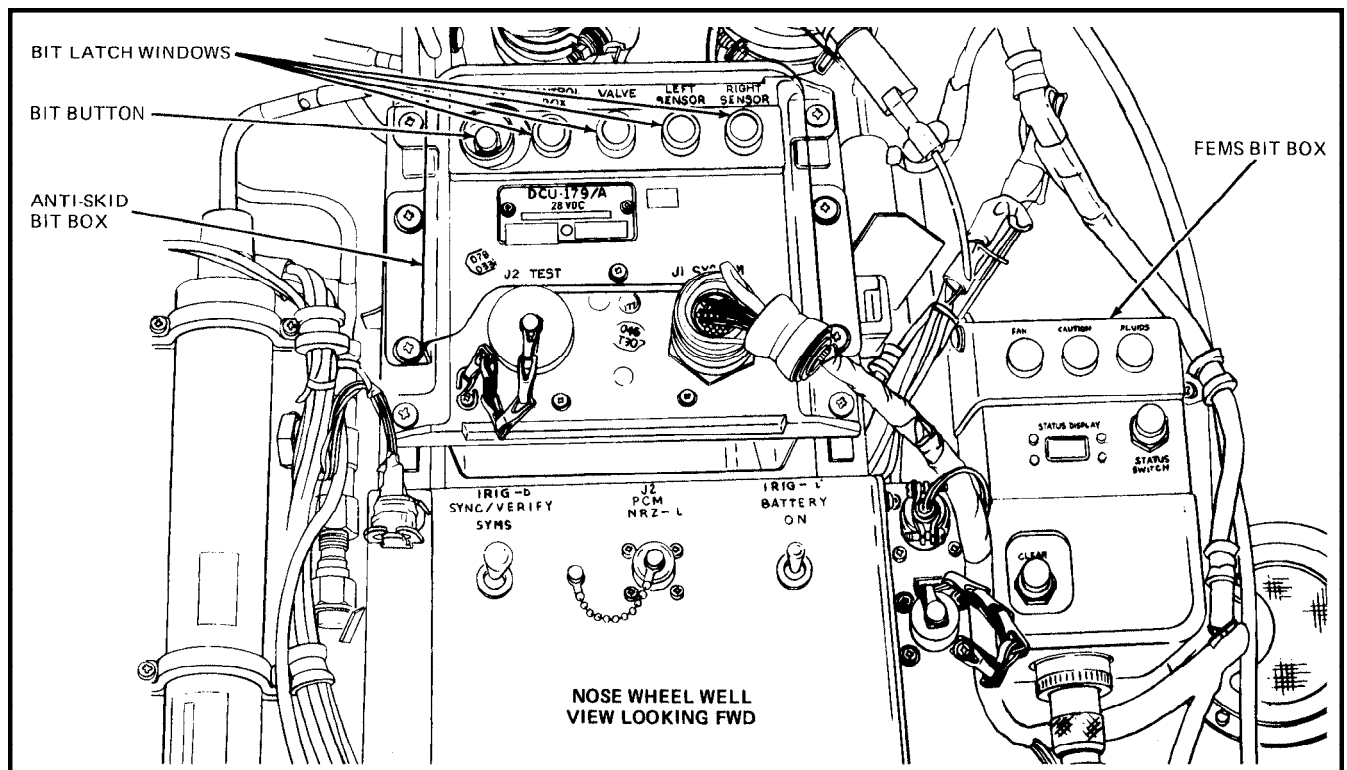
The antiskid system is inoperative when the wheel-brakes are in the auxiliary or parking modes of operation since the emergency brake lines bypass the brake valve. If an

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 2-74).

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 2-74. 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. Brake-riders 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 brake 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 brake pedals, sufficient accumulator fluid pressure remains for a minimum of three parking brake applications.

WARNING

For shipboard operations, before breaking down and moving an aircraft without combined hydraulic pressure, the parking brake handle should be cycled and the toe brakes should be tested for effectiveness. (The AUX and PARK brake needles should drop slightly after brake application.) The brake pressure indicator should then be pumped back up to the top of the green band with the cockpit handpump. The indicator should be maintained in the green band until the aircraft is secured. Full 3000 psi pressure is required if conditions are severe (greater than 4 degree roll, wet brakes, etc.).

CAUTION

Normal brakes are not available with parking brake handle pulled. If parking brake accumulator pressure is depleted, aircraft brakes are isolated from brake pedal master cylinders. Parking Brake handle shall be pushed in to restore normal brake operation.

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 2-75).

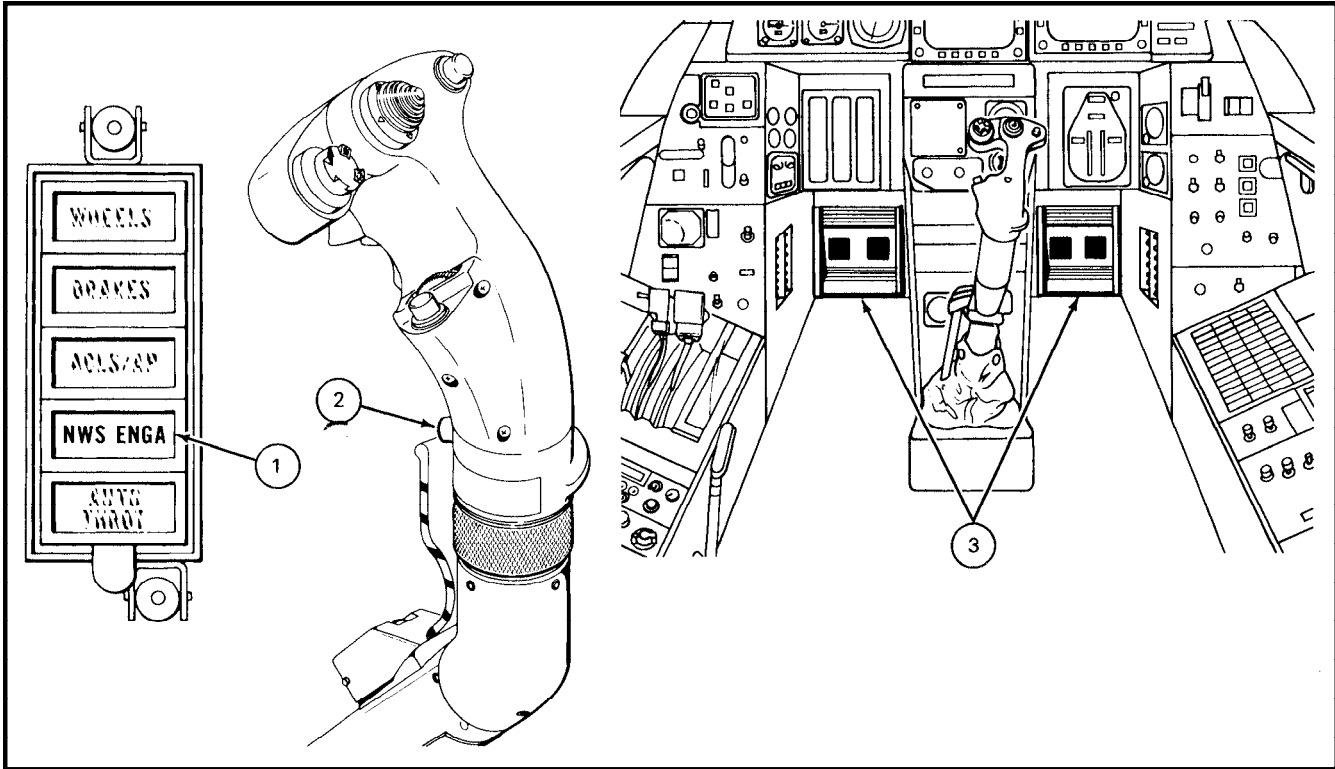
Note

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 the pilot stick grip (see Figure 2-75). 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 $\pm 5^\circ$ 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 nose-gear. 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
<p>① NWS ENGA caution light</p>	<p>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.</p>
<p>② Autopilot reference and nosewheel steering pushbutton</p>	<p>Press to engage and disengage nosewheel steering. Requires weight-on-wheels.</p>
<p>③ Rudder pedals</p>	<p>Controls nosewheel steering position with system engaged.</p>

Figure 2-75. 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 fly-away technique.

2.28.1 Nose Strut Kneel

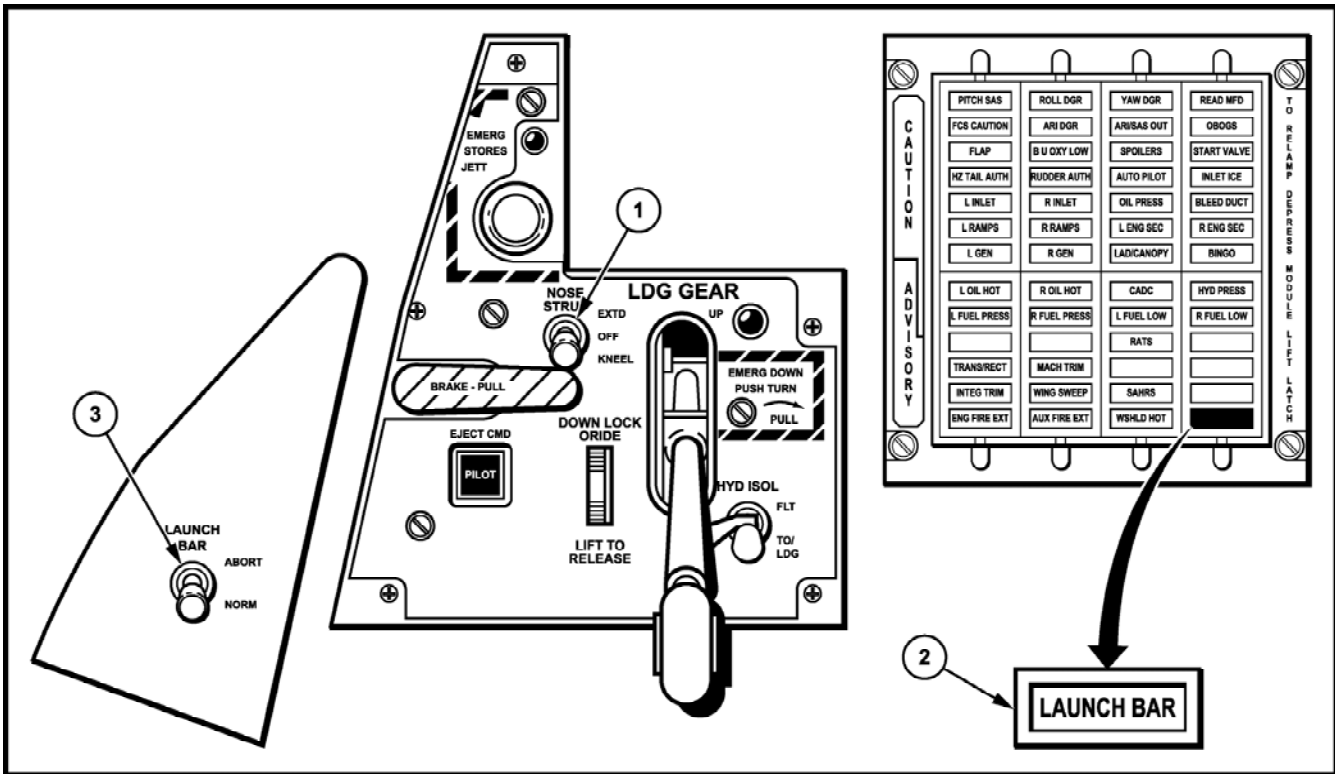
Prior to catapult hookup, the nose strut is compressed 14 inches. Control of the nose strut kneel function is provided by the NOSE STRUT switch on the landing gear control panel (see [Figure 2-76](#).) The three-position (EXTD, OFF, and KNEEL) toggle switch is spring-loaded to return to the center detent position of 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 fly-away 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
<p>① NOSE STRUT switch</p>	<p>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.</p> <p>OFF — Spring-loaded return position.</p> <p>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.</p>
<p>② LAUNCH BAR advisory light</p>	<p>Illuminates under the following conditions:</p> <p><i>Weight On Wheels</i> 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)</p> <p><i>Weight Off Wheels (inhibits nose gear retraction)</i> Launch bar not up and locked Nosewheel not within ± 15 of center Nose strut not fully extended</p>
<p>③ LAUNCH BAR switch</p>	<p>ABORT — Enables pilot to disengage the launch bar from the catapult while remaining at MIL power and in the kneel position.</p> <p>NORM — Allows launch bar to be lowered.</p>

Figure 2-76. 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 2-77](#)). 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 $\pm 10^\circ$ from the centered position. The launch bar can also be lowered by the deck crew with no pilot action after the aircraft has been kneeling. A proximity sensing switch on the uplock detects the latch out of the locked position and illuminates the LAUNCH BAR advisory light (see [Figure 2-76](#)). 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.



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. Groundcrew 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 kneeling 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 $\pm 26^\circ$ 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

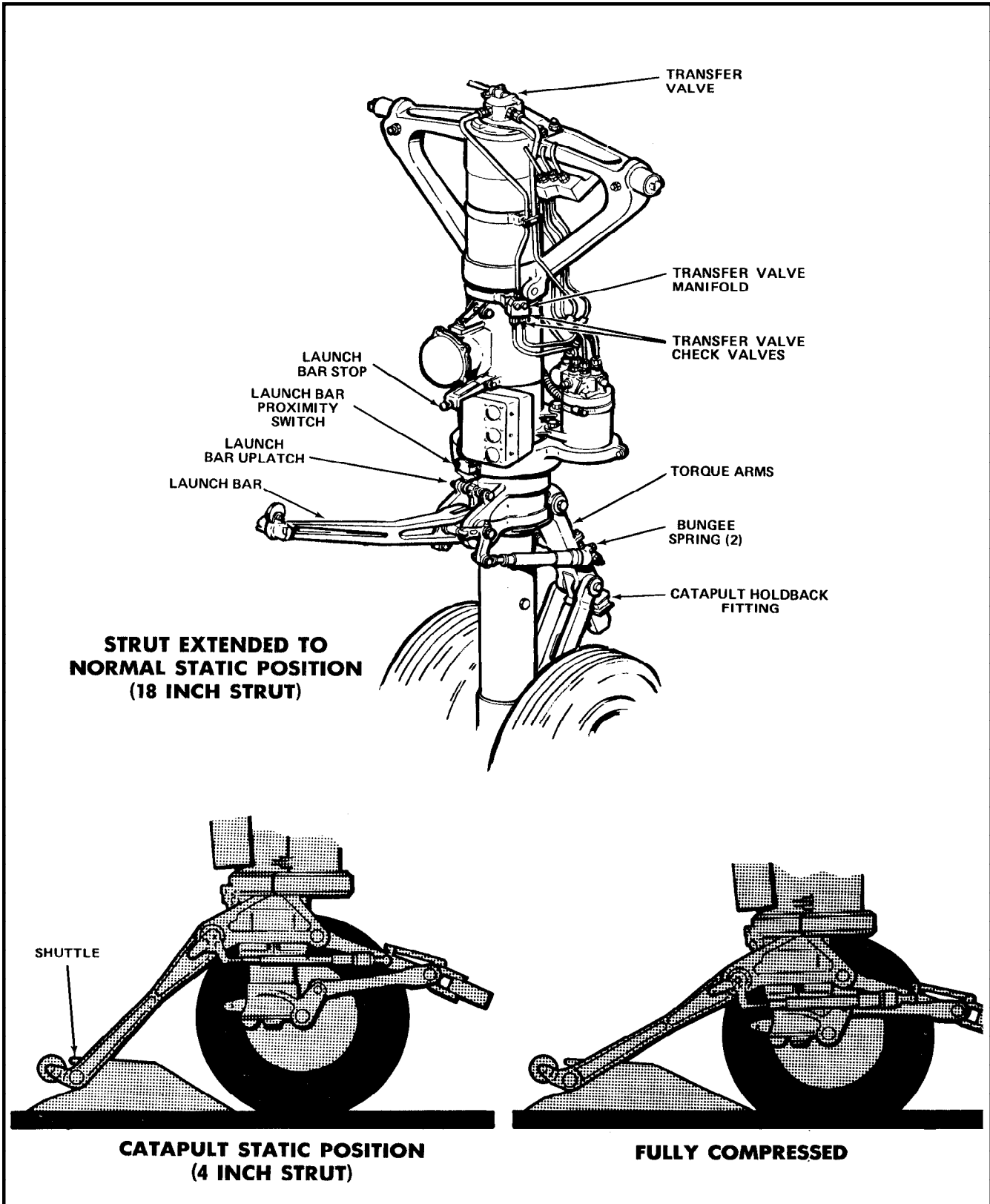
Hook retraction requires electrical and combined hydraulic power.

2.29.1.1 Normal Operation

Normal operation ([Figure 2-78](#)) 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.

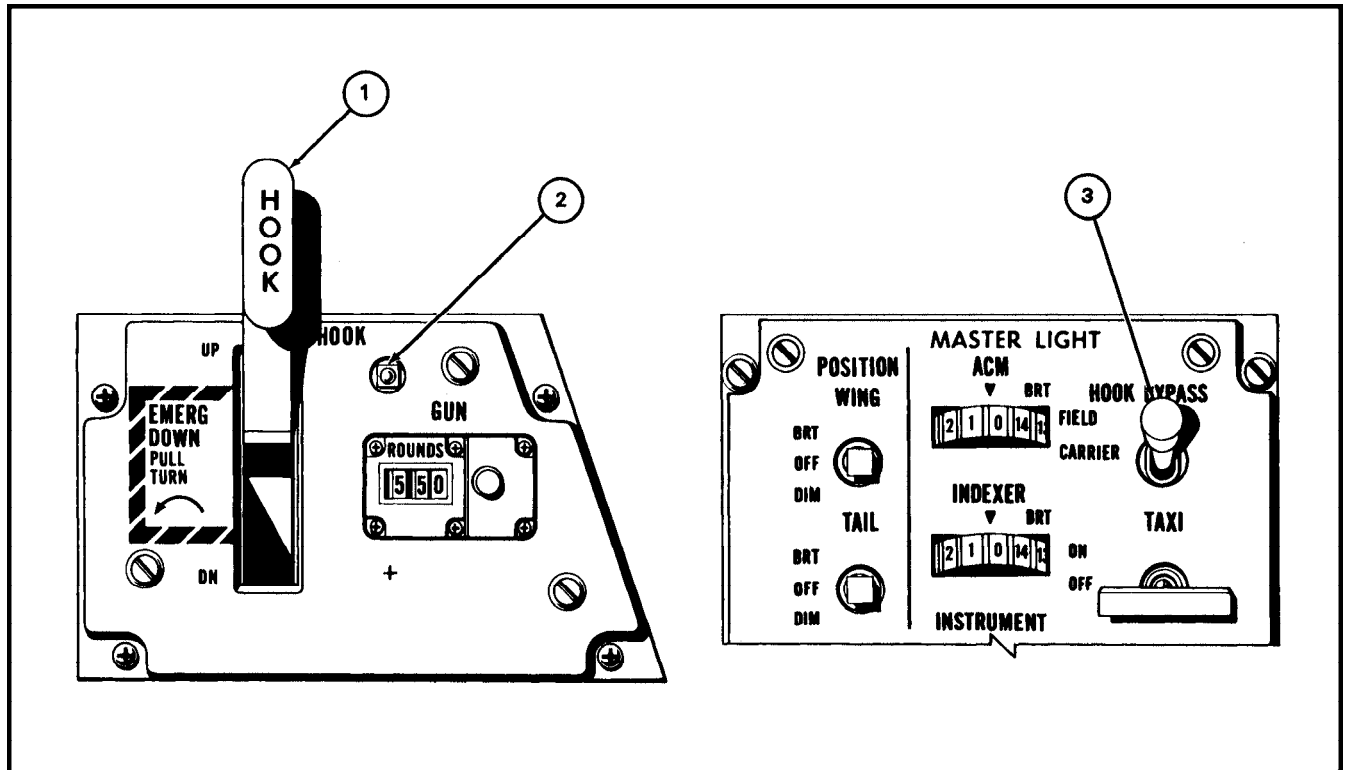
Note

If emergency hook extension is inoperative in conjunction with a flight hydraulic failure, cycling the HYD VALVE CONTR circuit breaker (8E5) with the hook handle down will permit hook extension.



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Figure 2-77. Nosewheel Strut and Launch Bar Positions



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NOMENCLATURE	FUNCTION
<p>① Arresting HOOK handle</p>	<p>UP — Electrically energizes hydraulic retract actuator to raise hook into uplock.</p> <p>DN — Electrically releases hydraulic uplock actuator and allows hook to extend by dashpot pressure and gravity.</p> <p>EMERG DOWN — (Pull-twist) mechanically releases uplock actuator and allows hook to extend by gravity and dashpot pressure.</p>
<p>② Hook transition light</p>	<p>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.</p>
<p>③ HOOK BYPASS switch</p>	<p>FIELD — Used for nonarrested landings. Bypasses the flashing feature of the approach lights and indexer when landing gear is down and hook retracted.</p> <p>CARRIER — Used for arrested landings. Approach lights and indexer flash when landing gear is down and the hook retracted.</p>

Figure 2-78. 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.



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 ant-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

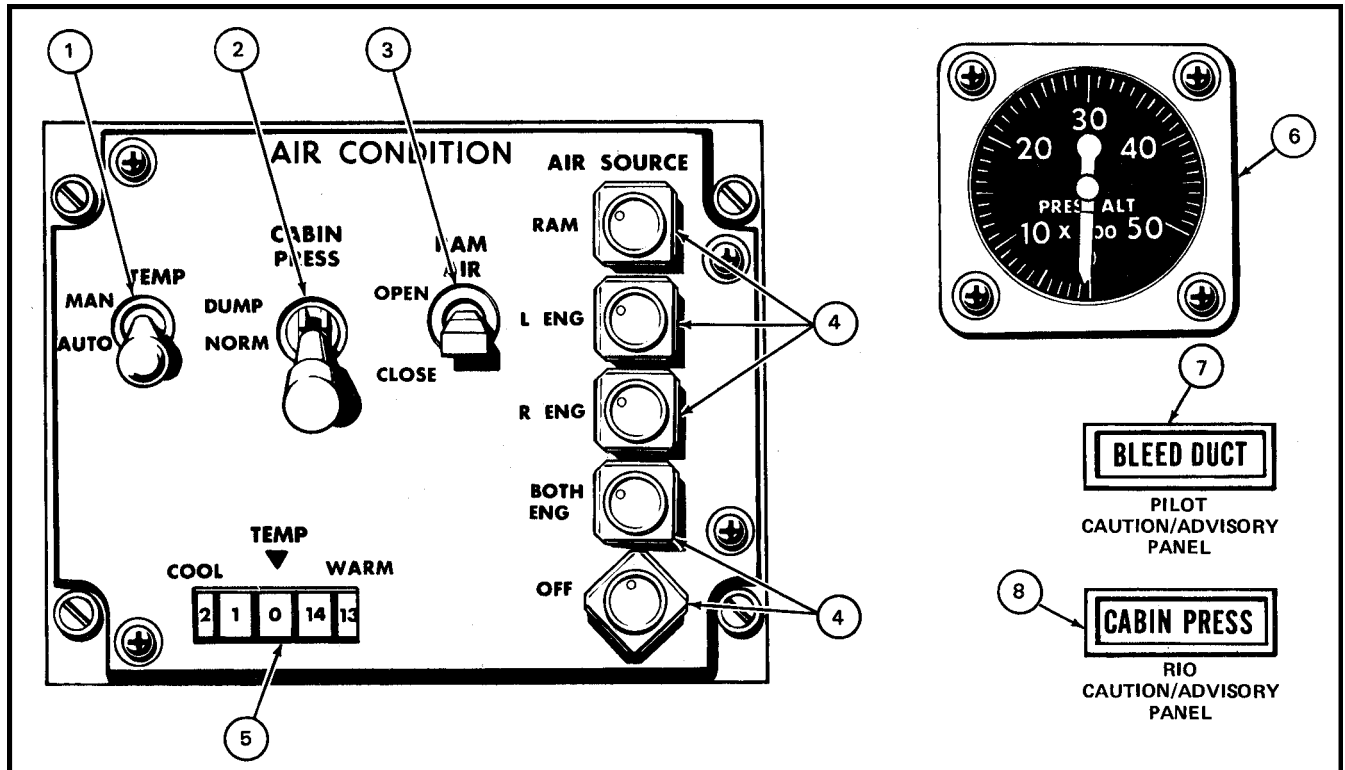
The normal source of ECS air is ninth-stage bleed air from both engines. Through a series of manifolds and valves, this air is cooled and mixed to reduce temperature and pressure to usable levels. The primary valves are the two engine bleed air shutoff valves, the dual pressure regulating and shutoff 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 2-79.)

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.



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.



0-F50D-36-0

NOMENCLATURE	FUNCTION
<p>1 TEMP mode selector switch</p>	<p>AUTO — Cockpit and pressure suit temperature is automatically maintained at that comfort level selected on the temperature control selector.</p>
<p>2 CABIN PRESS switch Lever-lock switch which must be lifted to be moved to DUMP.</p>	<p>MAN — Cockpit temperature and air flow must be manually selected as airspeed and altitude change to maintain a desired temperature.</p> <p>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. (See Figure 2-81).</p> <p>DUMP — The cockpit safety valve is opened, depressurizing the cockpit.</p>
<p>3 RAM AIR switch</p>	<p>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.)</p>

Figure 2-79. Air-Conditioning and Pressurization Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>④ AIR SOURCE selector pushbuttons</p>	<p>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.</p> <p>L ENG — The left engine is the source of bleed air for the environmental control system and the right engine bleed air shutoff valve is closed.</p> <p>R ENG — The right engine is the source of bleed air for the environmental control system and the left engine bleed air shutoff valve is closed.</p> <p>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.</p> <p>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.</p>
<p>⑤ TEMP thumbwheel control</p>	<p>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.</p>
<p>⑥ CABIN PRESS ALT indicator</p>	<p>Displays cabin pressure altitude in 1,000-foot increments from 0 to 50,000 feet.</p>
<p>⑦ BLEED DUCT caution light</p>	<p>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.</p>
<p>⑧ CABIN PRESS caution light (RIO's cockpit)</p>	<p>Indicates cabin pressure is less than 5-psi absolute pressure or cockpit altitude is above 27,000 feet.</p>

Figure 2-79. 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.



- Before opening the ram air door, reduce air-speed 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 air-speed 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-141, 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 2-79). 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 flightcrew'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 2-80](#).

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 2-80](#) 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 $230 \pm 5^\circ\text{F}$, 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 2-80](#).) 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

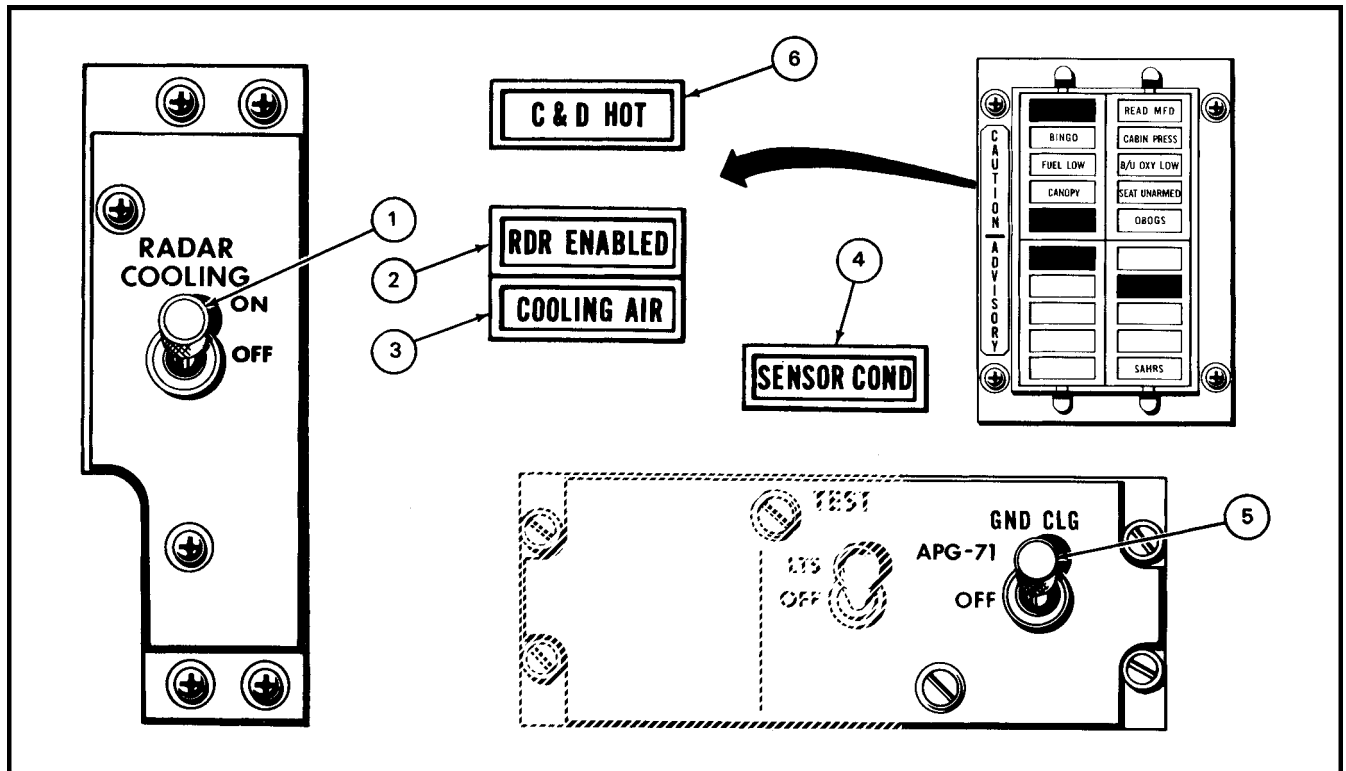
From sea level to 8,000 feet altitude the cockpit is unpressurized. Between altitudes of 8,000 feet to 23,000 feet the system maintains a constant cockpit pressure altitude of 8,000 feet. At altitudes above 23,000 feet, the cockpit pressure regulator maintains constant 5-psi pressure differential greater than ambient pressures. An illustration of the cabin pressure schedule is shown in [Figure 2-81](#).

2.30.4.1.1 Cockpit Pressure Indicators

A cockpit pressure altimeter ([Figure 2-79](#)) is provided for the pilot. The rear cockpit has a CABIN PRESS light on the CAUTION and ADVISORY panel. The CABIN PRESS, light 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.



0-F50D-97-0

NOMENCLATURE	FUNCTION
<p>① RADAR COOLING switch</p>	<p>OFF — Deactivates the radar cooling pumps.</p> <p>ON — Activates the radar cooling pump for ground and airborne thermal conditioning.</p>
<p>② RADAR ENABLE caution light</p>	<p>Indicates that radar operation on the ground is possible.</p>
<p>③ COOLING AIR advisory light</p>	<p>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.</p>
<p>④ SENSOR COND advisory light</p>	<p>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).</p>

Figure 2-80. 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. <p style="text-align: center;">CAUTION</p> <ul style="list-style-type: none"> • 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 PTID overheat condition.

Figure 2-80. Avionic Equipment Liquid Cooling Controls and Lights (Sheet 2 of 2)

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.

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 2-82).



- 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.

2.30.7 Degraded ECS Operation

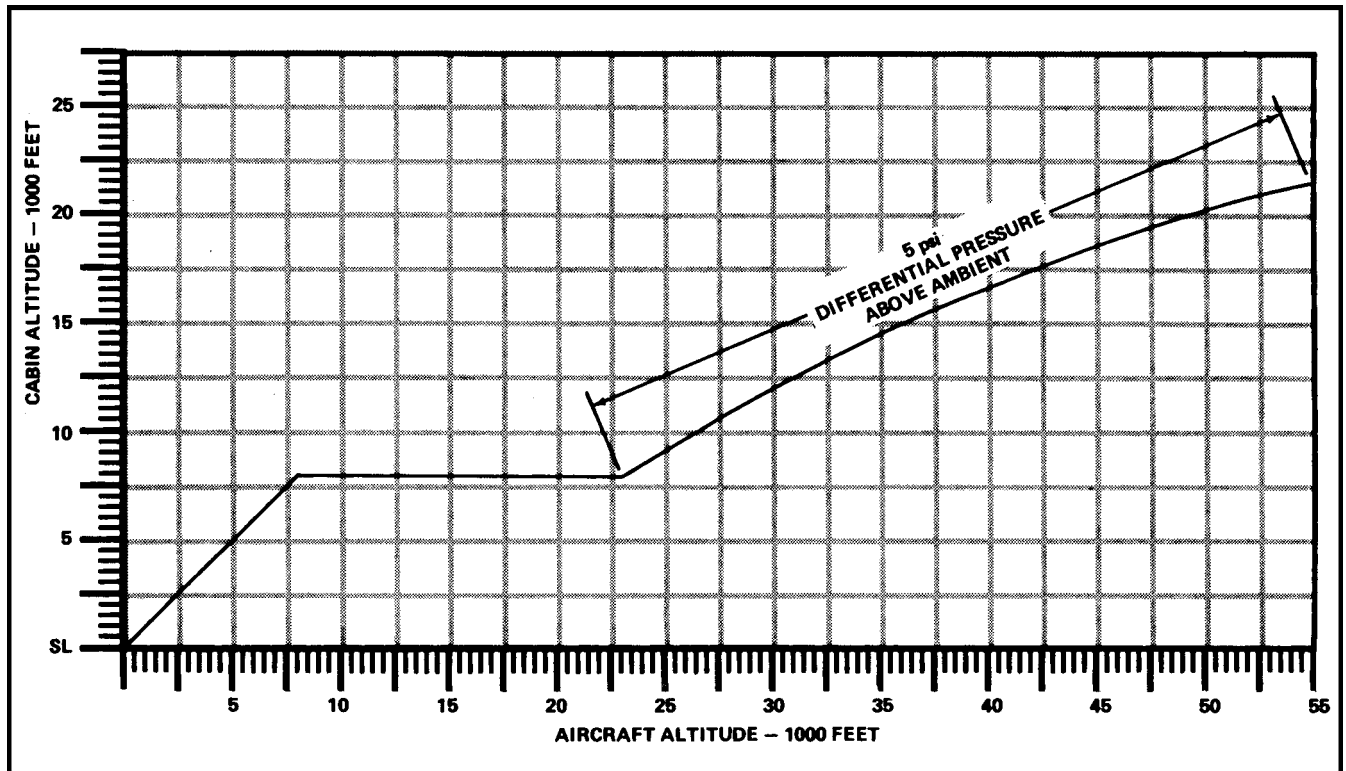
There are various temperature and pressure safeguard systems that cause the ECS system to shut down if an unsafe situation is detected. A complete failure of the dual valve will cause it to shut down the pressurization and air-conditioning system. Should that fail to close, a pressure switch will close 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 push-button, will cause total ECS air shutdown.



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.



0-F50D-11-0

Figure 2-81. Cabin Pressure Schedule

Note

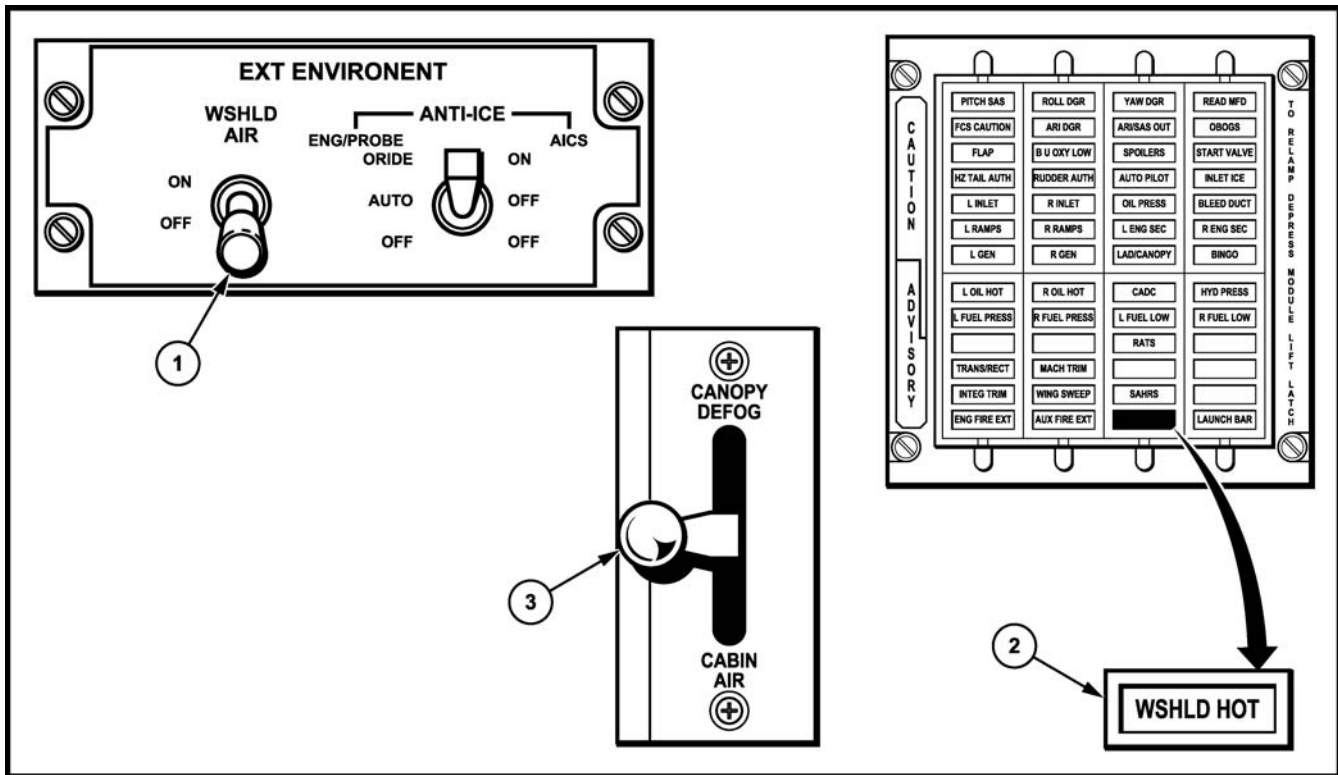
- Loss of electrical power with bleed air still operating will result in smoke entering the cockpit through the ECS when the aircraft is on the deck. In flight only cold air will be supplied to the cabin and suit. Icing of the water separator may occur, causing reduced flow to the cabin. Since the ECS 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



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NOMENCLATURE	FUNCTION
<p>① WSHLD AIR switch</p>	<p>ON — Provides a continuous blast of hot air (340°) over the exterior windshield. Used for windshield anti-ice.</p> <p>OFF — Closes the shutoff valve after a 5-second delay. The system is deenergized.</p>
<p>② WSHLD HOT advisory light</p>	<p>Light illuminates when a sensor in the warm air nozzle to the center windshield indicates overheat (300° F).</p>
<p>③ CANOPY air diffuser lever (both cockpits)</p>	<p>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.</p> <p>DEFOG — Air flow is directed through the canopy defog rails only.</p>

Figure 2-82. Canopy Defog Controls and Windshield Air

not in use. Selection of AIR SOURCE OFF and RAM AIR OPEN 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 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 (OBOGS)

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 2-83](#).

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 (7A1).

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.

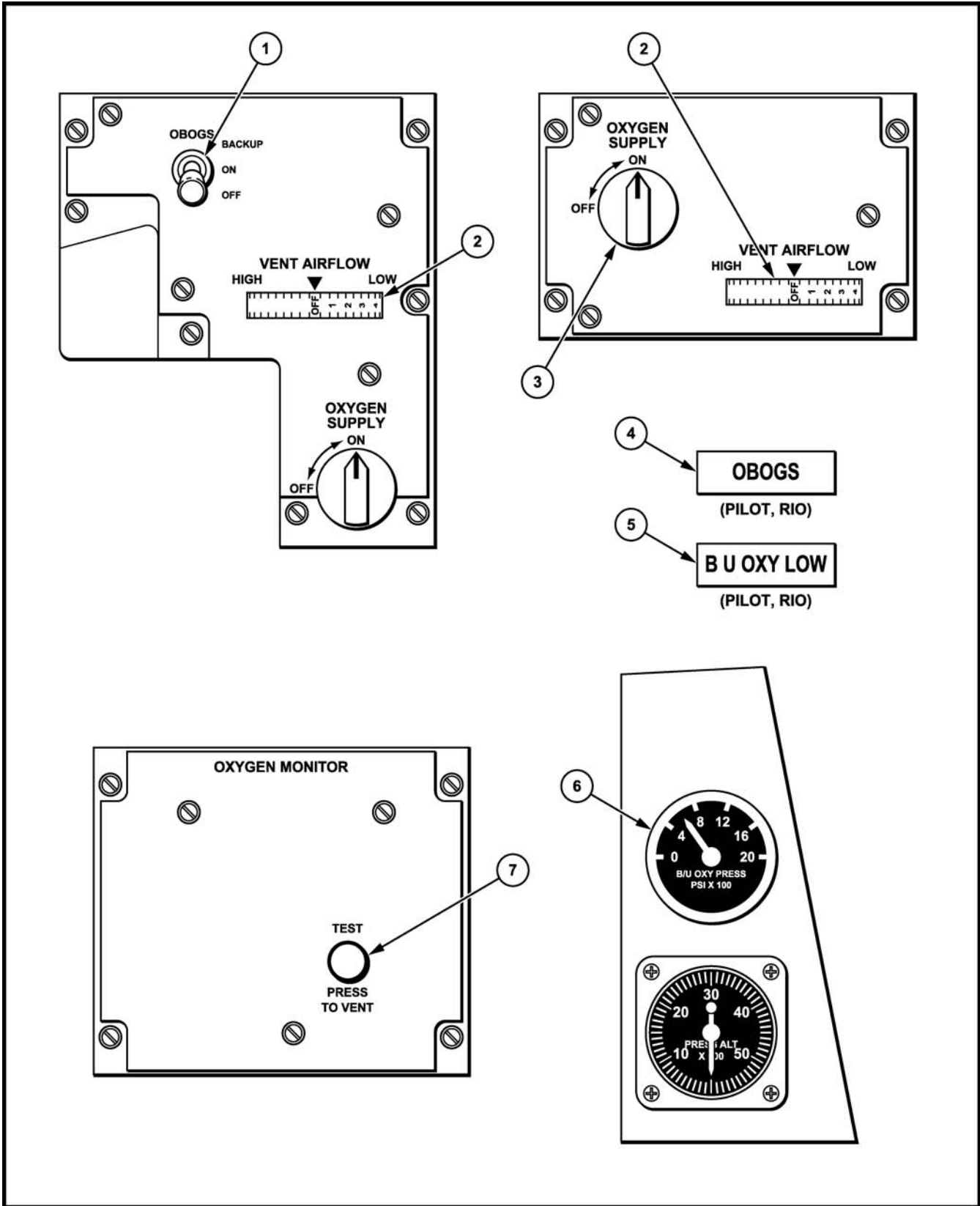
Power to the monitor is provided by 28 Vdc OBOGS control power from the essential dc bus No. 1 when the OBOGS master switch is in the ON position. The sensor in the monitor is heated for proper operation. Upon initial selection of the OBOGS master switch to ON, the OBOGS is powered and functioning but 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 OBOGS 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.



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Figure 2-83. Oxygen System Controls and Indicators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>① OBOGS master switch</p>	<p>BACKUP — Deenergizes oxygen concentrator and Process Air Shutoff Valve. Enables Backup Oxygen.</p> <p>ON — Applies power to oxygen generator and oxygen monitor. Opens solenoid valve providing ECS Service Air to Oxygen Concentrator.</p> <p>OFF — Removes power from OBOGS and BOS. Process air shutoff valve closes.</p>
<p>② VENT AIRFLOW</p>	<p>NOT FUNCTIONAL.</p>
<p>③ OXYGEN SUPPLY valve</p>	<p>ON — Opens oxygen supply permitting OBOGS or BOS oxygen flow to crewmember.</p> <p>OFF — Secures OBOGS and BOS oxygen flow to crewmember.</p>
<p>④ OBOGS caution light</p>	<p>Illuminates when OBOGS has failed or OBOGS master switch is in OFF or BACKUP</p>
<p>⑤ B/U OXY LOW caution lights</p>	<p>Illuminates when pressure remaining in BOS assembly oxygen cylinder is below 200 psi.</p>
<p>⑥ BACKUP OXY PRESS Indicator</p>	<p>Indicates pressure remaining in BOS assembly oxygen cylinder.</p>
<p>⑦ OXYGEN MONITOR TEST Button</p>	<p>Provides functional test of the oxygen monitor, BOS, and OBOGS control systems.</p>

Figure 2-83. Oxygen System Controls and Indicators (Sheet 2 of 2)

2.31.2 Backup Oxygen System (BOS)

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 2-83.) 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 (7A1). Alternate power is provided via the BOS CONTR/B/U OXY LOW circuit breaker (7A4) 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 2-84](#) 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 2-83](#)), 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.



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 2-85](#)).

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 (P_{S2}) static ports supply the static pressure to the left AICS P_S sensor. An electrical P_S input from the left AICS programmer is supplied to the CADC backup channel for wing sweep. Static pressure from the left aft (P_{S2}) static ports supply the left AICS programmer.

The CADC and AICS programmers provide Mach number information to the digital flight control computers (DFCCs). The alpha computer, angle of attack probe (used for displaying angle of attack to the pilot), and the AICS programmers provide angle of attack information to the DFCCs. Electrical interfaces are shown on [Figure 2-85](#).

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.

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 2-84. Backup Oxygen Duration Chart



The ANTI-ICE switch should normally be in AUTO/OFF during takeoff and landing. Engine anti-icing has adverse effects on engine stall margin.

2.33 CONTROL AND DISPLAY SYSTEM

The control and display system (Figure 2-86) provides the crew with 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

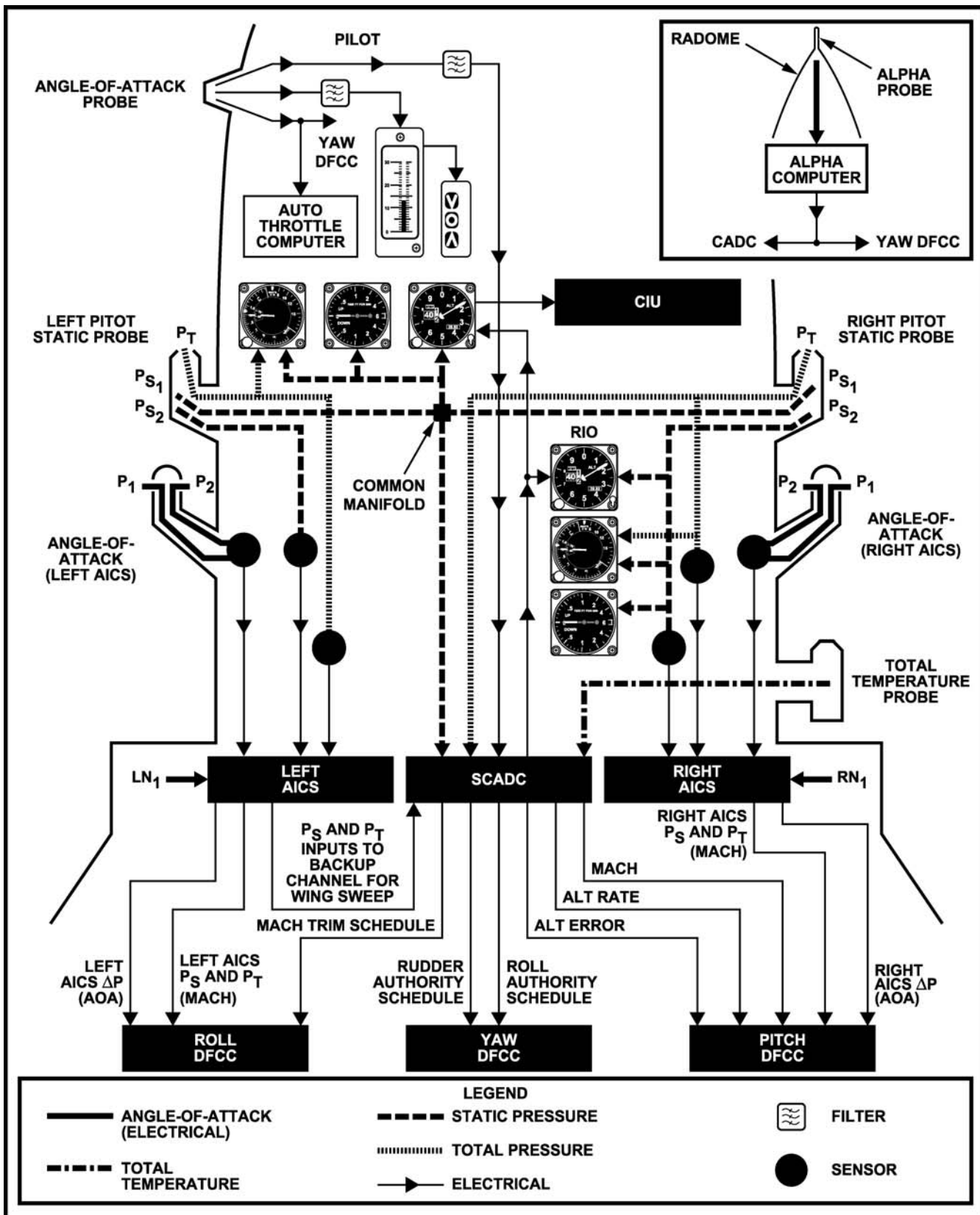
The following types of display information are provided by the MFD system:

1. Calligraphic or stroke writing is displayed on the HUD, MFDs, and the DD.
2. Raster video (for example, radar, and 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.

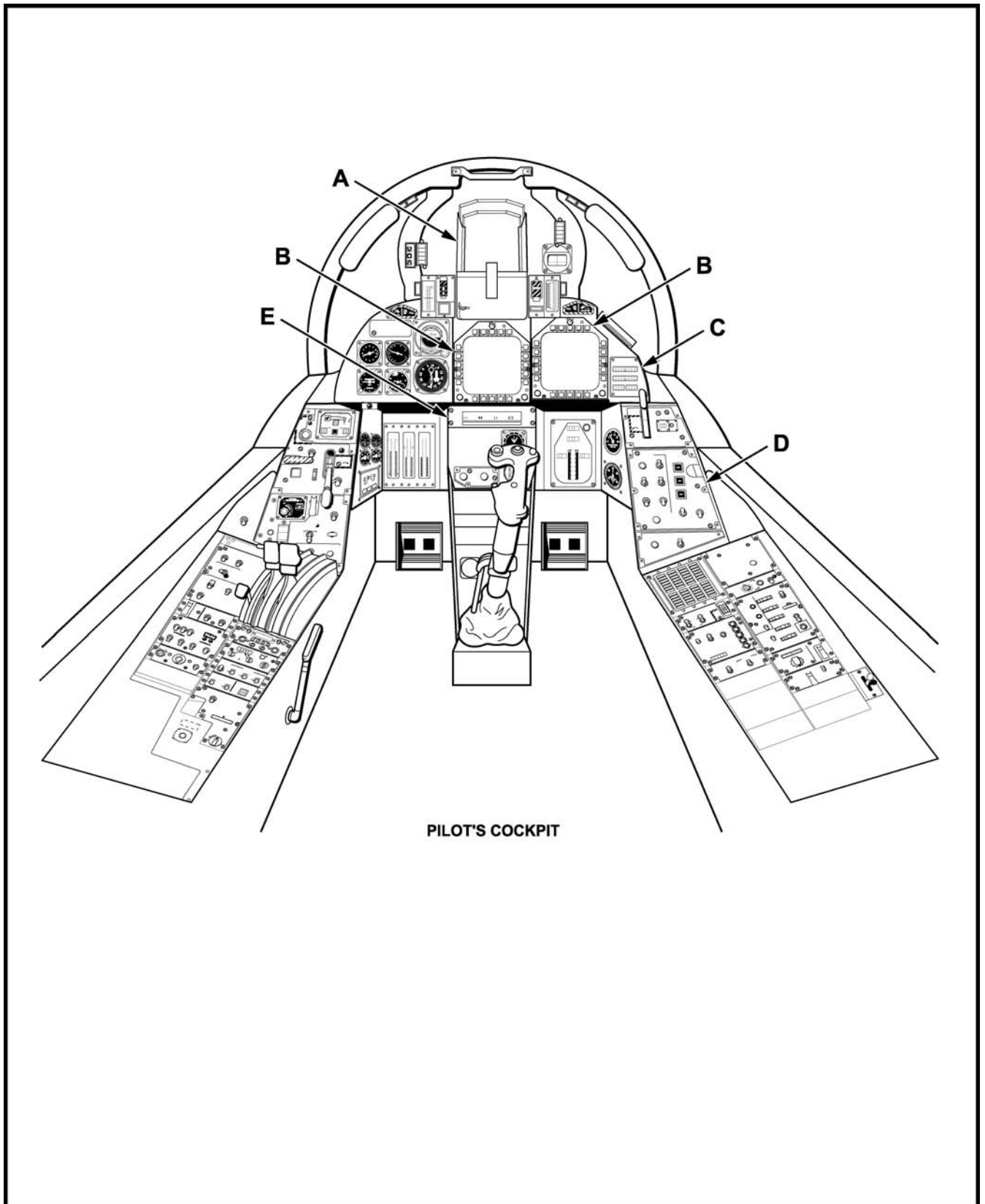
HUD format groups consist of takeoff/landing/navigation (TLN), air-to-air (A/A), air-to-ground (A/G), and multimode formats that can be overlaid on the other three. The HUD also displays a manual reticle and a test pattern.

MFD display format groups are shown in Figure 2-87. 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 PTID and DD as well as TCS and CCTVS video.



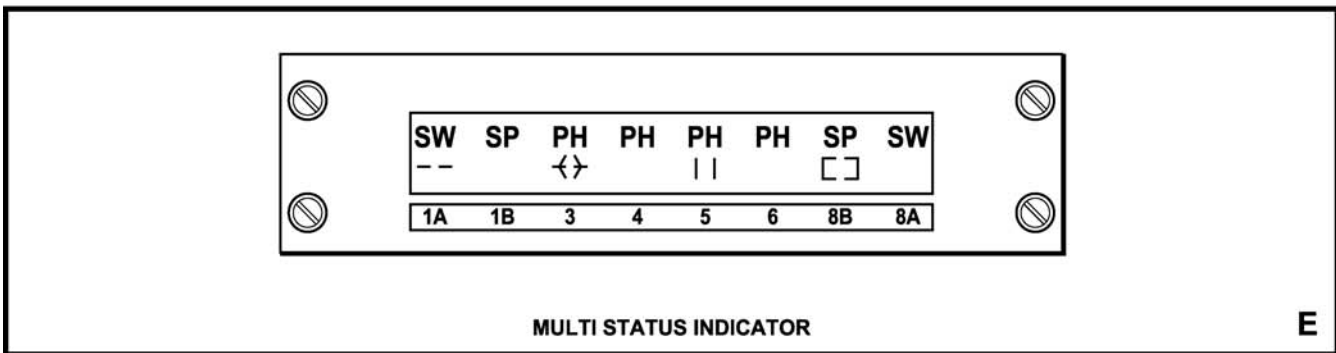
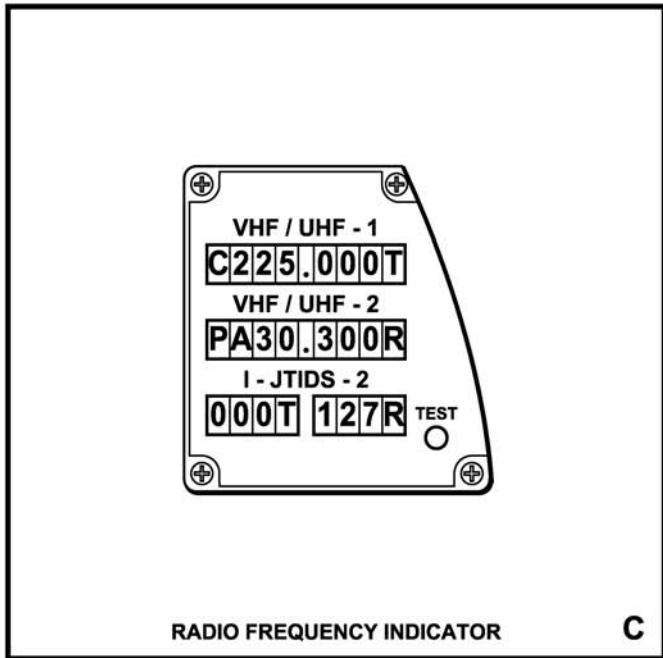
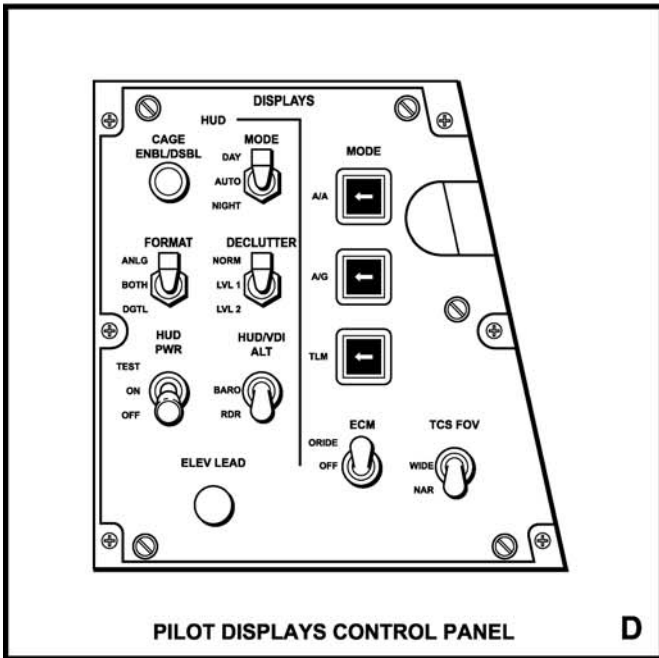
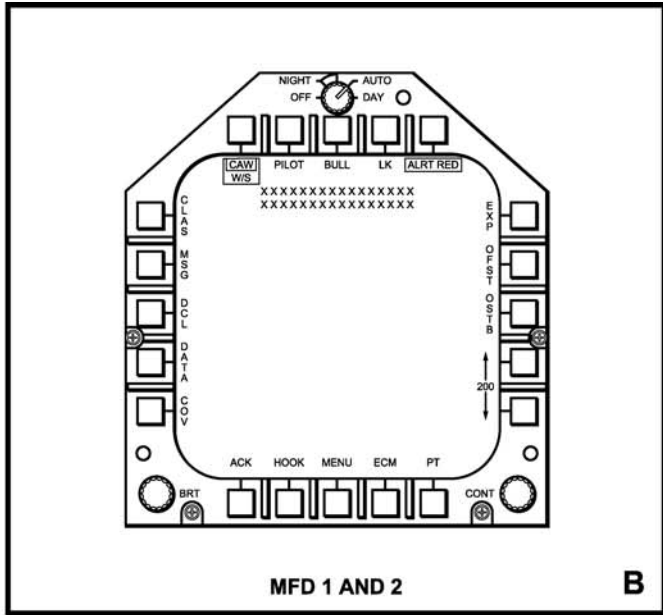
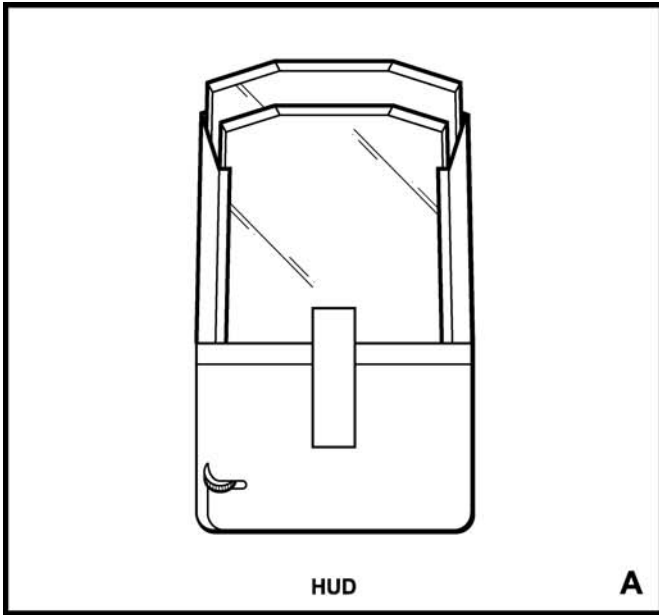
CSC-F14D-1-2-034

Figure 2-85. Airstream Sensors



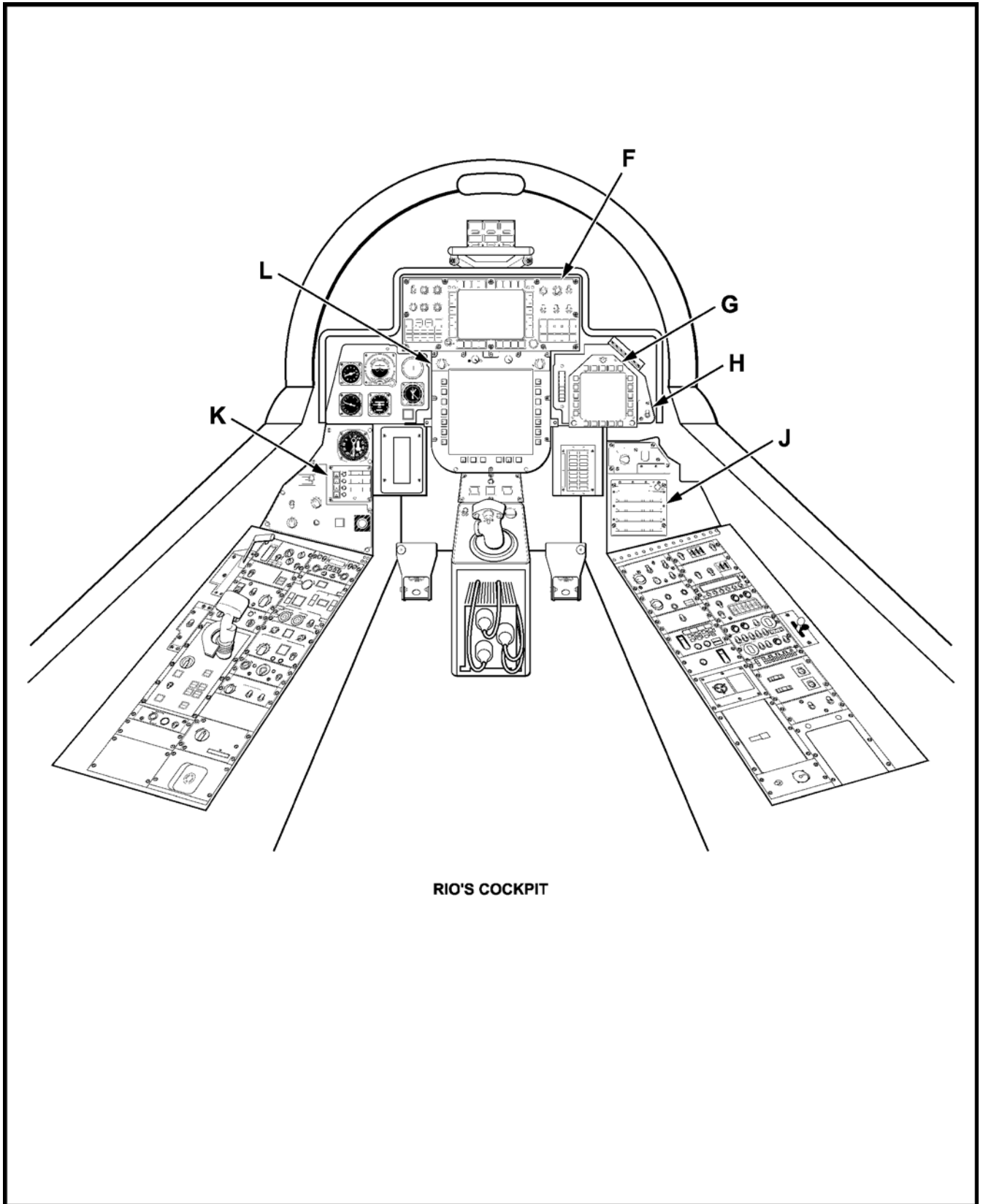
CSC-F14D-1-2-033A

Figure 2-86. Display Systems Controls and Indicators (Sheet 1 of 4)



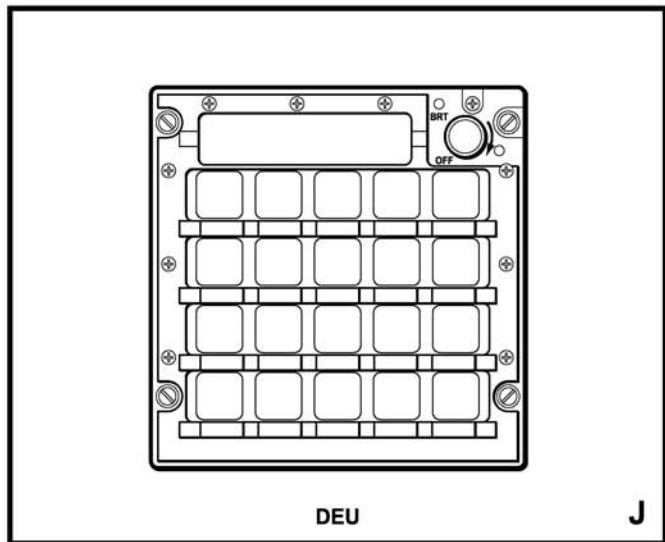
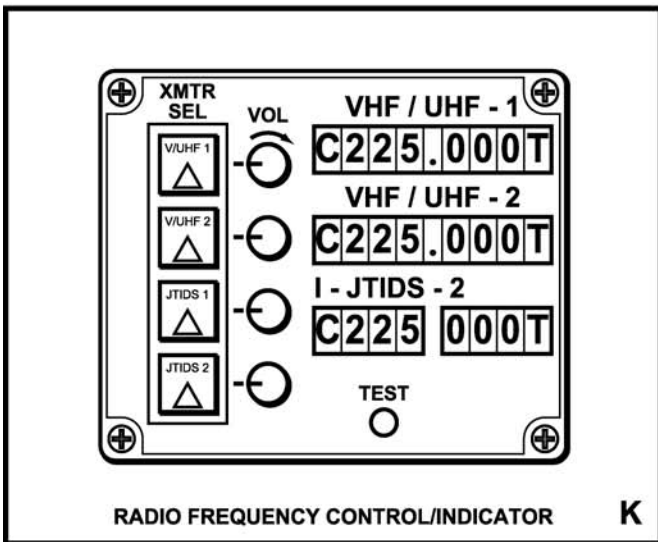
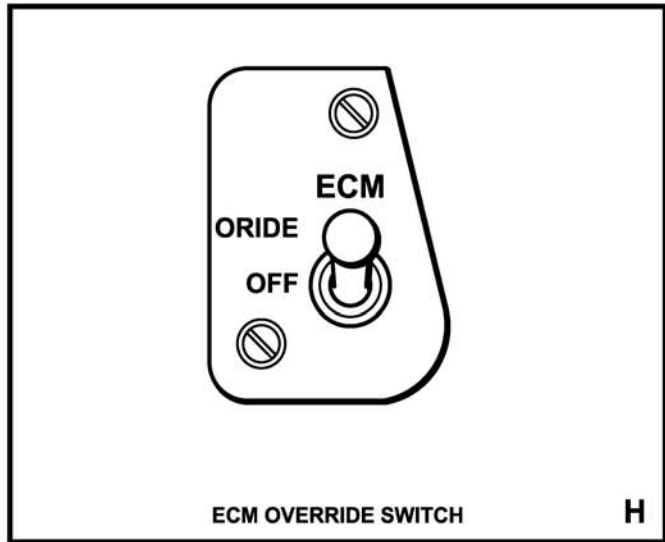
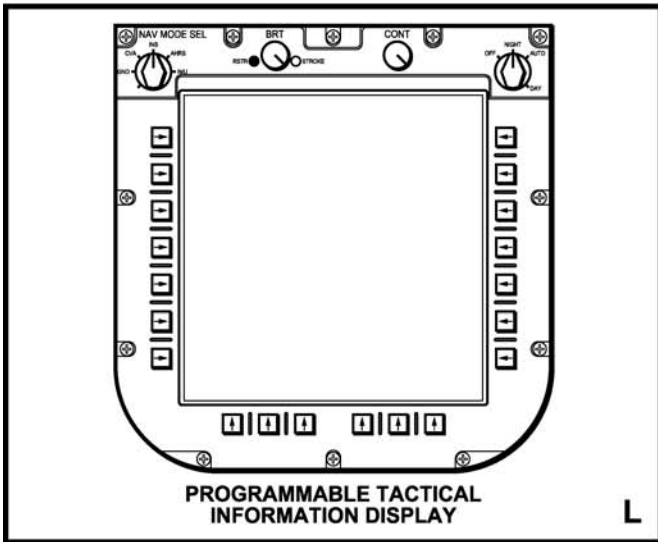
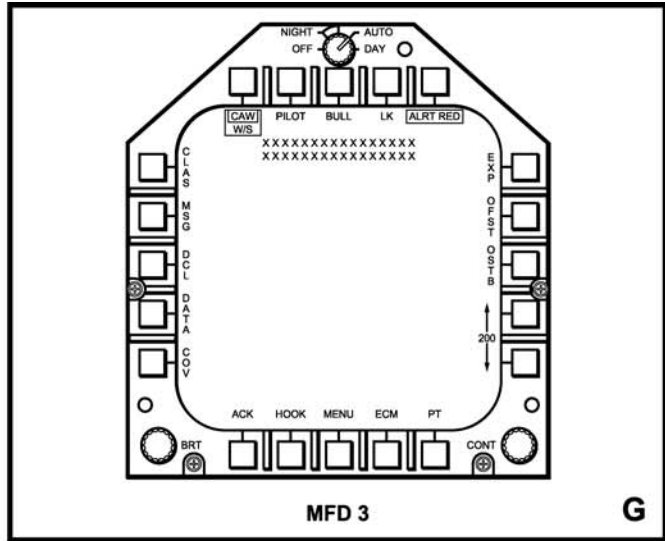
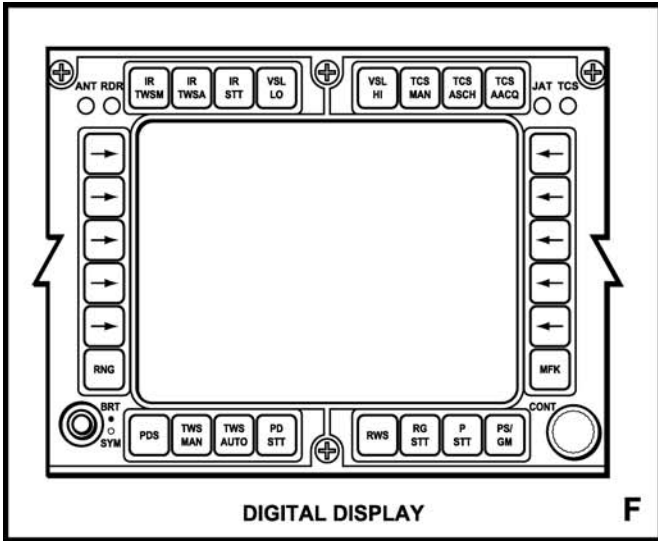
CSC-F14D-1-2-065

Figure 2-86. Display Systems Controls and Indicators (Sheet 2 of 4)



CSC-F14D-1-2-036B

Figure 2-86. Display Systems Controls and Indicators (Sheet 3 of 4)



CSC-F14D-1-2-037C

Figure 2-86. 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	WAYPOINTS TACAN CDI TACAN GPS AUTO
OWN A/C and WAYPOINT Formats	OWN A/C BASIC OWN A/C GROUND OWN A/C CVA OWN A/C IFA WAYPOINT DATA 0-99

Figure 2-87. Display Format Groups (Sheet 1 of 2)

DISPLAY FORMAT	FORMATS WITHIN GROUP
<p>NAV Align Formats</p> <p>Inertial Navigation System (INS) UPDATE Format Continuous Update Formats</p> <p>SURFACE WAYPOINT POSITION Format Stores Management System (SMS) Format SPIN INDICATOR Format ENGINE MONITOR Format On Board Checkout (OBC) Formats</p> <p>Failure History Format (FHF) Cooperative Support Software (CSS) Format Missile Status Readout Formats</p> <p>Electronic Counter Measures (ECM) Format Recon Formats</p> <p>Tactical Situation Display (TSD)</p> <p>JTIDS Data Readouts (JDR)</p> <p>Infrared Search and Track (IRST) Formats</p>	<p>CV MAN DATA</p> <p>CV Ships Inertial Navigation System (SINS) DATA IFA Standard Attitude Heading Reference System (SAHRS) (Norm Mag SHDG) SAHRS CV</p> <p>NAV AID CORRECTIONS NAV AID ENABLED NAV AID OPTIONS</p> <p>OBC BASIC OBC Groups: CD, CNI, FLT, NAV, AUX, TAC, EW, SMST, and SNSR OBC Failed Data: CADC, CIU, SAHRS, DINS, GPS, DEU, DP1, DP2, MC1, MC2, MDL/DSS, APC, EMSP1, EMSP2, IFX, SMS, SWITCHES, RWR, and RDR/TCS MAINT Format</p> <p>MISSILE SUBSYSTEM 1 MISSILE SUBSYSTEM 2</p> <p>RECON DATA RECON WPT DATA1 RECON WPT DATA2</p> <p>TSD MENU TSD PRIORITY TSD DECLUTTER 1 TSD DECLUTTER 2 TSD COMMAND TSD REPLY TSD TARGET MODIFIER</p> <p>OWN AIRCRAFT PPLI AIR PPLI NON-AIR PPLI INDIRECT PPLI</p> <p>IRSTS NORMAL IRSTS CSCAN IRSTS SUMMARY</p>

Figure 2-87. 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, and MFD1. 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, with weight on wheels, are as follows:

1. HUD — TLN basic
2. MFD — 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.

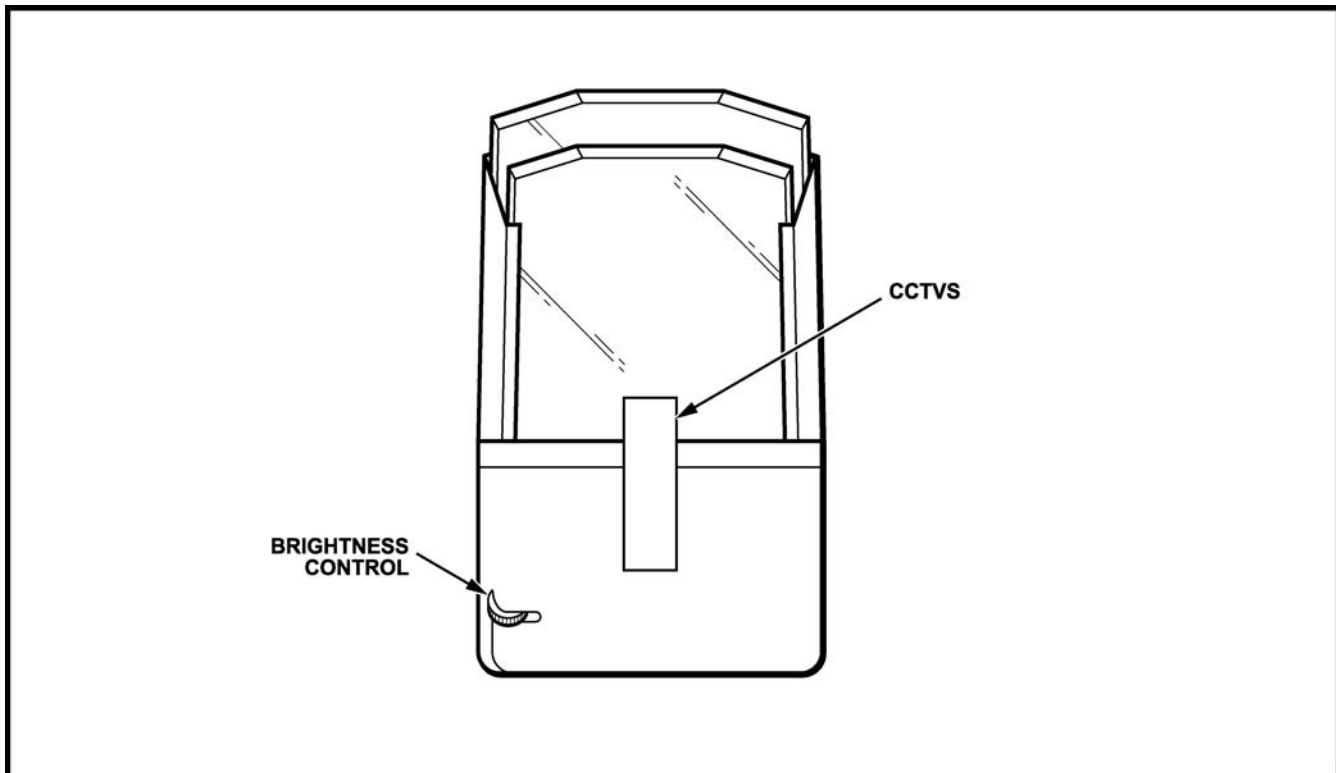
Format selection for the HUD is made by use of the MODE pushbuttons on the PDCP and by the type of steering selected. MFD format families are selected by pressing the pushbutton adjacent to a menu legend or by cursor designation of the legend. Every MFD format (except repeats) has MENU select as the 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 PTID) 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 (HUD)

The HUD ([Figure 2-88](#)) 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 (PDCP)

The PDCP on the pilot right console ([Figure 2-89](#)) provides control of the mode and display presentation of the



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Figure 2-88. Heads-Up Display

HUD, VDI, ECM, and TCS formats. Display information is dependent on the mode selected with the A/A, A/G, and TLN pushbuttons.

2.33.4.2 Color Cockpit Television Sensor (CCTVS)

The CCTVS 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 2-86). The sensor signal can be fed to the mission video recorder and can be displayed on the MFDs. Operation of the CCTVS is controlled by the VIDEO CONTROL switch on the HUD-VIDEO control panel.

2.33.4.3 HUD-VIDEO Control Panel

Operation of the CCTVS is controlled by the HUD-VIDEO control panel (Figure 2-86). 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 CCTVS; selecting OFF removes power. Depressing the BIT button initiates a CCTVS 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 CCTVS 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.

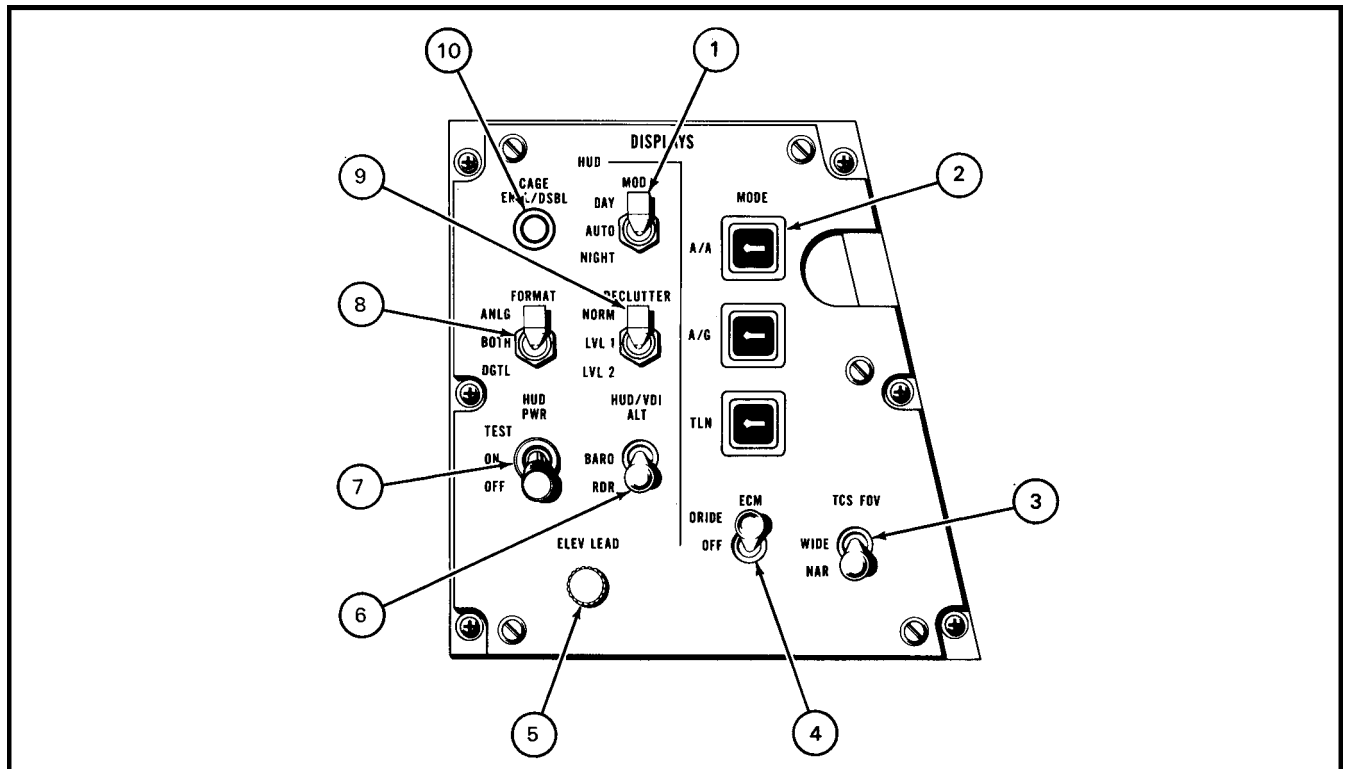
2.33.5 Multistatus Indicator (MSI)

The MSI is an LCD panel on the lower center instrument panel below the center MFD (MFD1) (Figure 2-86). 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 2-90 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.



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NOMENCLATURE	FUNCTION
<p>① MODE Switch</p>	<p>DAY — Provides a full range of HUD symbol brightness control: 0 to 100%. Disables automatic brightness control.</p> <p>AUTO — Provides automatic symbol brightness operation superimposed on the level selected with the symbol brightness control.</p> <p>NIGHT — Provides a HUD symbol brightness control range of 0 to 1.0% of DAY level.</p> <p style="text-align: center;">Note</p> <p>When switching from NIGHT to DAY, the brightness level gradually increases until it reaches the level established for DAY.</p>
<p>② Display MODE Pushbuttons</p>	<p>A/A — Provides selection of air-to-air display mode.</p> <p>A/G — Provides selection of air-to-ground display mode.</p> <p>TLN — Provides selection of takeoff/landing/navigation mode.</p>

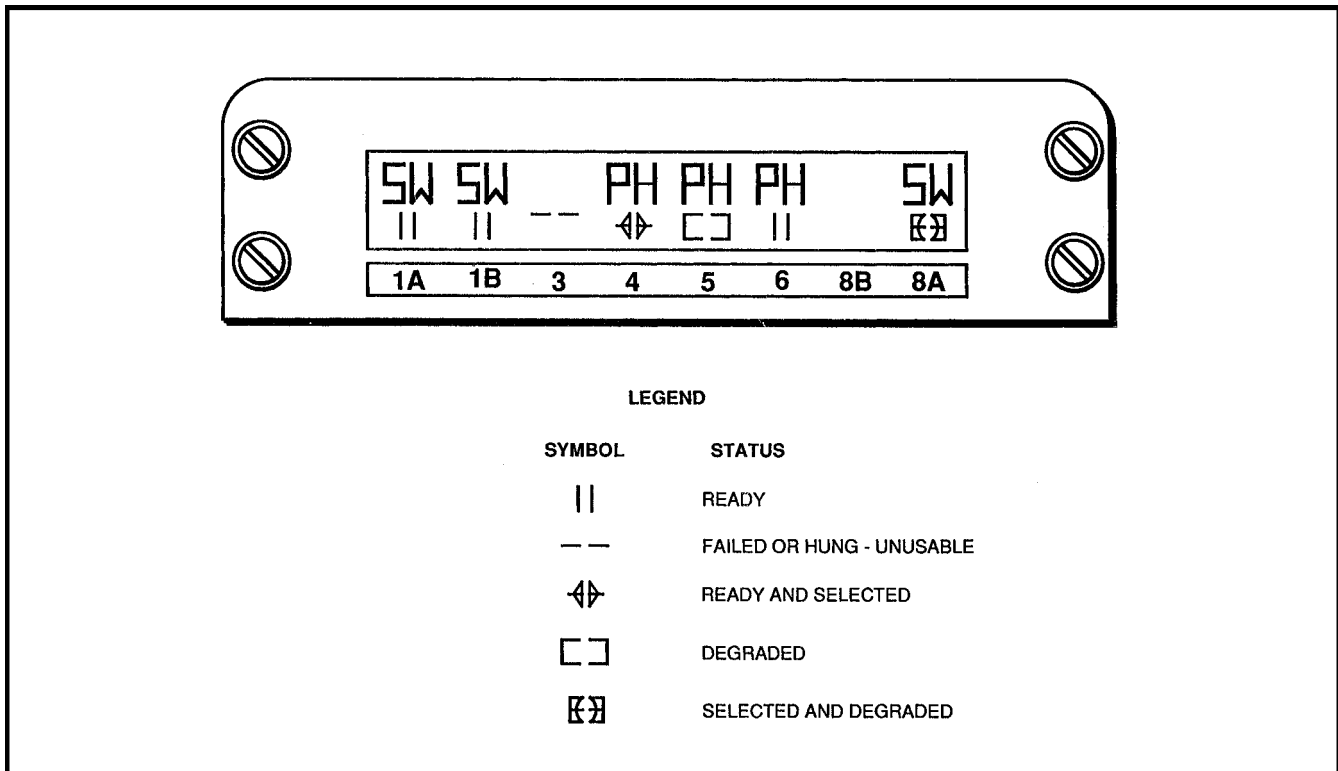
Figure 2-89. Pilot Displays Control Panel (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
<p>3 TCS FOV (Television Camera Field of View)</p>	<p>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.</p>
<p>4 ECM switch</p>	<p>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.</p>
<p>5 ELEV LEAD Control</p>	<p>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.</p>
<p>6 HUD/VDI ALT source switch</p>	<p>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:</p> <ul style="list-style-type: none"> • Below 5000 feet AGL • Radar altitude valid • AOB ≤ 45°
<p>7 HUD PWR switch (lever lock)</p>	<p>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.</p>
<p>8 FORMAT switch</p>	<p>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.</p>
<p>9 DECLUTTER switch</p>	<p>NORM — Normal display symbology is presented. LVL 1 — Depending on MODE selected, the following symbols are removed:</p> <p>TLN – GEAR UP (AOA bracket and target pointer/AON are not displayed)</p> <ul style="list-style-type: none"> • Vertical velocity • AOB scale • Peak G

Figure 2-89. Pilot Displays Control Panel (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
<p>9 DECLUTTER switch (continued)</p>	<p>TLN – GEAR DOWN (Target pointer/AON and Mach are not displayed)</p> <ul style="list-style-type: none"> • Peak G (displayed as required in normal mode only) • AOB scale • Radar altitude <p>A/A</p> <ul style="list-style-type: none"> • Radar altitude readout <p>A/A and A/G (Vertical velocity, AOB scale, and AOA bracket are not displayed)</p> <ul style="list-style-type: none"> • AOA readout • Potential flight path marker (PFPM) <p>LVL 2 – Depending on MODE selected, the following additional symbols are removed:</p> <p>TLN – GEAR UP</p> <ul style="list-style-type: none"> • AOA • Mach • Nav range • PFPM • Radar altitude readout • Digital boxes • Clock/Timer readout • Steering Mode/WPT #/Range <p>TLN – GEAR DOWN</p> <ul style="list-style-type: none"> • AOA • Digital boxes • PFPM • Vertical velocity • Clock/Timer readout • Steering Mode/WPT #/Range <p>A/A</p> <ul style="list-style-type: none"> • Nav range <p>A/G (Closure and target pointer/AON are not displayed)</p> <ul style="list-style-type: none"> • Radar altitude readout <p>A/A and A/G (AOB scale, AOA bracket, and vertical velocity are not displayed)</p> <ul style="list-style-type: none"> • Mach number • Peak G • Digital boxes • Heading scale • Ghost FPM • Clock/Timer readout • Steering Mode/WPT #/Range
<p>10 CAGE ENBL/DSBL Pushbutton</p>	<p>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.</p>

Figure 2-89. Pilot Displays Control Panel (Sheet 3 of 3)



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Figure 2-90. Multistatus Indicator Symbols/Meanings

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 2-91).

2.33.6 Multifunction Displays (MFD)

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 MENU1 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.

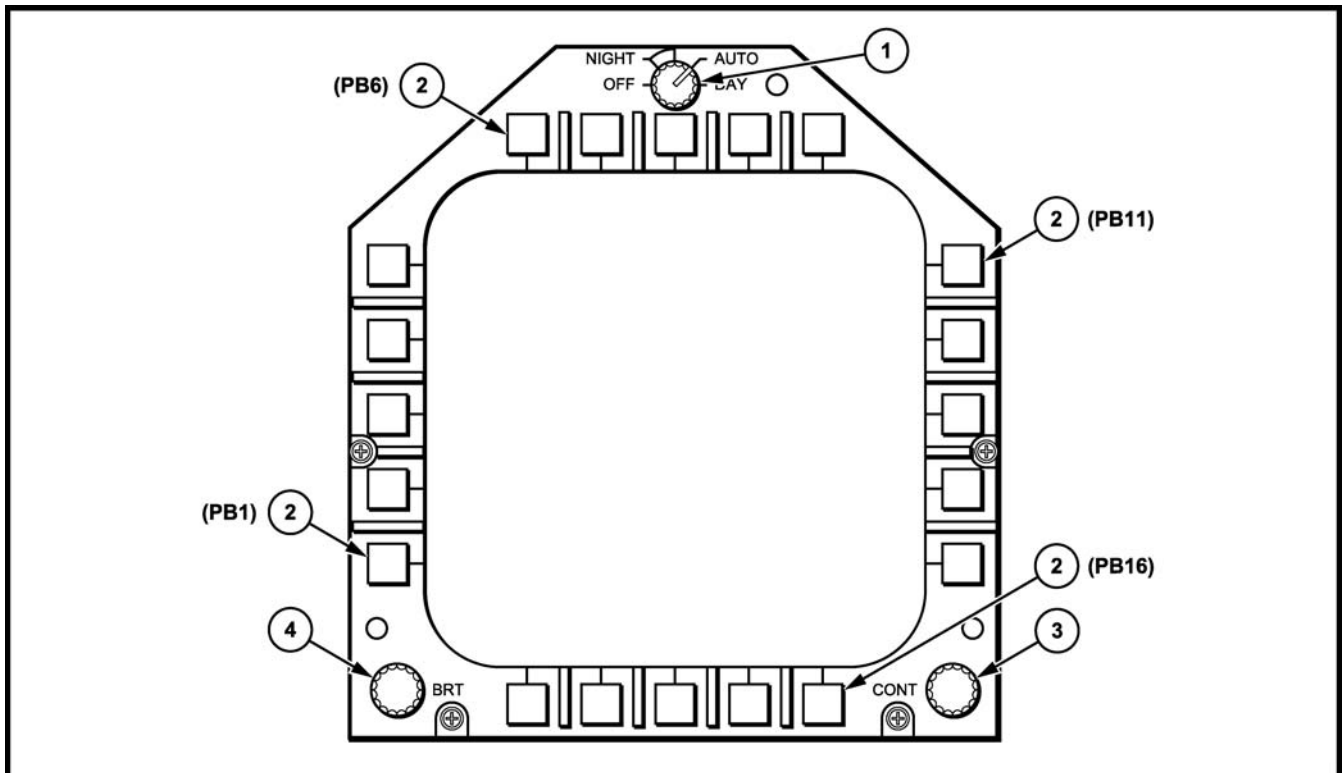
The flight parameters displayed include magnetic heading, data link (D/L), commanded airspeed (Mach number), airspeed, altitude, and vertical velocity.

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 2-92) 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



CSC-F14D-1-2-063

NOMENCLATURE	FUNCTION
<p>1 Power switch</p>	<p>OFF — Power removed from MFD.</p> <p style="text-align: center;">Note</p> <p>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.</p> <p>NIGHT — Disables automatic contrast adjustment and limits automatic brightness adjustment to a small percentage of the DAY range.</p> <p>AUTO — Automatic adjustment of brightness and contrast to compensate for changing light conditions as seen by sensors above the BRT and CONT controls.</p> <p>DAY — Full range of manual brightness and contrast control. Disables automatic brightness and contrast adjustment.</p>

Figure 2-91. Multifunction Display (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>② Pushbuttons</p>	<p>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.</p>
<p>③ CONT control</p>	<p>Varies the amplitude of the shades of gray. Effects are most visible when viewing video or raster graphics.</p>
<p>④ BRT (brightness) control</p>	<p>Varies intensity of overall display. As brightness is decreased, fewer shades of gray are discernable.</p>

Figure 2-91. Multifunction Display (Sheet 2 of 2)

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.

2.33.7.1 Throttle Designator Controller (TDC)

The pilot controls cursor position with the throttle designator controller. The TDC is a circular disk that is a combination fourway 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, PTID, 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 PTID 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, PTID, TSD, and IRST normal format support symbol hooking.

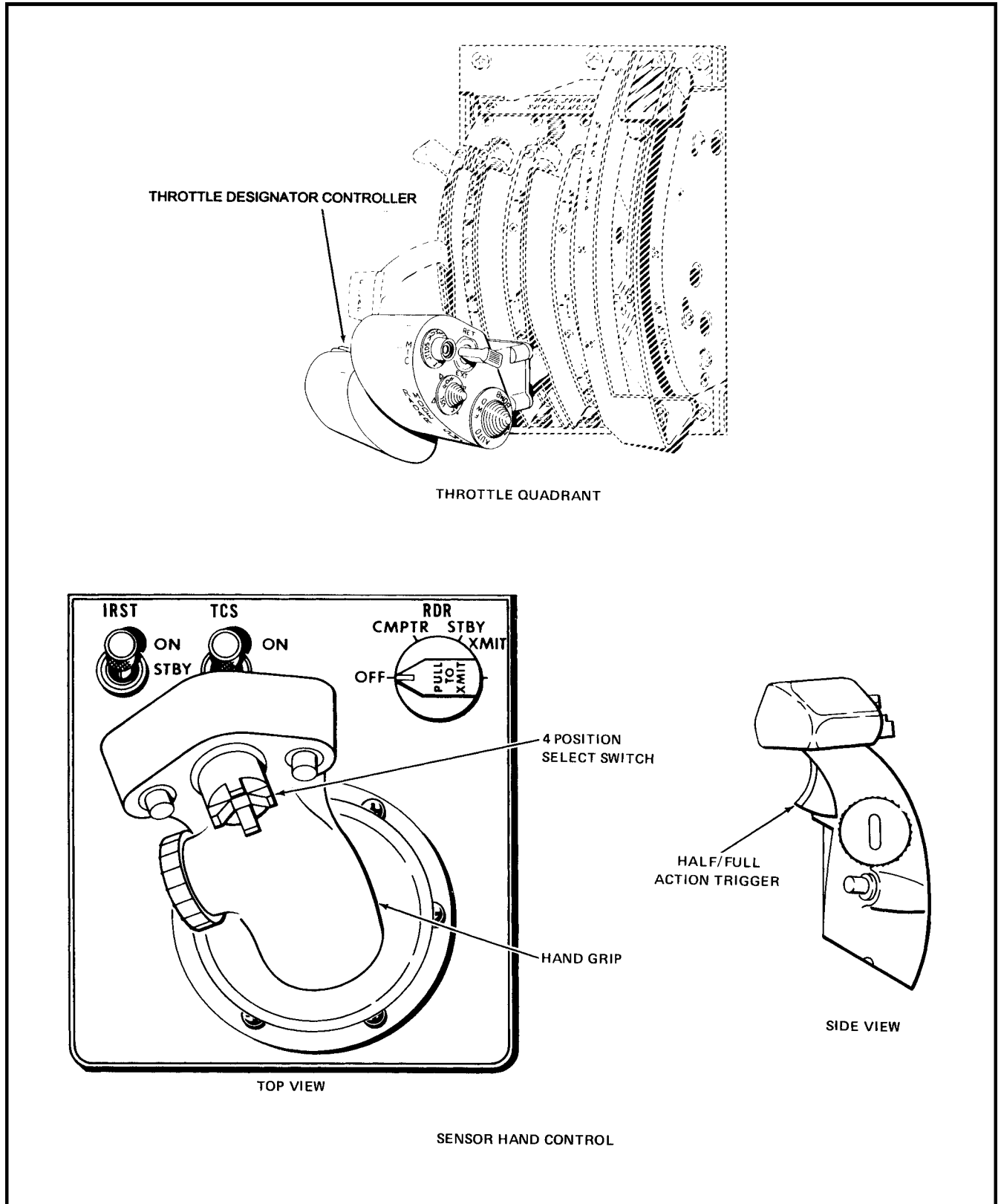
MFD pushbutton hooks permit remote activation of MFD pushbutton functions through the TDC or SHC. They are accomplished by positioning the cursor over the desired MFD menu choice and activating the cursor designate switch.

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 alpha- numerics are described but are not illustrated.



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Figure 2-92. Cursor Controls

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.

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 (Caution Advisory Warning) window or CAW box. 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 2-93](#) 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 PTID displays are repeats on MFD1; HUD, DD, and PTID displays are repeats on MFD2 and MFD3).

2.33.8.2 Test Patterns

The test patterns ([Figure 2-94](#)) 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 break-away symbol are used to check RASTER accuracy. Numerics 0 through 7 check RASTER shades of gray. 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. The HUD default format is the TLN basic format ([Figure 2-95](#)). 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

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 N ₂ .
R N2 OSP	C	PILOT	MFD	Indicates overspeed of right rotor N ₂ .
L N1 OSP	C	PILOT	MFD	Indicates overspeed of left rotor N ₁ .
R N1 OSP	C	PILOT	MFD	Indicates overspeed of right rotor N ₁ .
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.

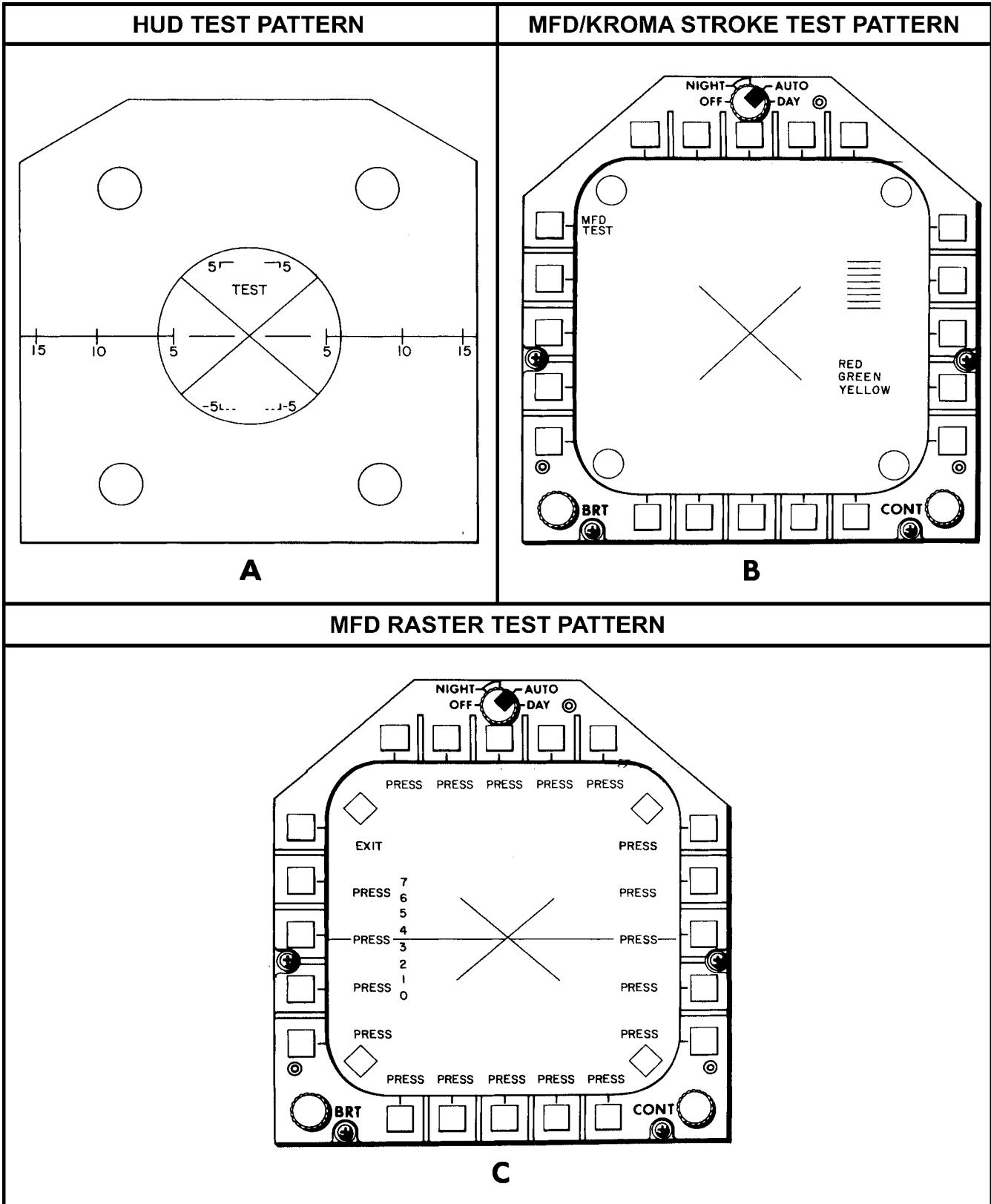
Figure 2-93. Warning, Caution, Advisory Functions (Sheet 1 of 3)

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.
GPS FAIL	A	RIO	MFD	Indicates the MAGR unit is failed or turned off.
POSITION	A	RIO	MFD	Position differs. Will be displayed if: <ul style="list-style-type: none"> ● GPS and INS differ by more than 4 nm. ● GPS and SAHRS differ by more than 11 nm. ● SAHRS and INS differ by more than 13 nm.

Figure 2-93. Warning, Caution, Advisory Functions (Sheet 2 of 3)

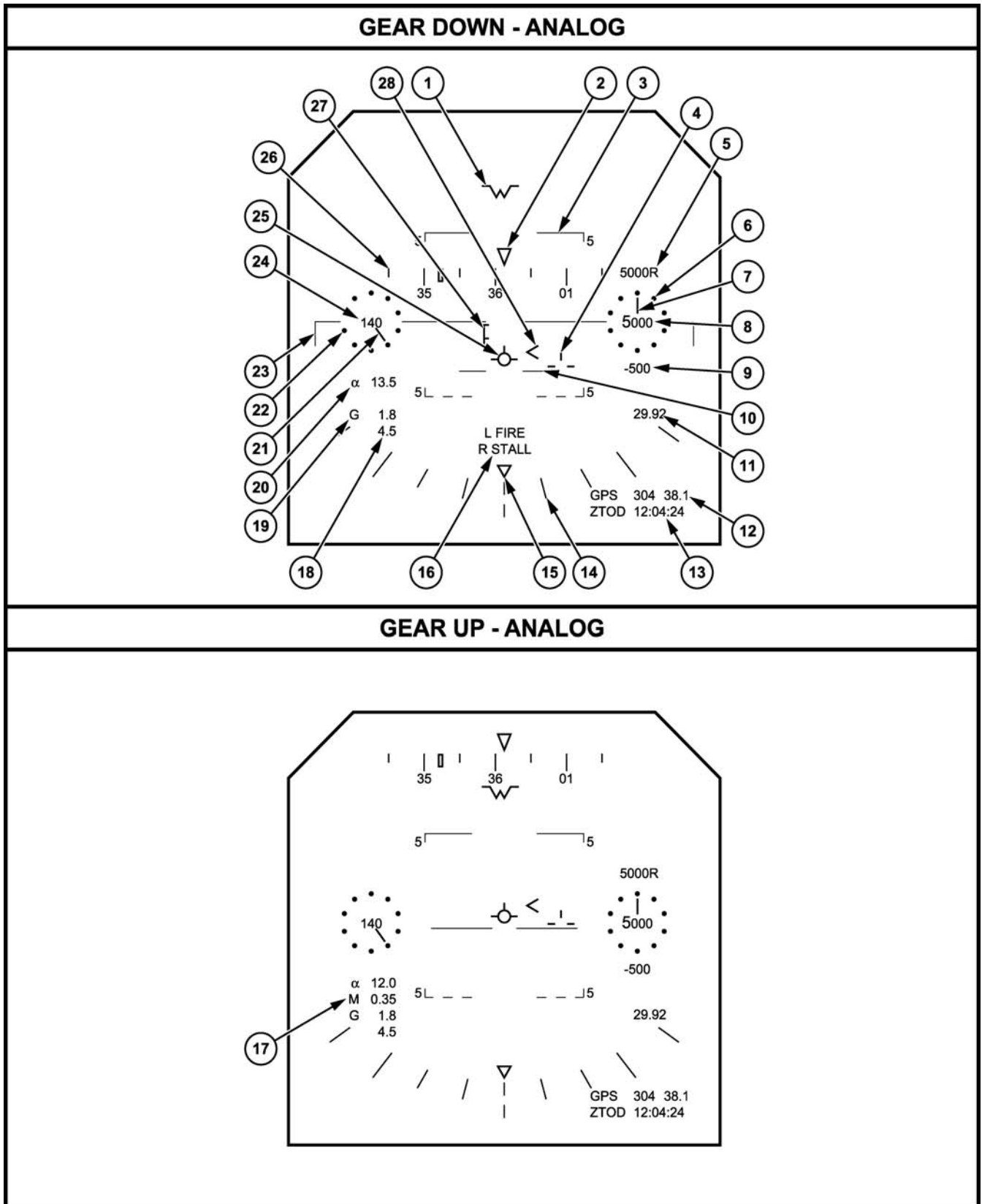
ACRONYM	TYPE	AIRCREW	DISPLAY	FUNCTION
GPS QUAL	A	RIO	MFD	Degradation of GPS occurred so GPS output is invalid.
VELOCITY	A	RIO	MFD	Feet/second.
CIU HOT	A	RIO	MFD	Indicates an overtemp condition of the CIU.
DP1 HOT	A	RIO	MFD	Indicates an overtemp condition of display processor 1.
DP2 HOT	A	RIO	MFD	Indicates 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.
SAHR HOT	A	RIO	MFD	Indicates an overtemp condition of the standard attitude heading reference set.

Figure 2-93. Warning, Caution, Advisory Functions (Sheet 3 of 3)



0-F50D-348-0

Figure 2-94. Test Patterns



CSC-F14D-1-2-043

Figure 2-95. 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 flight path 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/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 Ghost flightpath marker	Displayed at the true velocity vector position when the flight path marker is caged and the true velocity vector position differs from the caged position in azimuth. When the true flight path 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 AOL 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, radar, or GPS 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. A G is only displayed when SCADC altitude becomes invalid and the GPS altitude is used. The G acronym will flash if RADALT is selected and both SCADC and radar altitude are invalid.
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 2-95. 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 Navigation source and range readout	WPT, GPS or TCN; waypoint number, range.
13 Clock/timer readout	Derived from the GPS clock. Default time is ZTOD. Options selectable from the HSD ZTOD pushbutton are ZTOD, TTG, TTGT, TREL, ETA, ET and CD.
14 Bank scale	Provides indication of bank angle to $\pm 45^\circ$. Tick marks are provided at 0° , $\pm 10^\circ$, $\pm 20^\circ$, $\pm 30^\circ$ (slightly larger) and $\pm 45^\circ$.
15 Bank angle pointer	Moving pointer provides indication of aircraft bank angle. At bank angles in excess of $\pm 45^\circ$, the pointer will be pegged at $\pm 50^\circ$ and will flash.
16 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.
17 Mach number	Indicates speed of the aircraft in mach.
18 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.
19 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.
20 Angle of attack	Indicates angle of attack in units.
<p>Note</p> <p>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.</p>	
21 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.
22 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.
23 Extended horizon line	Represents the horizon with respect to the aircraft and changes orientation with any change in aircraft pitch or roll.

Figure 2-95. HUD TLN Basic Format (Sheet 3 of 4)

SYMBOL	FUNCTION
<p>24 Digital airspeed readout</p>	<p>Provides digital readout of calibrated airspeed.</p>
<p>25 Flight path marker</p>	<p>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.</p>
<p>26 Heading scale</p>	<p>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.</p> <p style="text-align: center;">Note</p> <p>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 readout.</p>
<p>27 Angle of attack bracket</p>	<p>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.</p>
<p>28 Potential flight path marker (PFPM)</p>	<p>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.</p>

Figure 2-95. HUD TLN Basic Format (Sheet 4 of 4)

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."

The symbols removed by the DECLUTTER switch vary with formats and are discussed in the applicable paragraphs. Refer to [Figure 2-96](#) 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 2-95](#) for the location and description of TLN basic symbology.

Steering mode selection is made through MFD push-button or cursor designate action on the VDI AWL formats. TCN, DEST and GPS steering mode selections are also available on the HSD by boxing the TACAN data buffer or waypoint data buffer. Making a steering mode selection changes TLN basic to TLN TCN (TACAN), MAN (manual), DEST (destination), GPS, D/L (data link), or AWL (all-weather landing).

SYMBOL NAME	HUD MODES/DECLUTTER SWITCH SELECTION											
	TLN-GD			TLN-GU			A/A			A/G		
	N	1	2	N	1	2	N	1	2	N	1	2
MACH*				■	■		■	■		■	■	
AIRCRAFT G	▨	▨	▨	■	▨	▨	■	■	▨	■	■	▨
PEAK G	▨			▨			▨	▨		▨	▨	
DIGITAL BOXES	■	■		■	■		■	■		■	■	
ANALOG DIALS	■	■	■	■	■	■	■	■	■	■	■	■
AOB SCALE	■			■								
AOA READOUT	▨	▨		■			■			■		
HEADING SCALE	■	■	■	■	■	■	■	■	■	■	■	■
NAV RANGE	■	■		■	■		■	■		■	■	
PFFPM	■	■		■	■		■	■		■	■	
GHOST FPM	▨	▨	▨	▨	▨	▨	▨	▨		▨	▨	
AOA BRACKET	■	■	■									
RADAR ALTITUDE READOUT	▨			▨	▨		▨			▨	▨	
VERTICAL VELOCITY	■	■		■								
WATERLINE	■	■	■	▨	▨	▨	▨	▨	▨	▨	▨	▨
A/A RANGE	▨	▨	▨	▨	▨	▨	▨	▨	▨			
CLOSURE	▨	▨	▨	▨	▨	▨	■	■	■			
TARGET POINTER/AON							▨	▨	▨			
PITCH LADDER	■	■	■	■	■	■	■	■	*	■	■	■

NOT PRESENT
 PRESENT
 AS REQUIRED

*Pitch ladder replaced on Spin

Figure 2-96. HUD Declutter Levels

Steering mode is identified on the HUD by a legend in the data readout display area. Steering modes are described in Chapter 20.

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, datalink, 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 flight path marker is at or beyond the HUD field of view or when altitude data is lost.

Figure 2-97 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 2-98 for a description of the symbols that are available for TLN formats.

2.33.8.3.2 Air-to-Air Formats

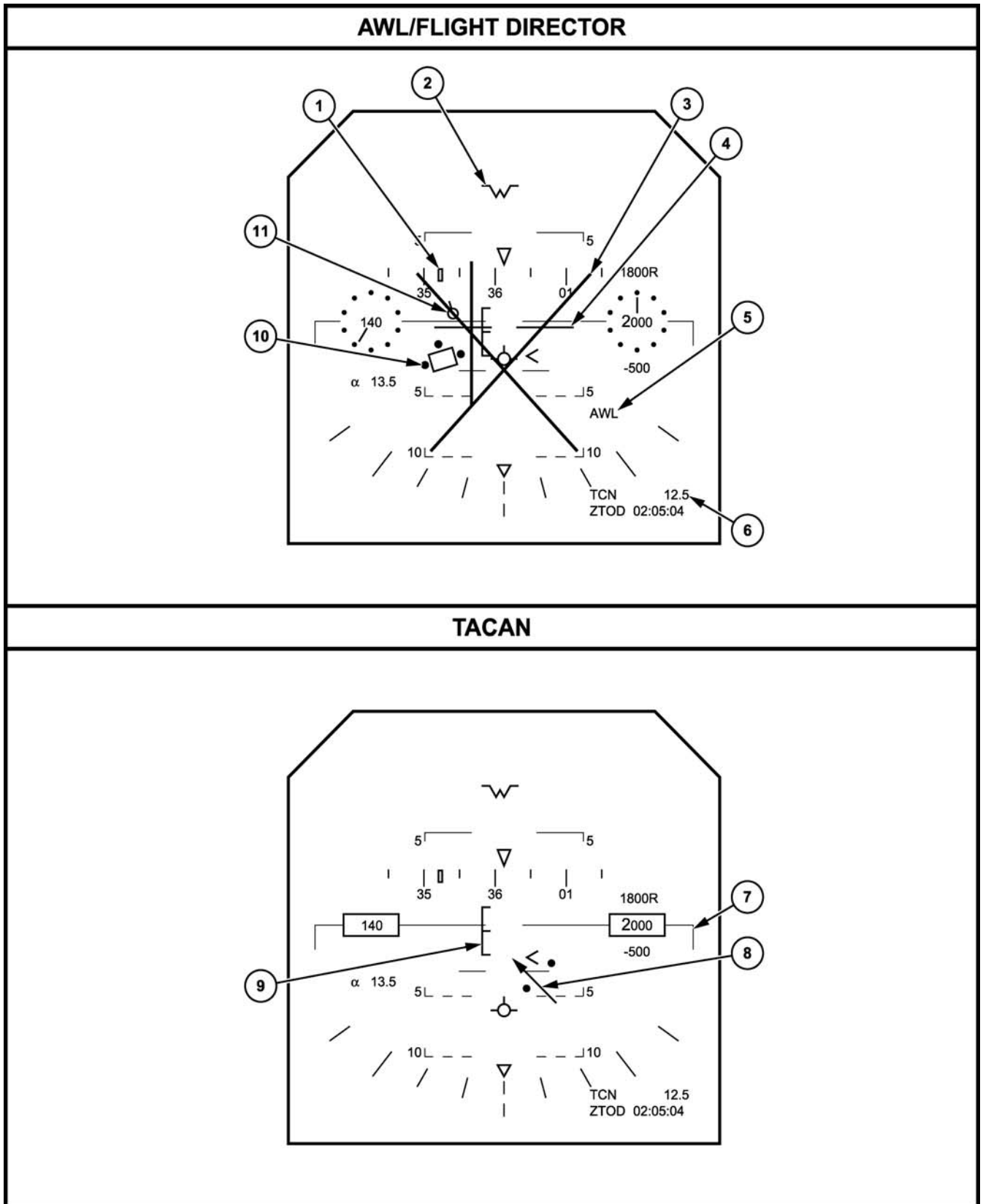
A/A formats (Figure 2-99 and Figure 2-100) are presented when the pilot selects the A/A pushbutton on the pilot displays control panel, when a weapon is selected, the radar hot modes are selected, or when the ACM guard is lifted. The A/A formats provide target acquisition, weapon status, and shoot prompts 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 the Supplemental NATOPS Flight Manual, 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 alphanumeric. The radar mode alphanumeric are removed when the radar is off or in the computer mode. An "X" overlays the mode indication if the IRST is failed (Figure 2-99). The radar mode alphanumeric 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 (RWSV)
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).



CSC-F14D-1-2-044

Figure 2-97. 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 needles	Consists of two independent needles (vertical and horizontal) which form a cross pointer. The horizontal needle responds to ILS glide slope error and the vertical needle 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 2-97. HUD Added Symbology (Sheet 2 of 2)

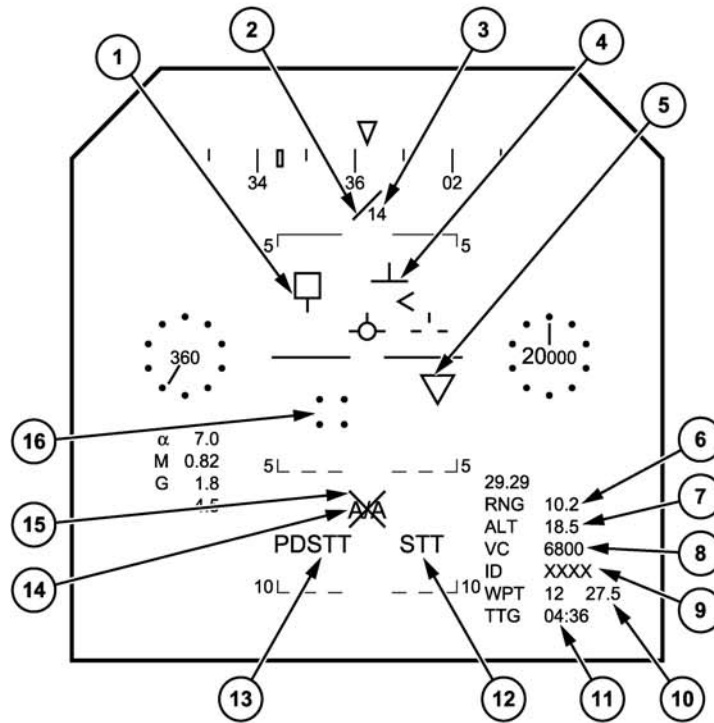
SYMBOL	FORMAT					
	BASIC	AWL	DATA LINK	DESTINATION	MANUAL	TACAN
Aircraft G Readout	(On all formats except GEAR DOWN & DECLUTTER-2)					
Airspeed Dial	(On all formats except DIGITAL)					
Airspeed Readout Box	(On all formats except ANALOG or DECLUTTER-2)					
Airspeed Readout	(On all formats)					
Altitude Dial	(On all formats except DIGITAL)					
Altitude Readout Box	(On all formats except ANALOG or DECLUTTER-2)					
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 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)					
Clock/Timer Readout	(On all formats except DECLUTTER-2)					

Figure 2-98. HUD Symbology Available on TLN Formats (Sheet 1 of 2)

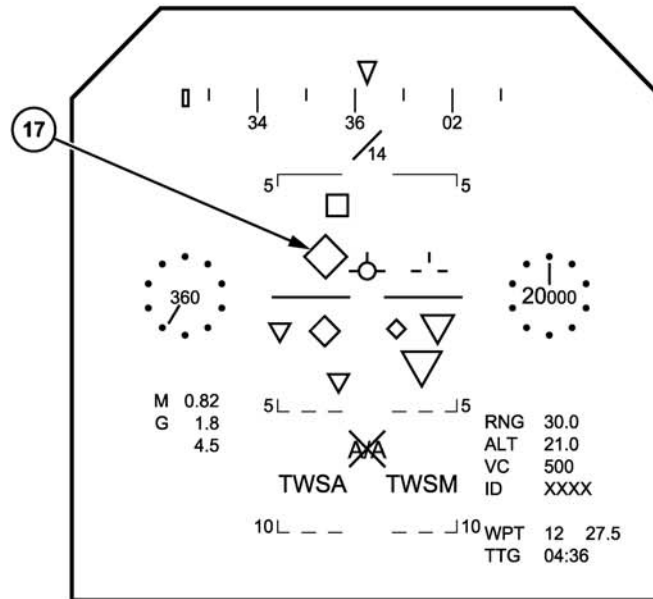
SYMBOL	FORMAT					
	BASIC	AWL	DATA LINK	DESTINATION	MANUAL	TACAN
Waterline	(On all formats or when flight path marker pegged or altitude data invalid)					
Altitude Source – B, R, or G	+	+	+	+	+	+
HUD Cursor	+	+	+	+	+	+
Potential Flight Path Marker	(On all formats except DECLUTTER–2)					
Angle of Attack 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 Needles	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	+
<p>Notes:</p> <ul style="list-style-type: none"> + 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 2-98. HUD Symbology Available on TLN Formats (Sheet 2 of 2)

A/A BASIC, STT FORMAT - ANALOG, NO DECLUTTER



HUD TWS, IRST SEARCH-ANALOG, DCL LVL 1



CSC-F14D-1-2-045

Figure 2-99. HUD A/A Search Formats (Sheet 1 of 2)

NOMENCLATURE	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 symbol is positionable over the total HUD field of view (FOV). When the target moves beyond the FOV limits of the HUD, the symbol will peg 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) PTID hooked track is outside the IFOV with no FONO 1 present. 3) Closest TMA is outside the IFOV and there is no FONO 1 PTID 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 IRST target location. 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 Navigation data	Displays steering mode, waypoint selected or range (DEST or D/L).
11 Clock/timer readout	TTG is selected from the HSD ZTOD pushbutton, and indicates time-to-go to read designated waypoint.
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 TCS track location.
17 NCTR	Indicates non-cooperative target recognition is available. Refer to NAVAIR 01-F14AAD-1A.

Figure 2-99. HUD A/A Search Formats (Sheet 2 of 2)

SYMBOL	FORMAT								
	BASIC	PHOENIX		SPARROW		SIDEWINDER		MMGS	GUN BACKUP
		SEARCH	TRACK	SEARCH	TRACK	SEARCH	TRACK		
Aircraft G 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-2)								
Baro Setting Readout	+	+	+	+	+	+	+	+	+
Clock/Timer Readout	(On all formats except DECLUTTER-2)								
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 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 2-100. HUD Symbology Available on A/A Formats (Sheet 1 of 2)

SYMBOL	FORMAT								
	BASIC	PHOENIX		SPARROW		SIDEWINDER		MMGS	GUN BACKUP
		SEARCH	TRACK	SEARCH	TRACK	SEARCH	TRACK		
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 2-100. HUD Symbology Available on A/A Formats (Sheet 2 of 2)

IRST modes are indicated on the HUD via alphanumerics. The IRST mode alphanumeric is removed when the IRST is failed. The IRST alphanumeric is 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 (Figure 2-101 and Figure 2-102). 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 the Supplemental NATOPS Flight Manual, NAVAIR 01-F14AAD-1A.

2.33.8.4 Overlay Symbolology

Symbolology (Figure 2-103) 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 2-104) 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

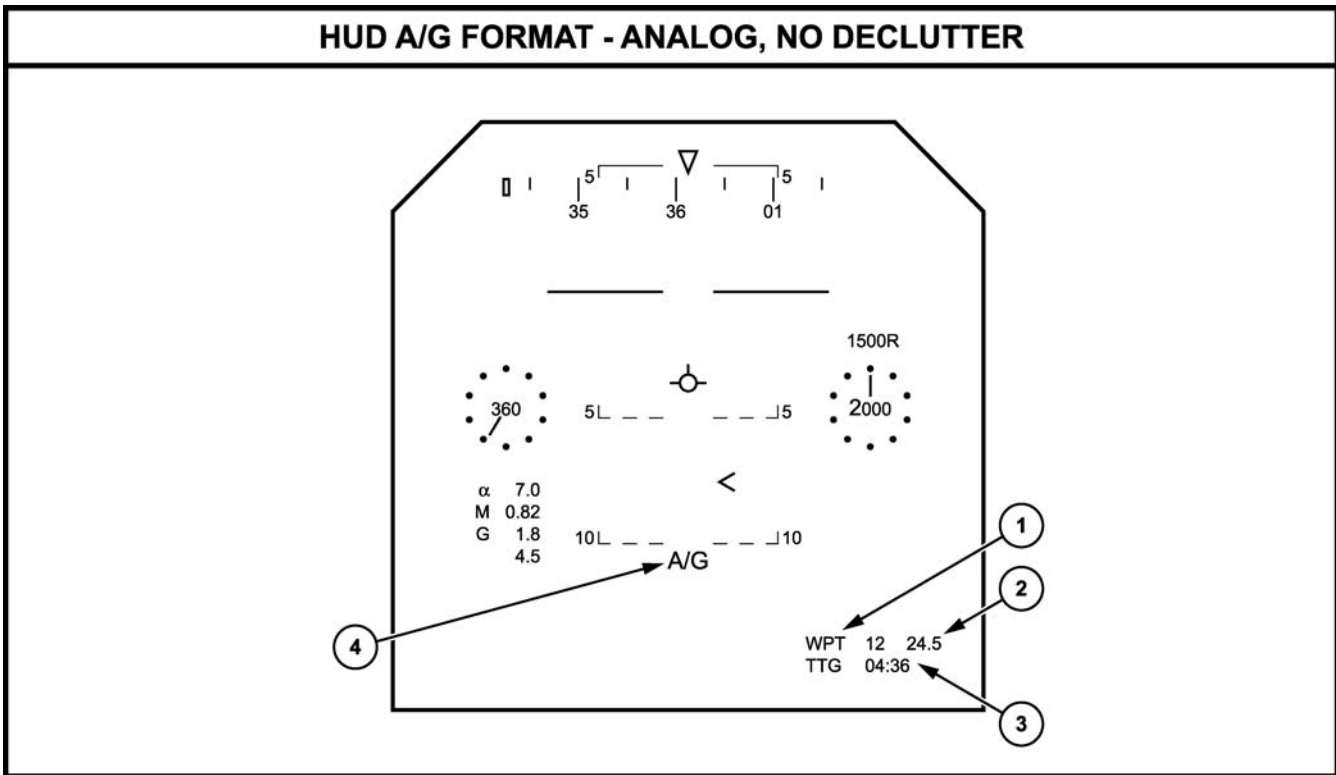
Initial turn on or a cold start (defined as a system reset or a MCS power outage of at least 300 milliseconds) causes the following default formats to be displayed: With gear down and weight on wheels, VDI/TLN basic on MFD1, OBC basic on MFD2, and OWN A/C on MFD3; with gear down and weight off wheels, VDI/TLN basic on MFD1, HSD on MFD2, and HSD on MFD3; and with gear up and weight off wheels, TSD on MFD1, HSD on MFD2, and HSD 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 2-105 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 master mode selection, 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 PTID 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 are the SMS and ECM pushbutton legends (Figure 2-106).

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.



CSC-F14D-1-2-046

NOMENCLATURE	FUNCTION
① Waypoint select	Displays destination waypoint selection.
② Range to waypoint readout	Displays range to selected waypoint.
③ Clock/timer readout	TTG to reach designated waypoint (based on HSD format clock/timer select [PB7]).
④ Select legend	Displays mode/weapon selected. Will display A/G If no weapon has been selected.

Figure 2-101. HUD A/G Basic Format

SYMBOL	FORMAT		
	BASIC	CCIP	MANUAL
Aircraft G Readout	o	o	o
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	+	+	+
Clock/Timer Readout	(On all formats except DECLUTTER - 2)		
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 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 2-102. HUD Symbology Available on A/G Formats (Sheet 1 of 2)

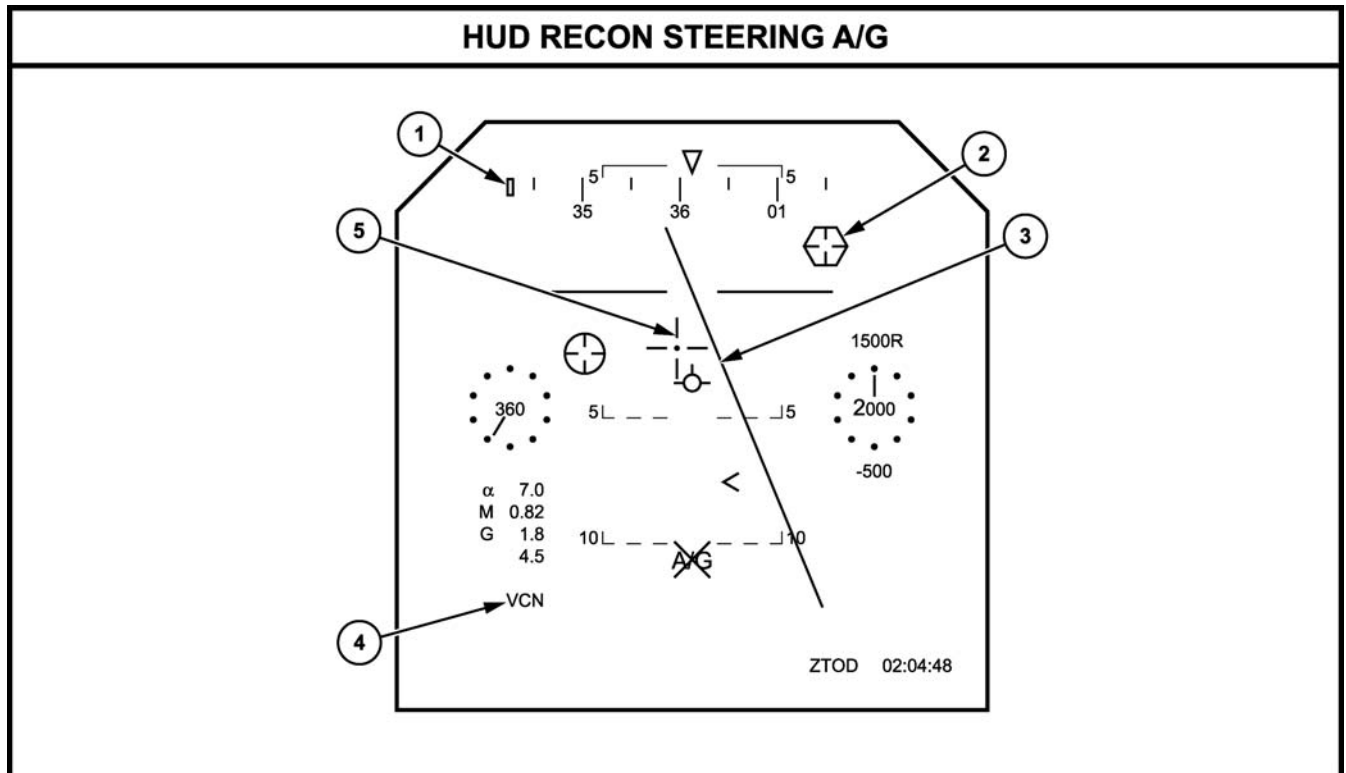
SYMBOL	FORMAT		
	BASIC	CCIP	MANUAL
IRST Pointer	+	+	+
TCS Pointer	+	+	+
Caution/Advisory/Warning	+	+	+
Breakaway Symbol	o	+	o
Command Heading Marker	+	+	+
Select Legends, Weapon – Qty	A/G	G	G
Master Arm Switch Safe Cue	+	+	+
Pull Up Cue	o	+	o
Waypoint Select	+	+	+
Steering Tee	+	+	+
TACAN Digital Readout	+	+	+
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.

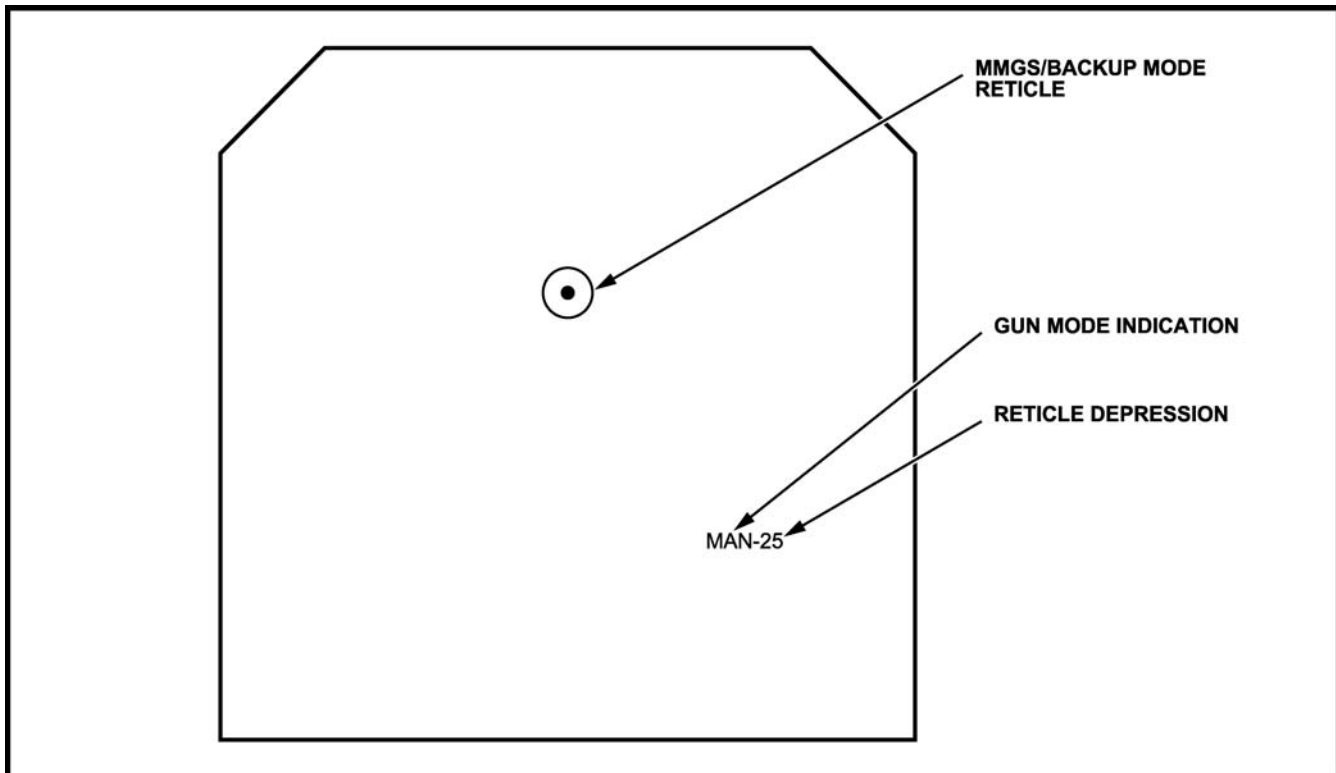
Figure 2-102. HUD Symbology Available on A/G Formats (Sheet 2 of 2)



CSC-F14D-1-2-047

SYMBOL	FUNCTION
<p>① Recon command heading marker</p>	<p>Indicates the magnetic heading to the dynamic steering point or commanded heading in the 90 deg - 270 deg maneuver during map steering.</p>
<p>② Target designator, hexagon</p>	<p>Displays target position. Positioned by on-board sensors or data link.</p>
<p>③ Command ground track line</p>	<p>Displays the path of the command ground track.</p>
<p>④ Camera selection legend</p>	<p>Displays the camera operational mode. First letter indicates frame position: V = vertical, 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.</p>
<p>⑤ Recon steering symbol</p>	<p>Provides elevation and azimuth steering information.</p>

Figure 2-103. HUD Overlay Formats



CSC-F14D-1-2-026

Figure 2-104. HUD Manual Reticle Format

With a MENU display selected, format legends (Figure 2-106) 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 on the display is enclosed by 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

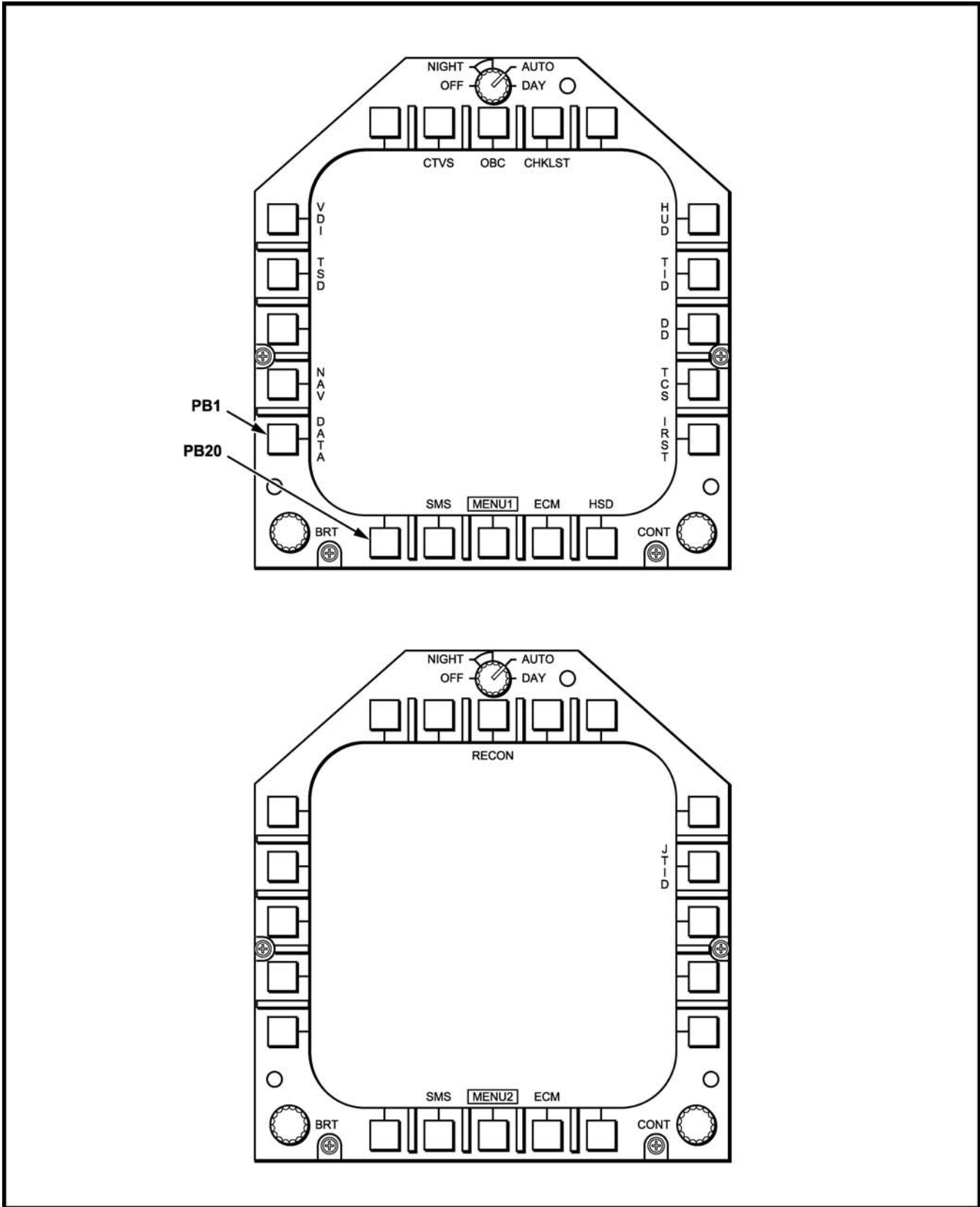
the RIO cockpit. Either OWN A/C basic, ground align, CVA (carrier align), or IFA (in-flight align) formats will be displayed.

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 — Selection results in placement of the tactical situation display format on the selected MFD. Switching logic prevents the TSD from appearing on two MFDs at the same time. Therefore, selecting TSD on MFD1, while TSD is displayed on MFD2, will result in the TSD moving to MFD1 and MENU1 appearing on MFD2. 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
GPS STAT	OWN A/C
HSD WAYPOINT	WAYPOINT PLOT
WAYPOINTS DATA (Note 1, 2)	WAYPOINT
FLIGHT PLAN	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
<p>Notes:</p> <p>(1) No slaved DEU format shall be established if MFD 3's previous format was WAYPOINT DATA 2 or RECON WPT DATA 1.</p> <p>(2) No slaved DEU format shall be established if MFD 3's previous format was WAYPOINT DATA 1 or RECON WPT DATA 2.</p> <p>(3) No slaved DEU format shall be established if MFD 3's previous format was CV SINS DATA.</p> <p>(4) No slaved DEU format shall be established if MFD 3's previous format was CV MAN DATA.</p> <p>(5) No slaved DEU format shall be established if MFD 3's previous format was NAV AID CORRECTIONS.</p> <p>(6) No slaved DEU format shall be established if MFD 3's previous format was RECON WPT DATA 2.</p> <p>(7) No slaved DEU format shall be established if MFD 3's previous format was RECON WPT DATA 1.</p>	

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 color 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 PTID — This selection displays a repeat of the programmable 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.

Figure 2-105. Slaved DEU Page Control



CSC-F14D-1-2-064

Figure 2-106. MFD MENU Displays

17. PB17 ECM — This selection displays 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 a threat is being reported.
18. PB18 MENU1 — This legend will be boxed. Selection of MENU1 when boxed presents MENU2.
19. PB19 SMS — This selection displays 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 2-106) 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 PTID 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 2-107) is displayed on MFD 1 and the PTID, 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 PTID repeat, MENU 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 2-86) 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.

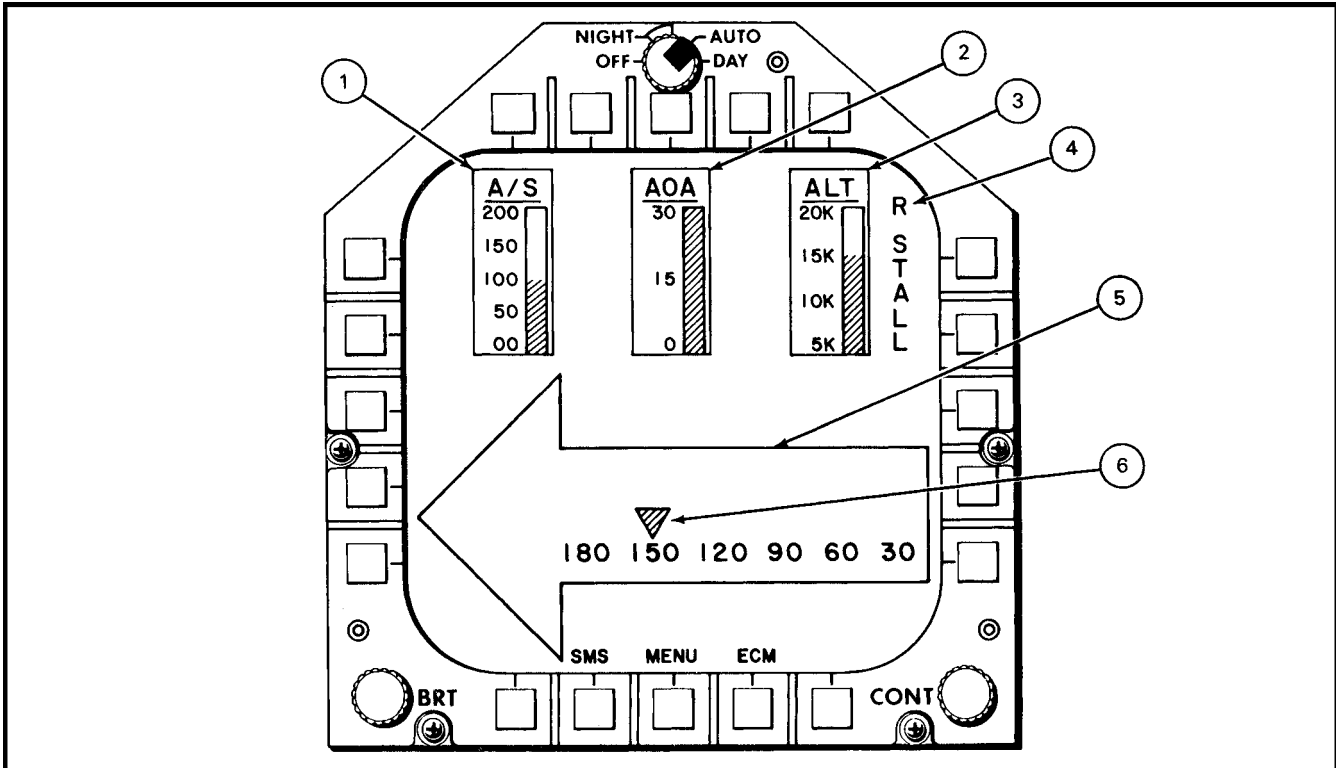
The ECM format can also be selected manually by pushbutton selection. The ECM legend appears on all MFD formats above PB17. When selected, the legend is boxed. Pressing PB17 with ECM boxed returns the previous format to the display. For further information, refer to NAVAIR 01-F14AAD-1A.

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 2-108 shows the locations of these overlays and describes their control logic.

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.

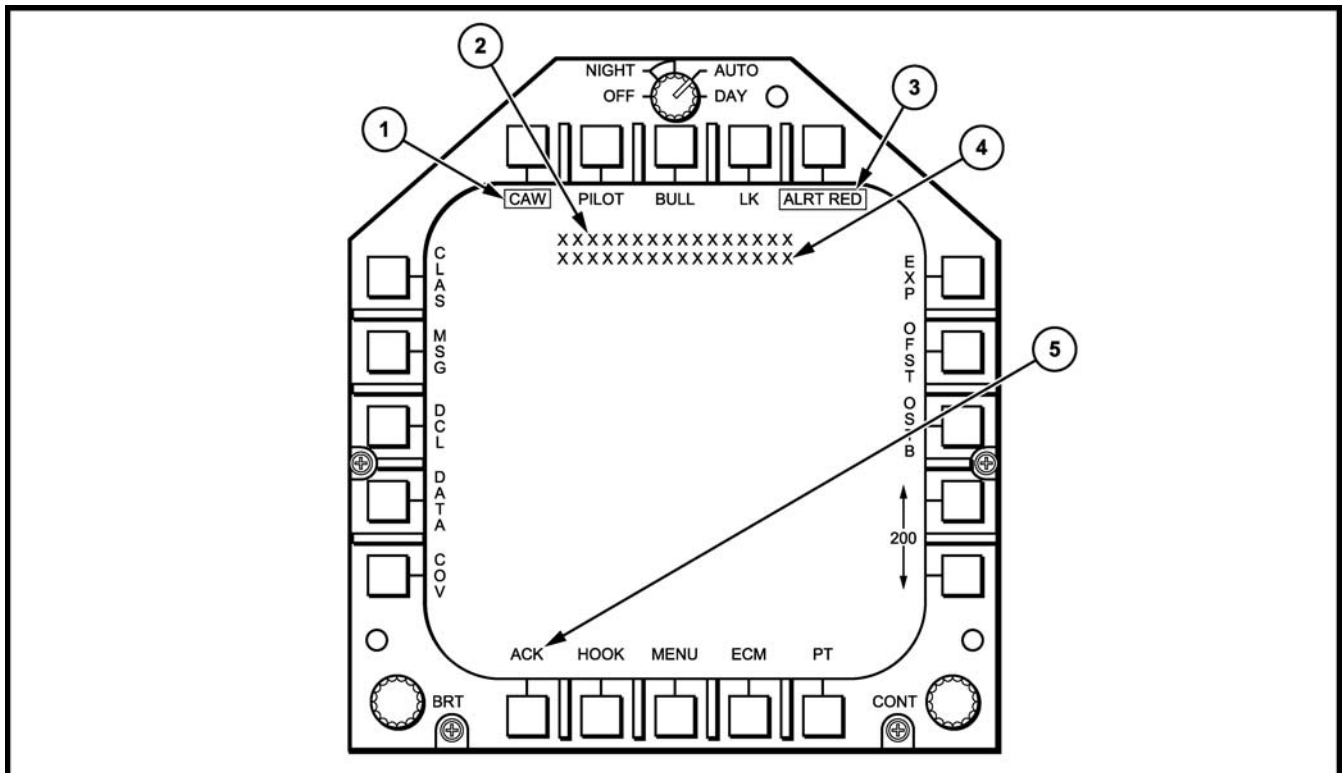
Systems messages are generated by the mission computer to alert the crew of system conditions. Two categories of system messages are displayed: computer messages (those that can appear on any MFD format), and OBC messages (those that can only appear on the OBC and maintenance current-failure display formats). The OBC and maintenance current-failure display formats are capable of supporting both categories of system messages simultaneously. The messages are displayed on the upper



0-F50D-340-0

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 tape 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 2-107. MFD Spin Indicator Display



CSC-F14D-1-2-039A

SYMBOL	FUNCTION
<p>① Warning/caution/advisory readout</p>	<p>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.</p>
<p>② Computer message</p>	<p>The first row of ASCII characters is used to display the computer messages for all display formats. See Figure 2-109 for a listing of these messages.</p>
<p>③ Data link/JTIDS advisory readout</p>	<p>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 the Supplemental NATOPS Flight Manual, NAVAIR 01-F14AAD-1A.</p>

Figure 2-108. MFD Warning/Caution/Advisory and Message Overlays (Sheet 1 of 2)

SYMBOL	FUNCTION
<p>④ OBC messages</p>	<p>The second row of ASCII characters is used to display the OBC messages on the OBC and maintenance current failure formats. See Figure 2-109 for a listing of these messages.</p>
<p>⑤ Acknowledge (ACK) pushbutton</p>	<p>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.</p>

Figure 2-108. MFD Warning/Caution/Advisory and Message Overlays (Sheet 2 of 2)

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 2-109) 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 2-110 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 (Figure 22-5 and Figure 22-6).
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 (Figure 22-5 and Figure 22-6).
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 (Figure 22-5 and Figure 22-6).

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 (Figure 20-15). 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, GPS STAT, 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
INTERLOCK ABORT	1,3	2 (Note 8)

Figure 2-109. Computer and OBC Messages (Sheet 1 of 4)

COMPUTER MESSAGE	PRIMARY MFD	SECONDARY MFD
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)
GPS FAIL	1,3	2 (Note 8)
IFA AVAILABLE	1,3	2 (Note 8)
MDL FAIL DETECTED	1,3	2 (Note 8)
INVALID MDL FORMAT	1,3	2 (Note 8)

Figure 2-109. Computer and OBC Messages (Sheet 2 of 4)

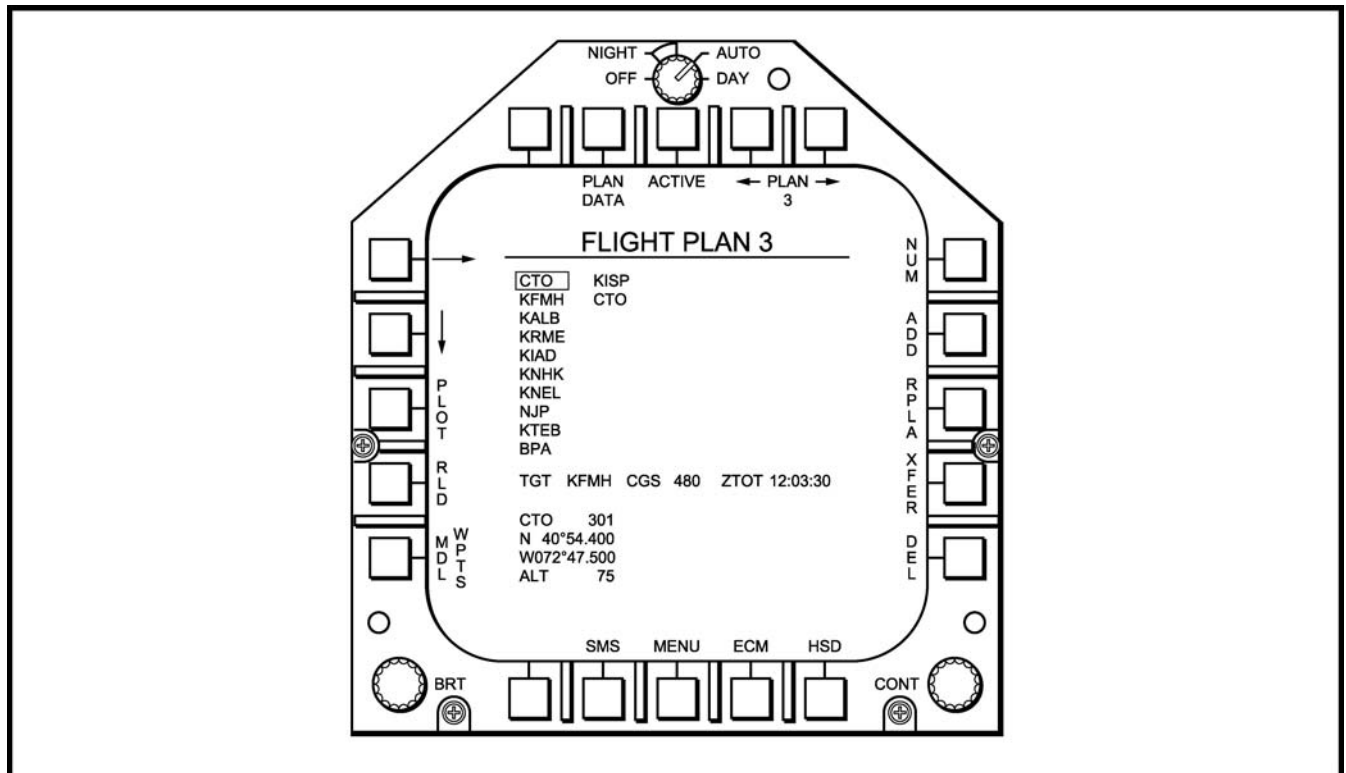
COMPUTER MESSAGE	PRIMARY MFD	SECONDARY MFD
<p>Notes:</p> <p>(1) through (6) indicates the range of the ADVISORY DATA from the application function and the corresponding ASCII strings:</p>		
<p>(1) GGGGG</p> <p>1 AUX</p> <p>2 CD</p> <p>3 CNI</p> <p>4 FLT</p> <p>5 NAV</p> <p>6 EW</p> <p>7 TAC</p> <p>8 IRST</p> <p>(2) WWWW</p> <p>1 MC1</p> <p>2 MC2</p> <p>4 DEU</p> <p>5 MDS1</p> <p>6 MDS2</p> <p>7 RDR</p> <p>8 CIU</p> <p>9 SAHR</p> <p>10 SMS</p> <p>11 ADAC</p> <p>12 DSS</p> <p>13 ASPJ</p> <p>14 PWR</p> <p>15 IRST</p> <p>16 SDIS</p>	<p>(3) XXX</p> <p>(4) SSSS</p> <p>6</p> <p>8</p> <p>9</p> <p>10</p> <p>11</p> <p>12</p> <p>13</p> <p>15</p> <p>16</p> <p>17</p> <p>18</p> <p>(5) NN 0-99</p> <p>(6) AAAAA</p> <p>1</p> <p>2</p>	<p>0-999</p> <p>MDS1</p> <p>CIU</p> <p>DEU</p> <p>MC1</p> <p>MDS2</p> <p>ADAS</p> <p>SMS</p> <p>MC2</p> <p>IRST</p> <p>SDIS</p> <p>JTIDS</p> <p>INS</p> <p>SAHRS</p>
<p>(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.</p> <p>(8) MFD 2 is secondary only when MFD 1 fails.</p> <p>(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.</p>		

Figure 2-109. 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 2-109. 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 (Figure 20-24 and Figure 20-25).
8. IFA — This format presents similar data to OWN A/C and also provides selection of in-flight alignment. It is selected via PB4 (IFA) on the OWN A/C IFA format (Figure 20-23).
9. WPT DATA — Up to 649 waypoints are stored on the MDL. This format displays the latitude, longitude, and altitude of these waypoints as well as OWN A/C and CVA, INS/SAHRS formats. Ten waypoints are presented on each waypoint data page and the waypoint page number is indicated at the top of the display. The data page can be incremented (PB 10) or decremented (PB 9). To select the waypoints for display, PB 1 through PB 5 and PB 11 through PB 15 may be used to box waypoint data, highlighting waypoints of interest (Figure 20-29).
10. FLIGHT PLAN — This format is selectable from the OWN A/C formats or HSD format. This format shows the waypoints contained in Flight Plans 1 through 7. The flight plans are selected by incrementing (PB 10) or decrementing (PB 9). The format presents the flight plan number and up to 50 waypoints associated with waypoints by name or by number when NUM (PB 11) is boxed. The individual waypoint in each flight plan can be selected using arrows (PB 4 and PB 5) and the waypoint name, number, latitude, longitude, and altitude will be displayed in the lower left of the display (Figure 20-35 and Figure 20-37).
11. 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.
12. 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.
13. 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.
14. 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.



CSC-F14D-1-2-048

Figure 2-110. Typical MFD Alphanumeric Format

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.

Note

Refer to Chapter 20 for more information on navigation related formats.

15. MISSILE SUBSYSTEM formats — Two formats display the status of the missiles. Refer to the Supplemental NATOPS Flight Manual, NAVAIR 01-F14AAD-1A.
16. 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 push-button 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 (Figure 38-12 and Figure 38-13).
17. 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.
18. 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.
19. 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 (Figure 38-20).

Note

Chapter 38 includes a complete description of the OBC, MAINTENANCE, FHF, and CSS formats with a discussion of their use and interpretation.

20. 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.
21. 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 PTID.

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 in lighter shades 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 2-111](#) identifies and describes TLN symbol functions in various steering and tracking modes. The last example in [Figure 2-111](#) illustrates VDI declutter. Refer to [Figure 2-111](#) 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, 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 2-112](#). [Figure 2-113](#) 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 2-114](#) lists the symbols available on VDI A/A formats.

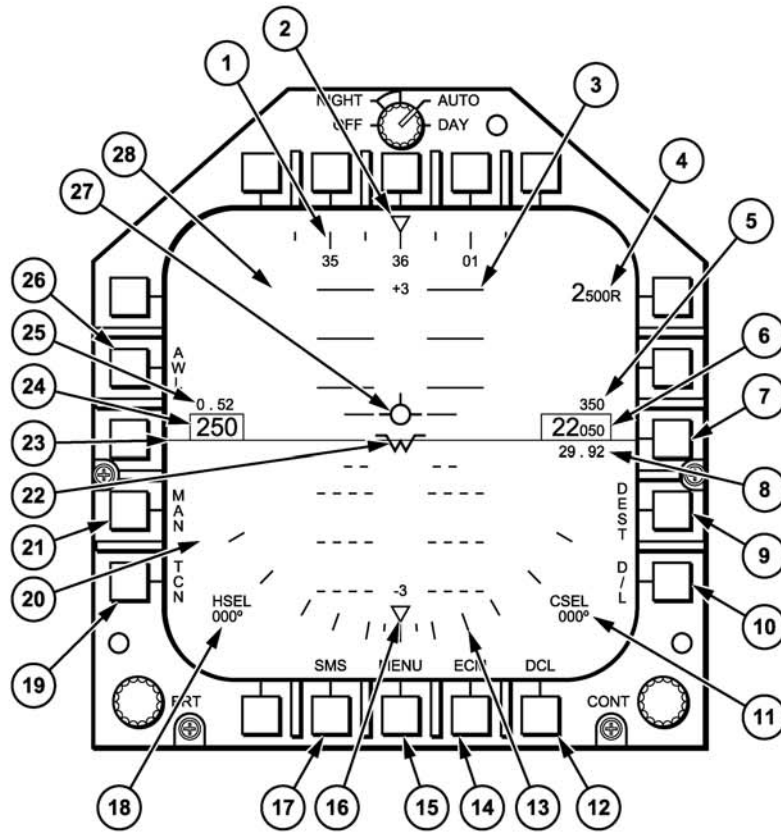
2.33.9.4.3 VDI Air-to-Ground (A/G) Formats

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 2-114](#) shows the A/G symbol set and [Figure 2-115](#) 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.

TLN BASIC



CSC-F14D-1-2-054

Figure 2-111. 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 pitch angle and roll angles. 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, radar, or GPS 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. A G is only displayed when SCADC altitude becomes invalid and the GPS altitude is used. The G acronym will flash if radar altitude is selected and both SCADC and radar altitude are invalid. 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 DCL legend.

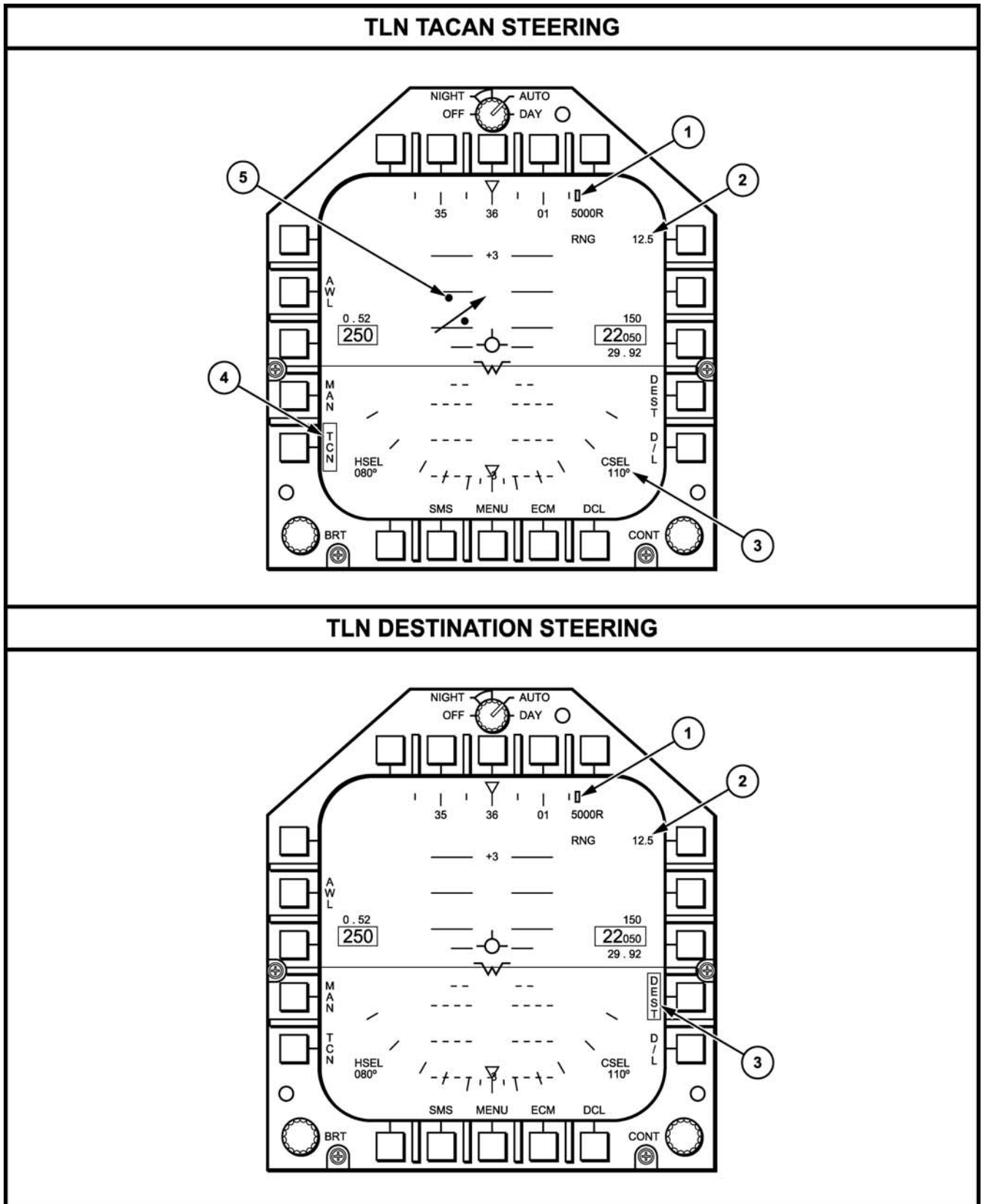
Figure 2-111. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 2 of 9)

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	Selects the ECM 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 of aircraft bank angle. At bank angles in excess of 65° the pointer will be removed from the display.
17 SMS display pushbutton	Selects 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	Selects the TACAN steering mode.
20 Ground plane	The dark shaded ground plane.
21 MAN pushbutton	Selects the manual steering mode.
22 Waterline	In TLN, a fuselage reference line 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	Selects 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.
	<p style="text-align: center;">Note</p> <p style="text-align: center;">With VDI on MFD 3, AWL selection is possible, but deselection is inhibited.</p>

Figure 2-111. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 3 of 9)

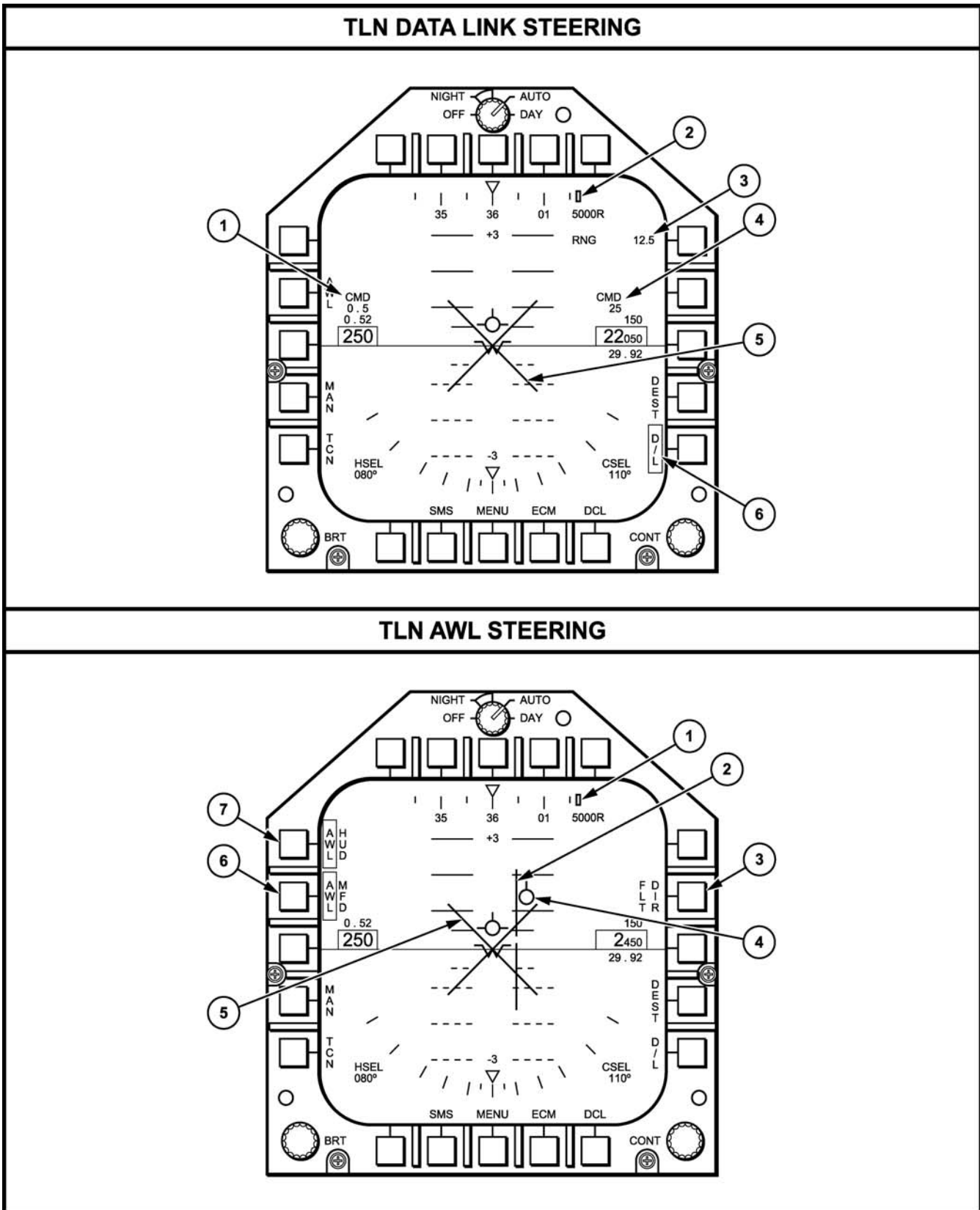
SYMBOL	FUNCTION
<p>②⑦ Flight path marker</p> <p>②⑧ Sky plane</p>	<p>The vertical position of the flight path marker with respect to the flight path ladder indicates the vertical flight path angle of the aircraft.</p> <p>The light shaded area represents the sky.</p>
<p>TLN TACAN STEERING</p> <p>① Command heading marker</p> <p>② TACAN range</p> <p>③ VDI selected course indicator</p> <p>④ TACAN steering mode selection</p> <p>⑤ Course arrow</p>	<p style="text-align: center;">Note</p> <p style="text-align: center;">The following changes or additions occur when TACAN steering is selected.</p> <p>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.</p> <p>Indicates distance to the selected TACAN station.</p> <p>Indicates selected course.</p> <p>Box around TCN pushbutton legend indicates the TACAN steering mode has been selected.</p> <p>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. The flight path marker centered over the course arrow indicates being on course. For TACAN bearings aft of +90°, the arrow will be dashed.</p>
<p>TLN DEST STEERING</p> <p>① Command heading marker</p> <p>② Destination range</p> <p>③ DEST steering mode selection</p>	<p style="text-align: center;">Note</p> <p style="text-align: center;">The following changes or additions occur when destination steering is selected.</p> <p>Indicates the heading required to steer to the waypoint selected by the pilot/RIO. Where commanded heading is beyond display limits, the marker will be pegged at the edge nearest to the commanded heading.</p> <p>Indicates distance to the selected waypoint.</p> <p>Box around DEST pushbutton legend indicates the destination steering mode has been selected.</p>

Figure 2-111. MFD VDI Formats — Takeoff, Lading, Navigation (Sheet 4 of 9)



CSC-F14D-1-2-055

Figure 2-111. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 5 of 9)



CSC-F14D-1-2-056

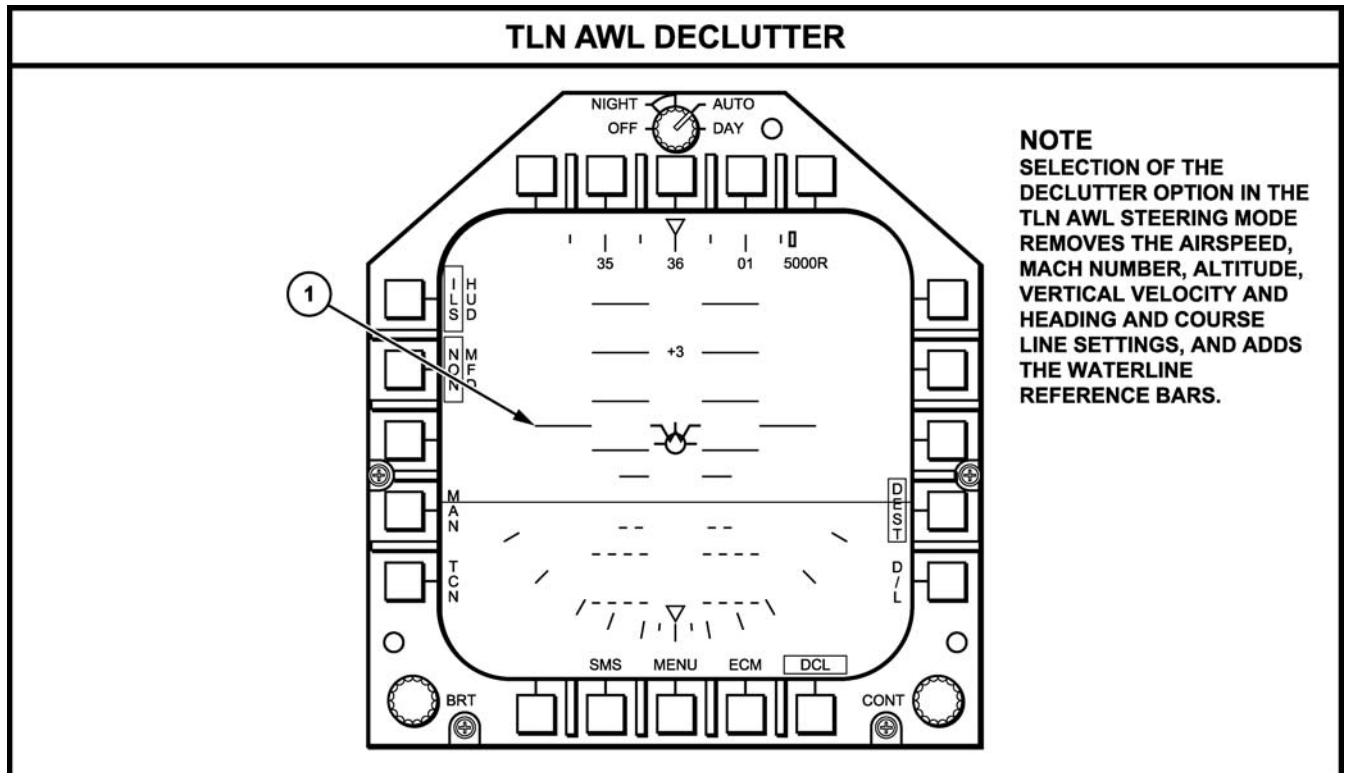
Figure 2-111. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 6 of 9)

SYMBOL	FUNCTION
<p>TLN DATA LINK STEERING</p> <p>① Command Mach Indicator</p> <p>② Command heading marker</p> <p>③ Data link range</p> <p>④ Command altitude indicator</p> <p>⑤ Breakaway</p> <p>⑥ D/L steering mode selection</p>	<p style="text-align: center;">Note</p> <p style="text-align: center;">The following changes or additions occur when data link steering is selected.</p> <p>Indicates data link commanded mach number.</p> <p>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.</p> <p>Indicates data link commanded range.</p> <p>Indicates data link commanded altitude. The two digits displayed represent thousands of feet.</p> <p>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.</p> <p>Box around D/L pushbutton legend indicates the data link steering mode has been selected.</p>

Figure 2-111. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 7 of 9)

SYMBOL	FUNCTION
<p>TLN AWL STEERING</p> <p>① Command heading marker</p> <p>② Precision course needles</p> <p>③ Flight Director</p> <p>④ ACL steering indicator</p> <p>⑤ Waveoff</p> <p>⑥ MFD AWL display select</p> <p>⑦ HUD AWL display select</p>	<p style="text-align: center;">Note</p> <p style="text-align: center;">The following changes or additions occur when AWL steering is selected.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>Provides ACL steering commands driven by the ASW-27C data link.</p> <p>During carrier landings, a large X will appear flashing in the center of the display to indicate a waveoff command.</p> <p>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, ILS, ACL, and no steering information on the MFD, in that order.</p> <p>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. 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.</p>

Figure 2-111. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 8 of 9)



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.

CSC-F14D-1-2-057

SYMBOL	FUNCTION
<p>TLN AWL DECLUTTER</p> <p>① Waterline reference indicators</p>	<p>The waterline reference indicators are displayed when DCL is selected and indicate the fuselage reference line.</p>

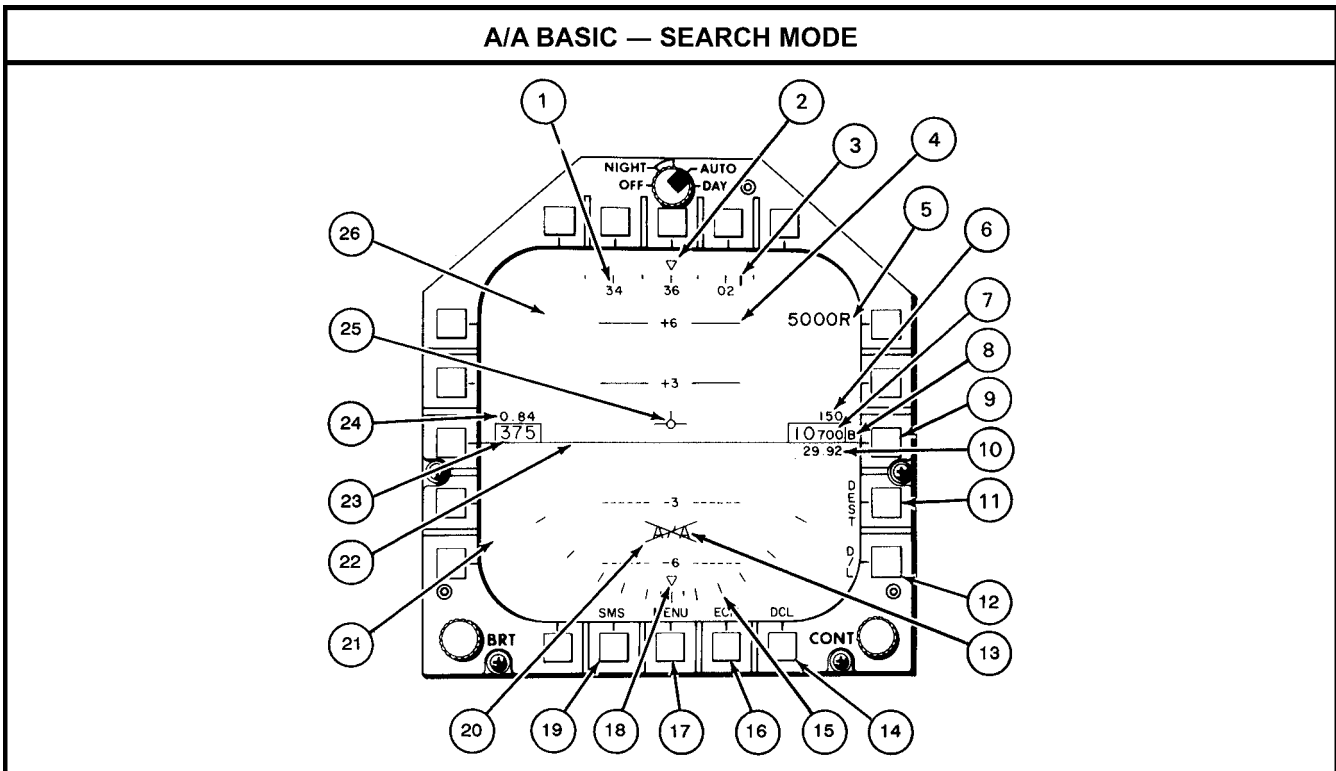
Figure 2-111. MFD VDI Formats — Takeoff, Landing, Navigation (Sheet 9 of 9)

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 2-112. 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 Needles	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	+
<p>Note:</p> <p>'+' indicates that the symbol is available for display on the selected format.</p> <p>'o' indicates that the symbol is not available for display on the selected format.</p>						

Figure 2-112. MFD VDI Symbology Available on TLN Formats (Sheet 2 of 2)



1-F50D-352-1

SYMBOL	FUNCTION
<p>A/A Basic - Search</p> <p>1 Heading scale</p> <p>2 Heading pointer</p> <p>3 Command heading marker</p>	<p>Note</p> <p>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 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.</p> <p>Aircraft magnetic heading is indicated by the moving 360° heading scale in A/A. The major divisions are numbered every 20 degrees.</p> <p>Actual aircraft heading is displayed below the stationary pointer.</p> <p>Positioned along the heading scale to correspond with the command heading.</p>

Figure 2-113. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 1 of 6)

SYMBOL	FUNCTION
④ Pitch/flight path	Ladder displays aircraft pitch 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° climb and DOWN appears at -90° dive. 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 HUD/VDI ALT 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, radar, or GPS altitude will be displayed depending on the source of data. When SCADC altitude is invalid, GPS altitude will be displayed and identified by a G next to the altitude. 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. If both radar and SCADC altitude are invalid, GPS altitude will be indicated by a flashing G next to the 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 and weapon system is the value entered on the pilot's altimeter. 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	Selects destination steering mode.

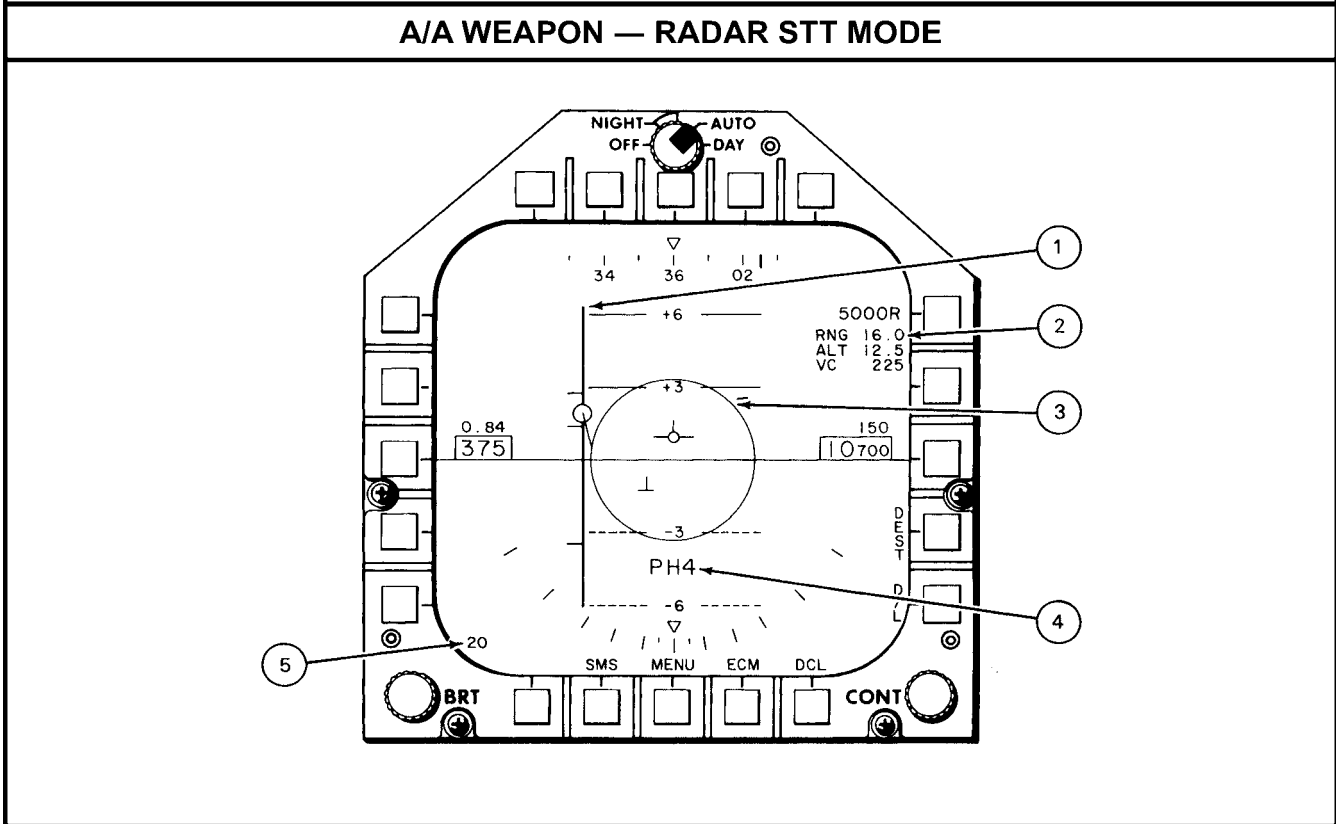
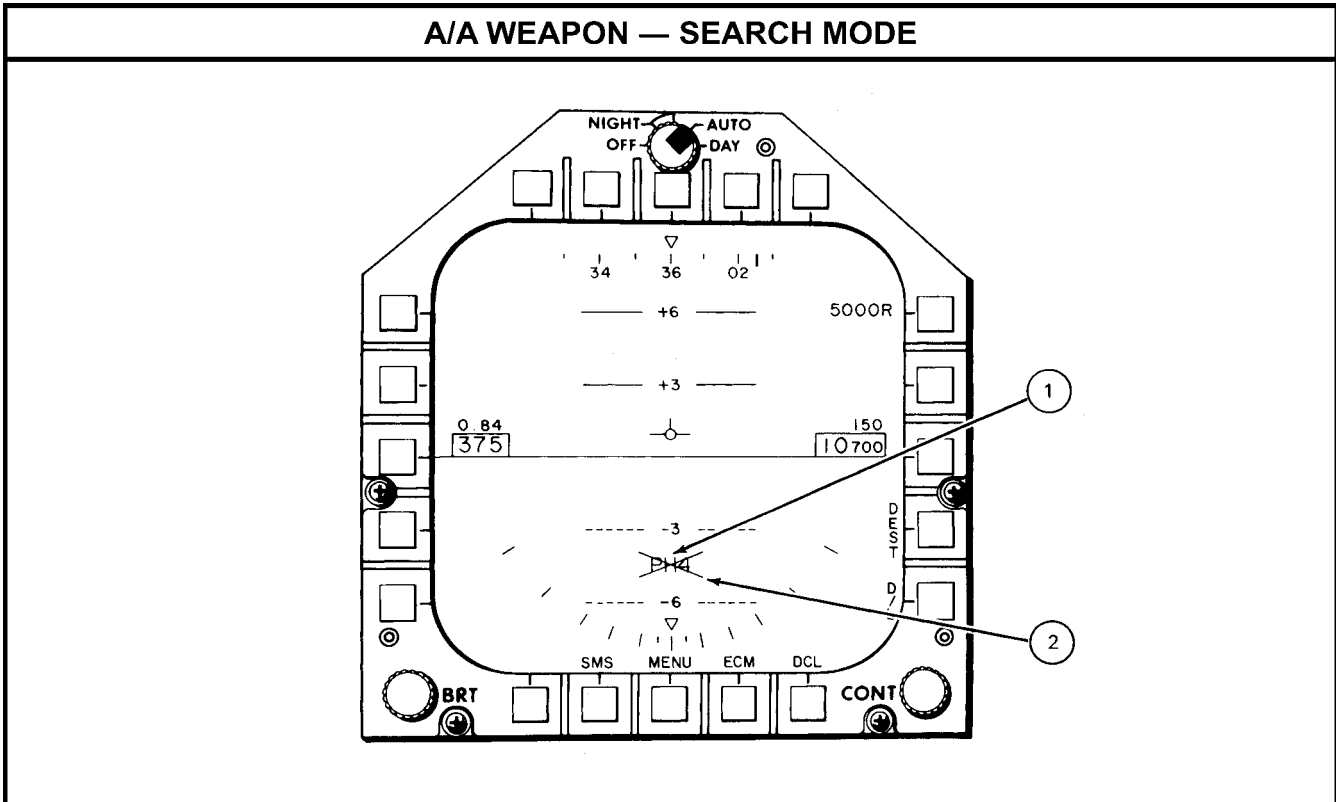
Figure 2-113. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 2 of 6)

SYMBOL	FUNCTION
12 D/L steering pushbutton	Selects 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 $\pm 60^\circ$. Marks are provided at 0° , $\pm 5^\circ$, $\pm 10^\circ$, $\pm 20^\circ$, $\pm 30^\circ$, $\pm 45^\circ$ and $\pm 60^\circ$.
16 ECM pushbutton	Selects the ECM 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 pushbutton 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	Selects the SMS display. 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 2-113. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 3 of 6)

SYMBOL	FUNCTION
<p>(23) Airspeed</p> <p>(24) Mach number</p> <p>(25) Flight path marker</p> <p>(26) Sky plane</p>	<p>Provides display of indicated airspeed. The bottom of the airspeed box is positioned at the waterline reference position.</p> <p>Provides display of aircraft speed in Mach to the nearest hundredth.</p> <p>The vertical position of the flight path marker with respect to the pitch ladder indicates the vertical flight path angle of the aircraft.</p> <p>The light shaded area represents the sky.</p>
<p>A/A Weapon – Search</p> <p>(1) Selected weapon type and quantity indication</p> <p>(2) Master arm switch safe indication</p>	<p style="text-align: center;">Note</p> <p>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.</p> <p>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).</p> <p>An X through the weapon type and quantity indicates that the master arm switch is in the safe position.</p>
<p>A/A Weapon – Radar STT</p> <p>(1) Range bar</p>	<p style="text-align: center;">Note</p> <p>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.</p> <p>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.</p>

Figure 2-113. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 4 of 6)



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Figure 2-113. 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.
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.

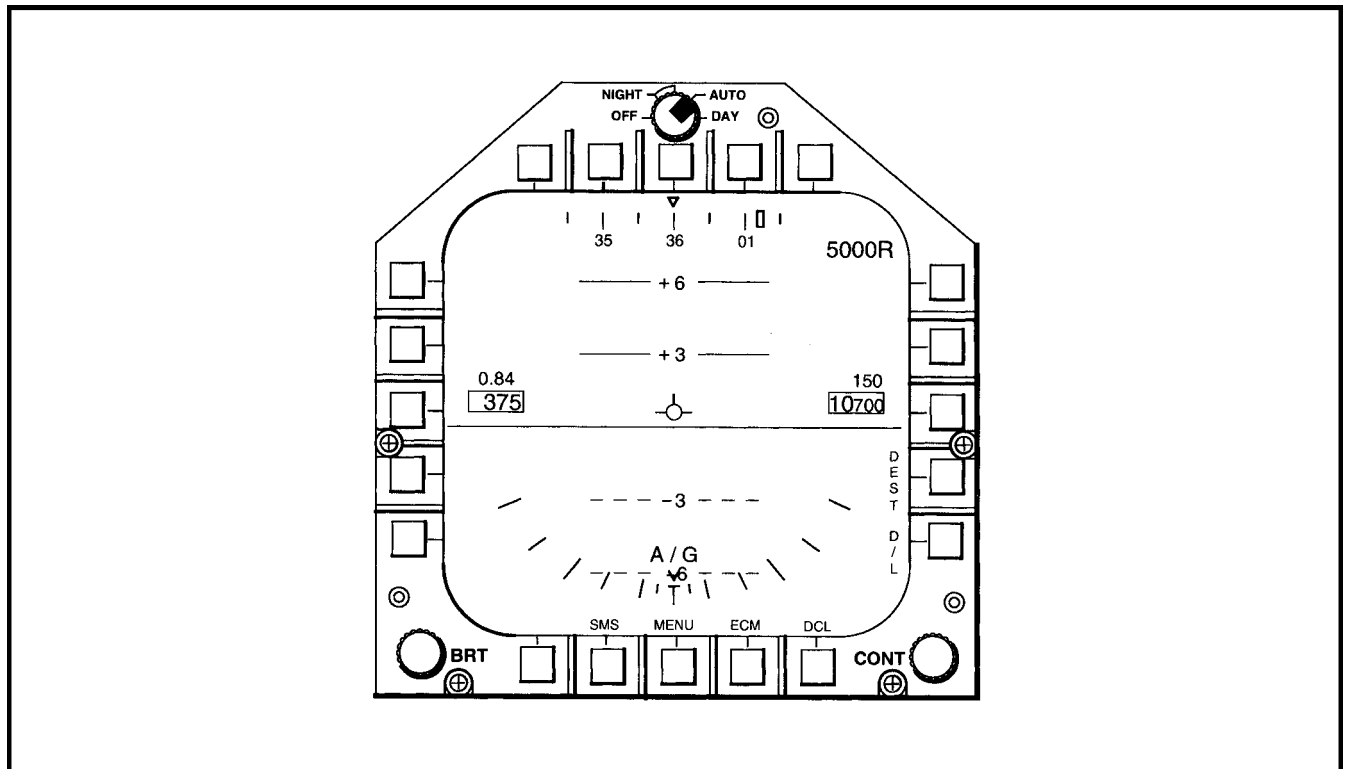
Figure 2-113. MFD VDI Air-to-Air and Air-to-Ground Formats (Sheet 6 of 6)

SYMBOL	FORMAT							
	BASIC	PHOENIX		SPARROW		SIDEWINDER		GUN
		SEARCH	TRACK	SEARCH	TRACK	SEARCH	TRACK	
Aircraft Readout and 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 Attitude 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 2-114. MFD VDI Symbology Available on Air-to-Air and Air-to-Ground Formats (Sheet 1 of 2)

SYMBOL	FORMAT							
	BASIC	PHOENIX		SPARROW		SIDEWINDER		GUN
		SEARCH	TRACK	SEARCH	TRACK	SEARCH	TRACK	
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
<p>Note</p> <p>'+' indicates that the symbol is available for display on the selected format.</p> <p>'o' indicates that the symbol is not available for display on the selected format.</p> <p>* Sidewinder does not display opt range.</p>								

Figure 2-114. MFD VDI Symbology Available on Air-to-Air and Air-to-Ground Formats (Sheet 2 of 2)



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Figure 2-115. MFD VDI Air-to-Ground (A/G) Format

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.

When RECON is selected from the RECON DATA formats, reconnaissance symbols are overlaid on the HUD and any MFD (Figure 2-116) 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 2-117 shows the radar TWS mode and is overlaid on an A/A basic format.

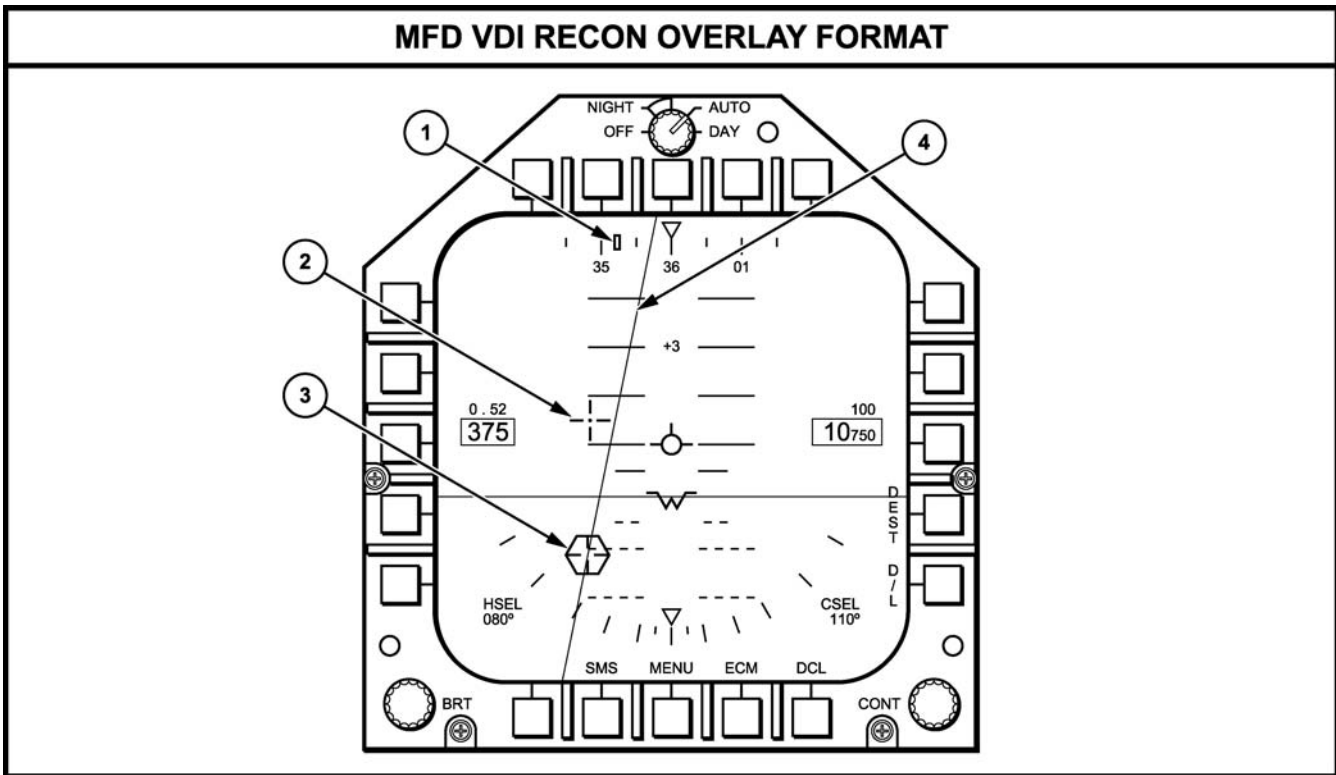
When the IRSTS detects valid targets, IRSTS triangles are overlaid on VDI formats. Position scaling is the same as that of radar priority target diamonds. However, since range cannot be accurately determined by the IRSTS, no range information is presented on this overlay.

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.

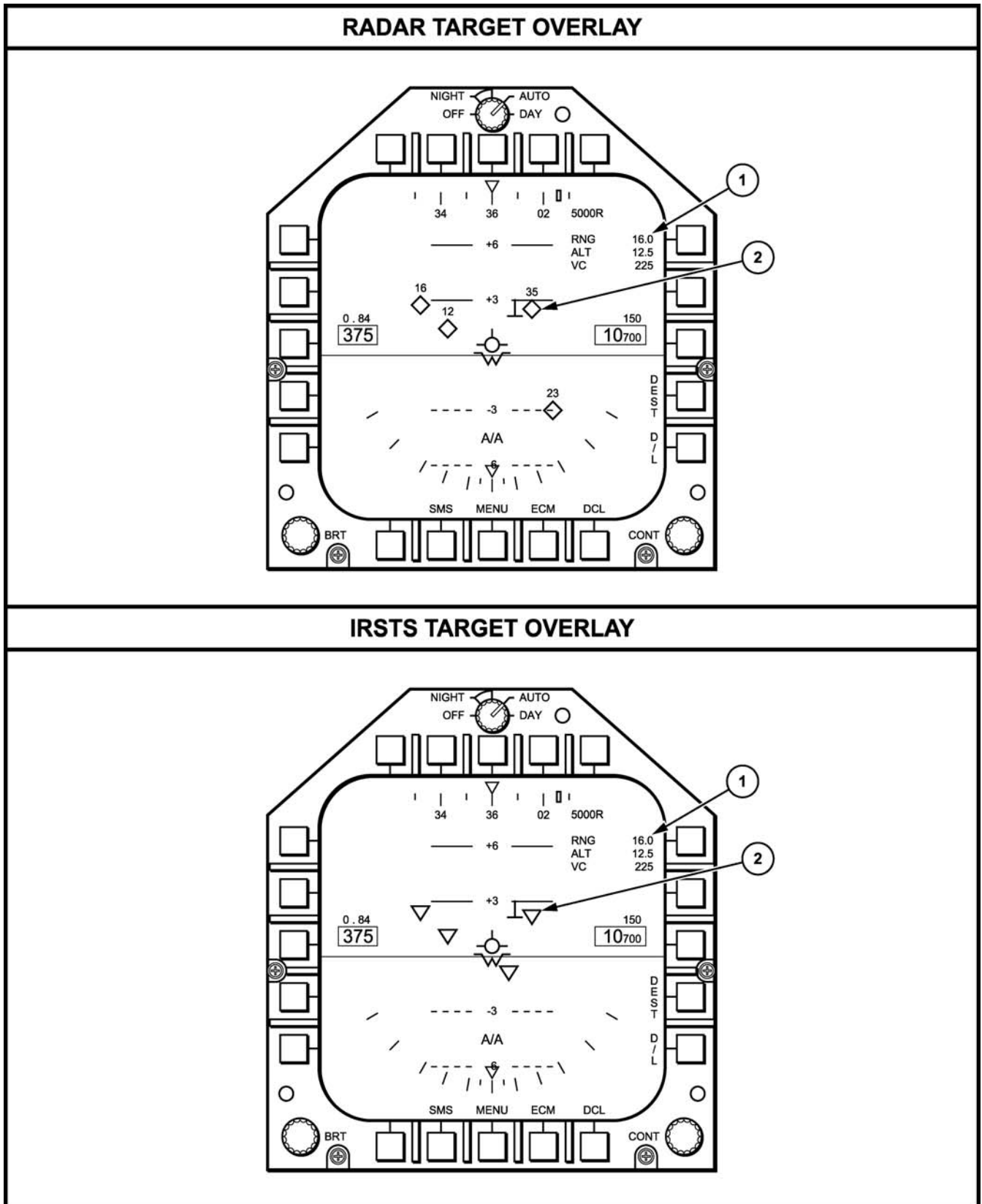
The HSD format family consists of HSD waypoint, TACAN, and TACAN CDI. Selection of PB16 from the MENU, OWN A/C, CV, IFA, WPT DATA, RECON DATA, INS UPDATE, NAV AID, SURFACE WPT, GPS STAT, FLT PLN, MDL WPTS, or SAHRS ALIGN formats will place the previously selected HSD format on the MFD. After a cold start, the HSD waypoint format is shown. Figure 2-118 describes HSD symbols. Figure 2-119 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.



CSC-F14D-1-2-058A

SYMBOL	FUNCTION
<p>① Recon Command Heading Marker</p>	<p>Indicates the magnetic heading for Recon steering.</p>
<p>② Recon Steering Symbol</p>	<p>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.</p>
<p>③ Target Designator, Hexagon</p>	<p>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).</p>
<p>④ Command Ground Track Line</p>	<p>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).</p>

Figure 2-116. MFD VDI Recon Overlay Format

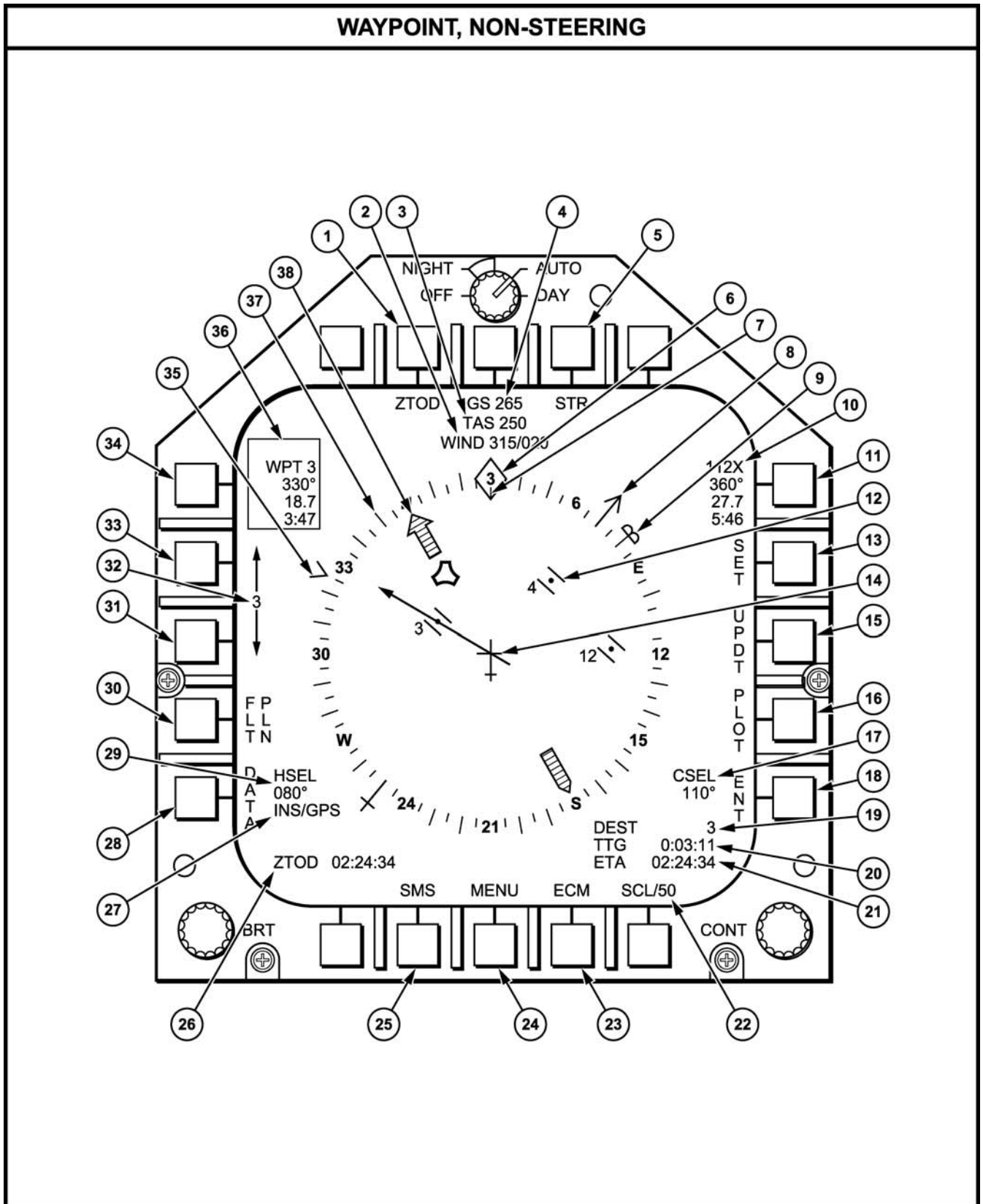


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Figure 2-117. MFD VDI Radar and IRSTS Overlay Formats (Sheet 1 of 2)

SYMBOL	FUNCTION
<p>Radar Target Overlay</p> <p>① Radar target data</p> <p>② Radar TWS target priority diamonds</p>	<p style="text-align: center;">Note</p> <p>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.</p> <p>Range, altitude, and closing velocity of the closest radar TWS target will be presented.</p> <p>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.</p>
<p>IRSTS Target Overlay</p> <p>① Target data</p> <p>② IRST TWS target priority triangles</p>	<p style="text-align: center;">Note</p> <p>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.</p> <p>Range, altitude, and closing velocity of the closest IRST TWS target will be presented.</p> <p>Up to 4 TWS target priority triangles may be displayed to show direction and relative altitude of the 4 closest IRST targets.</p>

Figure 2-117. MFD VDI Radar and IRSTS Overlay Formats (Sheet 2 of 2)



CSC-F14D-1-2-049

Figure 2-118. MFD HSD Format (Sheet 1 of 4)

SYMBOL	FUNCTION
① Clock/timer pushbutton	Selects clock/timer display for HUD and corresponding readout. Options are ZTOD, ETA, TTG, ET, or CD.
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 Steering mode pushbutton	STR pushbutton cycles through steering modes: DEST, AUTO, GPS, and TACAN.
⑥ Lubber line	The lubber line indication (diamond) is fixed at the top of the compass rose and indicates aircraft magnetic heading.
⑦ Ground track line	The ground track line rotates inside the compass rose to represent the ground track.
⑧ ADF pointer	The ADF symbol shows the direction of the nearest automatic direction finder station.
⑨ 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.
⑩ TACAN data	Displays TACAN channel, range, bearing, and time-to-go to the selected TACAN station.
⑪ TACAN display option pushbutton	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 is indicated by a box around the TACAN data.
⑫ Waypoint symbol	The numbers (1 to 750) 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.
⑬ Set pushbutton	Enables the establishment of a waypoint at the designated cursor position on the HSD.
⑭ 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.

Figure 2-118. MFD HSD Format (Sheet 2 of 4)

SYMBOL	FUNCTION
⑮ Update (UPDT) pushbutton	Selects the INS update format on the MFD.
⑯ Plot pushbutton	Enables/disables the display of plotted lines between waypoints on the HSD waypoint format.
⑰ Course line setting	Indicates selected course in degrees.
⑱ Enter (ENT) pushbutton	Selects the boxed waypoint for destination steering.
⑲ Steering readout	Steer mode indication and steerpoint.
⑳ Time remaining readout	Selected automatically based on steering mode target selected or weapon selected. Options are TTG, TTGT, or TREL.
㉑ Clock/timer readout	Clock indication per PB7 selection.
㉒ Scale (SCL XXX) pushbutton	Selects range scale (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.
㉓ ECM pushbutton	Selects the ECM threat display. 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.
㉔ MENU pushbutton	Selects 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.
㉕ SMS pushbutton	Selects the SMS display. 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.
㉖ ZTOD readout	Zulu time of day always displayed in this location on HSD formats.
㉗ Navigation mode	Indicates the current navigation mode.
㉘ DATA pushbutton	Selects own A/C data format.

Figure 2-118. MFD HSD Format (Sheet 3 of 4)

SYMBOL	FUNCTION
②9 Heading select setting	Indicates the magnetic heading selected.
③0 FLT PLAN pushbutton	Selects the appropriate NAV AID or SAHRS ALIGN format as determined by the mission computer.
③1 Waypoint decrement (down arrow) pushbutton	Selects the decrement of the waypoint number of the associated waypoint data display and is used to select the waypoint for destination steering.
③2 Waypoint number	Indicates the selected waypoint number (via the increment/decrement push-buttons) of the associated waypoint data display and the desired waypoint for destination steering.
③3 Waypoint increment (up arrow) pushbutton	Selects the increments of the waypoint number of the associated waypoint data display and is used for the selection of the waypoint for destination steering.
③4 Waypoint (WPT) display option pushbutton	Enables the presentation and activation of waypoint-related symbology and display options. Selection of this option allows the appearance of the plot line display selection. Selection of this option is indicated by a box around the waypoint data.
③5 Waypoint bearing pointer	Provides bearing indication of the waypoint entered by the aircrew for destination steering.
③6 Waypoint data	Range, bearing and time-to-go to the waypoint selected via the increment/decrement pushbuttons.
③7 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.
③8 TACAN bearing pointer head and tail	Provides bearing indication to and from the selected TACAN station.

Figure 2-118. MFD HSD Format (Sheet 4 of 4)

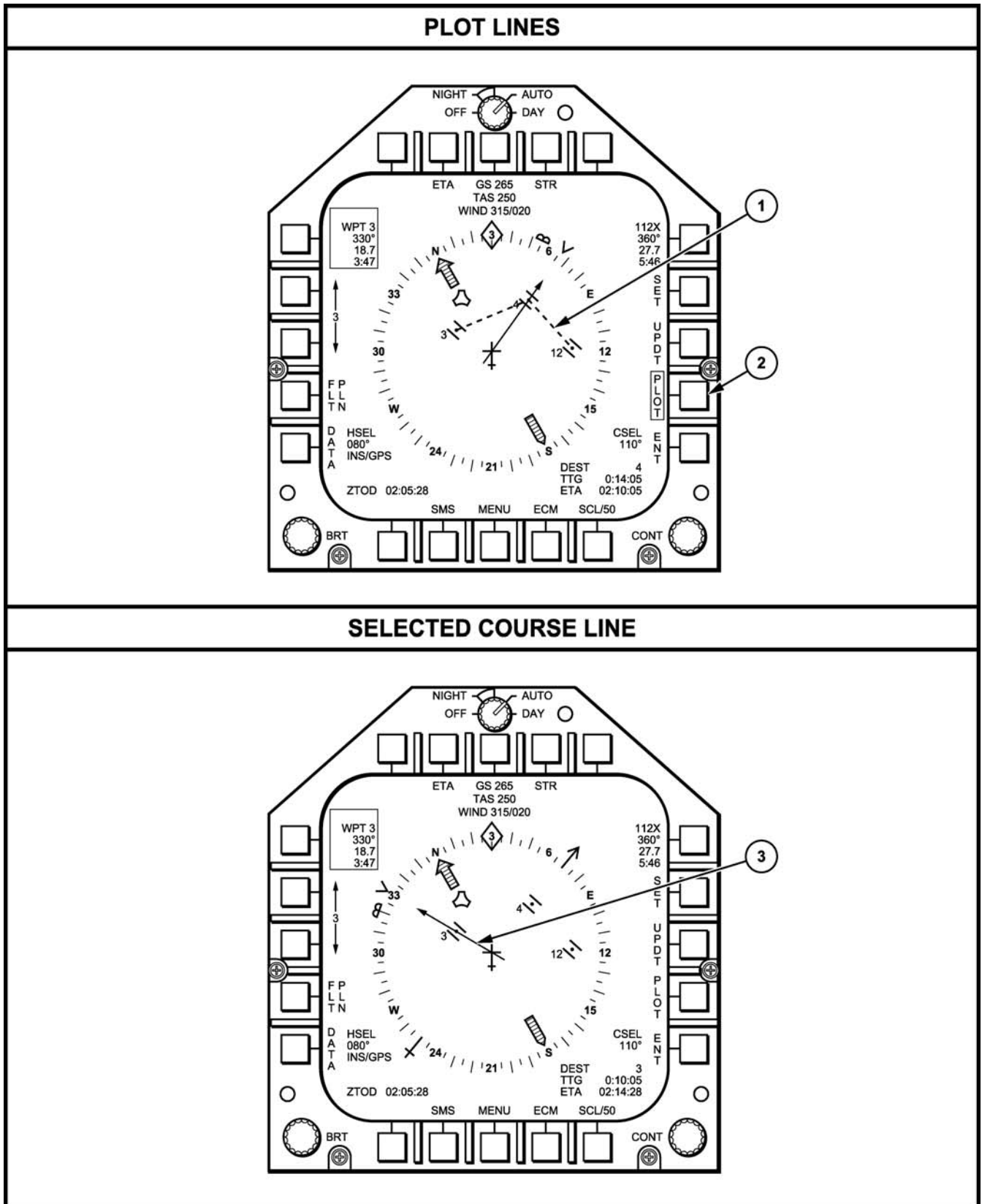


Figure 2-119. Plot Line and Course Line Displays (Sheet 1 of 2)

CSC-F14D-1-2-050

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 2-119. Plot Line and Course Line Displays (Sheet 2 of 2)

HSD steering is selected by PB9 (STR). Selecting the pushtile cycles through the available steering modes: DEST (destination), AUTO (automatic), GPS, TACAN, and blank. CDI can be selected from TACAN or GPS steering.

Chapter 20, NAVIGATION, describes the use of the HSD formats.

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 2-120](#).

For SMS symbols, configurations, and phases of launch, including an explanation of the AIM-54 MOAT and DMA results, refer to the Supplemental NATOPS Flight Manual, NAVAIR 01-F14AAD-1A.

2.33.9.7 Engine Monitor Format

The engine monitor format ([Figure 2-121](#)) 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

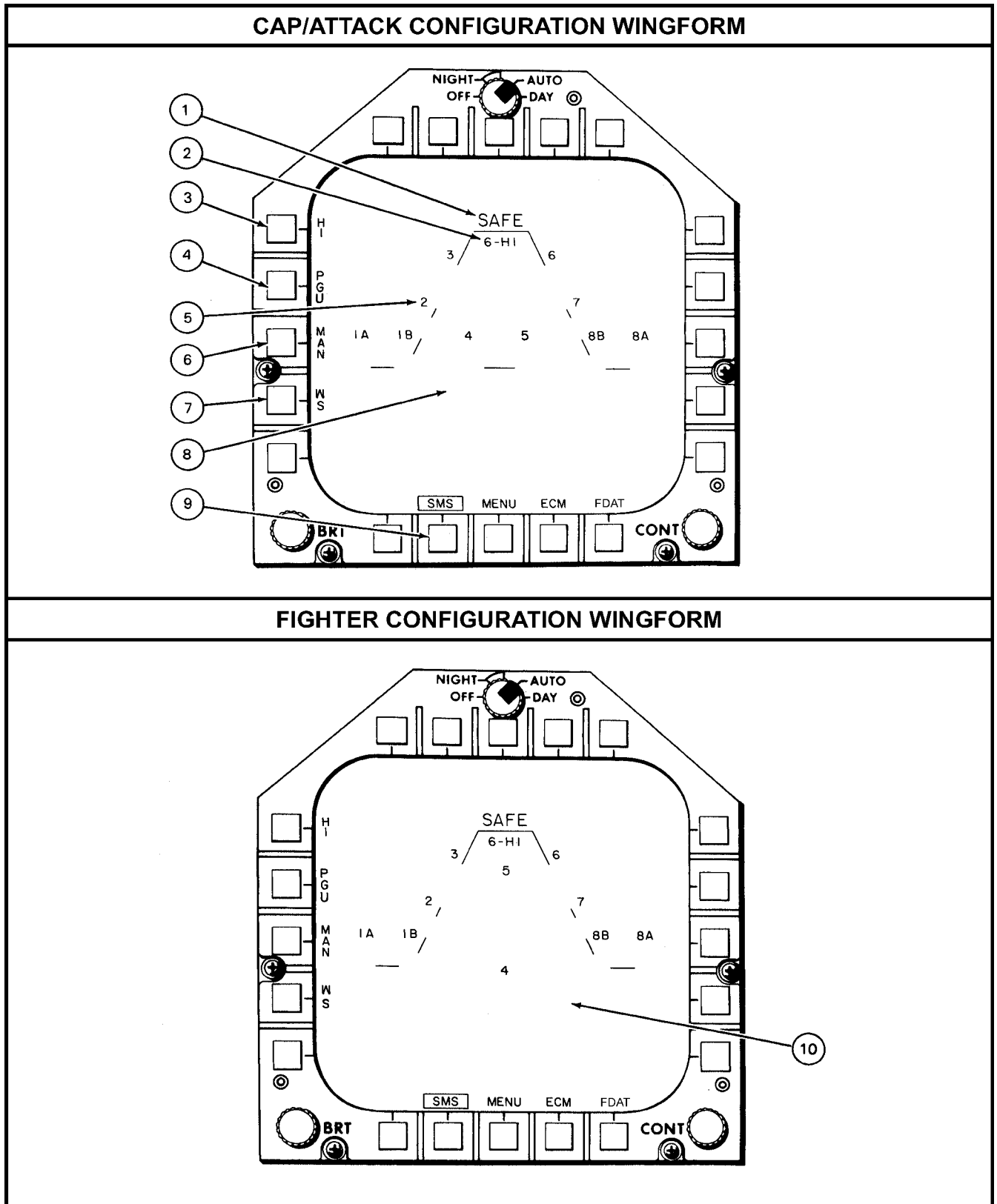
Refer to NAVAIR 01-F14AAD-1A.

2.34 DATA ENTRY UNIT

The DEU ([Figure 2-122](#)) 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 parametr 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

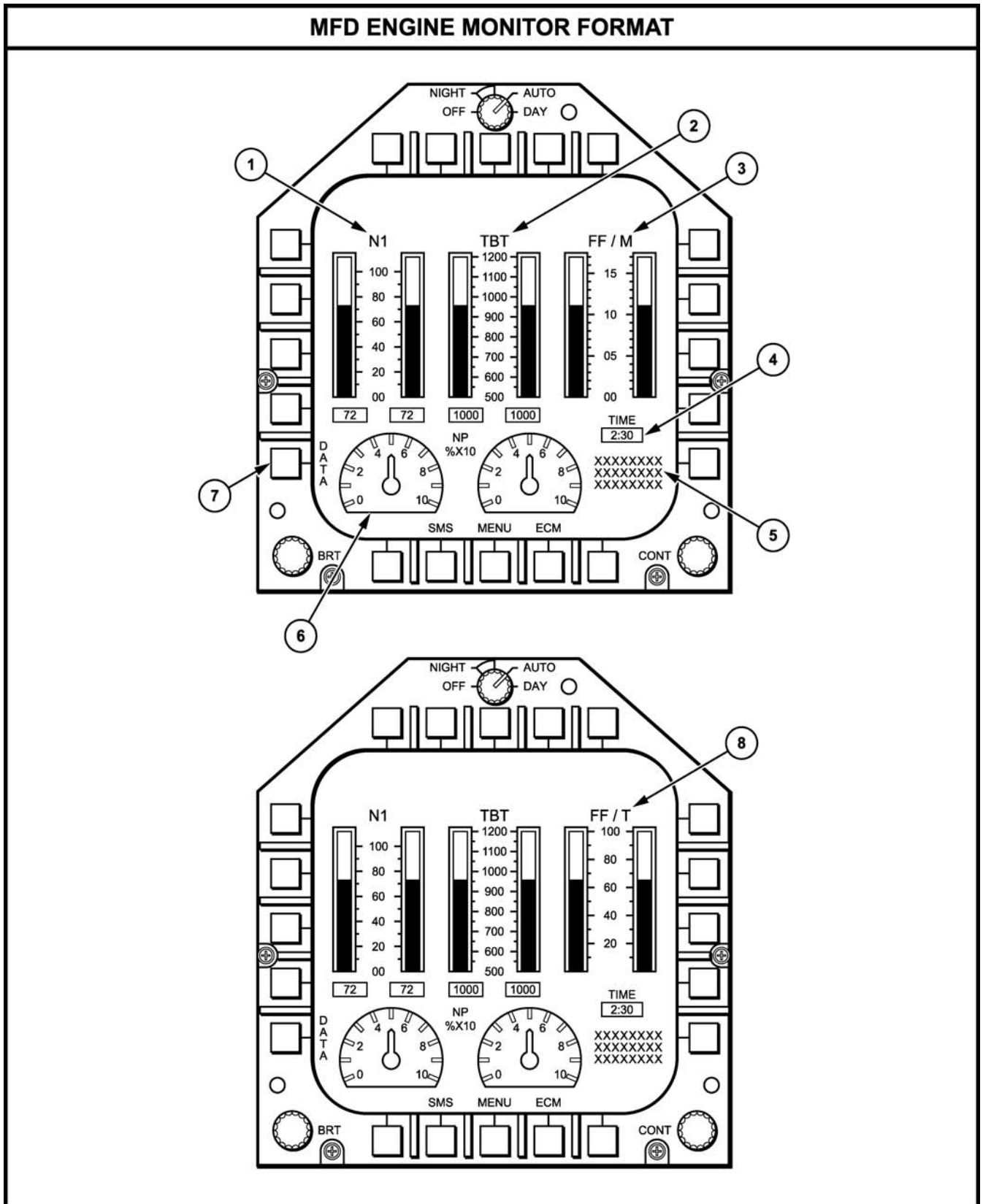


CSC-F14D-1-2-067

Figure 2-120. 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 selected fire rate.
③ HI/LO gun rate pushbutton	Toggles the HI or LO rate of gun fire. HI rate is default mode.
④ PGU/M56	Toggles the PGU or M56 round.
⑤ Store station numbers (1A, 1B, 2, 3, 4, 5, 6, 7, 8A, and 8B)	Indicates the location of the stores (weapons and fuel tanks) loaded on the aircraft.
⑥ Manual (MAN) gun mode pushbutton (A/G only)	Selects 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 the Supplemental NATOPS Flight Manual, NAVAIR 01 -F14AAD-1A.
⑦ Missile status (MS) pushbutton	Selects 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 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 2-120. MFD SMS Format—CAP/Attack, Fighter Wingforms (Sheet 2 of 2)

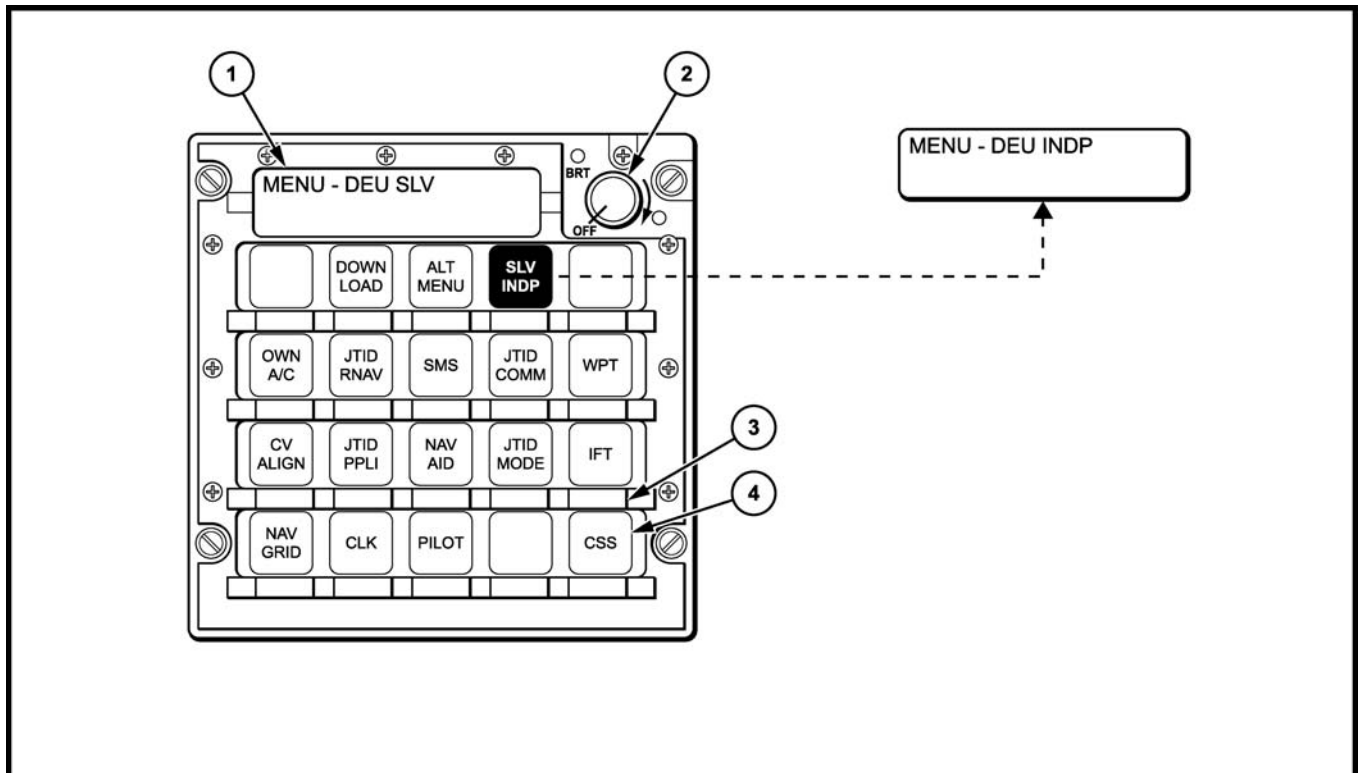


CSC-F14D-1-2-061

Figure 2-121. 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 rate of 1 per second 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
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.
<p>Note</p> <ul style="list-style-type: none"> ● Engine data is not provided while in SEC mode. ● When afterburner is selected, the total fuel flow consists of main and augmented fuel. This format illustrates the afterburner condition where total fuel flow are displayed. 	

Figure 2-121. MFD Engine Monitor Format (Sheet 2 of 2)



CSC-F14D-1-2-051

NOMENCLATURE	FUNCTION
<p>① Data Entry Display</p>	<p>Displays the name of the page selected and provides a scratchpad used to enter and change data as required.</p>
<p>② DEU control knob</p>	<p>Initial clockwise rotation past the detent turns system power on; continued rotation increases brightness of the data entry display and option legend placarding. When depressed, a self-test of the panel is initiated.</p>
<p>③ Option keys (twenty)</p>	<p>Selects the desired menu options and used to enter required mission data.</p>
<p>④ Option legend</p>	<p>Displays the various menu options for the function or parameter selected. Option legends vary with page selection.</p>

Figure 2-122. Data Entry Unit/Main Menu Page

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 2-122). When the MFD displays a format to which the DEU is slaved, the DEU configures the corresponding page (Figure 2-105). However, when the MFD 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 2-122) 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.
17. CLK – Clock control.

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 2-123. 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 $+5^\circ$, -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.

VARIABLE INPUT NAME	UNITS	LIMITS	SIGN	FIELD/PROMPT	DIR OF ENTRY
ALTITUDE	FT	-5000 to +131071	±(1)	QXXXXXXXX	(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 750	NONE	XX	RT to LT
Weapon option	—	0 to 6	NONE	X	RT to LT
Range	NM	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	to 128	NONE	XXX	RT to LT
Map lines	—	to 99	NONE	XX	RT to LT
Map offset	FT	±131071	± (1)	QXXXXXXXX	RT to LT
Target length	NM	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 2-123. Data Entry Parameters

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.

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 a climb or dive 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 (landing gear handle down) when the aircraft passes through the altitude set on the limit index. If the landing gear handle is up, the tone will remain on continuously until the landing gear handle is placed down or aircraft altitude rises above the limit index setting. When the aircraft is below the altitude index limit setting, a night vision compatible post light will illuminate with a yellow radiance. The post light is located just below the height indicator, on the forward instrument panel.

Note

- Radar altimeter can read as much as 100 feet higher than actual altitude when operating over water.
- The low altitude warning light is an anvis green grimes light mounted on a bracket below the RADALT.

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 1,000-Hz tone, modulated at two pulses per second and is available to both crewmembers. The tone activates for 3 to 5 seconds when aircraft altitude descends below the limit index setting, with the landing gear handle in the DOWN position. If the landing gear handle is in the UP position, the tone will remain on continuously.

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 semifloat-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 2-124](#) 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.

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 index can be made by selecting LTS on the MASTER TEST switch.

2.36.2 AOA Indicator

This indicator ([Figure 2-125](#)) 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 $+40^\circ$ 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 2-125](#)) 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.

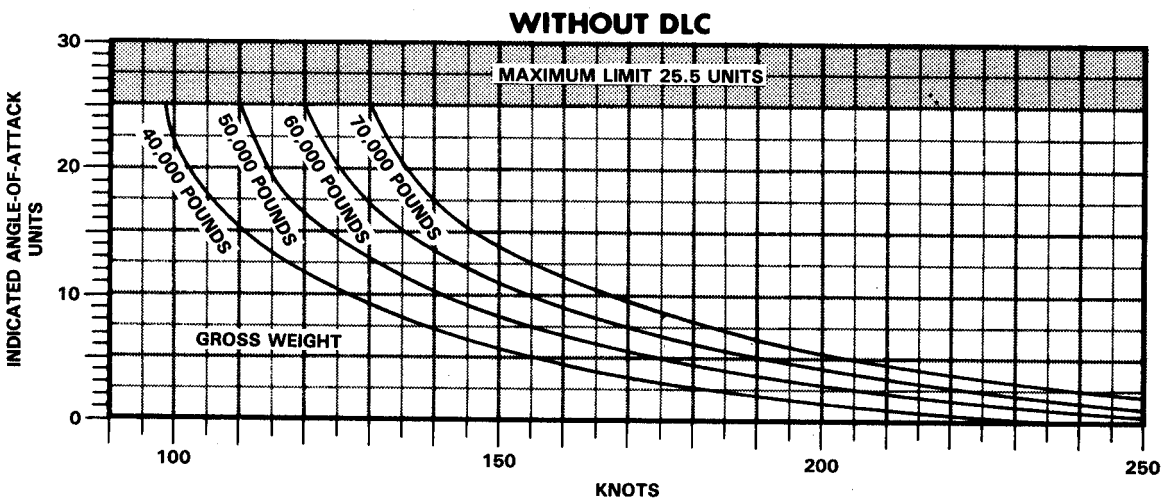
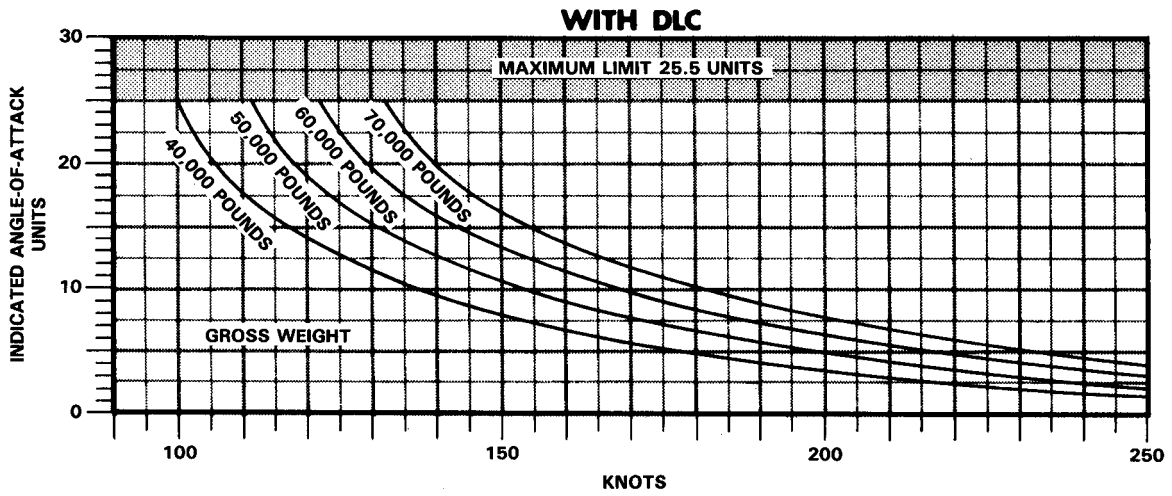
2.36.4 Approach Lights

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

DATE JANUARY 1974
 DATA BASIS: FLIGHT TEST

SEA LEVEL

AIRCRAFT CONFIGURATION:
 FLAPS AND SLATS, GEAR DOWN,
 SPEED BRAKES EXTENDED,
 FOUR AIM-7F



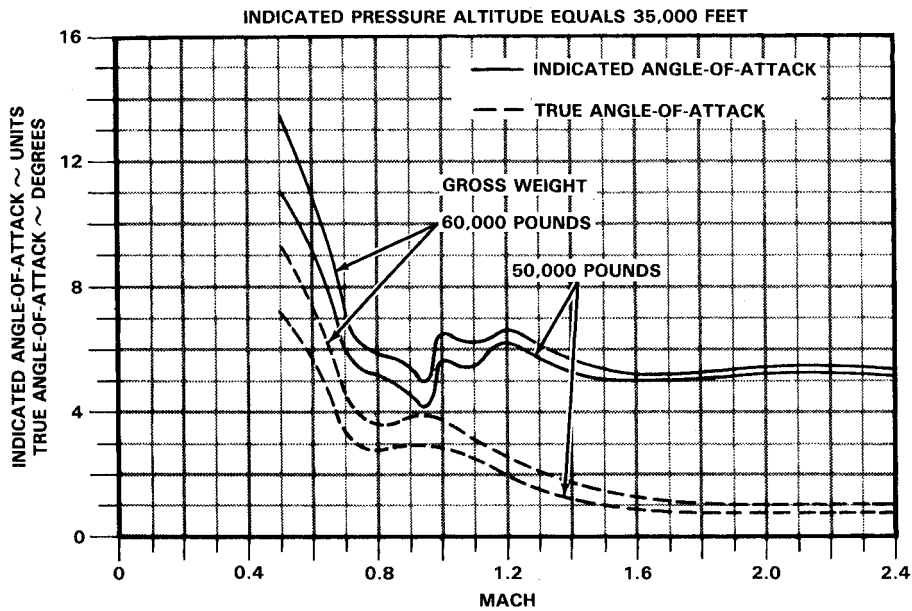
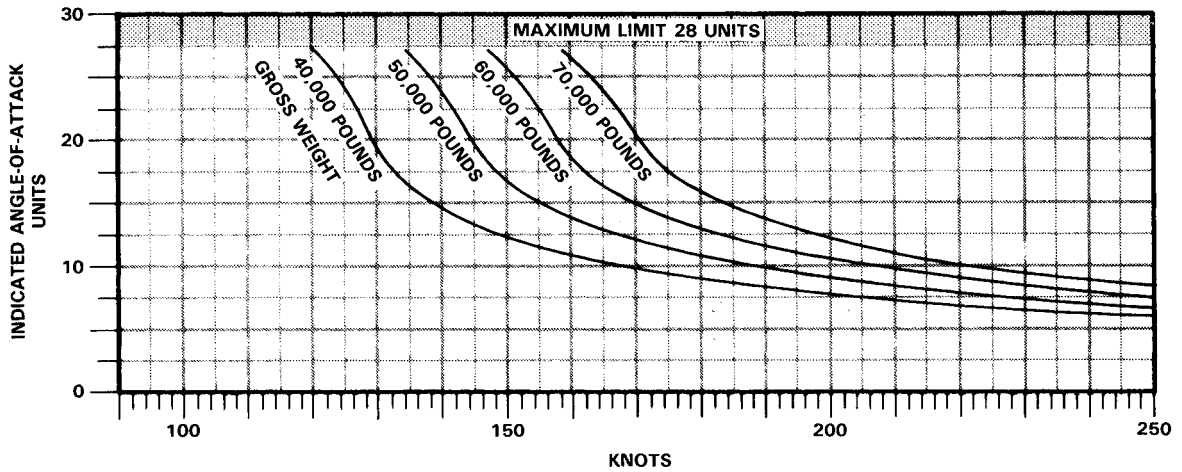
0-F50D-142-1

Figure 2-124. Angle-of-Attack Conversion (Sheet 1 of 2)

SEA LEVEL INDICATED PRESSURE ALTITUDE 35,000 FEET

DATE JANUARY 1974
DATA BASIS: FLIGHT TEST

AIRCRAFT CONFIGURATION:
FLAPS/SLATS UP, GEAR UP, SPEED BRAKES
RETRACTED - CADC OPERATIONAL (4)
AIM-7F



0-F50D-142-2L

Figure 2-124. Angle-of-Attack Conversion (Sheet 2 of 2)

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.

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.



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

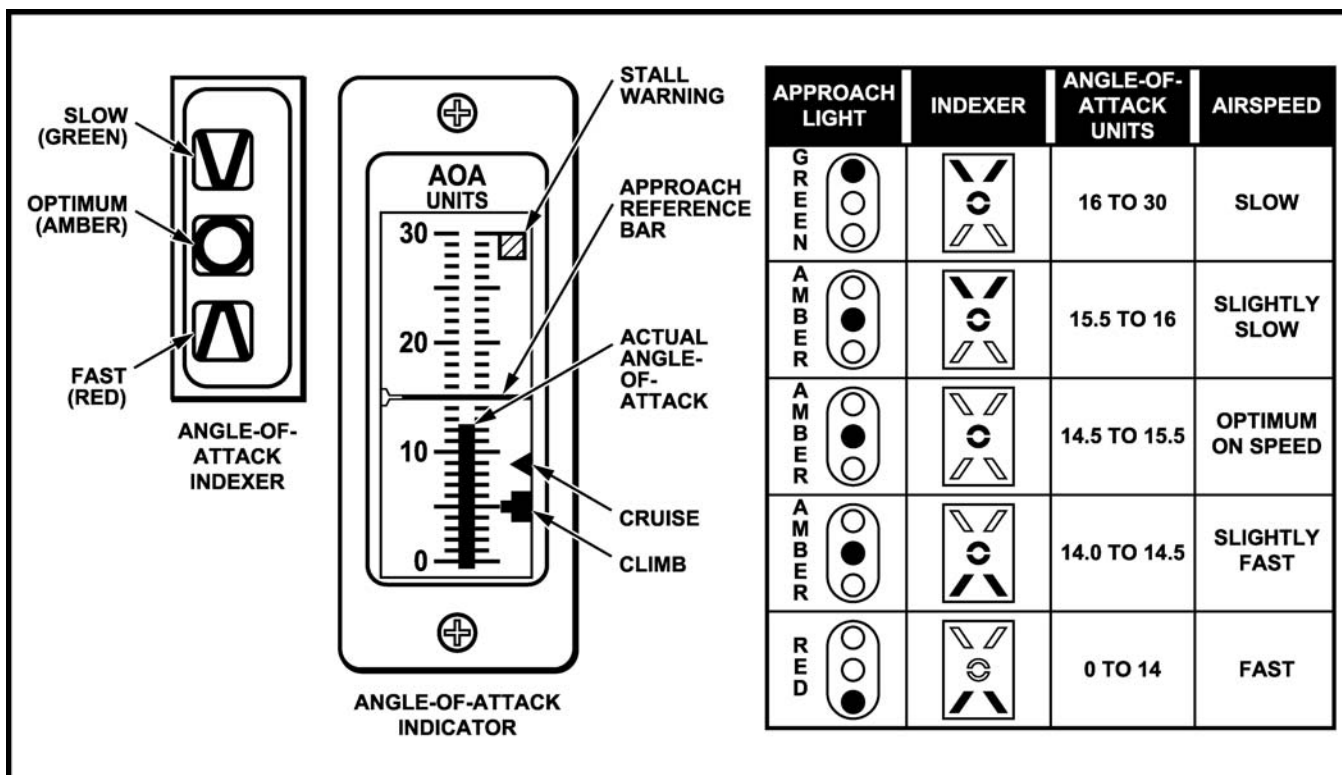


Figure 2-125. Angle-of-Attack Displays

CSC-F14D-1-2-040

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 2-126), 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.

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 pneumatic pressure.

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 pneumatic pressure. 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

Selecting CLOSE 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.

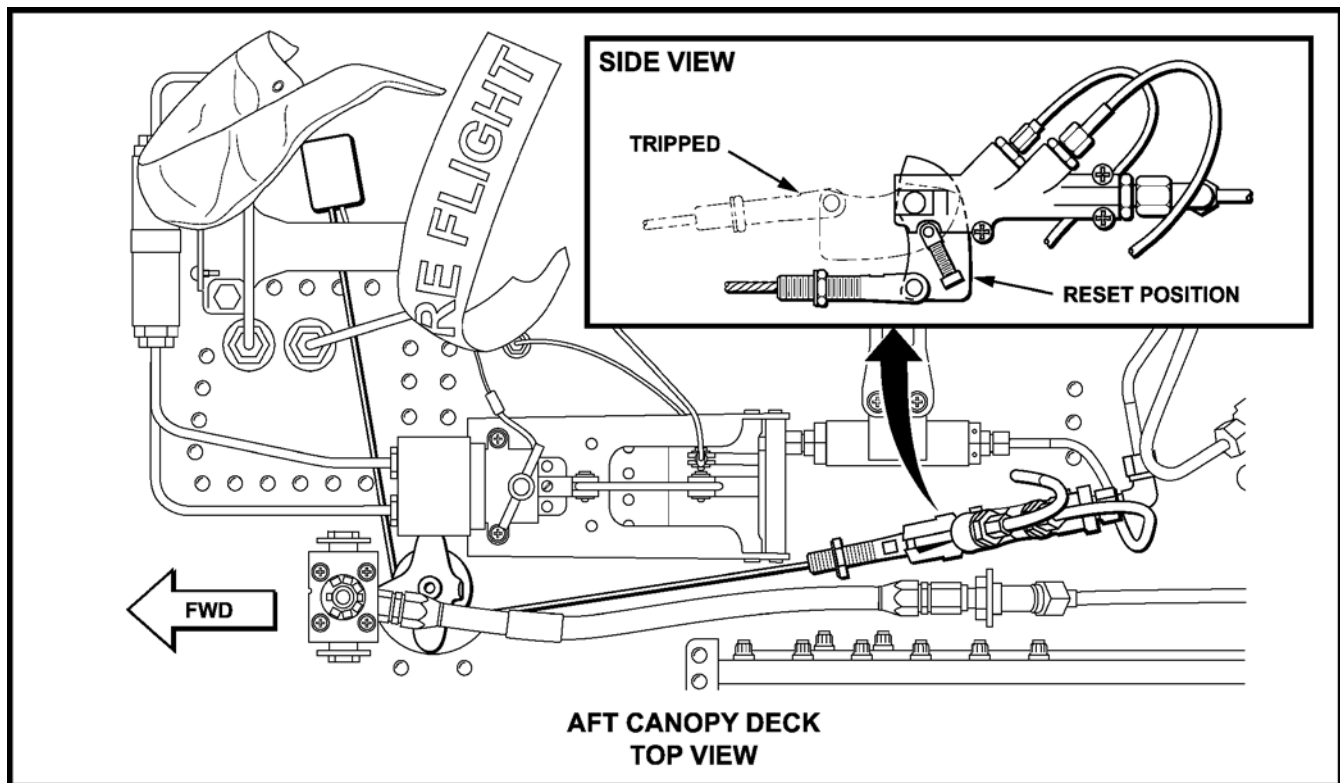
2.37.1.3 Auxiliary Canopy Opening

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 using the auxiliary mode. 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). (See Figure 2-125A.)

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.



CSC-F14D-1-2-069

Figure 2-125A. Auxiliary Pneumatic Selector Valve Reset

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 canopy jettison handle in each cockpit (Figure 2-126) is on the forward right side of each flightcrew instrument panel and is painted yellow and black for ease of identification. To activate the canopy jettison 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

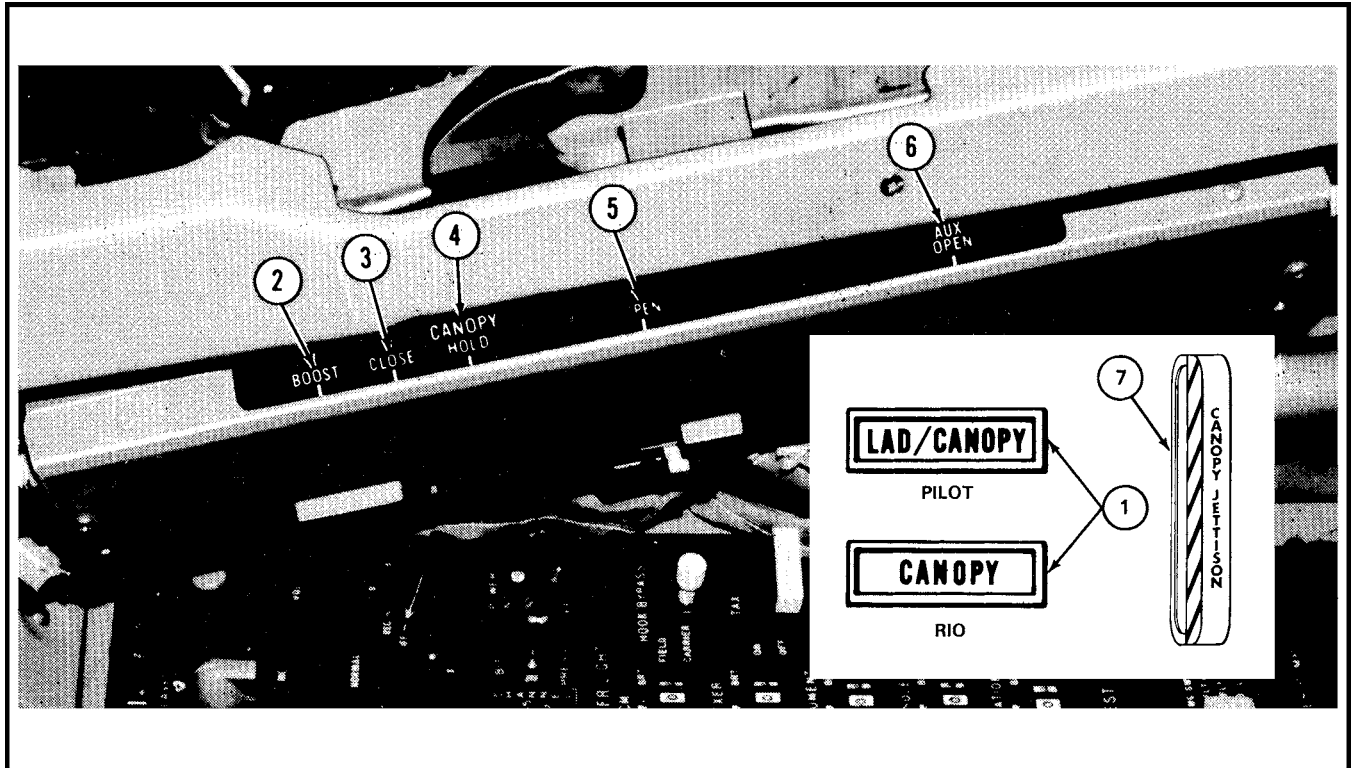
There are two external canopy jettison handles located on the lower left and right fuselage below the pilot cockpit,

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 external canopy jettison 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



CSC-F14D-1-2-003A

NOMENCLATURE	FUNCTION
<p>① CANOPY caution light</p>	<p>Advises that the canopy is not in a down and locked position.</p>
<p>② LAD/CANOPY caution light</p>	<p>Advises that the boarding ladder is not in the up and locked position or that the canopy is not in the down and locked position.</p>
<p>③ BOOST</p>	<p>Used to close the canopy in cold or hot weather or when headwinds are greater than 30 to 60 knots.</p>
<p>④ CLOSE</p>	<p>Closes canopy under normal conditions.</p>
<p>⑤ HOLD</p>	<p>Used to hold canopy in any position other than closed.</p>
<p>⑥ OPEN</p>	<p>Used to open the canopy under normal conditions.</p>
<p>⑦ AUX OPEN</p>	<p>Used to open canopy manually, which is required when nitrogen bottle pressure drops below 225 psi.</p>
<p>⑧ CANOPY JETTISON handle</p>	<p>Used to jettison canopy.</p>

Figure 2-126. Cockpit Canopy Control Handle and Indicator Lights

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

- 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 injury from ejection.
- 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 Navy Aircrew Common Ejection Seat (NACES) (Figure 2-127) 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 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. Depending on MSL 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. 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.

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 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.

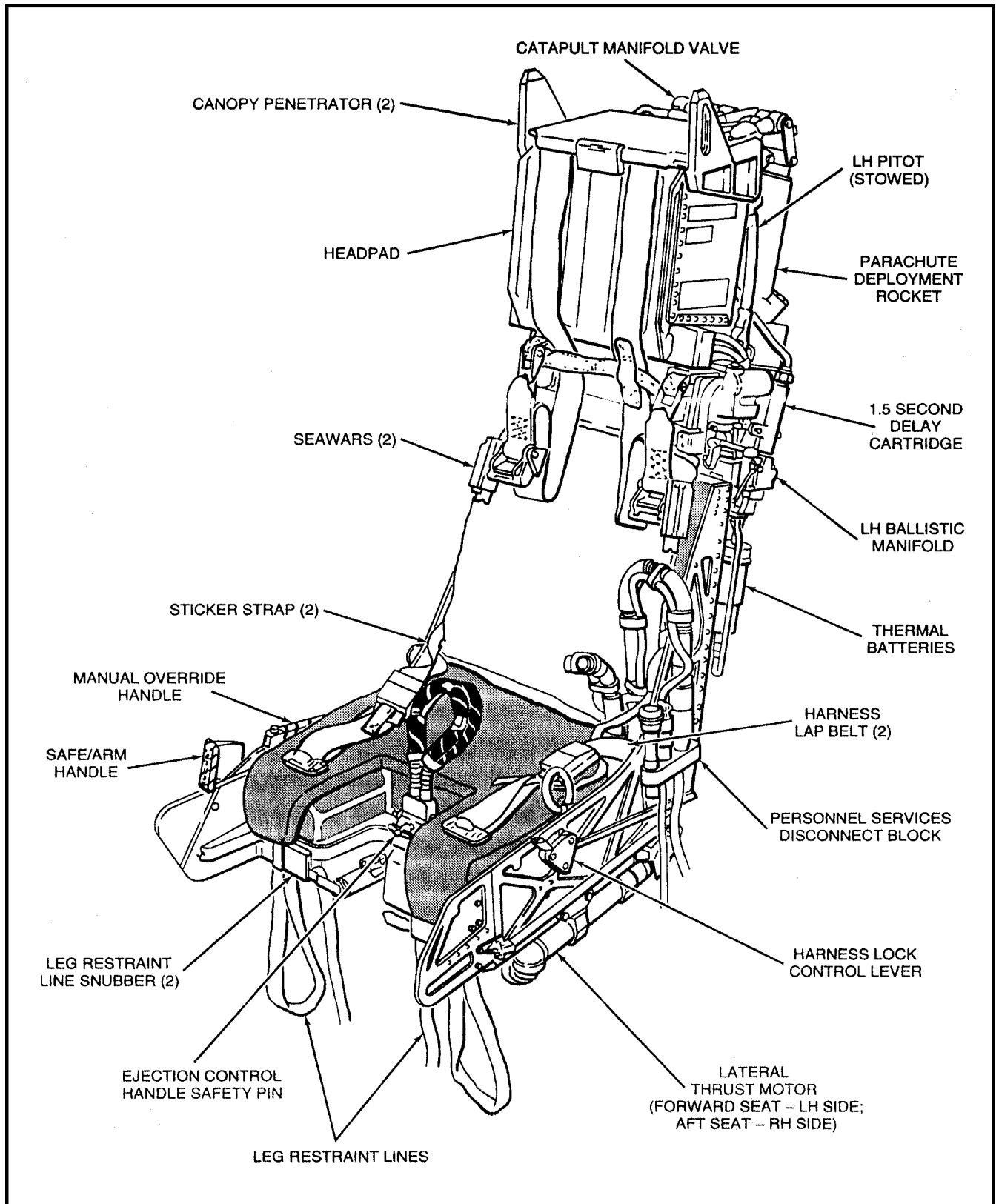
2.38.1.3 Manual Override Handle

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, and the leg restraint line locks to permit emergency ground egress with the survival kit attached.

Note

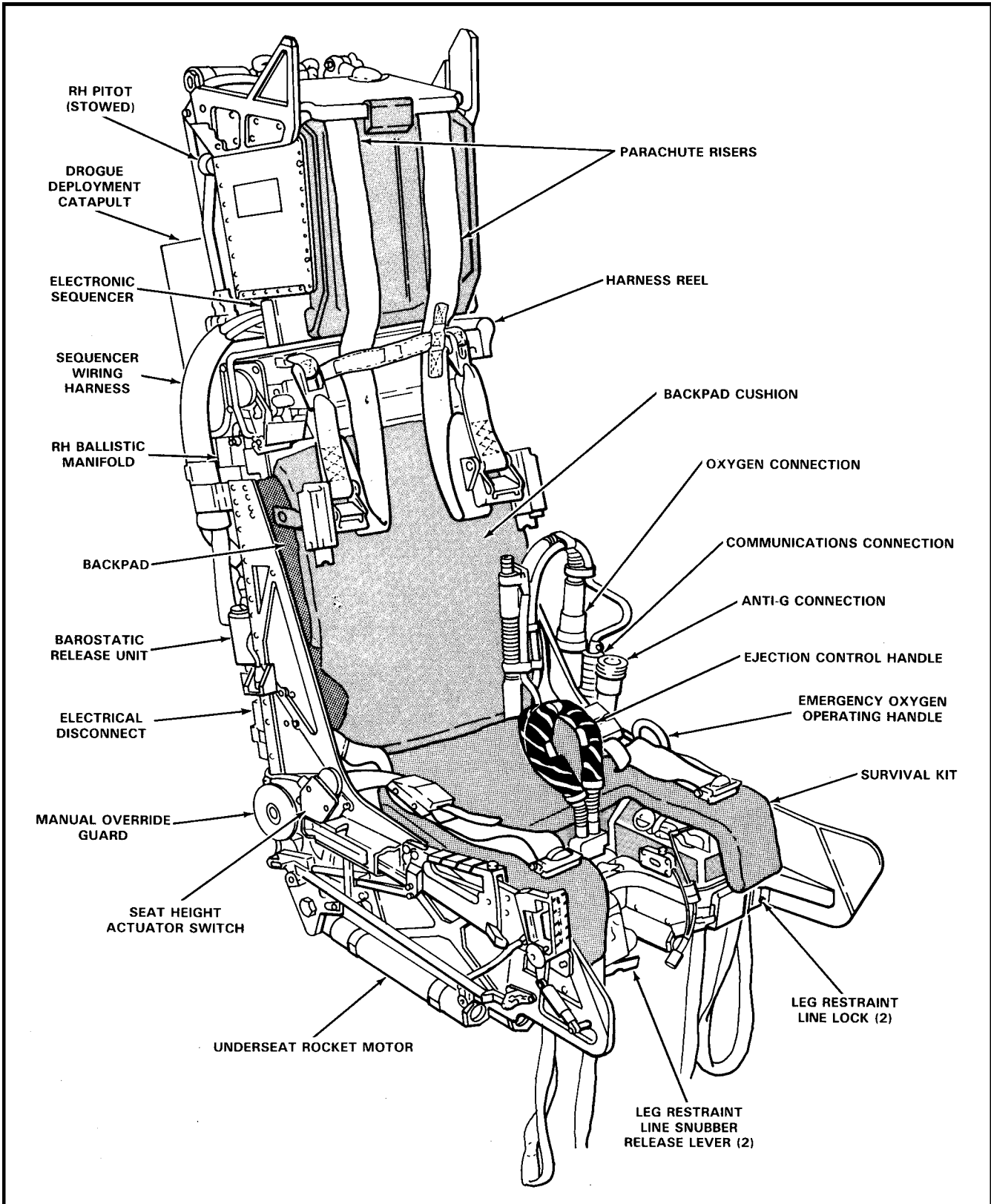
The parachute risers and personnel services must be disconnected manually.

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.



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Figure 2-127. Ejection Seat (Sheet 1 of 2)



0-F50D-369-2L

Figure 2-127. Ejection Seat (Sheet 2 of 2)

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. Two buckles on the lower part of the torso harness 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 legs 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 (214).



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 2-128) 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.

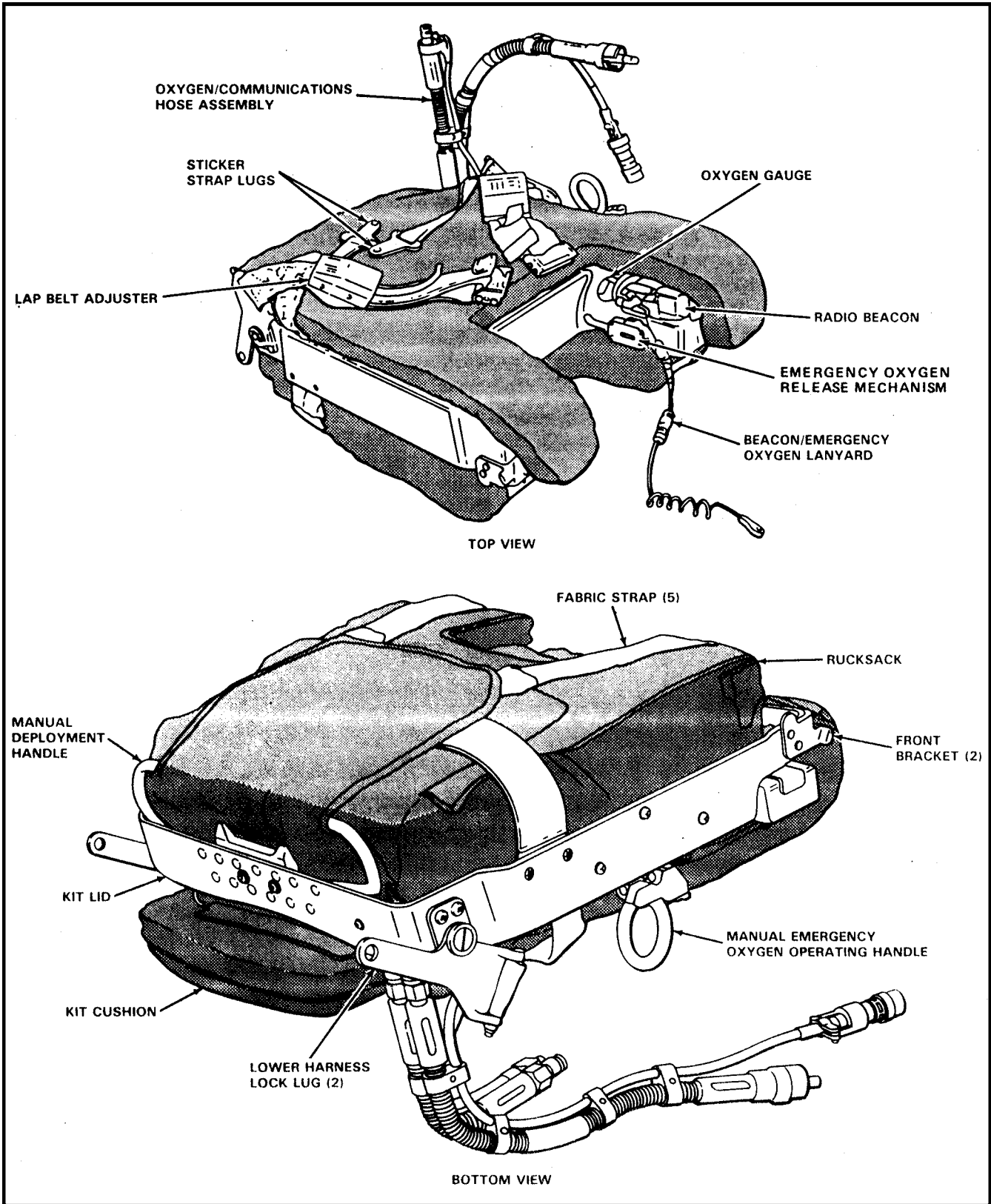
The survival kit accommodates a liferaft, an emergency oxygen cylinder, and the survival aids. The emergency oxygen cylinder is mounted to the underside of the platform, a pressure gauge is on the left thigh support, and a green manual operating handle is on the left side of the platform. The emergency 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. 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



0-F50D-370-0

Figure 2-128. Survival Kit

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 2-129) 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.

WARNING

In aircraft with an LCP installed, the controller handrest may interfere with the CMD EJECT lever, preventing the handle from reaching the

full-aft (MCO) position. Adjusting the handrest to the full-down position will minimize this interference and should allow normal operation of the CMD EJECT lever.

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.

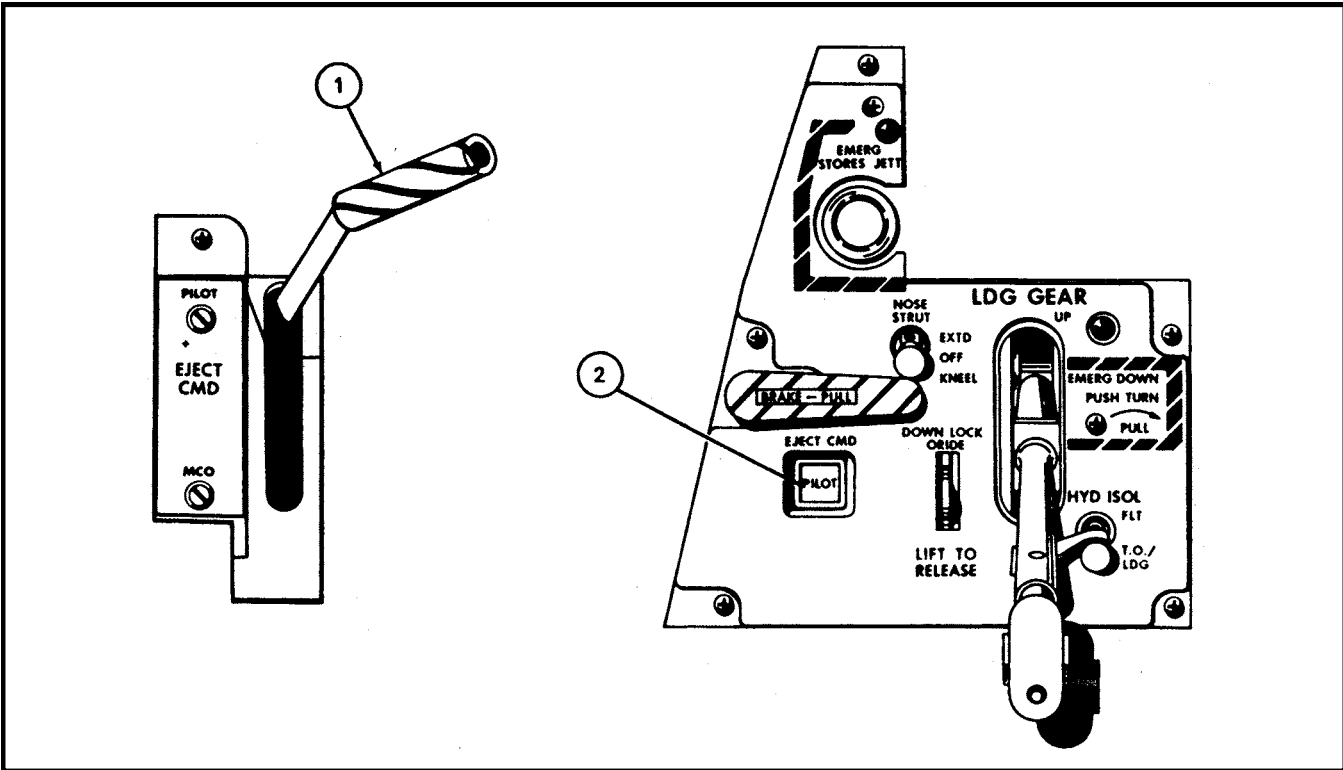
When canopy jettison is complete, a lanyard attached to the canopy pulls a sear, firing the safe and arm device. This initiates the thermal batteries that power the seat electronic sequencer and fires the two-stage catapult, ejecting the seat. The RIO seat is fired immediately on firing of the safe and 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,



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NOMENCLATURE	FUNCTION
<p>① EJECT CMD lever (RIO cockpit)</p>	<p>PILOT– Ejection initiated by the pilot will eject pilot and RIO (RIO first). Ejection initiated by the RIO will eject only the RIO. Pilot eject command indicator – pilot.</p> <p>MCO – Ejection initiated by the pilot will eject pilot and RIO (RIO first). Ejection initiated by the RIO will eject pilot and RIO (RIO first). Pilot eject command indicator – MCO.</p>
<p>② EJECT CMD (flip-flop) indicator</p>	<p>PILOT– Indicates command ejection lever is in PILOT. Only the pilot can eject pilot and RIO. RIO-initiated ejection will eject only RIO.</p> <p>MCO – Indicates command ejection lever is in MCO. Both pilot and RIO can eject both flightcrew members. RIO will eject first.</p>

Figure 2-129. Command Ejection Lever

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

Post-ejection 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-air-speed 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.

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 barostat 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

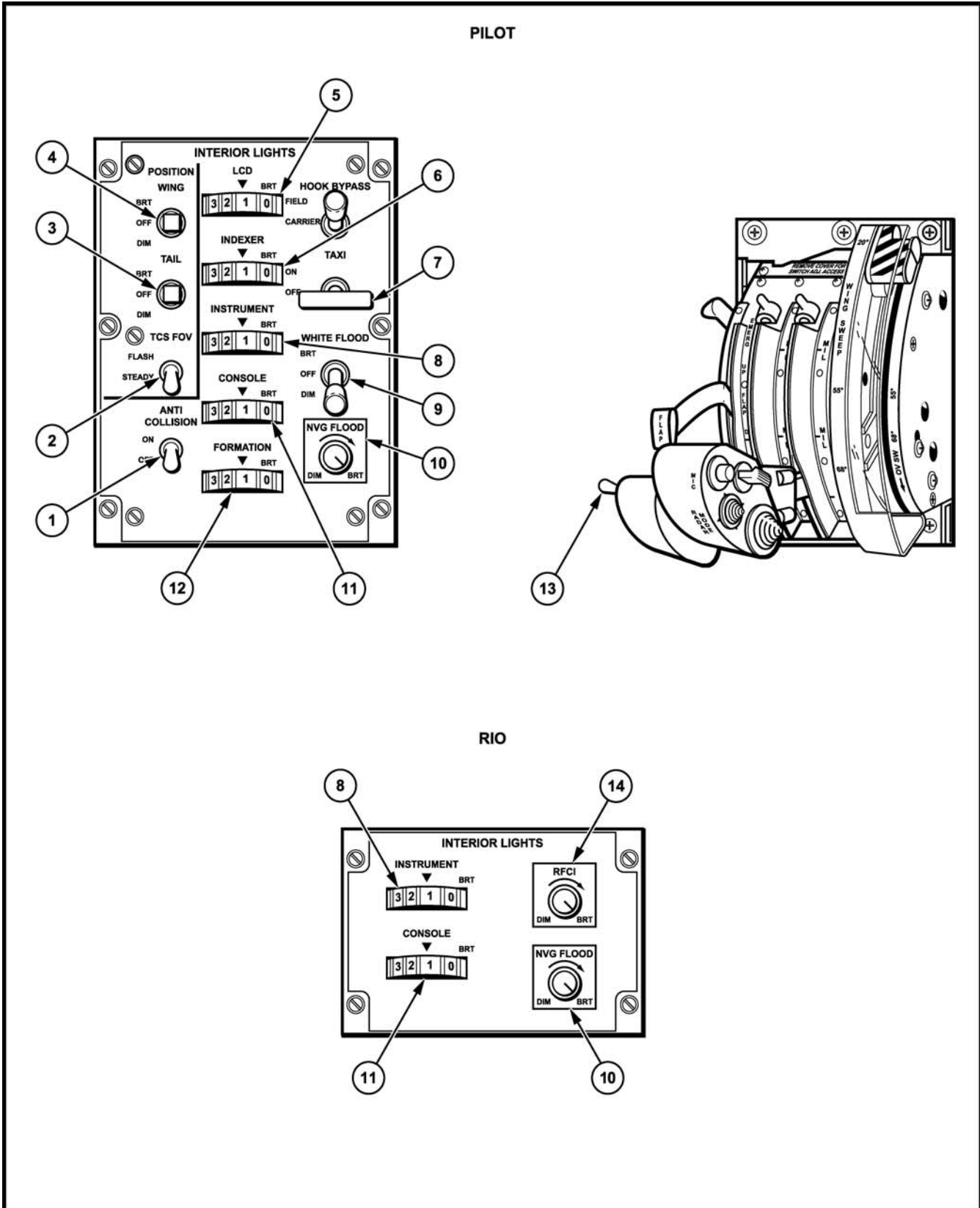
The exterior lights include position lights, formation lights, anticollision lights, a taxi light, approach lights, and an air refueling probe light. All exterior lighting controls, except for the air refueling probe light and approach lights, are located on the MASTER LIGHT panel on the pilot right 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 2-130](#). 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 LT 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



CSC-F14D-1-2-041

Figure 2-130. 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 switch. OFF – Deenergizes wing lights. DIM – Dim wing lights.
⑤ LCD panel light thumbwheel	0 to 1 – Pilot’s liquid crystal display (LCD) and EIG white backlighting on. 1 to 14 – Sets intensity of pilot’s LCD.
⑥ INDEXER thumbwheel	0 to 14 – Sets 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 – Sets instrument lights intensity, maximum brightness at 14.
⑨ WHITE FLOOD lights switch Note Switch must be pulled up to be moved to BRT or DIM.	BRT – Bright white flood lights. DIM – Dim white flood lights. OFF – Turns white flood lights off.
⑩ NVG FLOOD lights control	Variable control – Sets intensity of green instrument and console flood lights from DIM to BRT.
⑪ CONSOLE lights thumbwheel	0 to 1 – Turns console lights and console white flood lights on. 1 to 14 – Sets console lights intensity, maximum brightness at 14.
⑫ FORMATION lights thumbwheel	0 to 1 – Turns formation lights on. 1 to 14 – Sets formation of light intensity, maximum at 14.

Figure 2-130. Cockpit Light Controls (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
(13) Exterior lights master switch	ON – Enable 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.
(14) RIO's light control RFCI	Variable control – Sets intensity of green flood light illuminating Radio Frequency Control Indicator.

Figure 2-130. Cockpit Light Controls (Sheet 3 of 3)

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 wing-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 and its lens is blacked out except for 1½ inches at the rear of the light. 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 green floodlights mounted on the glareshield, the instrument console and above each outboard console, and utility lights for each flightcrew station. The MASTER LIGHT panel, at the pilot's station on the right outboard console, permits varying the intensity of the floodlights from dim to bright. The RIO's interior lights control panel permits varying the intensity of his interior lighting.

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 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. 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.

Note

When pilot's instrument panel lighting is turned off (daytime or to enable NVD compatibility), RIO instrument panel and console panel lighting is disabled.

2.39.2.2 Floodlights

The floodlights consist of night vision green floodlights 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 WHITE 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. During NVIS mode, rotating the NVIS FLOOD potentiometer on the RIO interior light panel to vary the intensity of the NVIS flood lights will also vary the intensity of the backlighting on the CDNU.

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 green console and instrument panel floodlights are continuously variable in intensity using the NVG FLOOD control on the pilot's MASTER lights and RIO's interior light controls. The panel floodlights are protected by a PANEL FLOOD LTS circuit breaker (4A6) on the RIO ac essential No. 1 circuit breaker panel. The white floodlights are protected by the STORM FLOOD LTS 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 night vision green 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 (Figure 2-131 and Figure 2-132) 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.

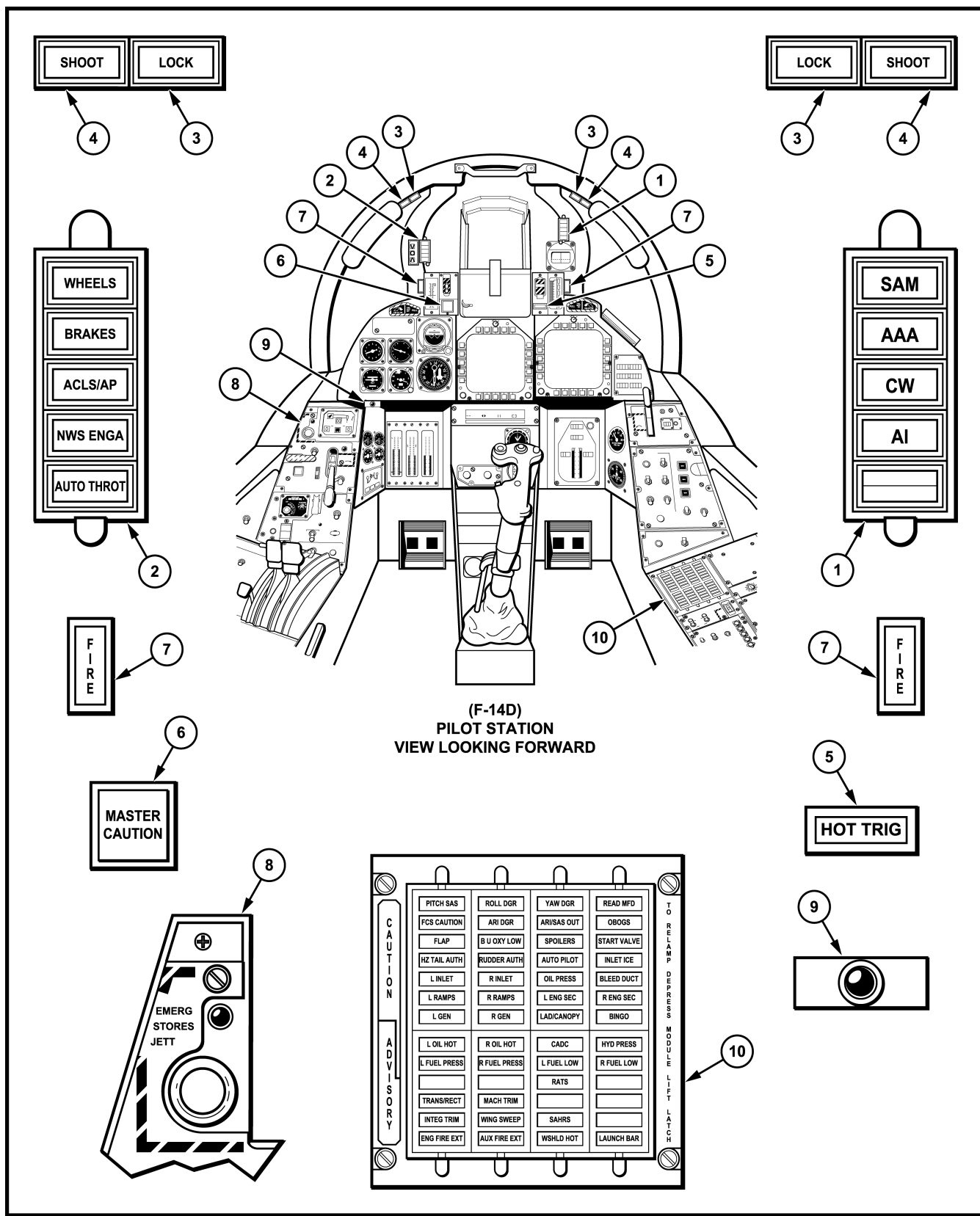


WARNING

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 through 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.



CSC-F14D-1-2-018A

Figure 2-131. Pilot Indicator Lights (Sheet 1 of 5)

NOMENCLATURE	FUNCTION
<p>① SAM (warning)</p> <p>AAA (warning)</p> <p>CW (warning)</p> <p>AI (warning)</p>	<p>Steady illumination when a surface-to-air missile tracking radar is detected. Flashing for missile launched condition.</p> <p>Steady illumination when an anti-aircraft artillery tracking radar is detected. Flashing when AAA radar firing signal is detected.</p> <p>Indicates continuous wave emitter detected.</p> <p>Steady illumination indicates airborne interceptor tracking condition is detected.</p>
<p>② WHEELS (warning)</p> <p>BRAKES (warning)</p> <p>ACLS/AP (caution)</p> <p>NWS ENGA (caution)</p> <p>AUTO THROT (caution)</p>	<p>Flashes with flaps down more than 10°, either throttle below approximately 85%, and any landing gear not down and locked.</p> <p>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.</p> <p>Auto pilot and automatic carrier landing system mode disengaged.</p> <p>Indicates nosewheel steering is engaged and will respond as a function of rudder pedal displacement.</p> <p>Indicates APC has been disengaged by means other than the THROTTLE MODE switch.</p>
<p>③ LOCK (advisory)</p>	<p>Indicates radar locked on target.</p>
<p>④ SHOOT (advisory)</p>	<p>Indicates target meets specified LAR requirements.</p>
<p>⑤ HOT TRIG (warning)</p>	<p>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.</p>
<p>⑥ MASTER CAUTION (caution)</p>	<p>Flashes when any light on the pilot's CAUTION ADVISORY panel illuminates.</p>
<p>⑦ FIRE (warning)</p>	<p>Fire/overheat condition in engine nacelle.</p>
<p>⑧ EMERG STORES JETT/ACK (warning)</p>	<p>Indicates EMERG STORES pushbutton is activated.</p>
<p>⑨ LOW ALTITUDE WARNING LIGHT</p>	<p>Illuminates NVIS Green to indicate that the aircraft has descended below the altitude set by the low altitude limit bug.</p>

Figure 2-131. Pilot Indicator Lights (Sheet 2 of 5)

NOMENCLATURE	FUNCTION
	<p>Note</p> <p>The following lights on the CAUTION ADVISORY panel are in alphabetical order.</p>
<p>⑩ ARI DGR</p>	<p>Indicates degraded ARI performance. If caused by loss of a Mach number signal, LSXC and wing rock suppression functions will be inoperative.</p>
<p>ARI/SAS OUT</p>	<p>Indicates loss of either ROLL or YAW SAS and all ARI functions. Will be illuminated if either the ROLL STAB AUG or YAW STAB AUG switches are selected OFF.</p>
<p>AUTO PILOT (caution)</p>	<p>Indicates failure of one or more pilot relief modes.</p>
<p>AUX FIRE EXT (advisory)</p>	<p>Indicates low pressure (approximately 90 psi below the nominal 600 psi) in the auxiliary fire extinguishing agent container.</p>
<p>BINGO (caution)</p>	<p>Indicates total fuel quantity indicator is less than BINGO preset value.</p>
<p>BLEED DUCT (caution)</p>	<p>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.</p>
<p>B/U OXY LOW (caution)</p>	<p>Indicates backup oxygen system pressure is 200 psi or less.</p>
<p>CADC (caution)</p>	<p>Indicates failure associated with central air data computer.</p>
<p>ENG FIRE EXT (advisory)</p>	<p>Indicates low pressure (approximately 90 psi below the nominal 600 psi) in the fire extinguishing agent container.</p>
<p>L ENG SEC R ENG SEC (caution)</p>	<p>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.</p>
<p>FCS CAUTION</p>	<p>Indicates DFCS failure has occurred. If no other lights are illuminated, indicates loss of redundancy only (subsequent failure may result in loss of significant DFCS functionality).</p>
<p>FLAP (caution)</p>	<p>Indicates: Disagreement between main and/or auxiliary flap position; asymmetry lockout; CADC failure; WG SWP DR NO. 2/MANUV FLAP (LE1) circuit breaker pulled; or, landing flaps down and airspeed greater than 225 knots.</p>
<p>L FUEL LOW R FUEL LOW (caution)</p>	<p>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).</p>
<p>L FUEL PRESS R FUEL PRESS (caution)</p>	<p>Indicates insufficient discharge pressure (less than 9 psi) from respective turbine driven boost pump.</p>
<p>L GEN R GEN (caution)</p>	<p>Indicates that corresponding generator is inoperative because of fault in generator, control unit, or electrical distribution system.</p>

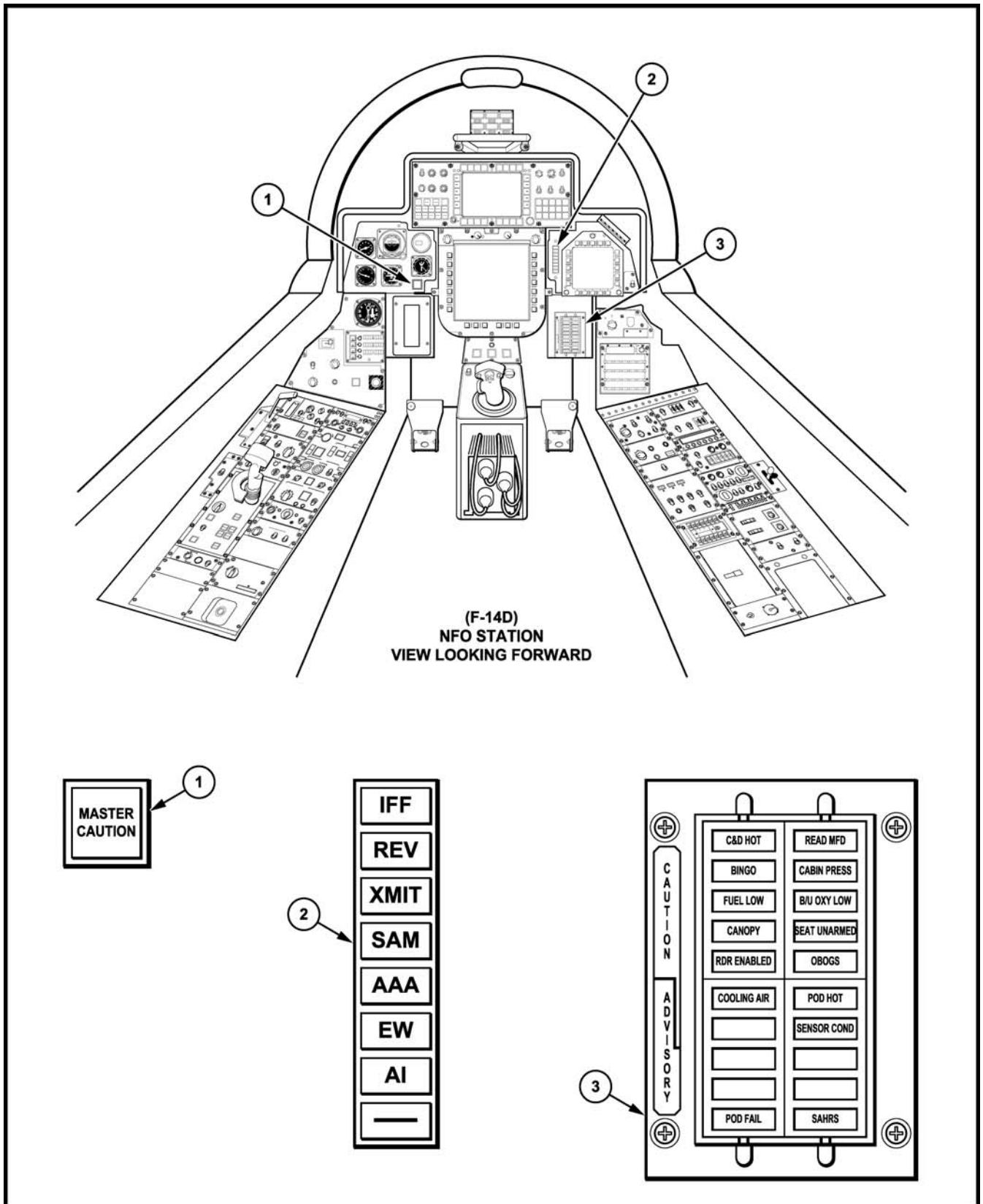
Figure 2-131. Pilot Indicator Lights (Sheet 3 of 5)

NOMENCLATURE	FUNCTION
<p>⑩ HYD PRESS (caution)</p> <p>HZ TAIL AUTH (caution)</p> <p>R INLET L INLET (caution)</p> <p>INLET ICE (caution)</p> <p>INTEG TRIM (advisory)</p> <p>LAD/CANOPY (caution)</p> <p>LAUNCH BAR (advisory)</p> <p>MACH TRIM (advisory)</p> <p>OBOGS (caution)</p> <p>L OIL HOT R OIL HOT (caution)</p> <p>OIL PRESS (caution)</p> <p>PITCH SAS</p> <p>L RAMPS R RAMPS (caution)</p> <p>RATS (advisory)</p>	<p>Indicates hydraulic pressure from either engine-driven pump is less than 2,100 psi.</p> <p>Indicates failure of lateral tail authority actuator to follow schedule or CADC failure.</p> <p>Indicates AICS programmer and/or system failure.</p> <p>Indicates ice accumulated on ice detector in left inlet with ENG/PROBE/ AICS ANTI-ICE switch in AUTO/OFF or ORIDE/ON selected.</p> <p>Indicates a discrepancy between input command signal and actuator position, or an electrical power loss within the computer.</p> <p>Advises that the boarding ladder is not in an up and locked position or that canopy is not in down and locked position.</p> <p>Weight-on-Wheels:</p> <ul style="list-style-type: none"> • Aircraft kneeled, either throttle less than MIL, launch bar not up and locked (normal indication until MRT checks). <p>Weight-off-Wheels:</p> <ul style="list-style-type: none"> • Launch bar not up and locked. • Launch bar not within $\pm 15^\circ$ of center, cocked nosegear. • Nose strut not fully extended. <p>Indicates failure of Mach trim actuator to follow schedule.</p> <p>Indicates a switchover to backup oxygen or OBOGS switch OFF.</p> <p>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.</p> <p>Indicates left or right engine oil pressure is 11 psi or less.</p> <p>Indicates inoperative pitch channel or PITCH SAS failure.</p> <p>Indicates ramps are neither positioned in stow nor trail locks during critical flight conditions. (See Figure 2-5.)</p> <p>RATS operation is enabled.</p>

Figure 2-131. Pilot Indicator Lights (Sheet 4 of 5)

NOMENCLATURE	FUNCTION
<p>⑩ READ MFD (caution)</p>	<p>Indicates any or all of the following warning/caution legends that appear on the upper left corner of the MFD.</p> <p>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</p>
<p>ROLL DGR</p>	<p>Indicates inoperative roll channel and degraded roll authority.</p>
<p>RUDDER AUTH (caution)</p>	<p>Indicates disagreement between position and command failure of rudder authority actuators to follow schedule, or CADC.</p>
<p>SAHRS (advisory)</p>	<p>Indicates attitude or heading information from SAHRS is unreliable.</p>
<p>SPOILERS (caution)</p>	<p>Indicates spoiler failure causing a set of spoilers to be locked down.</p>
<p>START VALVE (caution)</p>	<p>Starter solenoid air valve open after start. Starter overspeed and/or destruction possible.</p>
<p>TRANS/RECT (advisory)</p>	<p>Indicates one operable transformer-rectifier is powering the total dc load, or dual transformer-rectifier failure.</p>
<p>WING SWEEP (advisory)</p>	<p>Indicates failure of a single channel in the system.</p>
<p>WSHLD HOT (advisory)</p>	<p>Indicates center windshield is overheated.</p>
<p>YAW DGR</p>	<p>Indicates inoperative yaw channel and degraded yaw authority.</p>

Figure 2-131. Pilot Indicator Lights (Sheet 5 of 5)



CSC-F14D-1-2-042A

Figure 2-132. RIO Indicator Lights (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
<p>① INS status indicators</p>	<p>Not operational.</p>
<p>② IFF (advisory)</p> <p>RCV (advisory)</p> <p>XMIT (advisory)</p> <p>SAM (warning)</p> <p>AAA (warning)</p> <p>CW (warning)</p> <p>AI (warning)</p>	<p>Indicates mode 4 interrogation was received, but system has not generated reply.</p> <p>Indicates ALQ-165 is receiving a threat identification signal.</p> <p>Indicates ALQ-165 is transmitting.</p> <p>Steady illumination when a surface-to-air missile tracking radar is detected. Flashing when a missile has been launched.</p> <p>Steady illumination when an anti-aircraft artillery tracking radar is detected. Flashing when an AAA radar firing signal is detected.</p> <p>Indicates a continuous wave emitter is detected.</p> <p>Steady illumination indicates an airborne interceptor tracking is detected.</p>
<p>③ MASTER CAUTION (caution)</p>	<p>Flashes when any caution light on the RIO's CAUTION ADVISORY panel illuminates.</p>
<p>④ C&D HOT (caution)</p> <p>CABIN PRESS (caution)</p> <p>FUEL LOW (caution)</p> <p>B/U OXY LOW (caution)</p> <p>CANOPY (caution)</p> <p>POD HOT (caution)</p> <p>POD FAIL (caution)</p>	<p>Indicates DD and/or PTID controls and displays are overheating.</p> <p>Indicates aircraft cabin pressure has dropped below 5-psi pressure differential or cockpit altitude is above 27,000 feet.</p> <p>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.</p> <p>Indicates backup oxygen system pressure is 200 psi or less.</p> <p>Indicates that canopy is not in down and locked position.</p> <p>Indicates LANTIRN pod overheat condition exists.</p> <p>Indicates a failure with the LANTIRN pod.</p>

Figure 2-132. RIO Indicator Lights (Sheet 2 of 3)

NOMENCLATURE	FUNCTION																										
<p>④ SEAT UNARMED (caution)</p> <p>RDR ENABLED (caution)</p> <p>READ MFD (caution)</p> <p>BINGO (caution)</p> <p>SENSOR COND (advisory)</p> <p>COOLING AIR (advisory)</p> <p>OBOGS (caution)</p> <p>SAHRS (advisory)</p>	<p>Indicates either seat is in the SAFE position.</p> <p>Indicates that radar operation on the ground is possible or failure of right main landing gear safety switch or wiring.</p> <p>Indicates any or all of the following warning, caution, or advisory legends that appear on the upper left corner of the MFD.</p> <table border="0" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding-right: 20px;">SDU ALARM</td> <td>IMU</td> </tr> <tr> <td>ASPJ HOT</td> <td>CIU HOT</td> </tr> <tr> <td>JTID HOT</td> <td>DP1 HOT</td> </tr> <tr> <td>RWR</td> <td>DP2 HOT</td> </tr> <tr> <td>FWD ASPJ</td> <td>SMS HOT</td> </tr> <tr> <td>AFT ASPJ</td> <td>AFT CG</td> </tr> <tr> <td>MC1</td> <td>HUD HOT</td> </tr> <tr> <td>MC2</td> <td>RWR HOT</td> </tr> <tr> <td>MC1 HOT</td> <td>DSS HOT</td> </tr> <tr> <td>MC2 HOT</td> <td>DEKI HOT</td> </tr> <tr> <td>CIU</td> <td>IRST HOT</td> </tr> <tr> <td>INS</td> <td>MDL HOT</td> </tr> <tr> <td>GPS FAIL</td> <td></td> </tr> </table> <p>Indicates total fuel quantity indicator is less than BINGO preset value.</p> <p>Indicates coolant temperature exiting heat exchanger is 104°F, radar coolant pump output pressure is below 60 psi, or the overtemperature switch has shut down the coolant pump.</p> <p>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.</p> <p>Indicates a switchover to backup oxygen or OBOGS switch OFF.</p> <p>Indicates attitude or heading information from SAHRS is unreliable.</p>	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	MDL HOT	GPS FAIL	
SDU ALARM	IMU																										
ASPJ HOT	CIU HOT																										
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RWR	DP2 HOT																										
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AFT ASPJ	AFT CG																										
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GPS FAIL																											

Figure 2-132. RIO Indicator Lights (Sheet 3 of 3)

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 (SMP)

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 (FTJU)

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 (MSI)

The MSI (Figure 2-133) 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.

2.40.3 Stores Jettison Modes

Four jettison modes are available:

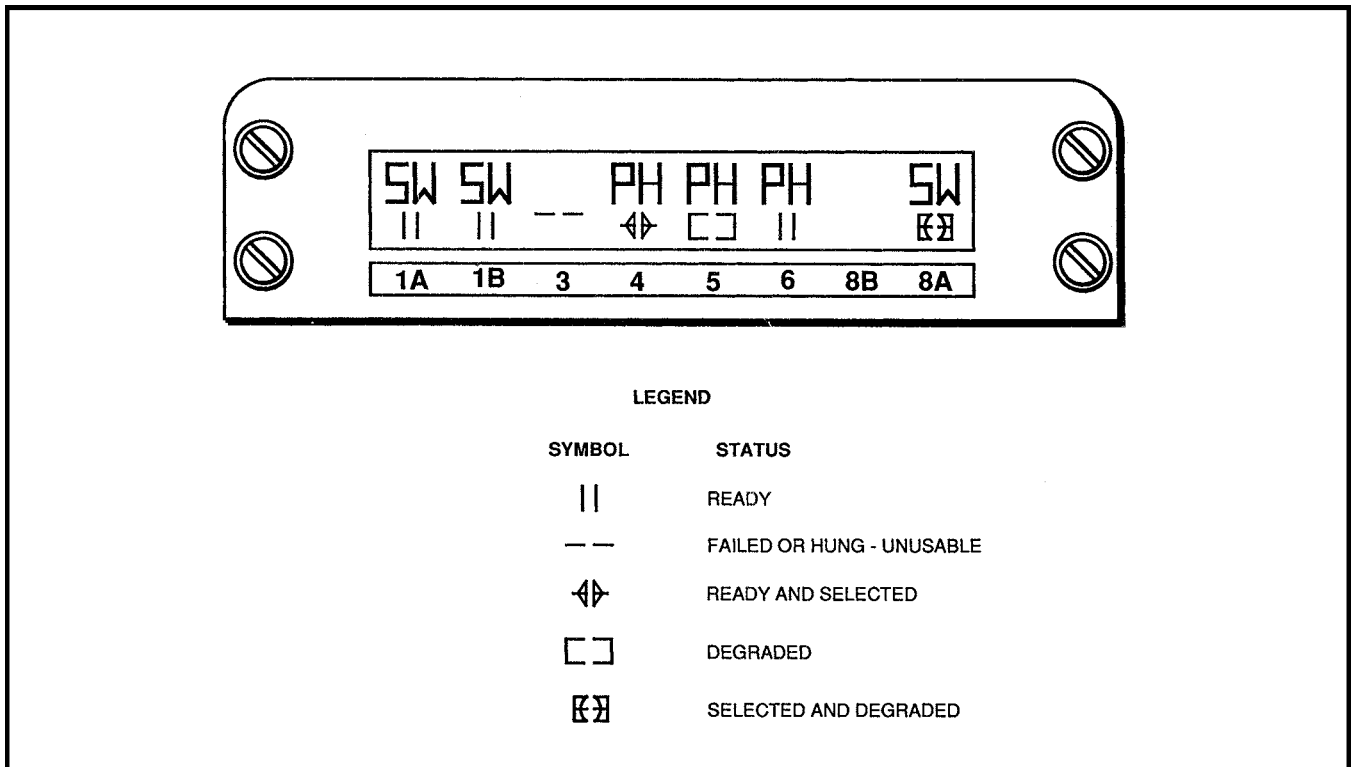
1. Emergency (EMERG)
2. Air combat maneuver (ACM)
3. Selective (SEL)
4. Auxiliary (AUX).

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.



- 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.



(AT)1-F50D-379-0

Figure 2-133. Multistatus Indicator

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 2-134). Emergency jettison has priority over all other SMS functions. This momentary, nonlatching pushbutton and the EMERG STORES JET (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 and Figure 2-135 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 non-volatile 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.

ACM jettison is initiated by the pilot raising the ACM guard (Figure 2-134) 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 jettison.

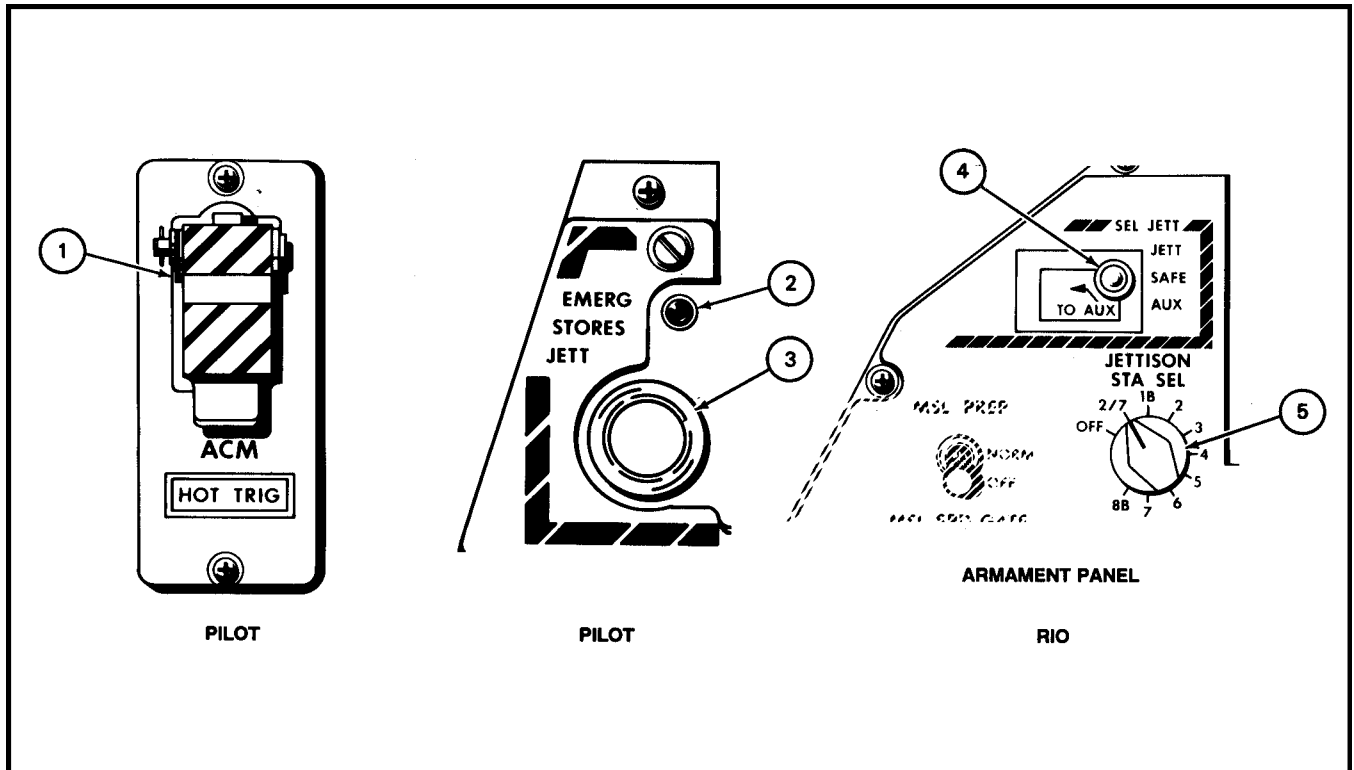
2.40.3.3 Selective Jettison

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.



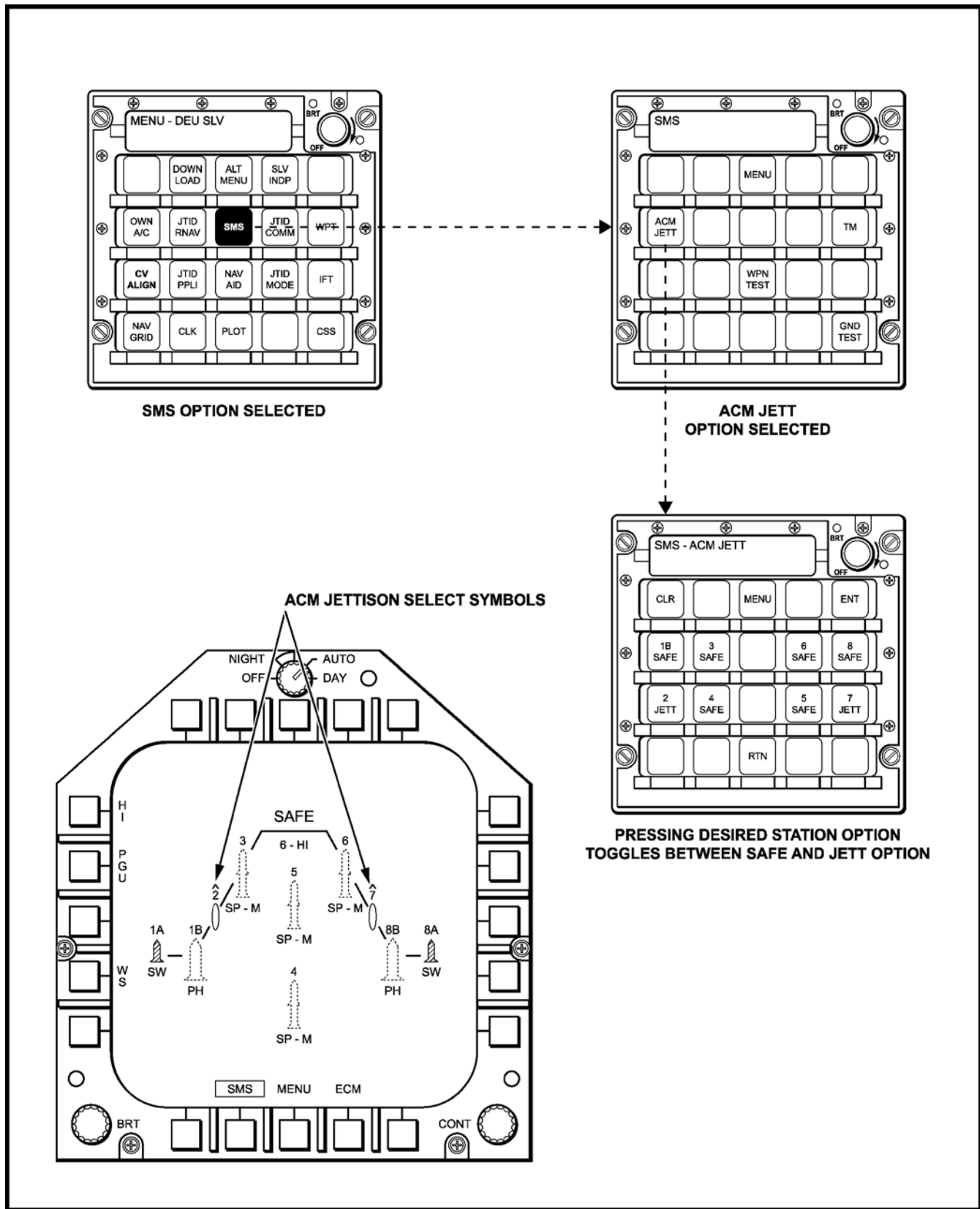
Do not attempt jettison of external fuel tanks until wing fuel tanks are depleted. Wing fuel may be lost if the external tank quick-disconnect valve sticks in the open position.



1-F50D-185-0

NOMENCLATURE	FUNCTION
<p>① ACM JETT pushbutton</p>	<p>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.</p>
<p>② ACK light</p>	<p>Redundant indicator for emergency jettison activation. Illuminates for 5 seconds, indicating the SMP has acknowledged the emergency stores jettison command.</p>
<p>③ EMERG STORES JETT pushbutton/light</p>	<p>Enables the separation of all jettisonable stores. 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.</p>
<p>④ SEL JETT switch</p>	<p>With Master Arm on and gear up, allows RIO to jettison from selected station(s). It is a three-position, lever-locked switch with guarded positions.</p>
<p>⑤ JETTISON STA SEL switch</p>	<p>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. OFF – Inhibits selective and auxiliary jettison. Station – Selects store(s) for jettison.</p>

Figure 2-134. Jettison Controls



CSC-F14D-1-2-052A

Figure 2-135. ACM Jettison Selection and Display

2.40.3.4 Auxiliary Jettison

Auxiliary jettison is a nonejection release mode for single A/G stores loaded on BRU-32s (Figure 2-134). 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.



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 unknocked, and 12 inches above the deck if the nosegear is knocked. 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

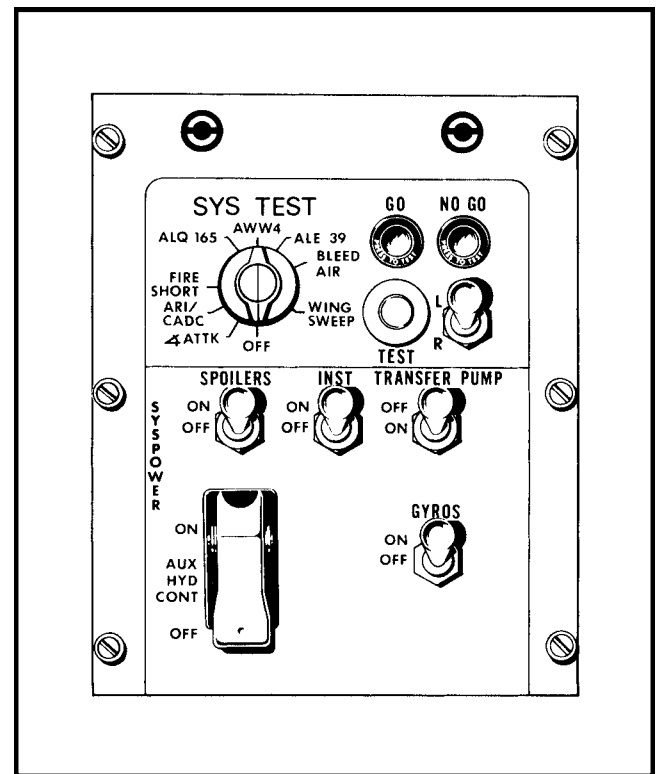
clearance of 16 feet is required when opening the radome. The radar antenna must be stowed before opening the radome. Antenna stow position is 0° azimuth and 60° tilted down.

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 2-136) 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.



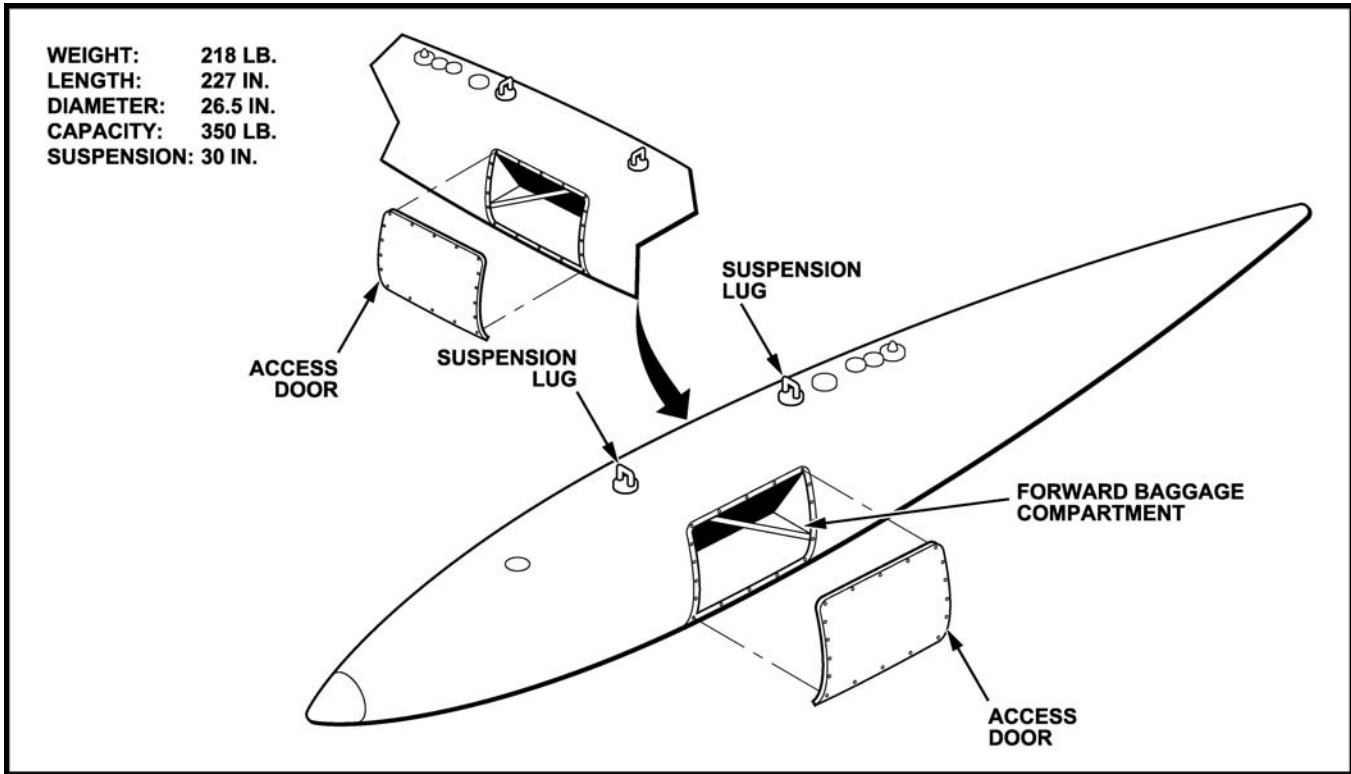
0-F50D-81-0

Figure 2-136. Systems Test and System Power Ground Panel

2.41.4 External Baggage Container (CNU-188/A)

The external baggage container (Figure 2-137) 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.



CSC-F14D-1-2-053

Figure 2-137. CNU-188/A External Baggage Container

CHAPTER 3

Servicing and Handling

3.1 SERVICING DATA

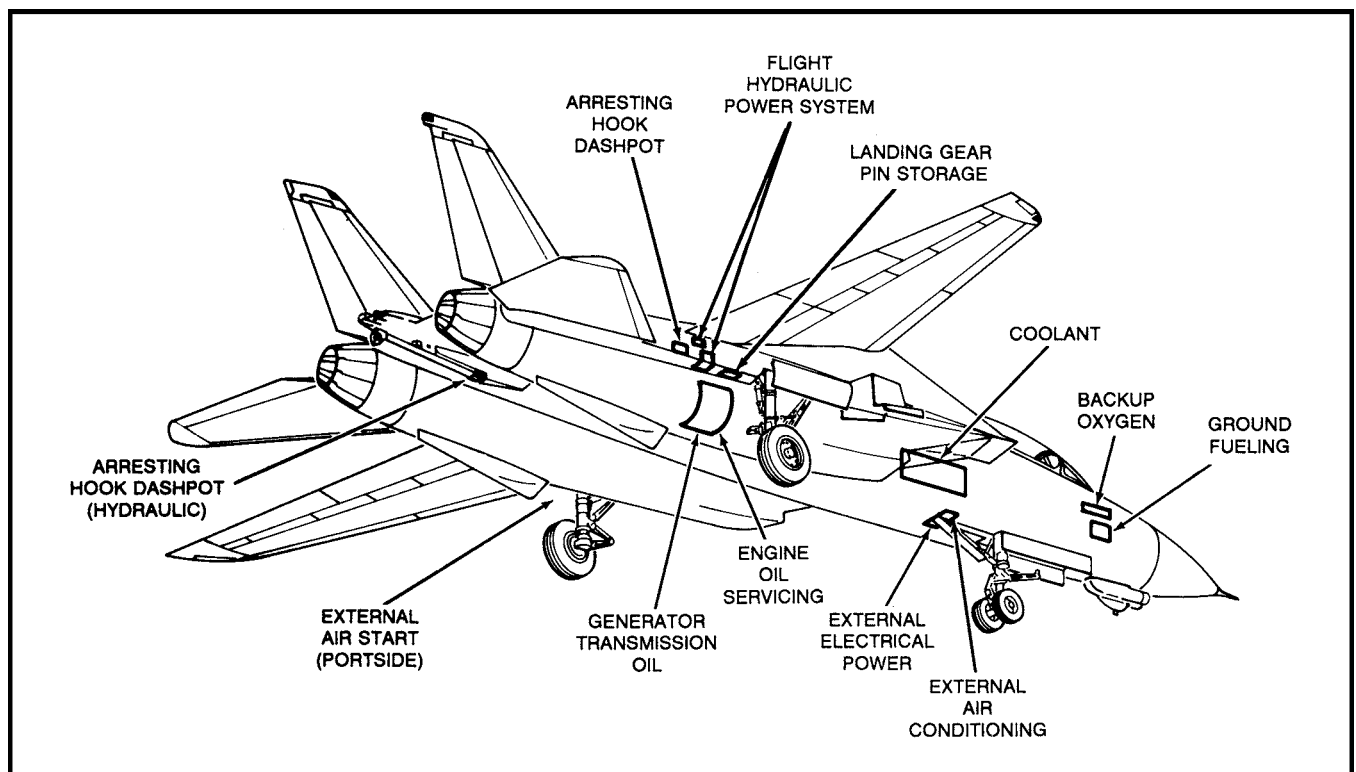
The following servicing data is for use by the flight-crew and maintenance crews who are unfamiliar with servicing the aircraft (Figure 3-1). When operating in and out of military airfields, consult the current DOD IFR Supplement for compatible servicing units, fuel, etc. Figure 3-2 provides a tabulation 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.



1-F50D-458-0

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	Selector (main engine control) on both engines should 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 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 ± 3psi (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 × 6.6-10 20 Ply	Ashore	105 psi
	Afloat	350 psi
Main (2) 37 × 11.50-16 28 Ply	Ashore	245 psi
	Afloat	350 psi

Note

Dry nitrogen, specification BB-N-411, 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

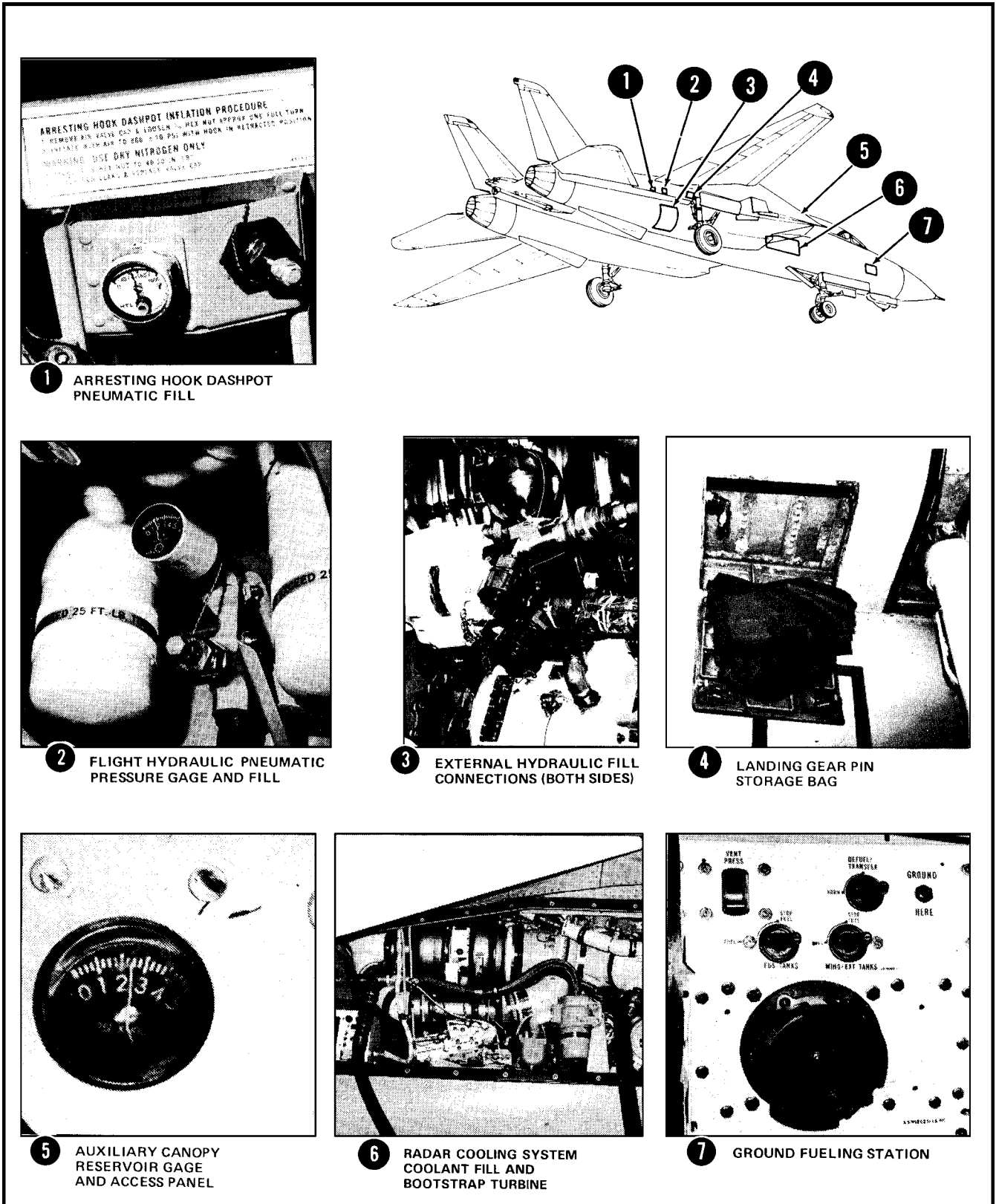
The IDG has a filter bypass indicator at the bottom of the filter bowl (Figure 3-3, sheet 2). Extension of the indicator indicates contamination of the filter and the need for filter element replacement. Refer to NAVAIR 01-F14AAD-2-1 for IDG oil filter replacement and servicing.

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

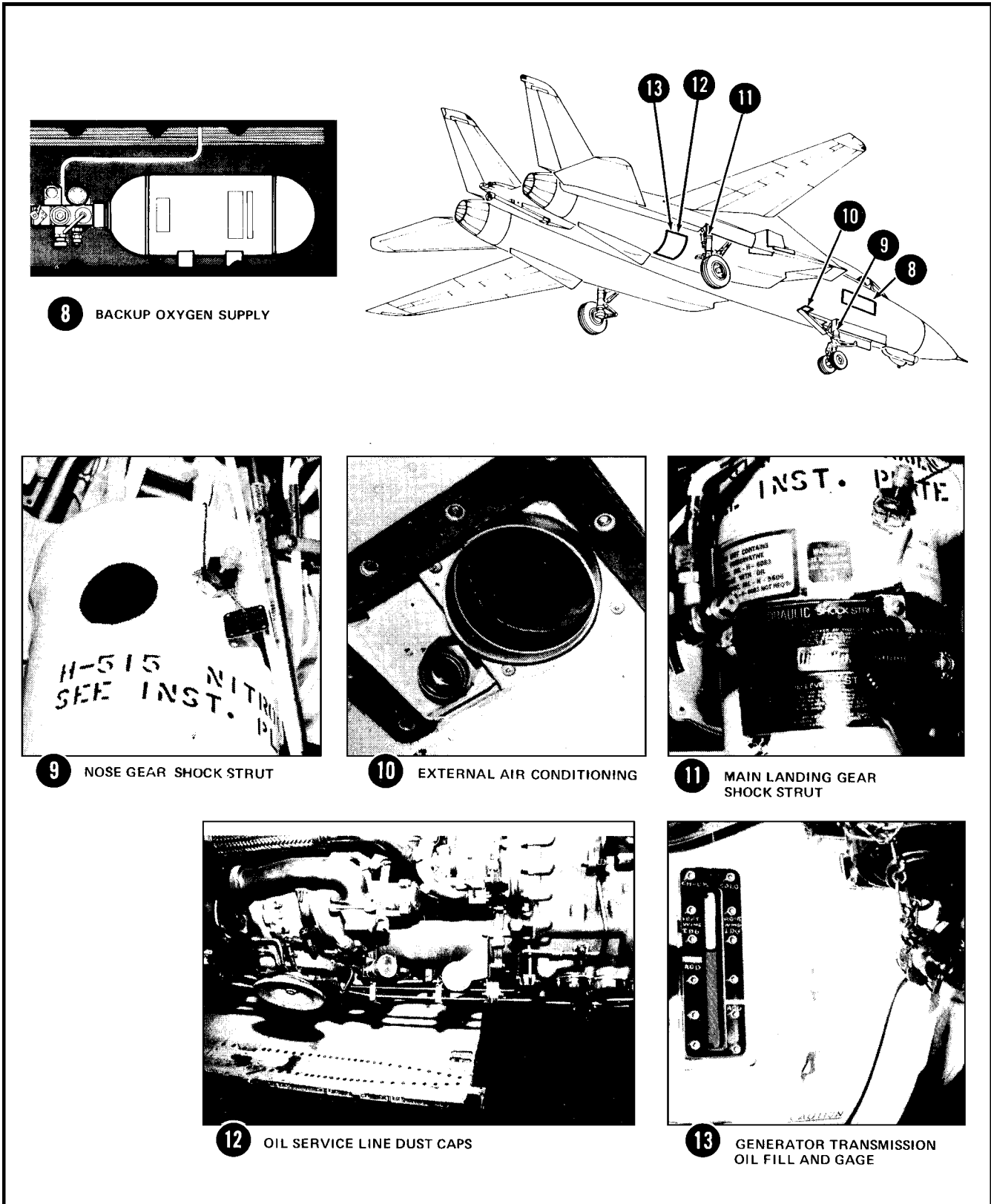
The main hydraulic systems are serviced at the flight and combined hydraulic system ground servicing panels. A hydraulic pressure filling cart is required to service the systems with fluid, and an air-nitrogen cart is required to preload the reservoirs. The outboard spoiler backup module is serviced 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 nose-wheel 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.



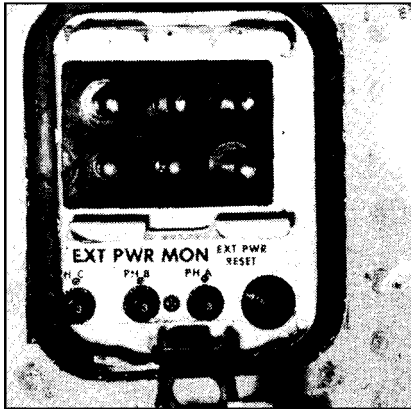
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Figure 3-3. Aircraft Servicing (Sheet 1 of 3)

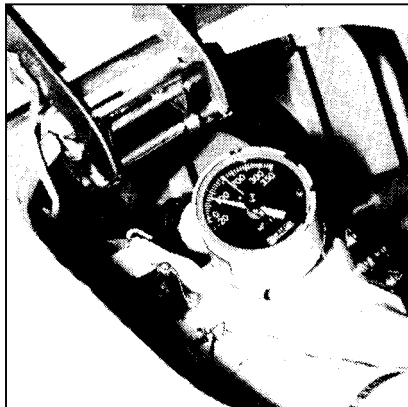
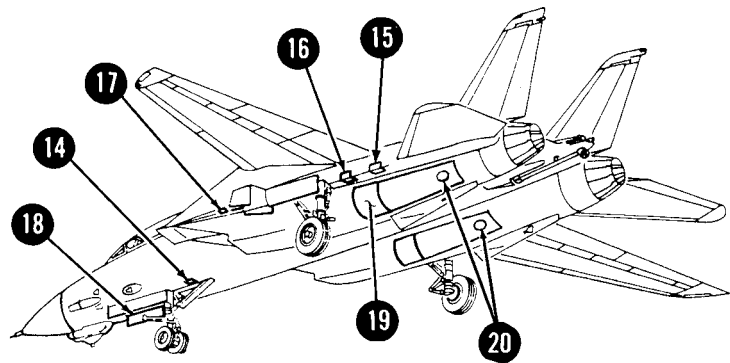


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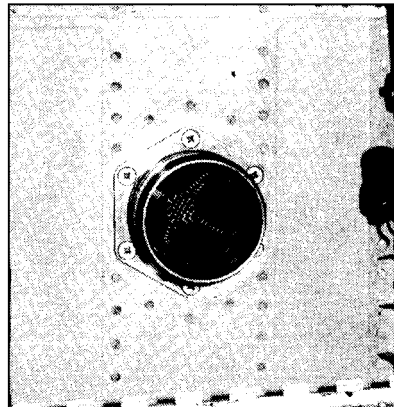
Figure 3-3. Aircraft Servicing (Sheet 2 of 3)



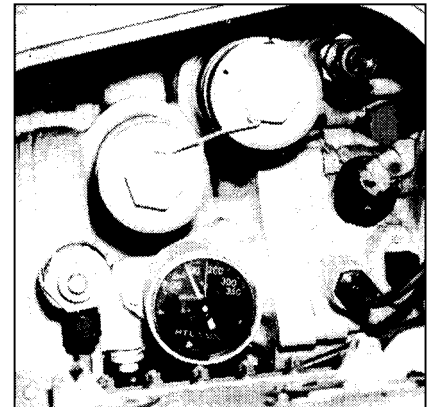
14 EXTERNAL ELECTRICAL POWER PANEL



15 COMBINED HYDRAULIC TEMPERATURE GAGE.



16 ENGINE GROUND START AND COMBINED FILL



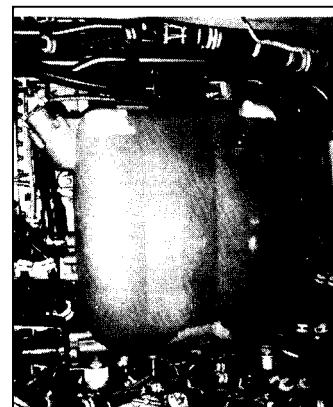
17 OUTBOARD SPOILER MODULE.



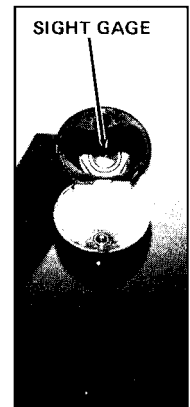
18 AUX AND PARK BRAKE/CANOPY/ EMERGENCY LANDING GEAR PRESSURE GAGES.



19 STARTER FILL AND DRAIN



20 ENGINE OIL LUBE TANK AND SIGHT GAGE



SIGHT GAGE

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 point and pressure gauges are provided for the auxiliary and parking brake systems.

Note

Dry nitrogen, specification BB-N-411, 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.



- 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 (HERO), and fuel ignition hazards generated during AN/APG-71 radar operation.



Illumination of RDR ENABLE caution light on RIO CAUTION ADVISORY panel indicates possible radar radiation on deck.

3.2.2.1 Hazards to Personnel

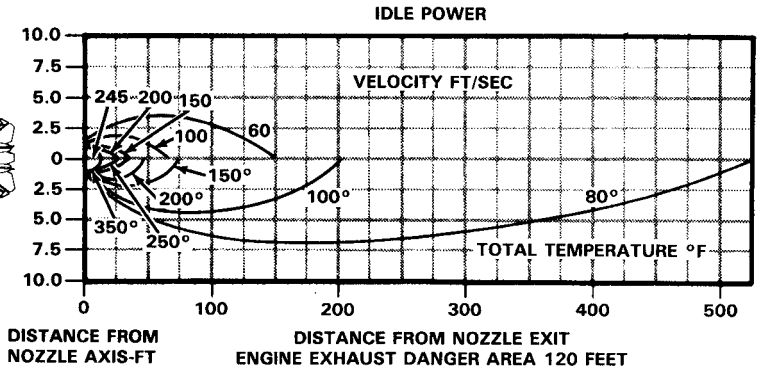
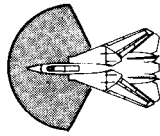
Minimum safe distances for personnel from ground operating radar are indicated in Figure 3-5, sheets 1 and 2. When the planar array radar antenna is not radiating, minimum safe distance from other radiating antennas is 6 feet.

3.2.2.2 HERO Condition

HERO conditions exist when ordnance or weapons containing electroexplosive devices (EED) 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.

WARNING

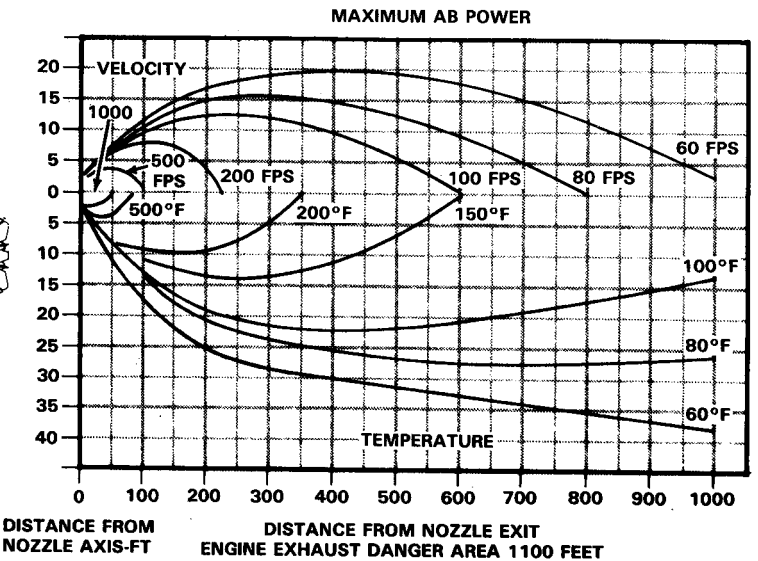
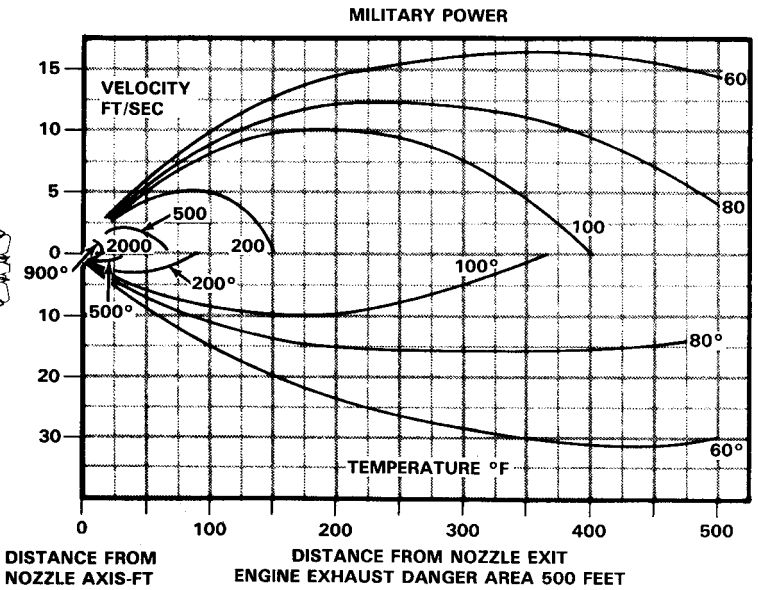
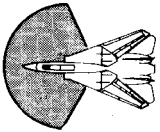
AT HIGH THRUST SETTINGS, THE SUCTION DANGER AREA AROUND ENGINE INLETS MAY EXTEND AS FAR AS 4 FEET AFT OF THE INLET DUCT LOWER LIP. EAR PROTECTION SHALL BE WORN AT ALL TIMES.



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.



0-F50D-65-0

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.

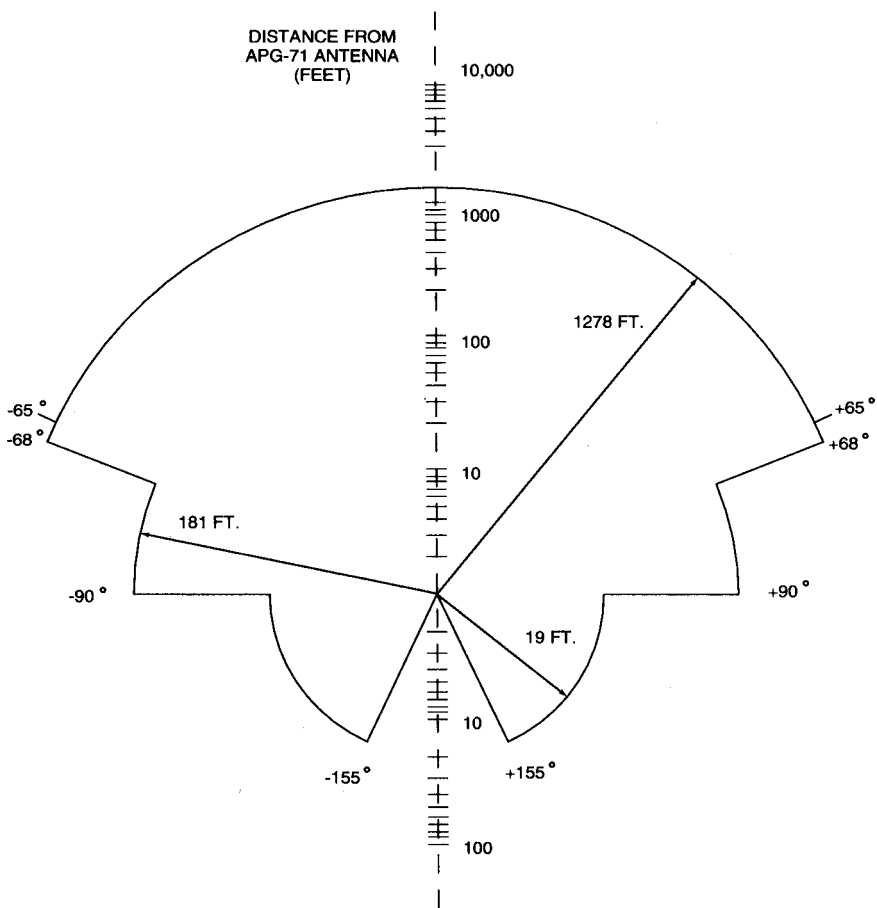
NOTES

- 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 $\pm 65^\circ$
- 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
 0° (BORESITE)



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.

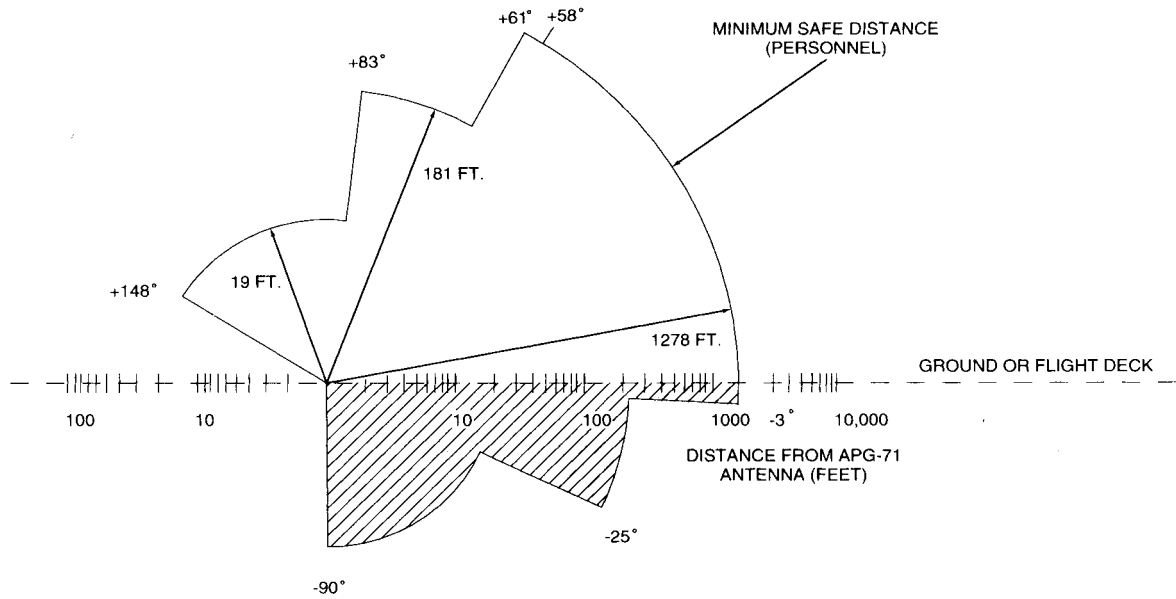
NOTES

- 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.
-  RF RADIATION HAZARD AREAS SHOWN ARE BASED ON 5 mW/cm² POWER DENSITY.

APG-71 PLANAR ARRAY PERSONNEL RADIATION HAZARD DISTANCE VS ELEVATION



2-F50D-302-2

Figure 3-5. Radar Radiation Hazard Areas (Sheet 2 of 4)

HAZARDS TO ORDNANCE - HERO

HERO UNSAFE ORDNANCE

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.

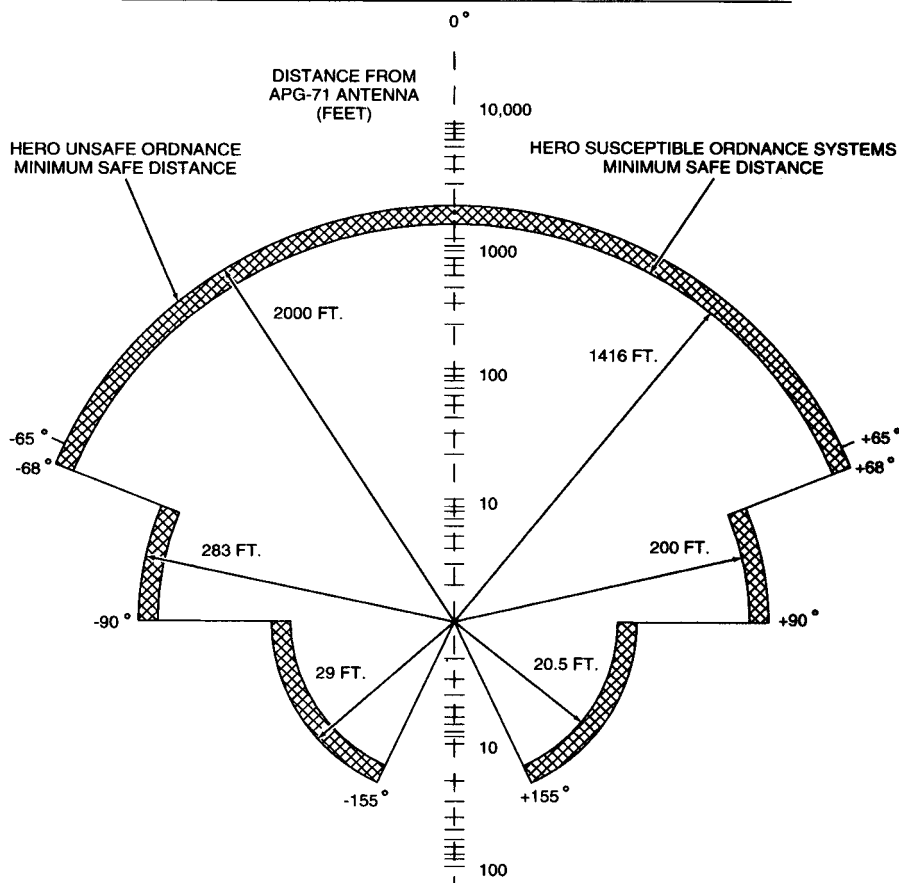
HERO SAFE ORDNANCE

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:

- HERO UNSAFE ORDNANCE HAZARD AREAS SHOWN ARE BASED ON 2.025 mW/cm² POWER DENSITY.
- HERO SUSCEPTIBLE ORDNANCE SYSTEMS HAZARD AREAS SHOWN ARE BASED ON 4.05 mW/cm² POWER DENSITY.

ORDNANCE RADAR SILENT ZONE RELATIVE TO APG-71 RADAR VS. AZIMUTH



2-F50D-302-3

Figure 3-5. Radar Radiation Hazard Areas (Sheet 3 of 4)

HAZARDS TO ORDNANCE - HERO

HERO UNSAFE ORDNANCE

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.

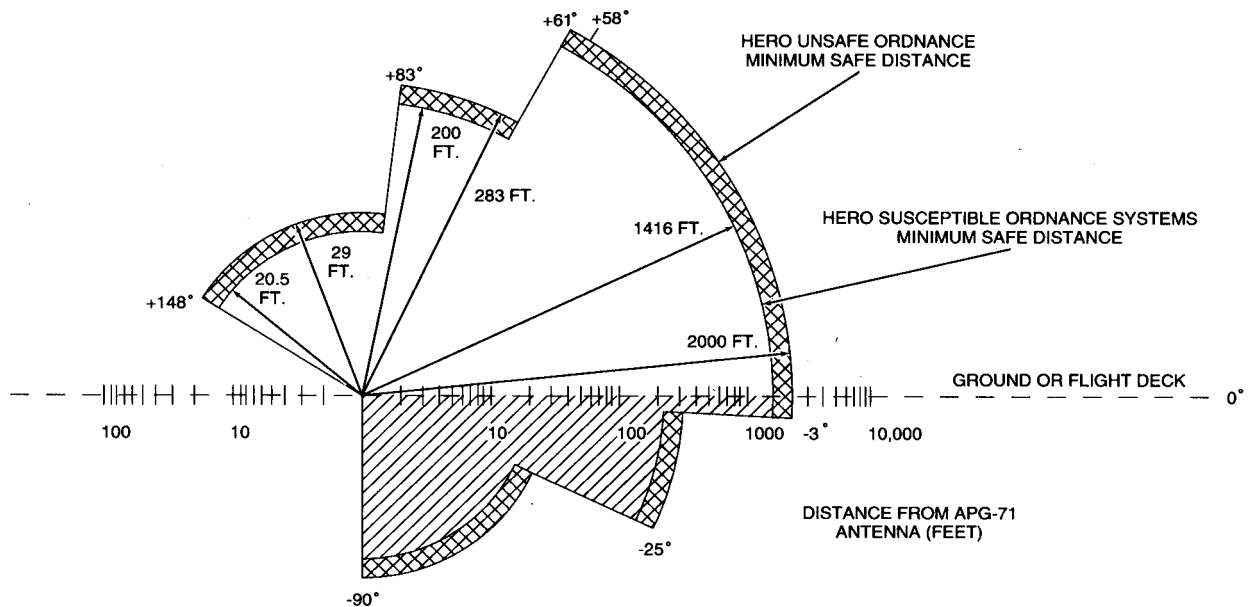
HERO SAFE ORDNANCE

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/cm² POWER DENSITY.
-  HERO SUSCEPTIBLE ORDNANCE SYSTEMS HAZARD AREAS SHOWN ARE BASED ON 4.05 mW/cm² POWER DENSITY.
-  OVER THE SIDE TRANSMISSION ABOARD CARRIER

ORDNANCE RADAR SILENCE ZONE RELATIVE TO APG-71 RADAR VS ELEVATION



2-F50D-302-4

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





TYPE EAR PROTECTIVE DEVICES	ALLOWABLE NOISE EXPOSURE SOUND LEVEL IN dBa (SLOW RESPONSE)						
	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

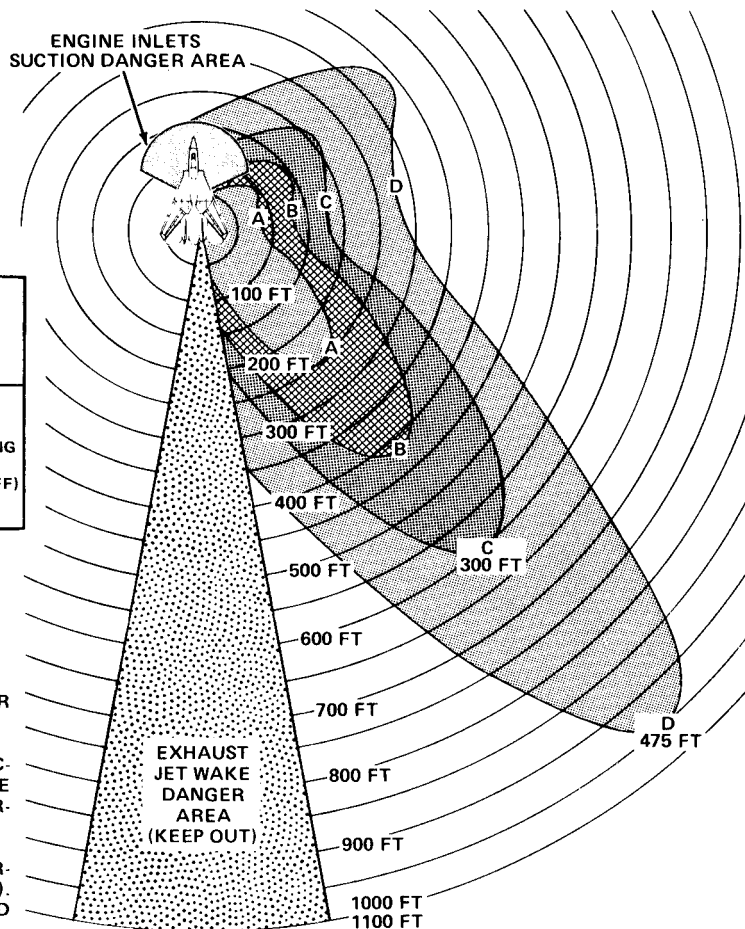
SOUND LEVEL CONTOURS SHOWN ARE FOR SINGLE-ENGINE OPERATION. CONTOURS ARE SYMMETRICAL ABOUT ENGINE CENTERLINES DURING DUAL-ENGINE OPERATION.

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 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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Figure 3-6. Noise Danger Areas

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.

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/cm² 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 ([Figure 3-7](#) and [Figure 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.

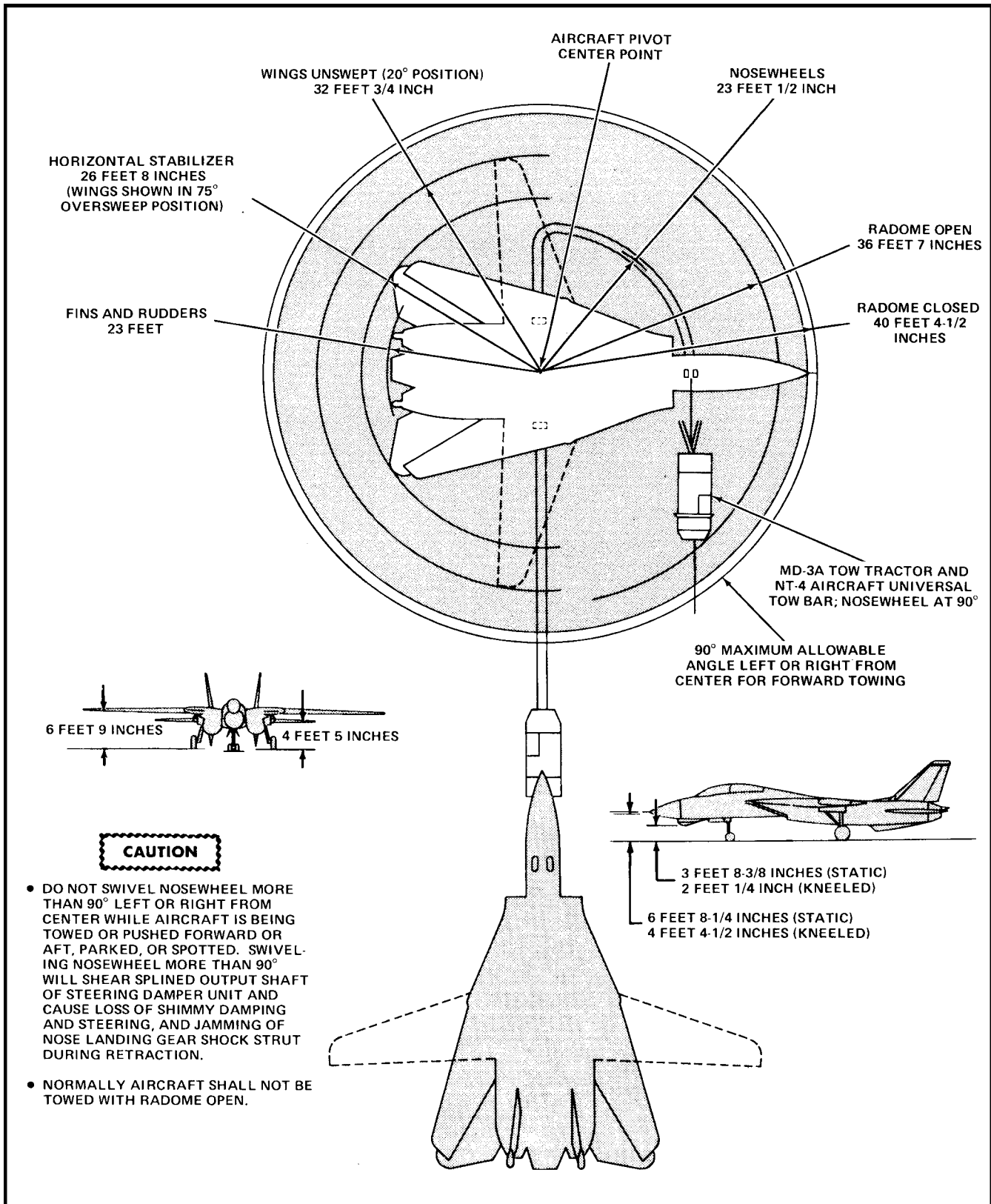


Before and during towing, ensure that the needle(s) in the AUX/PARK brake pressure gauge(s) remains in the green band to ensure sufficient pressure to lock the wheels.

3.2.4 Tiedown Points

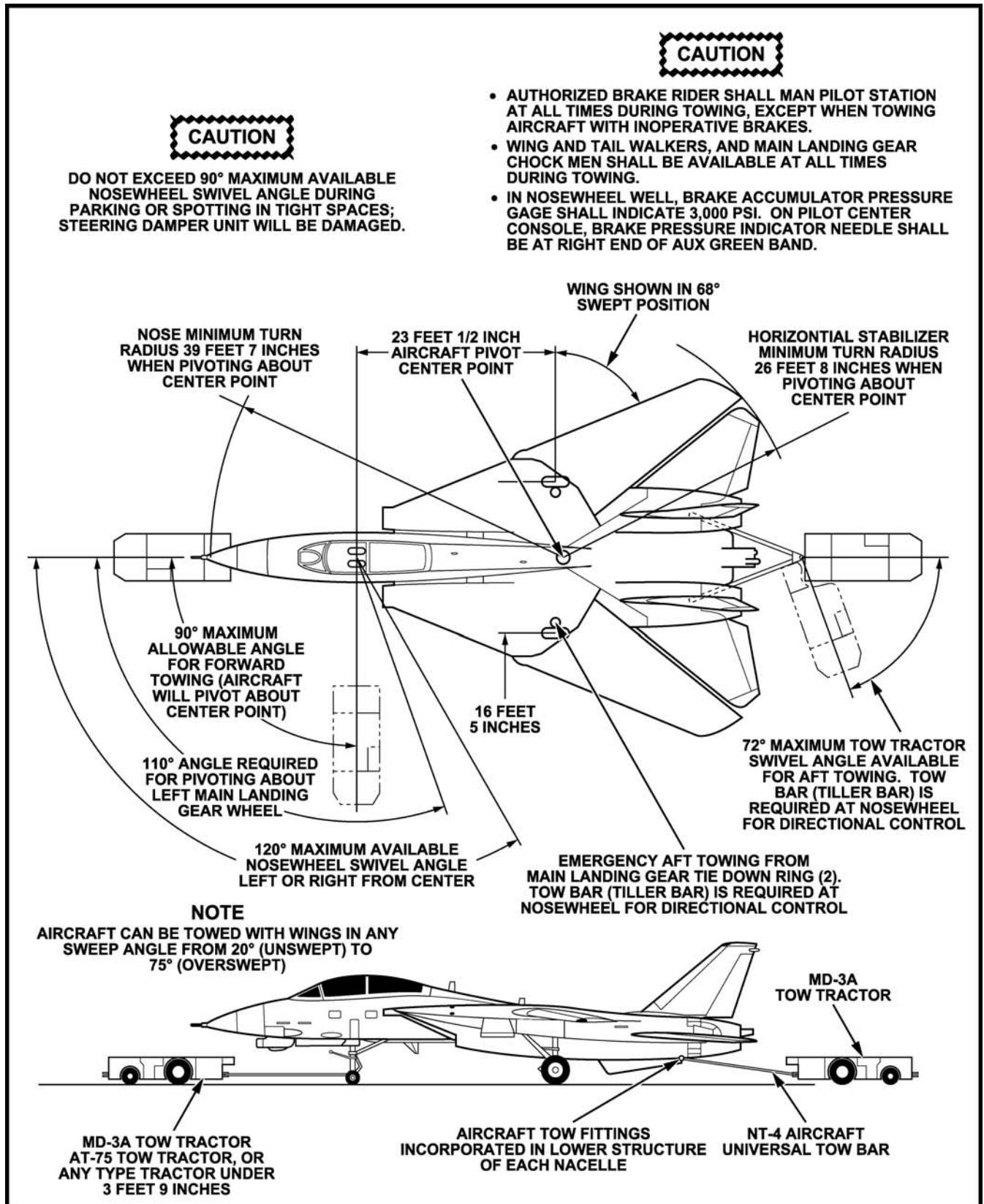
Aircraft tiedown points are illustrated in [Figure 3-9](#). When mooring a parked aircraft, do not depend upon chocks alone to hold the aircraft in position. Tiedowns shall be installed in a symmetrical pattern being careful not to chafe against the aircraft structure.

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).



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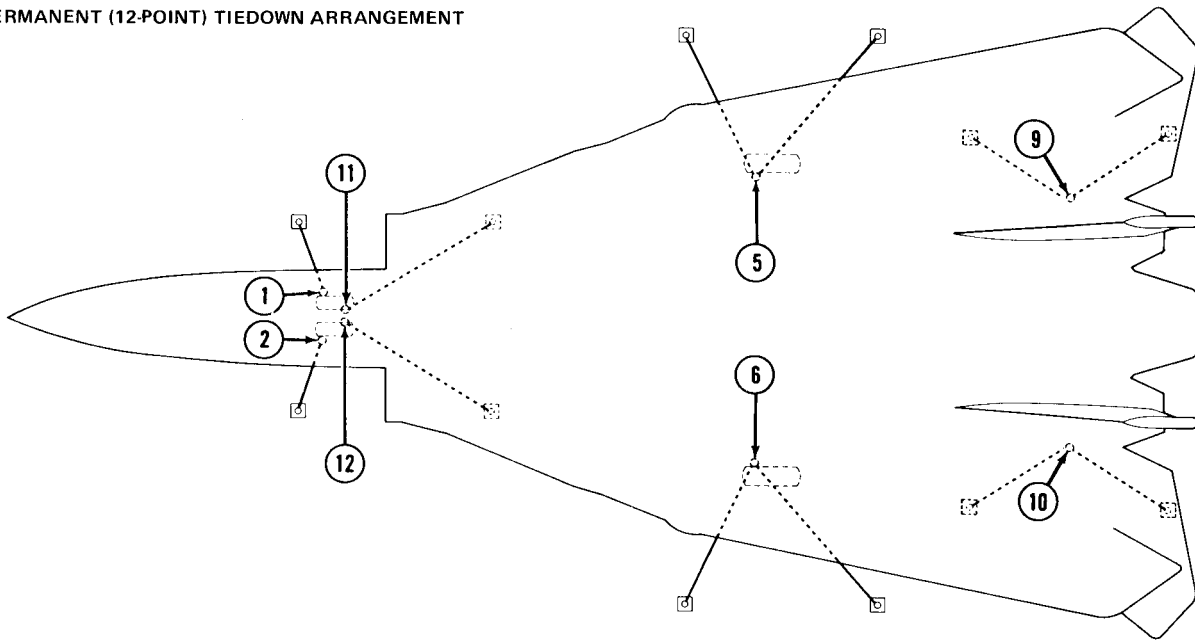
Figure 3-7. Towing Turn Radii



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Figure 3-8. Towing

PERMANENT (12-POINT) TIEDOWN ARRANGEMENT



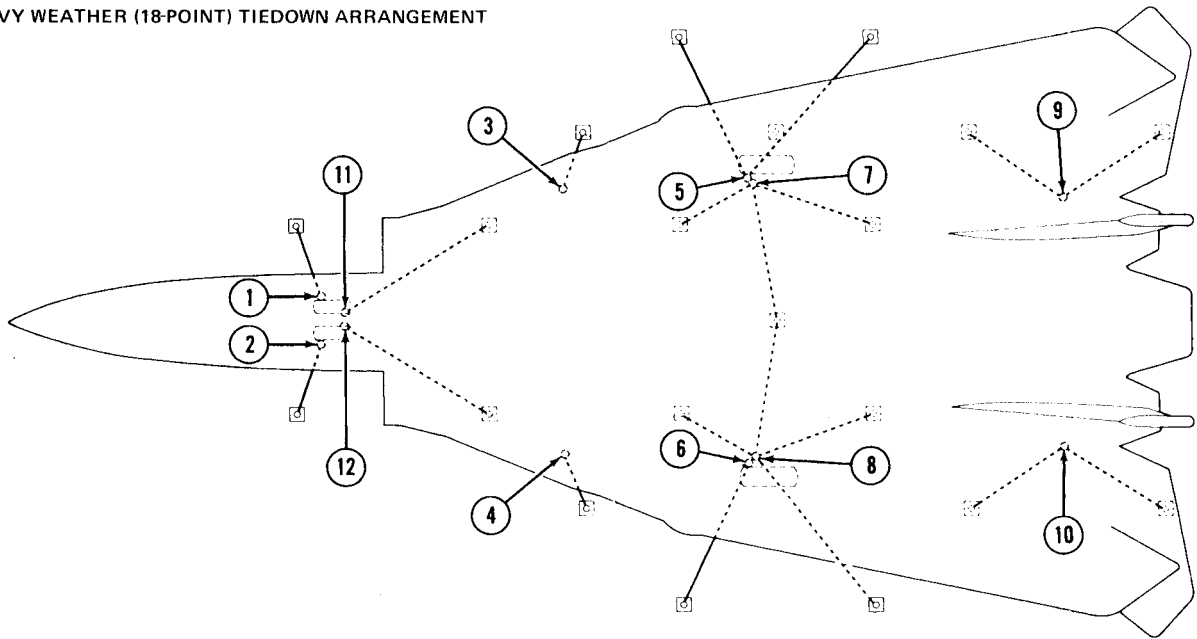
AIRCRAFT TIEDOWN FITTINGS

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 IMN.

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:

- 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.
- Use only during landing or aborted takeoff.
- 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 IMN.
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 these limits shall be entered on the maintenance action form for appropriate maintenance action.

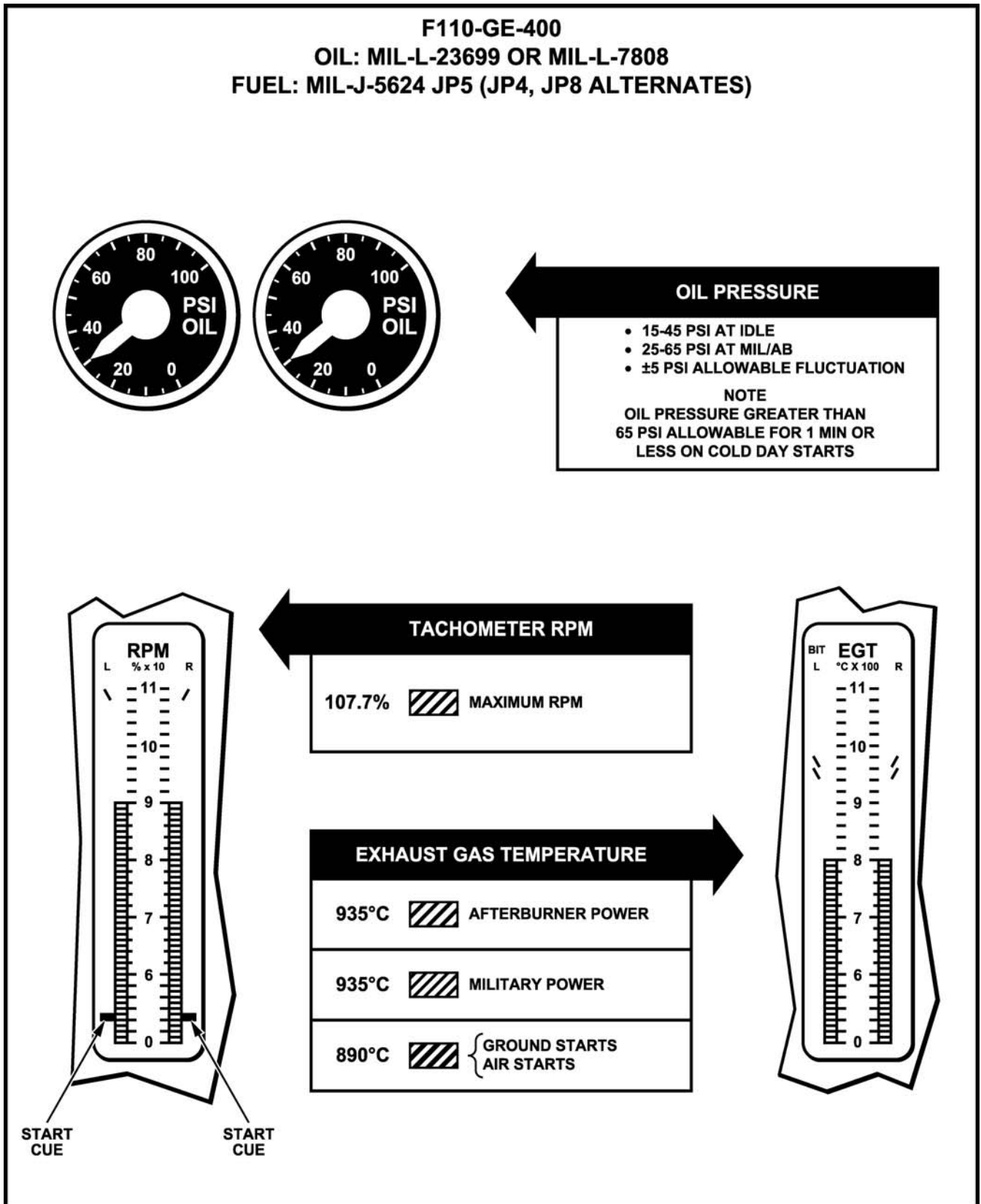
STORE CONFIGURATION	AIRCRAFT STORE STATION						
	1A	1B	2	3, 4, 5, & 6	7	8B	8A
1A(*)	-	-	-	-	-	-	-
1B1	AIM-9	AIM-9	-	-	-	AIM-9	AIM-9
1B2	AIM-9	-	-	-	-	-	AIM-9
1C	-	-	TANK	-	TANK	-	-
2A(*)	-	-	-	4 AIM-7	-	-	-
2B1	AIM-9	AIM-9	-	4 AIM-7	-	AIM-9	AIM-9
2B2	AIM-9	-	-	4 AIM-7	-	-	AIM-9
2B3	AIM-9	AIM-7	-	4 AIM-7	-	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 shore-based 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 stations 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



CSC-F14D-1-4-004A

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) (AIRSTART)		890 890	— —
NOTE			
<ul style="list-style-type: none"> • 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	

Figure 4-3. Engine Operating Limits

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 of 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.



- 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 [Figure 4-5](#) and [Figure 4-8](#).

4.3.2 Approach Configuration

1. Landing gear and/or landing flaps and slats extended — 0 to 2.0g (symmetrical or rolling).

4.4 ANGLE-OF-ATTACK LIMITS

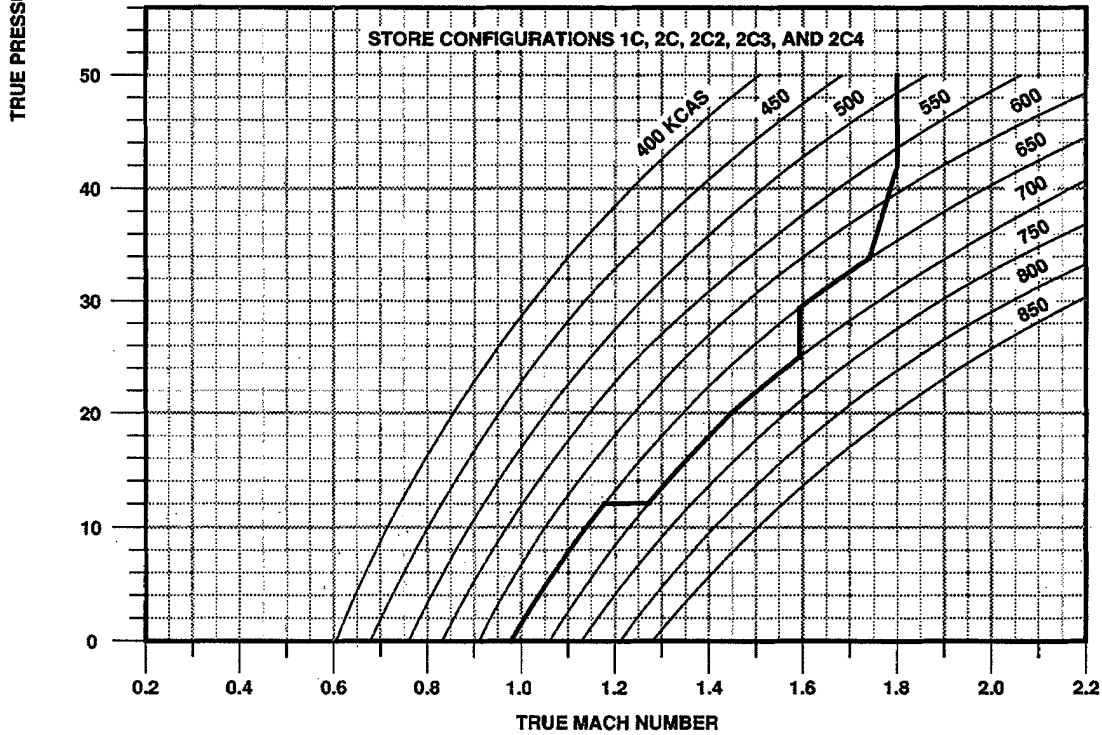
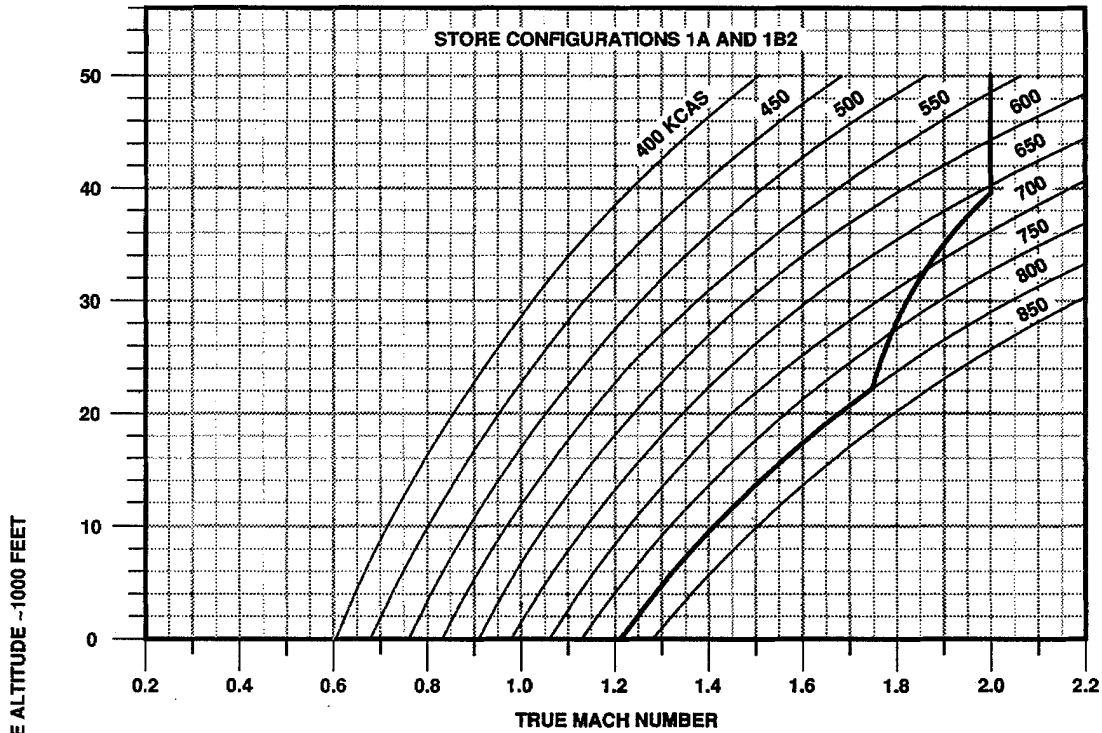
4.4.1 Cruise Configuration

AOA is limited by the maximum allowable load factor of [Figure 4-5](#). For wing sweep not in AUTO, AOA limits of [Figure 4-7](#) still apply. Since ROLL SAS now increases departure resistance at higher AOA, it should be left on for all flight conditions. With operating ARI, subsonic pilot control inputs with landing gear retracted are not limited by AOA or sideslip and therefore [Figure 4-8](#) applies only with ROLL SAS OFF or a Degraded DFCS condition.

WARNING

- Aircraft has significantly improved roll rate capability with ROLL SAS ON, which increases susceptibility to inertia coupled departures due to overly aggressive multi-axis control inputs.
- With ROLL SAS ON, departure resistance is increased because of DFCS ARI functionality and therefore should remain on at all times.

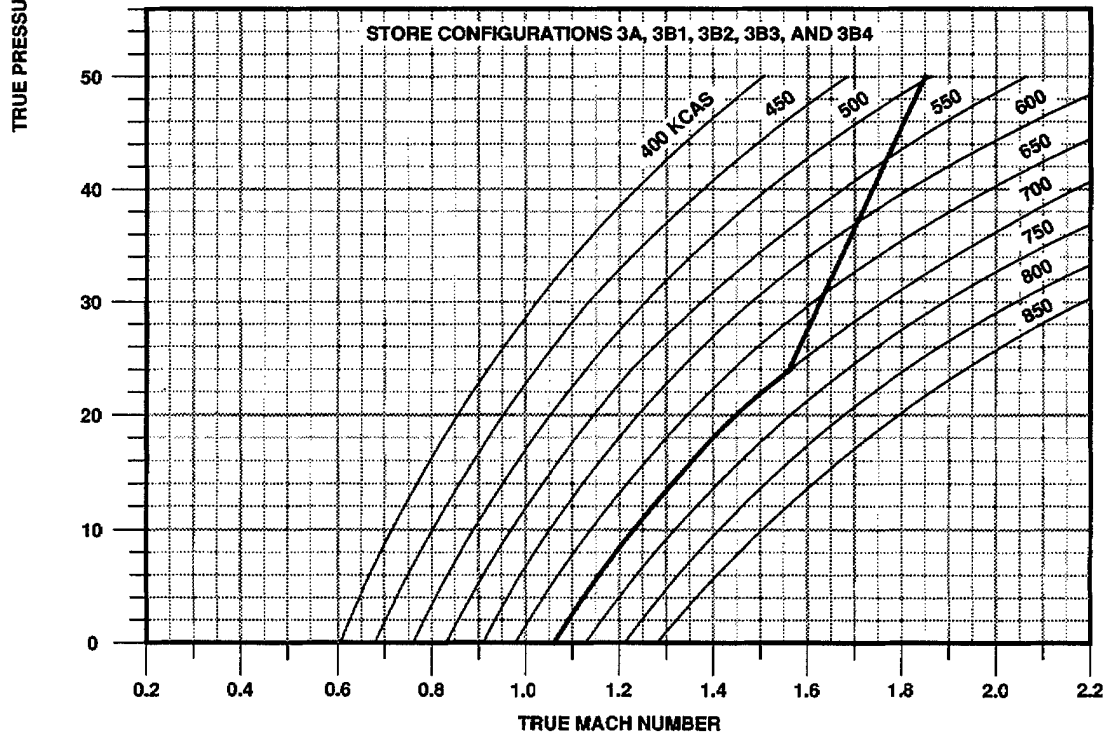
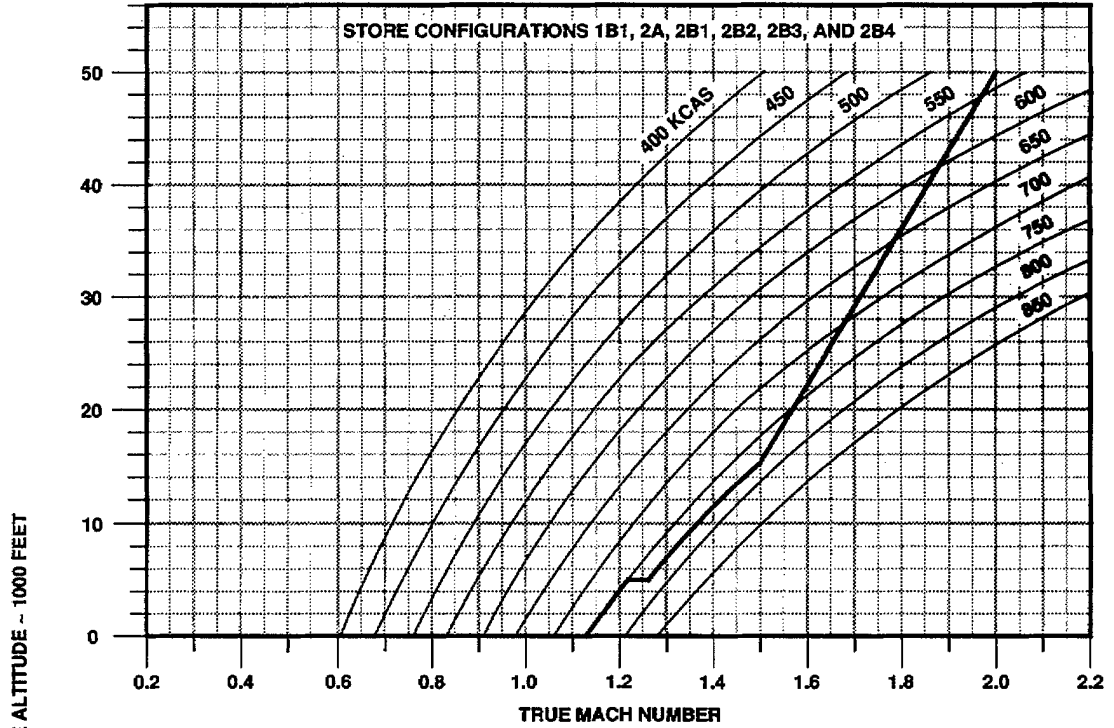
DATE : FEBRUARY 1992
 DATA BASIS : FLIGHT TEST



(AT)0-F50D-478-1

Figure 4-4. Maximum Allowable Airspeeds (Sheet 1 of 3)

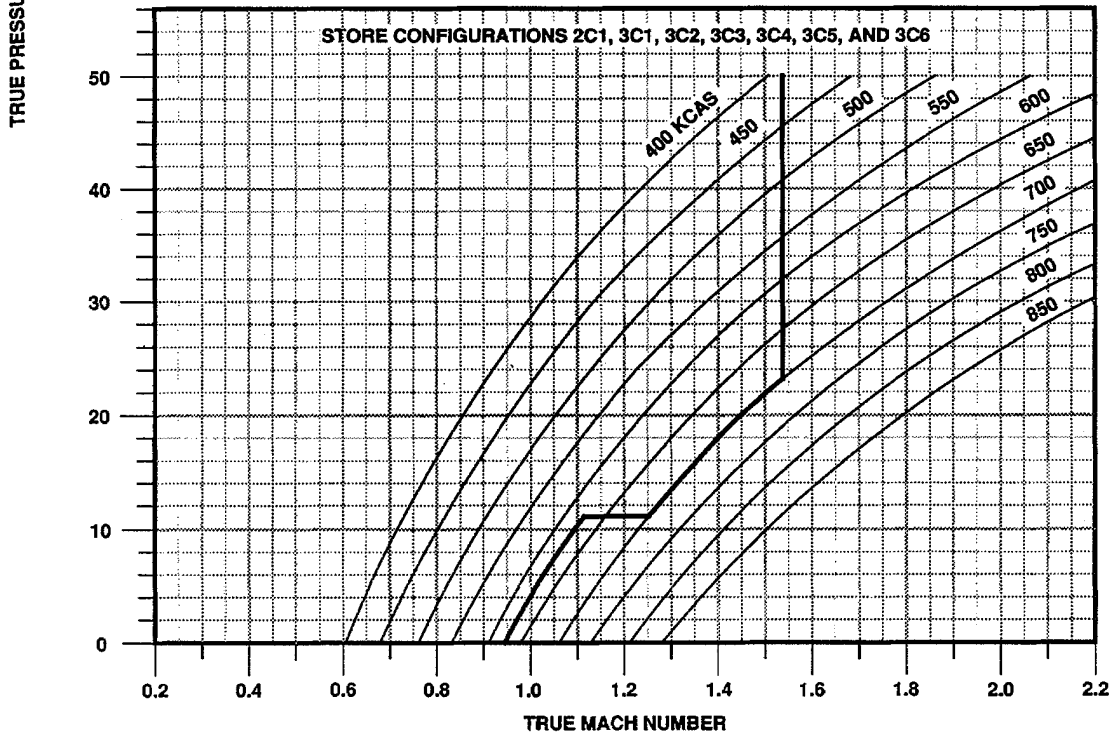
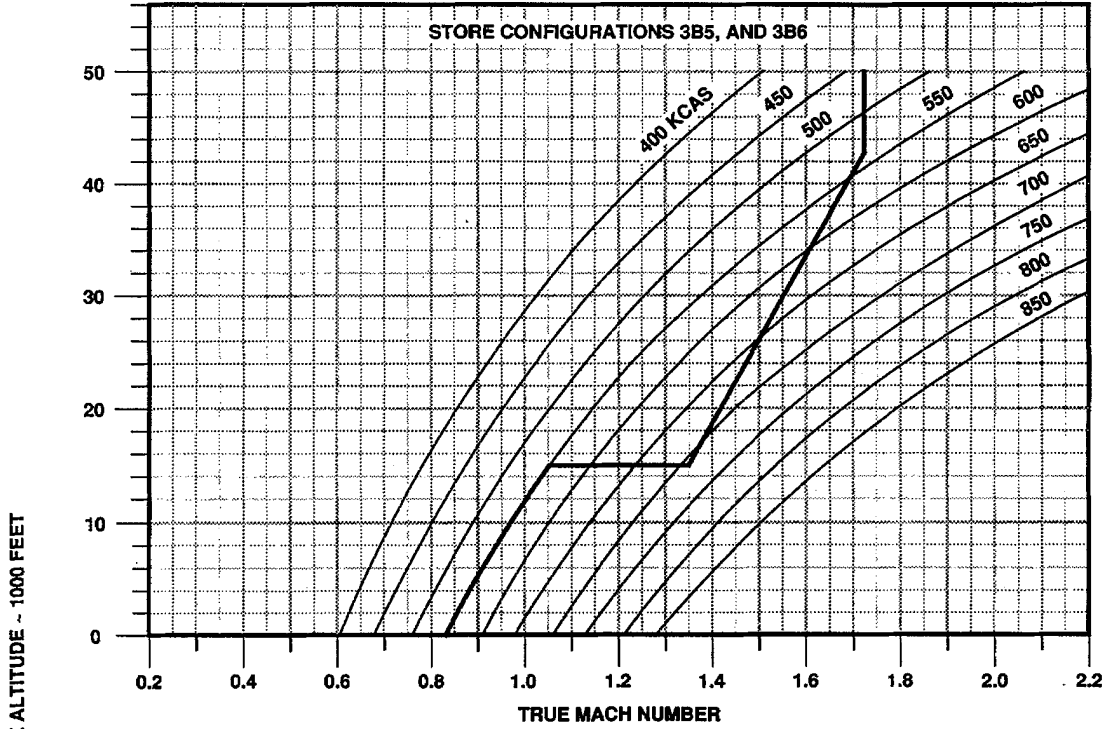
DATE : FEBRUARY 1992
DATA BASIS : FLIGHT TEST



(AT)0-F50D-478-2

Figure 4-4. Maximum Allowable Airspeeds (Sheet 2 of 3)

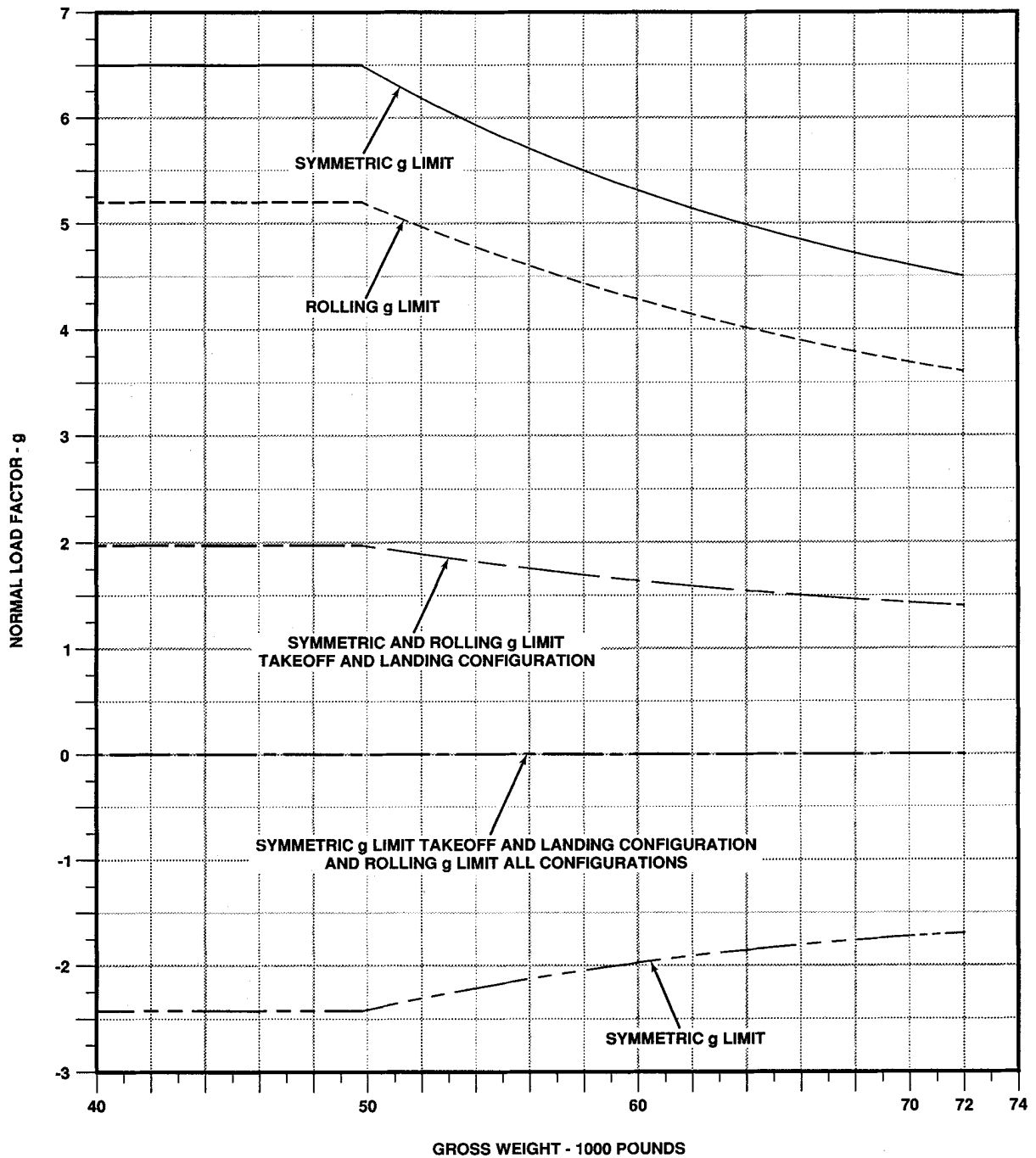
DATE : FEBRUARY 1992
 DATA BASIS : FLIGHT TEST



(AT)0-F50D-478-3

Figure 4-4. Maximum Allowable Airspeeds (Sheet 3 of 3)

DATE: JUNE 1992
 DATA BASIS: FLIGHT TEST



(AT)0-F50D-490-0

Figure 4-5. Variation of Maximum Allowable Normal Load Factor With Gross Weight

4.4.2 Approach Configuration

Maximum allowable AOA and rudder deflection 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. No additional g and/or AOA limits are placed on ROLL SAS ON maneuvering, or cross control inputs.



Maneuvering with YAW SAS OFF or inoperative shall not be conducted above 15 units AOA with landing gear retracted.

Since inoperative auto-maneuvering devices may signal improper operation of DFCS primary AOA input, uncoordinated lateral control inputs shall not be used in the area of the flight envelope indicated in [Figure 4-8](#) when auto-maneuvering flaps/slats are not operating.

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](#) whichever is less. Rolling limits are shown in [Figure 4-9](#).



- 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 (wing sweep not in AUTO, pylon mounted AIM-54).

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 1.7 TMN — Intentional sideslips prohibited.



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

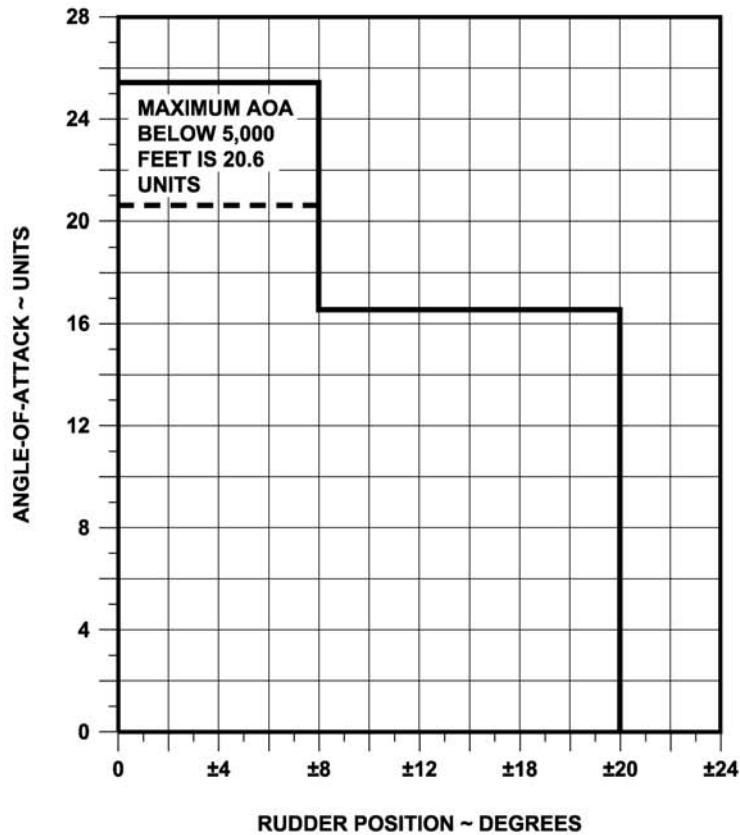
The following additional maneuvers are prohibited:

1. Intentional spins.
2. During afterburner operations:
 - e. Sustained 0 to -0.5g flight.
 - f. Flight from -0.5g to -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

- 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 $\pm 30^\circ$ 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.



CSC-F14D-1-4-005A

Figure 4-6. Maximum Allowable Angle of Attack Rudder Deflections

CRUISE CONFIGURATION

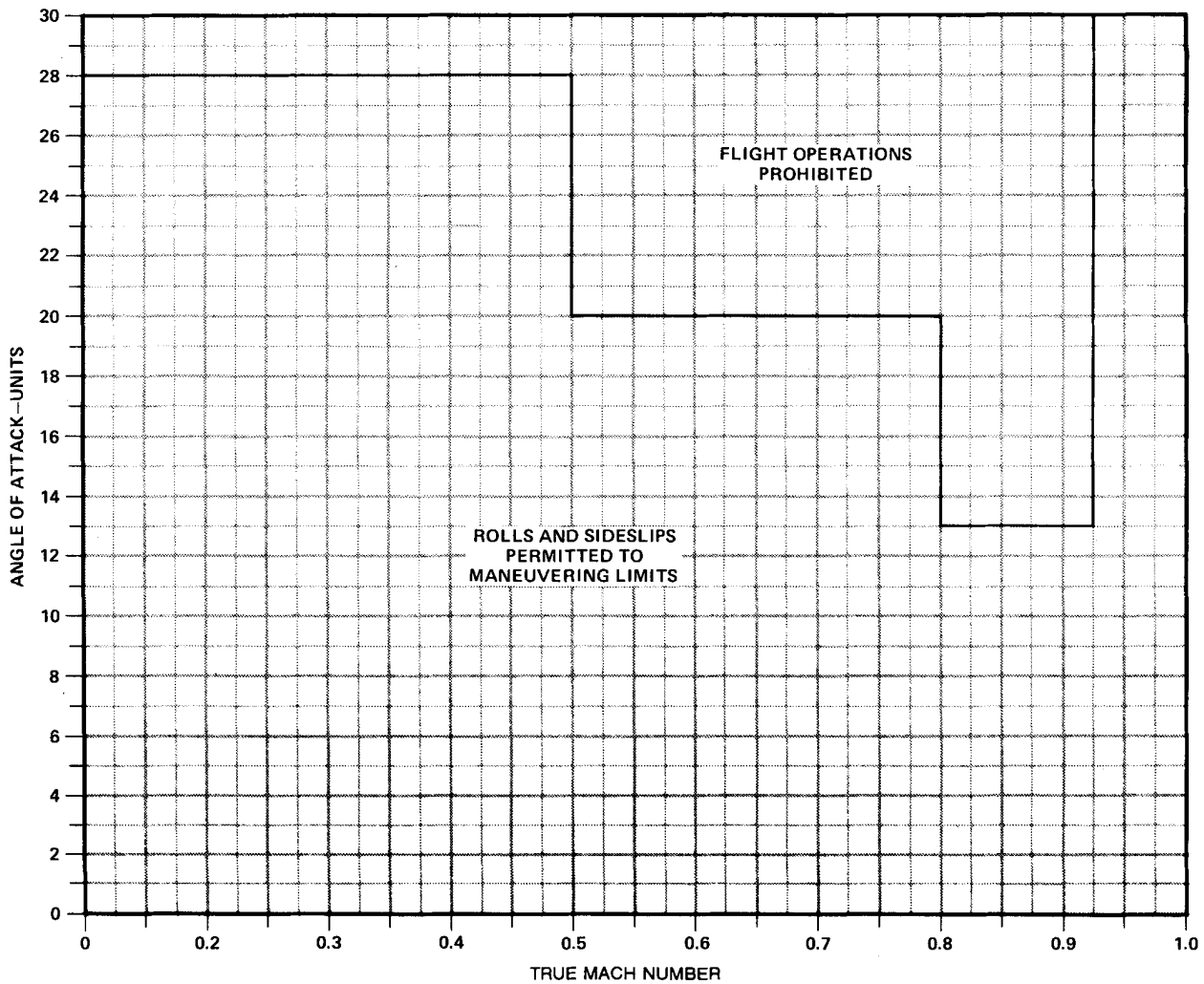
AIRCRAFT CONFIGURATION:

- ALL WING MOUNTED AIM-54 LOADINGS
- WING SWEEP NOT IN AUTO

DATE: FEBRUARY 1992
DATA BASIS: FLIGHT TEST

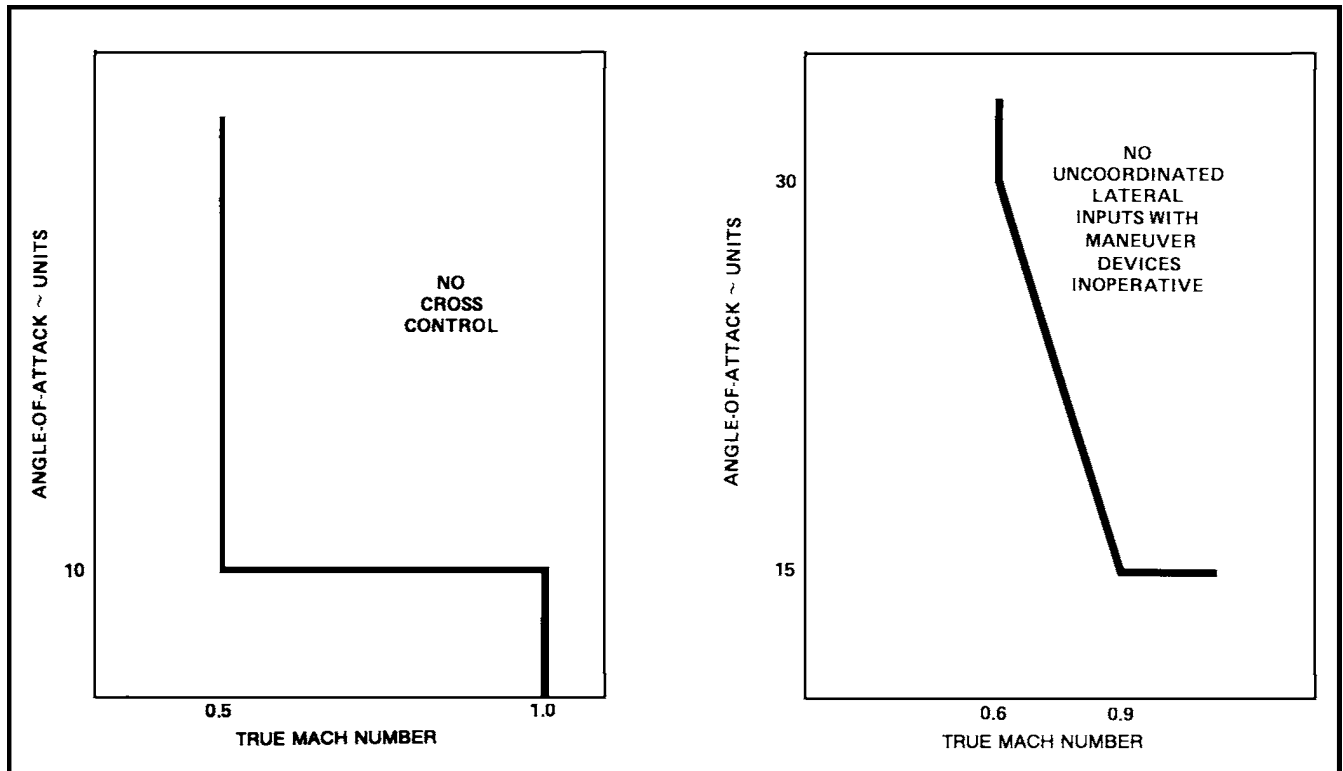
NOTE

ABOVE 0.93 TMN, AOA IS LIMITED BY
MAXIMUM ALLOWABLE LOAD FACTOR



0-F50D-479-0

Figure 4-7. Angle-of-Attack Limits



0-F50D-480-0

Figure 4-8. Maneuvering Limits — Cruise Configuration (Roll SAS Off or Degraded DFCS)

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. Use of maximum AB in event of engine failure during takeoff, catapult launch, waveoff or bolter.
8. Rolling maneuvers with AOB change greater than 360° are prohibited.

4.6 SAS LIMITS

FCS CAUTION Airspeed < 600 kts/1.3TMN
 > 0.5TMN/10 units AOA
 - No cross controls
 > 0.6TMN/15 units AOA
 - Coordinate all lateral stick

PITCH SAS No Limitations

ROLL DGR/YAW DGR
 and/or ARI DGR Airspeed <1.0TMN

ARI/SAS OUT Airspeed <1.0TMN
 - AOA: max 15 units
 - No aggressive maneuvering

4.7 TAKEOFF AND LANDING FLAP AND SLAT AND TRANSITION LIMITS

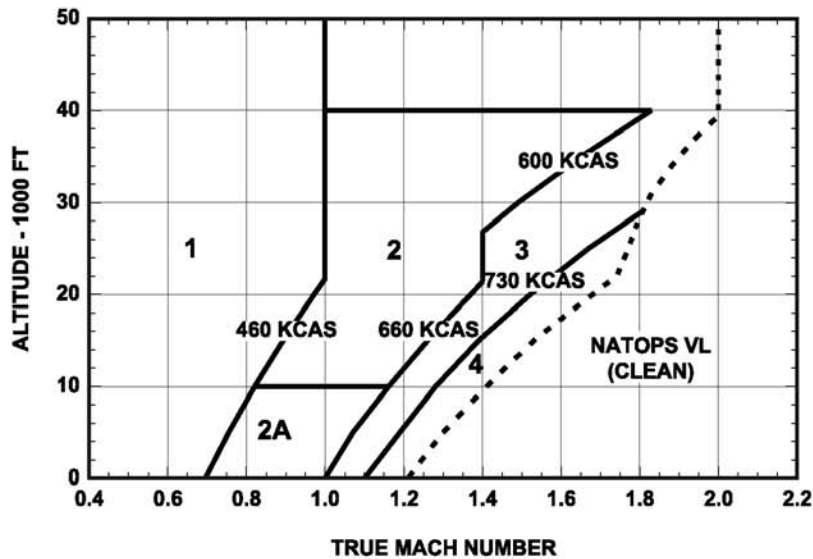
4.7.1 Clean and Symmetric Stores Loading

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.
4. All flap and slat extensions and retractions will be made at a maximum of 12 units AOA.

F-14D ROLL MANEUVERING LIMITS ROLL SAS ON

CLEAN / FUSELAGE STORES (EXCEPT TARPS) / AIM-9



ROLLING MANEUVERS LIMITED TO:

- REGION 1:** 0.0 TO 5.2 G.
360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1.0 G.
- REGION 2:** 0.0 TO 4.0 G.
360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1.0 G.
- REGION 2A:** 0.0 TO 3.0 G.
360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1.0 G.
- REGION 3:** NO ABRUPT STICK INPUTS.
360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G ONLY.
ABOVE 1 G, ROLLING MANEUVERS LIMITED TO COORDINATED TURNS
USING MAXIMUM 0.5 INCH LATERAL STICK INPUTS.
- REGION 4:** NO ABRUPT STICK INPUTS.
ROLLING MANEUVERS LIMITED TO COORDINATED TURNS AT 1.0 G
USING MAXIMUM 0.5 INCH LATERAL STICK INPUTS.

NOTES:

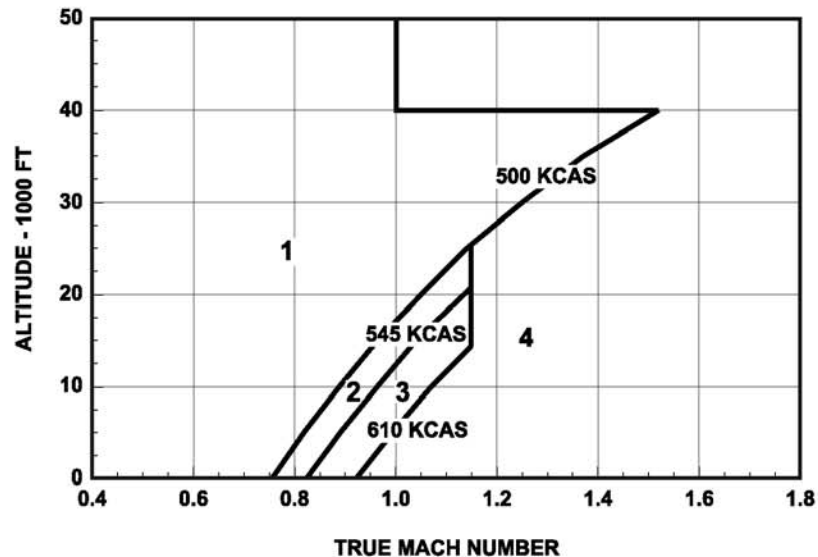
1. DO NOT EXCEED MAXIMUM ALLOWABLE AIRSPEED FOR STORE LOADING PER NATOPS FIGURE 4-4 (F14D).

CSC-F14D-14-001B

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

F-14D ROLL MANEUVERING LIMITS ROLL SAS ON

TANKS / PYLON STORES (EXCEPT AIM-9) / TARPS



ROLLING MANEUVERS LIMITED TO:

- REGION 1:** 0.0 TO 4.0 G.
360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1.0 G.
- REGION 2:** 0.0 TO 3.0 G.
360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1.0 G.
- REGION 3:** 360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G.
- REGION 4:** NO ABRUPT STICK INPUTS.
ROLLING MANEUVERS LIMITED TO COORDINATED TURNS AT 1.0 G
USING MAXIMUM 0.5 INCH LATERAL STICK INPUTS.

NOTES:

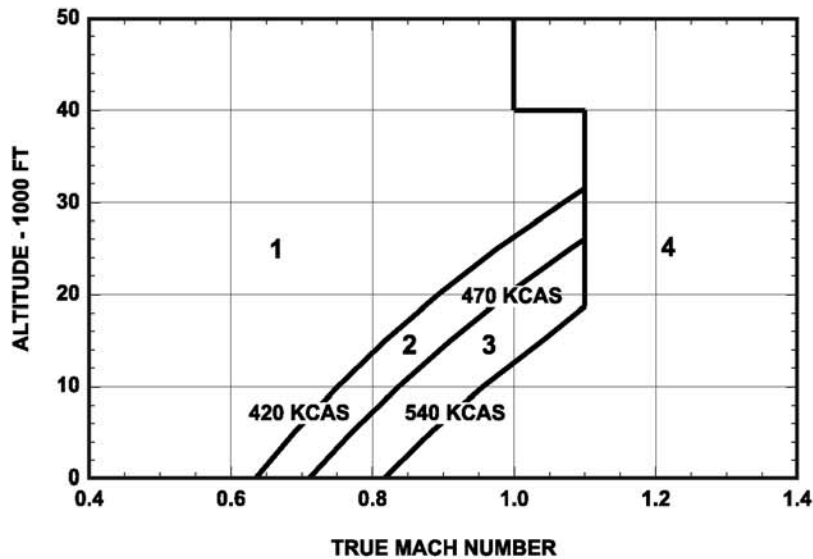
1. DO NOT EXCEED MAXIMUM ALLOWABLE AIRSPEED FOR STORE LOADING PER NATOPS FIGURE 4-4 (F14D).
2. CURRENT NATOPS ROLL SAS ON AIRSPEED LIMITS FOR TARPS LOADINGS APPLY.

CSC-F14D-1-4-002B

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

F-14D ROLL MANEUVERING LIMITS ROLL SAS ON

COMBINED TARPS + TANKS + PYLON AIM-7 (WITH OR W/O AIM-9)



ROLLING MANEUVERS LIMITED TO:

- REGION 1:** 0.0 TO 4.0 G.
360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1.0 G.
- REGION 2:** 0.0 TO 3.0 G.
360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G.
180° MAXIMUM BANK ANGLE CHANGE AT OTHER THAN 1.0 G.
- REGION 3:** 360° MAXIMUM BANK ANGLE CHANGE AT 1.0 G ONLY.
- REGION 4:** NO ABRUPT STICK INPUTS.
ROLLING MANEUVERS LIMITED TO COORDINATED TURNS AT 1.0 G
USING MAXIMUM 0.5 INCH LATERAL STICK INPUTS.

NOTES:

1. DO NOT EXCEED MAXIMUM ALLOWABLE AIRSPEED FOR STORE LOADING PER NATOPS FIGURE 4-4 (F14D).
2. CURRENT NATOPS ROLL SAS ON AIRSPEED LIMITS FOR TARPS LOADINGS APPLY.

CSC-F14D-14-003B

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

STORE ORDNANCE/STATION	FLAP LIMITATIONS (INCH-POUNDS)							
	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
<p>Note</p> <p>Do not attempt shipboard landing with inoperative ROLL SAS and greater than 170,000 in-lbs asymmetry unless divert field unavailable.</p>								
FLAP TRANSITIONS:								
CLEAN OR SYMMETRICAL	UP TO 66,000 IN-LBS ASYMMETRY			GREATER THAN 66,000 IN-LBS ASYMMETRY				
<ol style="list-style-type: none"> 1. Less than 45° angle of bank 2. ROLL SAS ON 3. Minimum 200 feet AGL on takeoff 4. Dirty-up altitude minimum 800 feet AGL 5. Minimum 180 knots 	<ol style="list-style-type: none"> 1. Wings level 2. ROLL SAS ON 3. Minimum 200 feet AGL 4. Dirty-up at minimum 800 feet AGL 5. Minimum 180 knots 			<ol style="list-style-type: none"> 1. Wings level 2. ROLL SAS ON 3. Minimum altitude of 1,200 feet AGL for takeoff and landing 4. Minimum 180 knots. <div style="text-align: center; margin: 10px 0;"> <div style="border: 2px solid black; padding: 5px; display: inline-block;">WARNING</div> </div> <p>Available roll control will be marginal to inadequate in event of asymmetric flap/slats without lockout.</p> <p style="text-align: center;">Note</p> <p>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.</p>				

Figure 4-10. Flap Limitations

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 63,000 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

1. 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.



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. Carrier landings — 54,000 pounds
Field carrier landing practice — 54,000 pounds.

Note

Landing approaches to touchdown should not exceed 17 units AOA to avoid nozzle/ventral fin damage.

4. Only normal 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:
 - a. AAC 618 — Modifies multipurpose pylon.
 - b. AAC 673 — Modifies fuselage backup structure.
 - c. AAC 688 — Modifies pylon-mounted sway-braces.

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.
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 equals 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. 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 aircraft 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.



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 IMN +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, +1g for straight and level flight.
3. Stations 4 and 5 — V_{min} to 400 KCAS, all altitudes, +1g for straight and level flight.



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 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 F14A/B/D A/G Tactical Manual (NWP 3-22.5-F14A/B/D, Volume III, NAVAIR 01-F14AAD-1T-2) for air-speed 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.



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 nosedown 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.

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 5.1.1.1 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 DFCS/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 1½; 1,000 and 1
20 to 45	700 and 1; 600 and 2; 500 and 3
45 and above	Field minimums or 200 and ½, 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 ½, whichever is higher.

Where adherence to these minimums unduly hampers pilot training, commanding officers may waive time-in-series 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 bold-face exams.
3. A flight syllabus at a fleet replacement squadron. 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 NATOPS evaluation check in a CNO approved flight simulator by an FRS instructor. If a simulator is not available, a separate NATOPS evaluation checkflight is required.
5. 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 are considered current in the F-14B. NATOPS requalification for the F-14A, and F-14B can be accomplished during the same evaluation check, provided the NATOPS open, closed, boldface, 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 commanding 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 flight 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 Administration

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/alpha check
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/Chart Update Manual
4. Entry/exit times
5. Formation/altitude/airspeed
6. Navigation mode/plan
 - a. Waypoint LAT/LONG
7. Communications
8. Checkpoints/turnpoints
9. Timing/corrections
10. Radar plan/search contracts
11. Threat awareness (SAM, AAA, A/A)
12. DECM/RWR/expendables
13. Target area ingress — Initial point/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
 - k. Laser codes
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/bullseye

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. Missile employment
 - h. Crank/expendables
 - i. Drop criteria/factor bandit range
 - j. Degrades
 - k. Float/split
 - l. Preplanned coordinated maneuvers
 - m. Radar warning receiver
 - n. Abort/reset
8. Approaching the merge/merge
 - a. Fuel package
 - b. IRCM
 - c. Section/division maneuvering
 - d. 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. Checkpoint
 - c. Post target 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 takeoff and landing checklists on the forward cockpit instrument panel is a fundamental element in all instances. 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 check flight 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 (F-14D Pocket Checklist), 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. Main landing gear 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

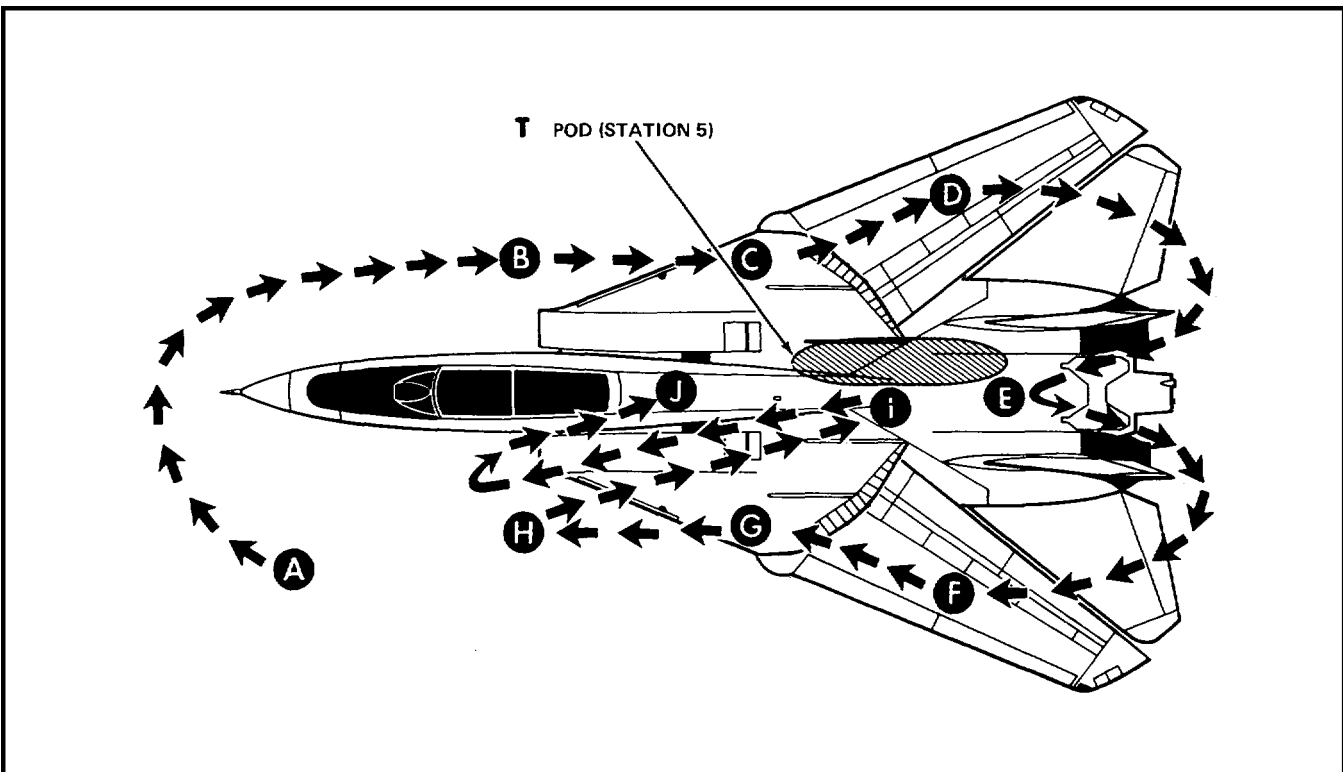
All movable surfaces (flight controls and high-lift devices) should be inspected for position, clearance, and obvious damage.

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 (A) Forward Fuselage

1. Access panel fasteners forward of engine inlets — No Loose or Missing Fasteners.
2. Gun— Safety Pin Installed in Clearing Sector Hold-back Assembly, Louvers Clear, cannon plug connected, wheelwell armament safety override switch guard down.
3. Probes— Secure, Openings Clear, AOA Probe Free For Rotation.
4. Nose wheelwell:
 - a. Electrical leads — Connected, No Evidence of Overheating.



0-F50D-105-0

Figure 7-1. Exterior Inspection

- b. Hydraulic lines — No Chafing or Leaks.
 - c. Doors and linkages — Cotter Pins Installed, No Distortion.
 - d. Brake accumulators — 1,900 Psi Minimum.
 - 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 (B) 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 (C) 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:

- d. Ground safety handle — Pulled.
- e. Fuel quantity sight gauge — Ball Float Vertical.
- f. Sway braces — Tightened Down.
- g. Hook latched indicator — White Vertical Line Visible.
- h. 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)
 - b. Uplock Hooks — Secure.
9. Gear down microrollers — Contact Made.
10. Engine compartment (if applicable)
 - a. Integrated drive generator - transmission fluid — Fluid Visible, Filter Pins (two) 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 (D) 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 (E) 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 **F** 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 **G** 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 or Leaks.
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 (H) 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 (I) 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 (J) 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.



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.

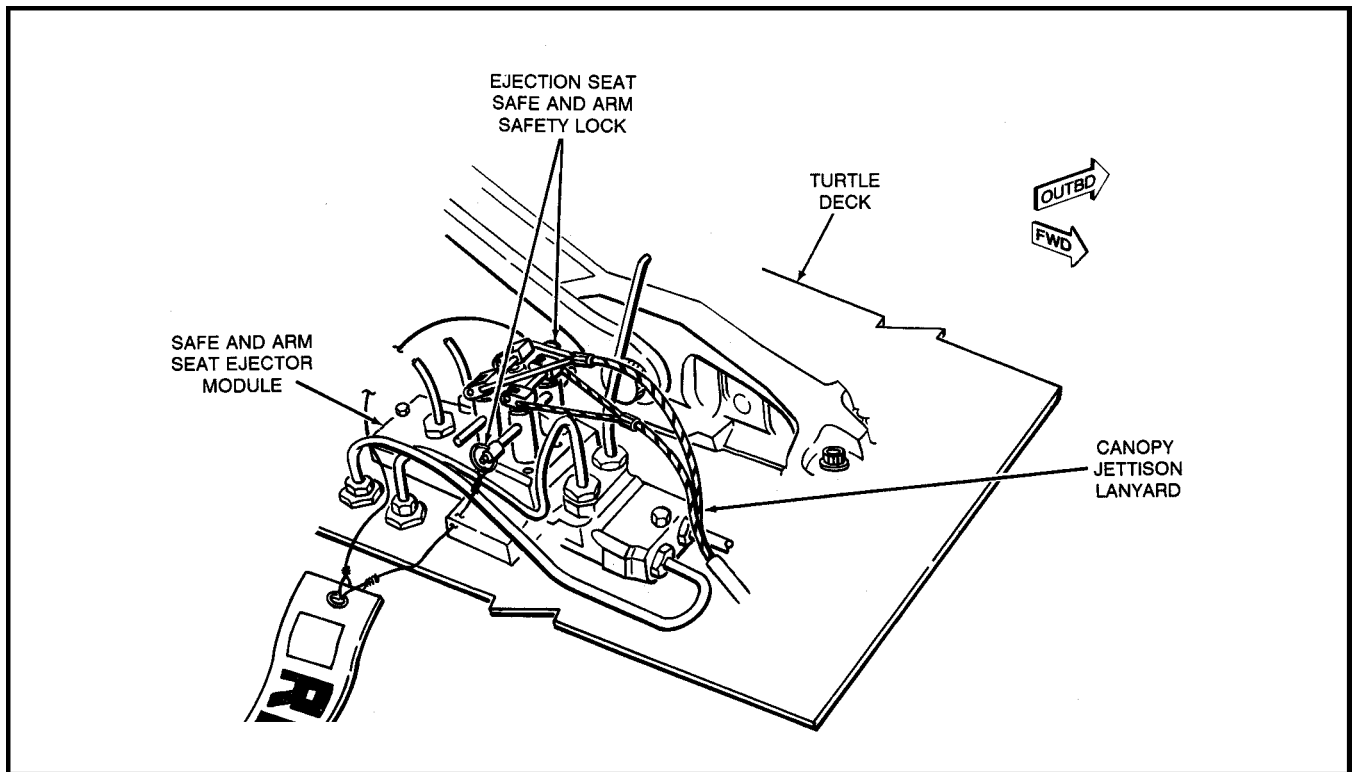
Pull up on each lapbelt to ensure that lugs are secure in seat bucket locks.

- 16. Right trombone tubes — Connected, Retaining Pin Installed.

- 17. Right pitot head — Stowed.

- 18. Parachute container lid — Secure, Sealed.

Check environmental seal indicator for correct indication.



1-F50D-104-0A

Figure 7-2. Ejection Seat Safe-and-Arm Module

19. Parachute risers — Properly Routed.
Check that risers are routed down forward face of parachute container and behind retention strap.
20. 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



NATOPS prohibits the attaching or stowing of unauthorized equipment on or above the canopy rails during CV launch and arrestment, due to the potential for missile hazard.

1. Harnessing — Fasten.
 - a. Leg restraint lines and garters — Connect.
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.



The emergency wingsweep handle can be moved independent of the wings and wingsweep indicators when no hydraulic power and/or electrical power are on the aircraft. Care must be taken to accurately determine the position of the emergency wingsweep handle prior to application of hydraulic power. Inadvertent wingsweep to the position selected by the emergency wingsweep handle may occur, resulting in potential damage to the aircraft. When positioning the wings during ground operation other than pilot poststart or postlanding checklist procedures, use the emergency wingsweep handle to minimize the possibility of moving the wings inadvertently.

9. Wing-sweep switch — MAN.
10. Emergency wingsweep handle — Corresponding.
11. Left and right throttles — OFF.
12. Exterior lights master switch — Set.
Position switch in accordance with standard procedures for day or night and field or carrier operations.
13. FLAP handle — CORRESPONDING.
14. Throttle friction lever—OFF (aft).
15. ASYM LIMITER switch — ON (guard down).
16. L and R ENG mode switches — PRI.
17. BACK UP IGNITION switch — OFF.
18. THROTTLE TEMP switch — NORM.

19. THROTTLE MODE switch — BOOST.
20. L and R INLET RAMPS switches — AUTO.
21. ANTI SKID SPOILER BK switch — OFF.
22. FUEL panel
 - a. WING/EXT TRANS switch — AUTO.
 - b. REFUEL PROBE switch — RET.
 - c. DUMP switch — OFF.
 - d. FEED switch — NORM (guard down).
23. LDG GEAR handle — DN.

Check HYD ISOL switch in TO/LDG.
24. NOSE STRUT switch — OFF.
25. Parking brake — Pull.
26. Altimeter — Set.

Set field or carrier elevation as applicable.
27. Radar altimeter — OFF.
28. Standby attitude gyro — Caged.
29. Left and right FUEL SHUT OFF handles — In.
30. MA ARM switch — OFF (guard down).
31. ACM switch — OFF (guard down).
32. Multifunction display mode switches — OFF.

Note

Visually check for security of cockpit equipment, particularly the multifunction displays, HUD, and instrument panel gauges.

33. Clock — Wind and Set.
34. Fuel BINGO — Set.

Set total fuel remaining value for initial activation of fuel BINGO caution reminder consistent with mission profile to be flown.

35. Circuit breakers — Checked.
36. 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.
37. HOOK handle — Corresponding.
38. GUN ROUNDS panel — Set.
39. 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.
40. ELEV LEAD knob — Set.
41. SW COOL switch — Set.
42. 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.

43. EMERG generator switch — NORM (guard down).
44. 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.

- 45. WSHLD AIR switch — OFF.
- 46. ANTI-ICE switch — AUTO/OFF.
- 47. ARA-63 panel
 - a. CHANNEL selector — Set.
 - b. POWER switch — OFF.
- 48. MASTER LIGHT panel controls — As Required.

Set external and interior lighting controls consistent with day or night and field or carrier operating conditions.

- 49. MASTER TEST switch — OFF.
- 50. EMERG FLT HYD switch — AUTO (guard down).
- 51. HYD TRANSFER PUMP switch — SHUTOFF (guard up).
- 52. CANOPY air diffuser lever — CABIN AIR.
- 53. VIDEO CONTROL switch — OFF.
- 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.



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 — $950 \pm 10^{\circ}\text{C}$.
Initiates engine overtemperature alarm.
- (3) FF — 10,500 Pph.
- (4) AOA (units) — $18 \pm .5$
Reference and indication.
- (5) Wing sweep — $45 \pm 2.5^{\circ}$.
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 — LOW-HIGH-AUTO (LOW).
 - 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.



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.



- 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.



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.
- Loss of electrical power may result in smoke entering the cockpit via the ECS.

8. R GEN light — OUT.

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 — OUT.

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.


CAUTION

Ensure ECS service air is available to OBOGS prior to selecting the OBOGS master switch ON.

18. 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 tailhook safety pin (ashore) and stow them.

7.4.4 Poststart — Pilot

1. STAB AUG switches — All ON.

2. MASTER TEST switch — EMERG GEN.

The resultant power interruption should cause the DFCS flight control computers to self-isolate, activating the lights listed below. With a good emergency generator check, (green 'GO' light) ensure that all lights clear with a MASTER RESET prior to deselecting the emergency generator. DFCS voltage monitoring should result in illumination of all lights when emergency generator is deselected. Lights will remain on when normal voltage is regained, requiring a MASTER RESET to re-engage DFCS flight control computers. STAB AUG switches should remain engaged.

DFCS caution/advisory lights:

PITCH SAS, ROLL DGR, YAW DGR, FCS CAUTION, ARI DGR, ARI/SAS OUT, HZ TAIL AUTH, RUDDER AUTH, SPOILERS, AUTO PILOT, & MACH TRIM.

3. MASTER RESET pushbutton — Depress.
Verify DFCS caution lights extinguished.

Note

An FCS CAUTION at this point probably indicates a PQVM fault due to a lack of pitch and roll attitude inputs from the IMU (DCP FAIL group will indicate IMU).

4. MASTER TEST switch — OFF.
5. MASTER RESET pushbutton — Depress.
Verify DFCS caution lights extinguished. STAB AUG switches should not disengage.
6. Advise RIO that test and checks are completed.
7. Controls and displays — ON.
8. AFTC—Check.
 - a. L ENG MODE SELECT switch — SEC.

L ENG SEC light illuminates; left NOZ indicator pointer below zero.
 - b. L ENG MODE SELECT switch — PRI.

L ENG SEC light goes out, left NOZ indicator to 100 percent.
 - c. R ENG MODE SELECT switch — SEC.

R ENG SEC light illuminates, right NOZ indicator pointer below zero.
 - d. R ENG MODE SELECT switch — PRI.

R ENG SEC light goes out, right NOZ indicator to 100 percent.



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.
- Operating engines in secondary mode inhibits the engine monitoring system portion of FEMS until primary mode is reselected.

9. Emergency WING SWEEP handle — OV SW.



If the “over” flag is not displayed in the wing-sweep indicator with the wings in oversweep, the stick should remain centered.

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.

10. WING-SWEEP MODE switch — AUTO.
11. WING SWEEP DRIVE NO. 1 and WG SW DR NO. 2/MANUV FLAP cb’s — IN (LD1, LE1).
12. WING/EXT TRANS switch — OFF.
13. OXYGEN SUPPLY valve — ON.

Turn OXYGEN SUPPLY valve ON, place mask to face and check for normal breathing, regulator, and mask operation. Turn OXYGEN SUPPLY valve OFF, check no breathing.
14. COMM/NAV/GEAR/DISPLAYS — ON.
 - a. V/UHF RADIO 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.
15. Trim — Set 000.
16. Standby gyro — Erect.
17. MASTER RESET pushbutton — Depress.

18. DCP — Verify codes (FAIL, FLT, IBIT).

Note

An FCS CAUTION at this point probably indicates a PQVM fault due to a lack of pitch and roll attitude inputs from the IMU (DCP FAIL group will indicate IMU). This fault will not affect DFCS IBIT results and can be cleared with a MASTER RESET before or after, but not during OBC.

19. MASTER TEST switch — OBC.

20. AUTOPILOT switch — ENGAGE.



OBC commencement with autopilot engaged and nose down trim may result in a force link disconnect when the stick hits the forward stick stop during the pitch parallel actuator checks.

21. Failure History File — Clear.

22. MFD OBC TEST — Select.

(Coordinate with RIO and plane captain.)



- Increased suction around intakes during inlet ramp programming and the automatic movement of the horizontal stabilizers presents a FOD hazard and a potential for injury to ground personnel not clear of these areas.

The following systems are automatically exercised during the 1½ minutes required to complete the OBC tests. Failures are displayed on the TID display.

- 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. AUTO THROTTLE.

This test is a computer self-test with output commands inhibited to prevent throttle movement.

c. Verify DFCS IBIT operation by flashing A/P REF and ACLS advisories. During the course of the test, the DFCS caution lights remain illuminated until the test is satisfactorily completed. All lights should be off at termination of test. Observe following:

- DFCS caution and advisory lights
- Pitch trim check (slow longitudinal stick motion)
- Pitch parallel actuator (rapid longitudinal stick motion)
- Individual spoiler operation (only if wings 20° and flaps down)
- Stab actuator tests (horizontal tail and rudder movement)
- Autopilot disengage
- Rudder pedal shaker
- DCP display LED check

d. Check for “PASS” in DCP. If faults are displayed, record FCS fault codes using INC/DEC push-buttons. Ensure FAIL and FLT codes are cleared prior to takeoff.

23. 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.

24. 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.

25. WSHLD AIR switch — Cycle.

26. MASTER TEST switch — OFF.

If engaged, verify that autopilot disengages automatically.

27. WING/EXT TRANS switch — OFF.

28. Trim — Checked and set 000.



Ensure adequate clearance before moving wings. Sweep times from 68° to 20° in excess of 9 seconds may be indicative of an impending wing sweep motor failure and should be further investigated.

Note

For CV operations, omit steps 29 through 55.

29. 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.

30. MASTER RESET pushbutton — Depress.

The WING SWEEP warning and advisory lights go out and the AUTO and MAN modes are enabled.

31. External lights — Check (prior to night/IMC flight).



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.

32. 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.

33. 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 — 36° TEU to 9° TED horizontal tail (33° to 12° without ITS).
- b. Lateral control — 24° total differential tail.
- c. Directional control — ±30° rudder.
- d. Longitudinal/Lateral combined — 35° TEU, 15° TED horizontal tail.
- e. Spoilers — 55°.

Note

A stabilizer vibration may occur when the control system linkage is held in contact with the tail stops fully engaged 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.

34. DLC — Check.

Verify horizontal tail shift with DLC input.

35. ANTI SKID SPOILER BK switch — SPOILER BK.

36. Spoilers and throttles — Check.

37. ANTI SKID SPOILER BK switch — OFF.

38. DCP — Verify codes (FAIL, FLT, IBIT).



Aircraft shall be considered down with PFCC, RFCC, or YFCC codes in the DCP FAIL group or with an inoperative DCP display. Initiation of OBC/IBIT with this condition will result in invalid IBIT indications.

39. MASTER TEST switch — DFCS BIT (IBIT ARM).
(Coordinate with RIO and plane captain.)
40. AUTOPILOT switch — ENGAGE.
41. MASTER TEST switch — DFCS BIT (IBIT RUN).
(Coordinate with RIO and plane captain.)
42. DCP — Verify & record codes (FAIL, FLT, IBIT).
Check for “PASS” in DCP. If faults are displayed, record FCS fault codes using INC/DEC push-buttons.
43. DCP — Clear codes (FAIL & FLT).
Ensure FAIL and FLT codes are cleared prior to takeoff.
44. Flaps and slats — UP.
45. Maneuver flaps — DN.
46. WING-SWEEP MODE switch — MAN 50°.



If wing-sweep commanded position indicator (captain bars) does not stop at 50°, immediately select AUTO with WING-SWEEP switch.

47. Maneuver flaps — Crack up.
48. WING-SWEEP MODE switch — BOMB.
Check maneuver flap retraction.
49. EMERGENCY WING SWEEP handle — 68°.
50. EMERGENCY WING SWEEP handle — OV SW.
51. WING-SWEEP MODE switch — AUTO.
52. MASTER RESET pushbutton — Depress.
53. ANTI SKID SPOILER BK switch — BOTH.
54. ANTI SKID — BIT.
Ensure coarse alignment is completed before releasing parking brake.
55. ANTI SKID SPOILER BK switch — OFF.

Note

CV checklist resumes.

56. Radar altimeter — BIT.
Depress SET knob; check that radar altitude displays 100 feet and indicator green light is illuminated. Release knob and pointer should

display 0 feet; warning tone signal (both cockpits) and ALT LOW light illuminated momentarily.

57. Displays/SMS — Check.

Note

If tanks are not ID'd on the SMS page, the possibility exists that they will jettison with weight off wheels or fail to jettison if selected airborne.

58. TACAN — BIT.
59. ARA-63 — BIT.
60. HUD-VIDEO — BIT.
61. Altimeter — Set.

Barometric setting and error determined.

62. Compass — CHECK.

Validate inertial navigation system desired heading on the display 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.

With parking brake in, 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.



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’s Signal; Check RATS Advisory Light On, Then Up.



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.



Failure to cycle nosewheel steering following hook check will permit 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, the right engine may be shut down to prevent excessive taxi speeds at IDLE thrust.



- 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.

Note

When shutting down one engine during taxiing, only the right engine should be shut down so that normal braking is maintained.

7.4.5.2 Taxi Interval

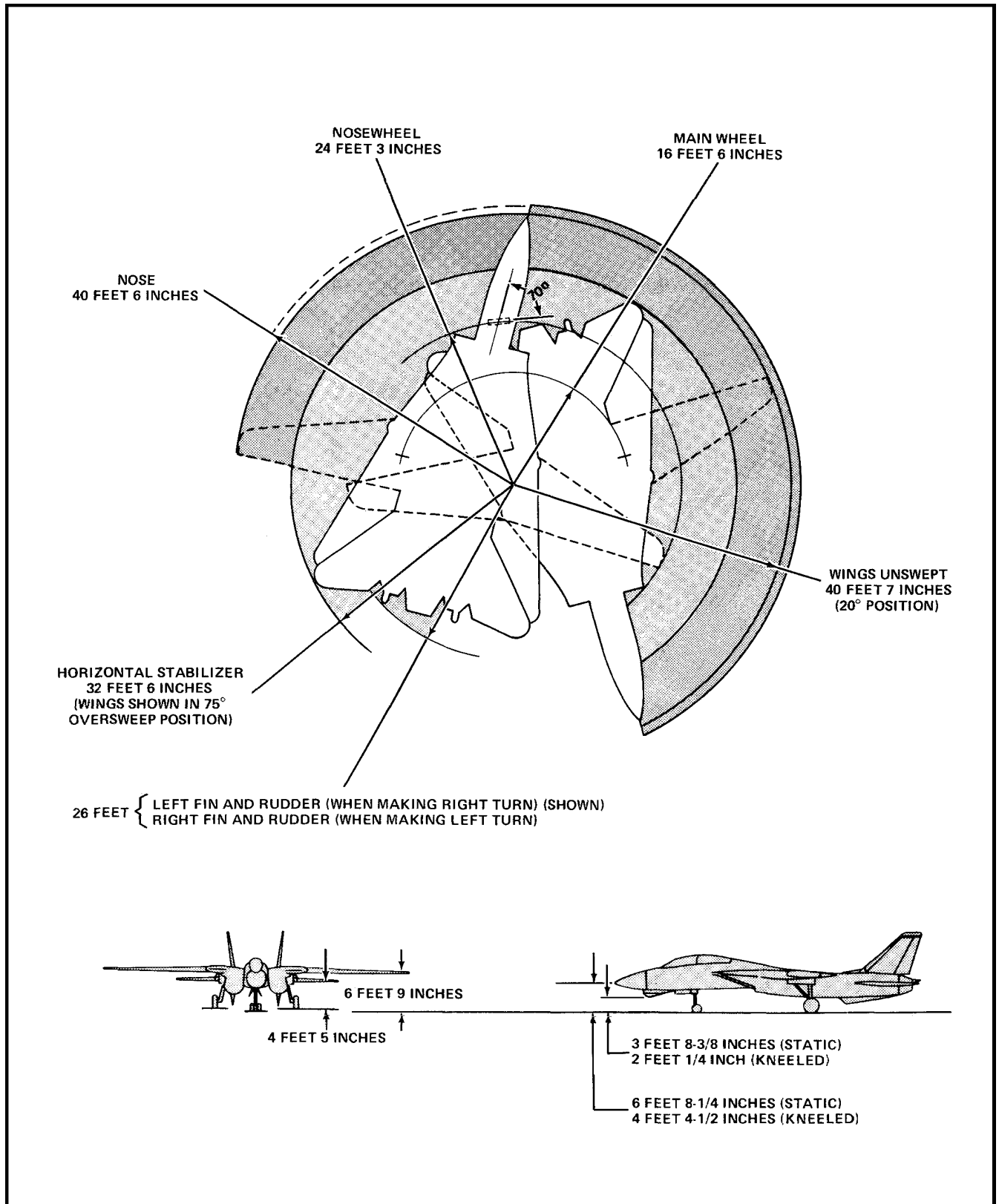
The taxi interval should be sufficient to avoid taxiing through another aircraft’s jet wash, which presents additional FOD potential. Although the antiskid system is armed at speeds less than 15 knots, the antiskid system is not operative. The nosewheel steering can remain engaged throughout the taxi 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 backwards 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 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, that 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. 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.



- On-deck engine operations for extended periods can result in an unacceptable buildup in fluid (hydraulic, engine oil, and IDG oil) temperatures by taxing 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 chance 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, or pull outboard spoiler module circuit breaker.



0-F50D-210-0

Figure 7-3. Taxi Turn Radii (Maximum Nosewheel Steering 70°)

7.4.6 Taxi — Pilot



Taxiing with the left engine secured is not authorized. Normal braking and nosewheel steering control will be lost if the hydraulic transfer pump (BI-DI) 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 takeoff regardless of thrust or gross weight conditions. Flightcrew 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.



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 in-board 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

Afterburner 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 (+1.5° pitch attitude) 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. After the pre-computed 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.



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) and at a minimum of 200 feet AGL, 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. Immediately after liftoff, do not attempt to counter a lateral drift caused by 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 (½-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. The combined hydraulic system nonflight essential components (landing gear, brakes, and nosewheel steering) may be isolated by selecting FLT on the hydraulic isolate switch. 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 pre-computed 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.



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; standing water on the runway; 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, and the leader then reduces power by 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 should 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.



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.



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 14 should be completed in the warmup area.

RIO CHALLENGE	PILOT RESPONSE
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 _____"

RIO CHALLENGE

PILOT RESPONSE

- | | |
|---|--|
| 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" |
| 8. "MASTER TEST SWITCH" | "OFF" |
| 9. "BI-DIRECTIONAL" | "NORMAL" |
| 10. "COMPASS, STANDBY GYRO, TURN NEEDLE AND ALTIMETER" | "COMPASS SYNCHRONIZED, STANDBY GYRO ERECT, GOOD TURN NEEDLE, AND ALTIMETER SET (local settings)" |

CV — APPROACHING CAT ON DIRECTOR'S SIGNAL

- | | |
|---|--|
| 11. "OXYGEN" | "OBOGS ON, MONITOR CHECKS GOOD" |
| 12. "WINGS (visually checked)" | "20", AUTO, NO WING-SWEEP CAWs" |
| 13. "FLAPS AND SLATS" (visually checked) | AS REQUIRED. |
| 14. "SPOILERS AND ANTI-SKID" | "SPOILER MODULE ON, SPOILER BRAKES SELECTED" (field) "SPOILER MODULE ON, SPOILER BRAKES OFF" (CV). |
| 15. "TRIM" | "0.0.0," (field) AS REQUIRED (CV) |
| 16. "SAHRS ATTITUDE REFERENCE" | "GOOD SAHRS ATTITUDE" |
| 17. "DISPLAYS" | "SET FOR TAKEOFF, HUD CAGED" |
| 18. "HARNES LOCKED" | "LOCKED" |
| 19. "CONTROLS" (RIO visually check for full spoiler deflection) | "FREE, 33° AFT STICK, FULL SPOILER DEFLECTION LEFT AND RIGHT, HYDRAULICS 3,000 PSI" |
| 20. "ALL WARNING AND CAUTIONS OUT" | "ALL WARNING AND CAUTIONS OUT" |

ASHORE — IN TAKEOFF POSITION

- | | |
|--------------------------------|----------------------|
| 21. "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. 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 BIT

If desired or required IBIT 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. AN/ALE-47 DCDU, MODE/PWR switch — OFF.
- 18. RDR switch — STBY OR XMIT (pulse).



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] FILM switch — OFF.



Before selecting system switch to OFF, delay 15 seconds for sensor shutdown, and mount to drive to vertical.

- 23. [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. 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 on-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.

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. When surface wind is not a factor, 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 Rollout

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.



- 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.
- If nosewheel steering hardover is suspected upon engagement of NWS, deselecting NWS, lowering the hook, and/or differential braking may be required to regain directional control.

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.



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. If runway length is critical, consideration should be given to reducing touchdown speed by flying a no DLC approach.

7.4.16.6 Crosswind Landings

Crosswind landings may be accomplished using either the sideslipped or crabbed technique, up to the crosswind limit (20 knots). The roll rate command function and revised spoiler gearing of the DFCS affect crosswind landing flight characteristics. During a sideslipped approach the DFCS spoiler gearing schedule results in nearly immediate spoiler breakout with lateral stick deflection from trim. This spoiler breakout may result in an overly sensitive roll response during lineup corrections. Because crabbed approaches are flown without this offset lateral stick input and do not exhibit this characteristic, pilots may find this technique easier for DFCS equipped aircraft.

If a landing must be made in crosswind conditions in excess of the limits, the techniques must be changed. 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. If after touchdown the wing is raised excessively, the spoiler brakes should be turned off and lateral stick applied to maintain a wings level attitude. If the crosswind component is greater than 25 knots, 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.

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, and use rudders or nose-wheel 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 shall call out the accomplishment of each step so that the RIO can double-check that all items have been performed.

1. Wing-sweep mode 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 mode switch — BOMB.



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. Avionics — OFF.
Turn off all avionics (data link, radar altimeter, displays, TACAN, ARA-63) except V/UHF radio.

7. DCP — Verify & record codes (FAIL, FLT, IBIT).
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.
(after BI-DI check)

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. Ejection seats — Safe (coordinate with RIO).
13. Ordnance — Dearm (field).
Dearm and safety ordnance in accordance with local operating procedures.
14. Wheels — Chocked.
15. Parking brake — Pull.



Do not pull parking brake subsequent to a field landing if the brakes have been used extensively.

16. V/UHF RADIO MODE switch — OFF.
17. Standby attitude gyro — Cage.
18. Left throttle — OFF (alert RIO).

Alert RIO and upon signal from plane captain, secure left engine. Check emergency generator automatic operation upon shutdown.

19. EMERG generator switch — OFF.
20. Lights — OFF.

Turn off internal and external light switches.

21. EJECT CMD indicator — Verify PILOT.
22. CANOPY handle — Clear RIO To Open.
23. Flightcrew — Egress.

7.5 RIO PROCEDURES

7.5.1 Interior Inspection — RIO



NATOPS prohibits the attaching or stowing of unauthorized equipment on or above the canopy rails during CV launch and arrestment, due to the potential for missile hazard.

1. Circuit breakers — Set.
2. Left and right foot pedals — Adjust.
3. Harnessing — Fasten.
 - a. Leg restraint lines and garters — Connect
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. FIRST switch — OFF.
 - c. TCS switch — OFF.
21. Programmable tactical information display — As Desired.

Note

PTID 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-47 DCDU, MODE/PWR switch — OFF.
31. AN/ALE-47 Ground Test/Dimmer PNL — GUARD DOWN
32. 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.
33. APX-76 — OFF.
34. IFF MASTER knob — OFF.
35. MODE 4 switch — OUT.
36. IFF ANT switch — DIV.
37. INTERIOR LIGHTS panel — As Desired.
38. RADAR BEACON switch — OFF.
39. RADAR BEACON MODE switch — As Desired.
40. GND CLG switch — OFF.
41. SYS TEST-SYS PWR ground check panel — Closed.
42. 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.



- 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.



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 mini-

imum 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. TACAN mode switch — T/R.
 13. 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.
 14. JTIDS MODE switch — As Required.
 15. Communications — ON/Set.
 16. KY-58 — As Required.
 17. Standby attitude gyro — Erect.
 18. DD — Set.
 19. PTID controls — Set.
 - a. POWER — As Required.
 - b. SYM ELEM — ON.
 - c. DATA LINK — As Required.
 - d. NON ATTK — As Required.
 - e. RU — As Required.
 - f. EXP — As Required.
 - g. LAUNCH ZONE — As Required.
 - h. JAM strobe — As Required.
 - i. TCS — As Required.
 - j. RIDD — OFF.
 - k. PTID Display Mode — As Required.
 - l. RANGE scale — As Required.
 - m. THLD — As Required.
 - n. CLSN — OFF.
 - o. BRIGHT control — Set.
 - p. CONTRAST — Set.
 20. Hand control — Set.
 21. ASPJ SYS switch — STBY.
 22. RADAR WARNING RCVR panel — Set.
 - a. Display type switch — NORM.
 - b. PWR switch — ON.
 - c. TEST switch — SPL.
 - d. MODE button — LMT.
 23. DATA LINK power — As Required.
 24. D/L reply — As Required.
 25. AAI control panel — Set.
 - a. TEST/CHAL CC switch — Test.

Check DD display.
 26. AN/ALE-47 DCDU, MODE/PWR switch — STBY.
- Note**
- Ensure correct mission loadout is displayed in LED window.
27. CANOPY DEFOG-CABIN AIR lever — CABIN AIR.
 28. Indicator lights — Test.
 29. [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.

30. [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.

31. [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.



Do not run PAN BIT (it may cause film jams).

32. [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.

After INS ALIGN COMPLETE computer message or when ready for takeoff:

33. NAV mode switch — INS.
Observe MFD transition from align format. Wait 5 seconds.
34. NAV mode switch — IFA.
35. DEST data — Verify.
36. BRG/DIST to destination — Check.
37. OWN A/C groundspeed — Check.
38. MAG VAR — Check.
39. 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] FILM switch — RUN.
Run only long enough to check operation and observe FRAME, and PAN green lights illuminated and check frame and foot counters.
4. [T] FILM switch — OFF.
5. [T] PAN switch — LEFT or RIGHT.
6. [T] FRAME switch — FWD.

Note

Prior to selecting FILM switch to RUN, delay 15 seconds for camera positioning.

7. [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.

8. [T] FILM switch — OFF.
9. [T] FRAME switch — OFF.
10. [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



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] SYSTEM switch — Cycle OFF/RDY.
2. [T] FILM switch — Cycle OFF/ RUN/OFF.
3. [T] FRAME switch — Cycle OFF/VERT or FWD.
4. [T] FILM switch — RUN.
5. [T] FILM switch — OFF.
6. [T] V/H — MANUAL.
7. [T] Thumbwheels — Set High Vg/H Value.
8. [T] FILM switch — RUN.

If not corrected:

9. [T] FILM switch — OFF.
10. [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.



- 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.



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.

7.5.8 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.



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, all SAS switches on, and the HYD TRANSFER PUMP switch should be in NORMAL before application of electrical power. The LTS, INST, EMERG GEN, and DFCS IBIT 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. Takeoff Checklist (complete non-OBC functions).

When ALIGN QUALITY ≤ 2.0 :

12. NAV MODE — INS.
13. Wait for "IFA AVAILABLE." NAV MODE — IFA.
14. Ordnance crew — Arm.

Note

- Sparrow tune occurs after CW is enabled and can complete after transmitter timeout.
- PH attack capability is present after launch and Sparrow tune occurs automatically whenever CW is enabled.

7.8 HOT SWITCH PROCEDURES

7.8.1 On-Deck, Maintenance Troubleshooting



To ensure a safe in-cockpit maintenance troubleshooting evolution, the following procedures should be used.

1. Parking brake — Pull.
2. THROTTLE MODE switch — MAN.
3. Throttle friction lever — INC.
4. Ejection seats — SAFED, CMD - PILOT.
5. Flightcrew — Remain strapped in.

7.8.2 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.



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, nose strut 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 1¼ miles abeam at 600 feet above field eleva-

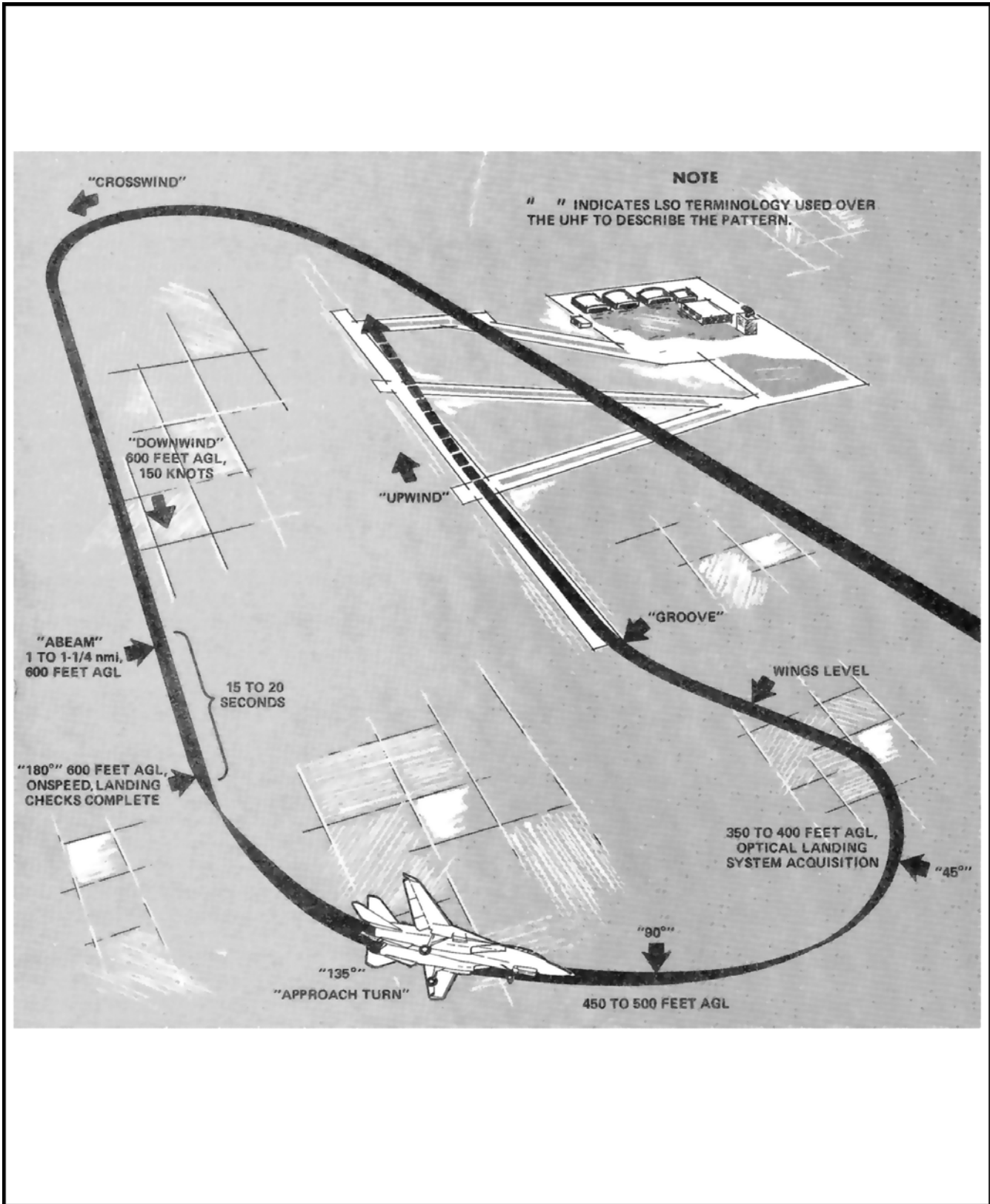
tion (see [Figure 7-4](#)). The length of the groove should be adjusted to give a wings-level descent on the glideslope of 15 to 18 seconds (approximately ¾ mile). For maximum gross weight at touchdown, refer to Chapter 4, Operating Limitations. The turn to the downwind leg should be commenced after 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 1 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 nose strut, 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 they are properly secured and 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. DATA LINK power switch — ON.
2. DATA LINK MODE switch — CAINS/WPT.
3. Verify parking brake is set.

Note

Application of SAHRS power prior to selecting CV ALIGN will not allow SAHRS to properly align.

4. NAV MODE switch — CV ALIGN.
5. Select OWN A/C MFD format by depressing DATA pushbutton on MFD MENU1 display. The CV SINS DATA format will appear.
6. Verify that SHDG is not boxed. If it is, depress the SHDG pushbutton to unbox it.
7. 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.

8. 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.
9. 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, waiting for 5 seconds, then setting it to IFA. The RIO may take the alignment anytime the QUAL reaches 1.0 nm per hour. The NAV Mode switch should be rotated to the INS position for a few seconds then rotated to the IFA position. This places the navigation system in the INS/GPS mode of operation.

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

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 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.
 - 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 through 11 for concurrent SINS carrier align.

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 align-

ment 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 via the SAHRS ALIGN MFD format by depressing the SAHR and then CV pushbutton. 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.

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.

8.2.3 GPS On-Deck IFA Alignment

This method of alignment will take about 5 minutes longer than a normal carrier (CV) alignment, but only requires you to place the NAV MODE switch in IFA and leave it there. Another advantage of GPS IFA Alignment is that you can taxi while aligning in this mode, but the satellites must be acquired before alignment begins.

Note

INS alignment to GPS data via the INS/GPS mode is not always optimum from a cold start. It may require up to 10 minutes (plus up to 2 minutes for MAGR initialization), compared to only 5 minutes for a normal carrier (CV) alignment. If movement of the aircraft during alignment is not anticipated, a normal concurrent CV alignment followed by placing the NAV MODE switch to INS momentarily, then selecting IFA (In-Flight Alignment) may be more expeditious and will yield the same system accuracy.

Global Positioning System satellite acquisition normally takes from 90 seconds to 3 minutes, depending on location and LOS (line-of-sight) blockage by other aircraft and carrier island, etc.

To get an IFA Alignment on deck, perform the following steps:

1. Place the NAV MODE switch in IFA at application of aircraft power.
2. Verify OWN A/C position is correct. Verify correct date and time on the GPS Status page. If satellites have been acquired, the OWN A/C data page will show own aircraft position based on GPS, if GPS is boxed.

Note

If GPS data is lost during alignment, the navigation system will go to align hold.

3. Monitor the GPS Status page to ensure satellites are acquired within a few minutes of placing the NAV MODE switch out of the OFF position to IFA. IFA alignment will not commence until satellites are acquired. If satellites are not acquired after a few minutes, transition to a normal CV alignment (on NAV Mode Switch select OFF then CV).
4. The alignment will progress on its own. When the QUAL gets to 1.0, the system will automatically take the alignment and display the INS ALGN CMPLT message. You can taxi and even take off without disrupting the align process.

Note

The pilot will not have an FPM (Flight Path Marker) until the alignment is complete.

5. If the system loses GPS quality at any time during flight or while on the CV deck due to satellite drop outs or antenna blanking, the system will continue in INS mode until FOM is ≤ 4 and will use GPS data.

Note

The NAV MODE switch must remain in the IFA position to remain in the primary navigation

mode, INS/GPS. This mode can also be obtained by conducting a normal CV alignment, followed by moving the NAV MODE switch from CV to INS to IFA. GPS FOM ≤ 4 to be effective.

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 main-mount 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.

8.3.3 Final Checker Aboard CV

1. Hook — Down On Director Signal; Check RATS Advisory Light On, Then Up.



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.



Failure to cycle nosewheel steering following hook check will enable nosewheel steering cen-

tering 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.

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.



- 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 holdback 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.



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.



- 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

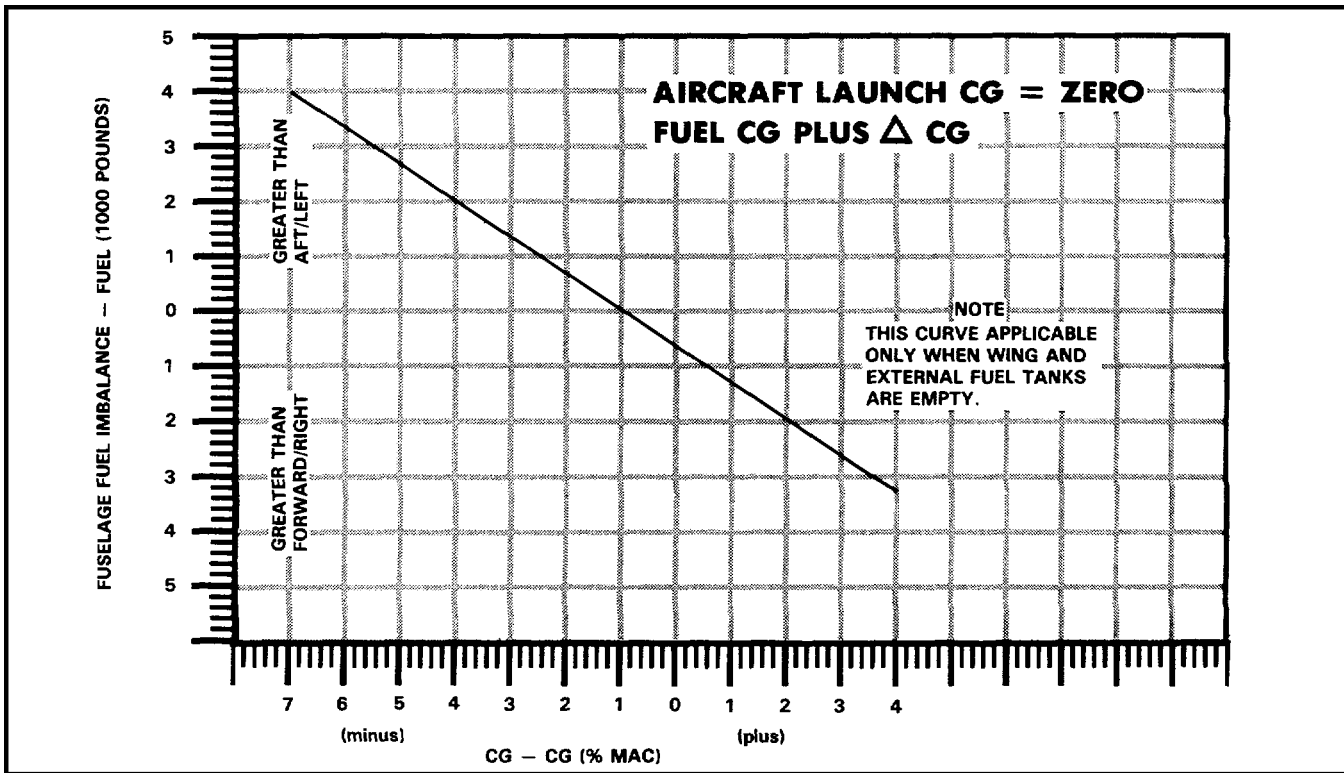
Aircraft launch gross weight will be cross-checked and verified by signal with the flight deck personnel prior to kneel. If the aircraft is to be catapulted with a partial fuel load, the pilot should ensure that longitudinal trim settings are adjusted if necessary (Figure 8-1). Upon receipt of the “tension-up 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.



- Failure to allow the control stick to move aft during the catapult stroke will result in degraded pitch rate and excessive sink rate off the bow.
- Catapult launch with a partially filled external tank is not authorized.

Initial catapult firing results in a short-term vertical acceleration of 15 to 20gs caused by full compression of the stored-energy nosestrut. Firmly restrain the throttles to prevent their aft travel during the catapult stroke.

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 attitude 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.



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Figure 8-2. Center-of-Gravity Variation With Fuel Loading

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.

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's 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 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.



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.



- 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.

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.



- 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

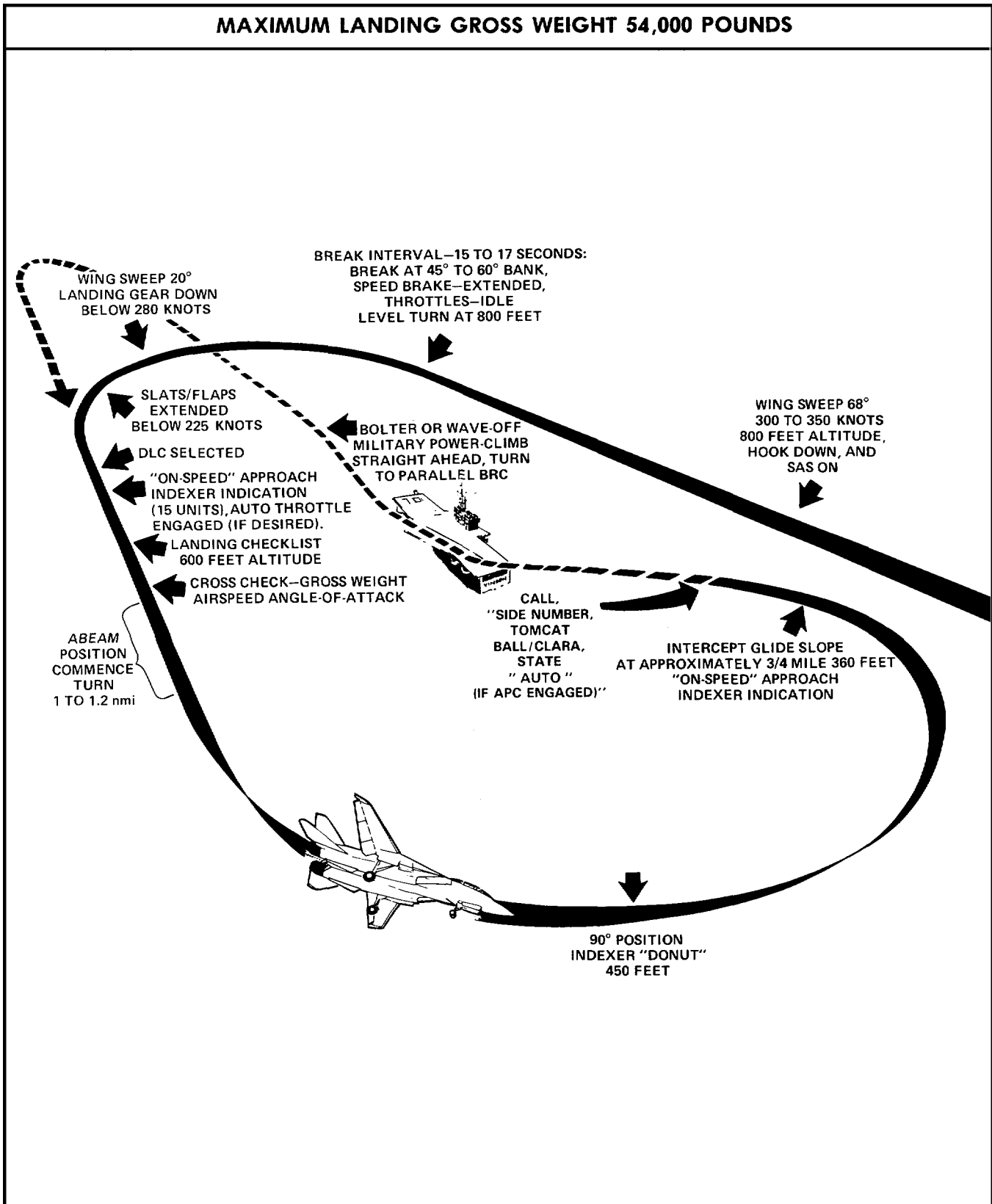
With the hook down, airspeed in excess of 300 knots may cause the hook transition light to illuminate.

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 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.



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Figure 8-3. Carrier Landing Pattern

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 movement to maintain 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 waveoffs 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 to 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 DFCS 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 pitch 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

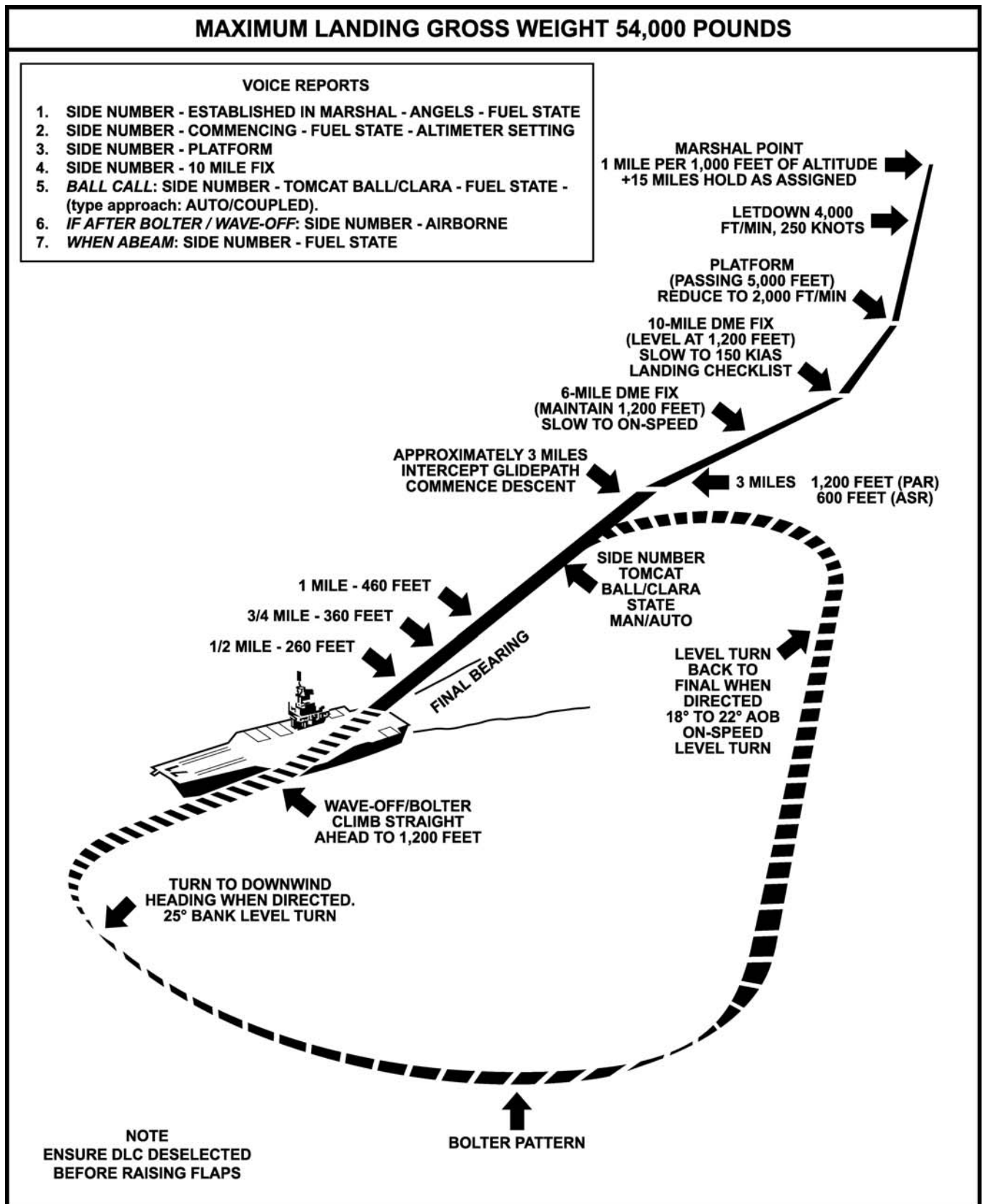
1. Commence transition to landing configuration, unless otherwise directed by CCA, maintaining 1,200 feet.
2. Gear and flaps shall be down by 8 miles.
3. Complete the landing checklist. Check anti-ice, lights, and rain removal, as required.

8.5.12 Six-Mile DME Fix

For a precision 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 1¼ to 1½ miles on a 3.5° slope. Commence a descent of 500 to 700 fpm, using the following checkpoints:

1. 1 mile — 460 feet.
2. ¾ mile — 360 feet.
3. ½ mile — 260 feet.



CSC-F14D-1-8-001B

Figure 8-4. Carrier-Controlled Approach (Typical)

8.5.13 Meatball Contact

When transitioning to a visual approach (at approximately $\frac{3}{4}$ of a mile), make a report call with the following information: 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 $\frac{1}{4}$ 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 instrument landing system (ILS) is an excellent aid during the approach and should be used whenever possible. ILS glideslope azimuth and elevation signals are provided as command "fly to" indications and are displayed via the VDI and/or the HUD in the TLN mode.

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's 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 the land/launch frequency the 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 way-point 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 aircraft holds this position until released by tow hookup crew. Escort aircraft maintains position on taxiway at approach end of runway.
2. When signaled to do so by tow hookup crew, tow aircraft proceeds to taxi down runway.
3. Upon receipt of visual taxi signal from tow hookup crew to slow down, escort aircraft relays this signal to tow aircraft via UHF radio.
4. Upon receipt of visual taxi signal from tow hookup crew to stop, escort aircraft relays this signal to tow aircraft via UHF radio.
5. Upon receipt of signal from tow hookup crew that tow hookup is complete, escort aircraft requests tow aircraft to take up slack.
6. Tow aircraft proceeds to taxi down the runway.
7. When banner moves forward onto runway, escort aircraft transmits, "Tow aircraft hold, good banner," and taxis onto runway abeam banner for takeoff.
8. When ready, tow aircraft transmits, "Tower, Lizard 616 for banner takeoff, escort to follow banner."
9. After banner becomes airborne, escort aircraft 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 aircraft 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 $\frac{3}{16}$ -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, and 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.



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.

- 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.



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.



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 of remaining tow cable length is confirmed by escort pilot, plan to touch down 1,000 to 1,500 feet long, runway length permitting.



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
<p>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)</p> <ol style="list-style-type: none"> 1. WING/EXT TRANS switch — OFF. 2. FUEL FEED switch — FWD/R Monitor 500-pound split, AFT/L high. 3. FUEL FEED switch — AFT/L Monitor 500-pound split, FWD/R high. 4. FUEL FEED switch — NORM Verify FWD/R high split remains constant. 5. Monitor WING/EXT TRANS switch returns to AUTO. AFT/L — 1,700 ±200 pounds, or FWD/R — 2,100 ±200 pounds. 6. Monitor tapes/feeds for system balancing. <p style="text-align: center;">Note</p> Balancing normally begins 6 to 9 minutes after WING/EXT TRANS switch returns to AUTO. 7. After landing, run both engines with matched throttles 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. 8. Shut down left engine and pull L FUEL SHUTOFF handle. Continue to run right engine to verify continued L FEED quantity decrease. Then shut down right engine. 	<p>Ensure 4,500 pounds on tapes for operation of FEED switch.</p> <ol style="list-style-type: none"> 1. Switch should not move until automatic interconnect occurs. Verifies proper automatic electrical operation. 2. Verifies sump tank interconnect valve open via manual operation and aft fuselage motive flow valve shut off. 3. Same as step 2 except forward fuselage motive flow valve shut off. 4. Verifies system returns to isolated mode with no leaks. 5. Verifies cell No. 2 or 5 low-level thermistor's proper operation to trigger automatic interconnect function. 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. Verifies proper operation of cell Nos. 2 and 5, and left box-beam and right box-beam low-level thermistors. 8. Verifies sump tank interconnect valve remains open via right 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

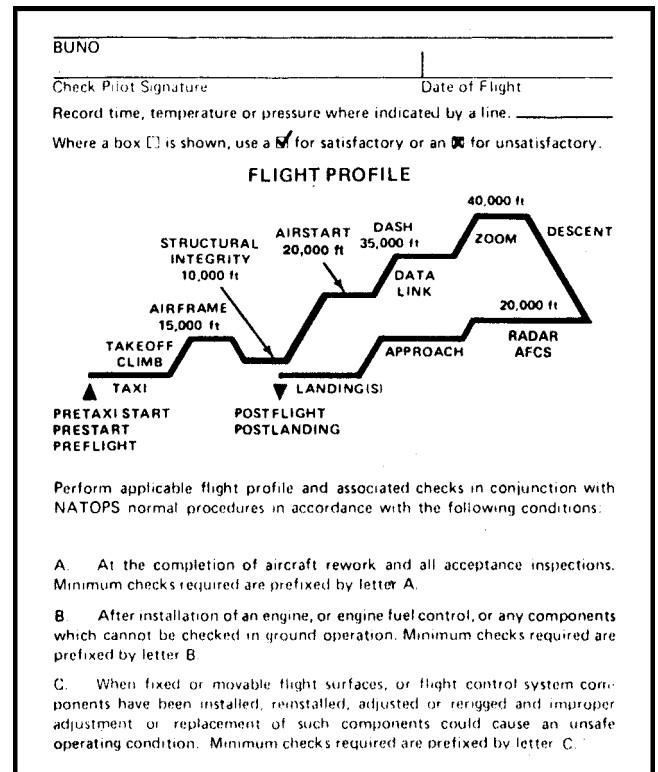
A flight profile has been established for each checkflight condition and is identified by the letter corresponding to the purpose for which the checkflight is being flown (A, B, C, as shown in Figure 10-1). The applicable letter identifying the profile precedes each item in the functional checkflight checklist (NAVAIR 01-F14AAD-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



1-F50D-147-0

Figure 10-1. Flight Profile

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.

PROFILE

ABC

10.3 FUNCTIONAL CHECKFLIGHT PROCEDURES (PILOT)

10.3.1 Prestart

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 quantity.

	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.

A

6. Seat adjustment — Check.

A

7. Canopy rigging.
 - a. Both cockpit handles in same position during operation.
 - b. BOOST not required to close.

10.3.2 Start

ABC

8. ENG CRANK switch — L (left engine).
 - a. Observe AUX and PARK brake pressure rise. Observe combined hydraulic system pressure rise.
 - b. Press left rudder pedal fully forward until rudder stop is contacted. Rudder display pointer L and R shall read 30 deg +/- 3.5 deg and be within 2 deg of each other.
 - c. Verify proper rudder operation through at least five cycles and confirm both rudders return to neutral when commanded.

If hydraulic lines are crossed, the rudder will remain hardover.

PROFILE

ABC

9. ENG CRANK switch — OFF.

ABC

10. ENG CRANK switch — R (right engine).
- a. Observe flight hydraulic system pressure rise.
 - b. Press right rudder pedal fully forward until rudder stop is contacted. Rudder display pointer L and R shall read 30 deg +/- 3.5 deg and be within 2 deg of each other.
 - c. Verify proper rudder operation through at least five cycles and confirm both rudders return to neutral when commanded.

If hydraulic lines are crossed, the rudder will remain hardover.

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 flight control 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 horizontal tail and rudder control surfaces and higher surface deflection rate as viewed on flight control surface position indicator.

- c. EMERG FLT HYD switch — AUTO (LOW).

Check that OFF flags are displayed in both EMER FLT HI and LOW hydraulic pressure windows.



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. BACKUP IGNITION — ON.

Note

With weight on wheels and BACK UP IGNITION switch ON, main high-energy ignition is disabled.

ABC

14. 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 45-percent rpm. Manual deselect of the switch to the OFF position will interrupt the crank mode at any point in the start cycle. Oil pressure and flight hydraulic pressure rise will become evident at 10-percent rpm.

PROFILE

ABC

Note

When using wells system air for engine start, manual deselection of starter crank switch may be required.

15. Right throttle — IDLE (20-percent rpm)



- Attempting a ground start at lower engine rotor speeds will aggravate hot-start tendencies. Exceeding 890°C EGT constitutes a hot start. Advance the throttle from OFF to IDLE when the rotor speed exceeds 20 percent rpm; this action 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 seconds, but no more than 20 seconds. The rapid rise in EGT should be carefully monitored for overtemperature tendencies. Peak starting temperatures will be achieved in the 40 to 50 percent rpm range when, after a slight hesitation, a reduction will return the EGT to the nominal 350 to 650°C level. During the initial starting phase, the nozzle should expand to a full-open position indication of 100%.
- 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

- 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% (open).
 - e. OIL — 25 to 35 psi (nominal) (15 psi minimum, 65 psi maximum for one minute on a cold day start).
 - 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.

Check the mechanical release of the tailhook uplock without combined hydraulic power.

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.

Verify hydraulic transfer pump pressure operation with slight rudder inputs.

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. ECS

a. AIR SOURCE pushbuttons — L ENG, R ENG, OFF, BOTH ENG. There should be no excessive interruption in cockpit airflow with single-engine air source changes. Selection of OFF should stop airflow and BOTH ENG should provide greatest airflow.

b. TEMP mode selector switch — Check MAN-AUTO. Cockpit temperature control and flow should be checked in both MAN and AUTO modes to ensure proper temperature control.

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 rpm indicates a failure of the N₂ 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 rpm indicates a failure of the N₂ deceleration auto-relight logic.

PROFILE

ABC
ABC
ABC
ABC

- 29. HYD TRANSFER PUMP switch — NORMAL.
- 30. Restore normal tailhook and raise.
- 31. Ground safety pins — Remove and stow.
- 32. Idle engine instrument readings.

	Left	Right	Nominal
NOZ position			100% open
OIL (psi)			25 to 65 (15 minimum)
RPM (%)			62 to 78
EGT (°C)			350 to 650
FF (pph)			950 to 1,400

ABC

- 33. OBOGS MASTER switch — ON.



Ensure ECS service air is available to OBOGS prior to selecting the OBOGS MASTER switch ON.

10.3.3 Poststart

ABC

- 34. MASTER TEST switch — EMERG GEN.

The DFCS caution/advisory lights may be illuminated prior to selection of EMERG GEN on the MASTER TEST panel. These lights should extinguish with a MASTER RESET with the possible exception of the FCS CAUTION light due to IMU/INS alignment (PQVM fault). Subsequent selection of EMERG GEN with the MASTER TEST switch may or may not illuminate DFCS caution lights. Following a good emergency generator check, (green 'GO' light) ensure that all lights clear with a MASTER RESET prior to deselecting the emergency generator. When the emergency generator is deselected, the resultant power interruption should cause the DFCS flight control computers to self-isolate due to voltage monitoring resulting in illumination of all the DFCS caution/advisory lights listed below. These lights will remain on when normal voltage is regained, requiring a MASTER RESET to re-engage the DFCS flight control computers. The STAB AUG switches are mechanically held and should remain engaged during this test.

DFCS caution/advisory lights:

- a. PITCH SAS
- b. ROLL DGR
- c. YAW DGR
- d. FCS CAUTION
- e. ARI DGR
- f. ARI/SAS OUT
- g. HZ TAIL AUTH
- h. RUDDER AUTH
- i. SPOILERS
- j. AUTO PILOT
- k. MACH TRIM.

PROFILE

ABC

35. AFTC — Check.

- a. L ENG MODE switch — SEC.

L ENG SEC light illuminates; left NOZ position indicator pointer is below zero.

- b. L ENG MODE 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 is below zero.

- d. R ENG select switch — PRI.

R ENG SEC light goes out; NOZ position indicator to 100-percent.



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.

ABC

36. 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, CADC, 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, FLAP, CADC, and REDUCE SPEED lights are 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.

A

37. UHF/VHF/JTIDS/ICS — Check.

Check complete operation of throttle communications switch — UHF 1, UHF 2, JTIDS, ICS.

PROFILE

ABC

38. MASTER TEST switch — OBC (AUTOPILOT switch — ENGAGE).

Run at least one OBC or IBIT with the WINGS — AUTO 20°, FLAPS — DOWN, ANTISKID/SPL BRK — OFF, AUTOPILOT — ON to fully test the system. Also run MAN DFCS BIT via the MASTER TEST panel. Running OBC by selection of OBC via the MASTER TEST switch will automatically run DFCS IBIT in addition to the standard OBC. Selection of DFCS BIT via the MASTER TEST switch will run only the DFCS IBIT. When the MASTER TEST switch is rotated to the OBC or DFCS BIT position, an IBIT ARM acronym will flash in the DCP display indicating that a DFCS IBIT may be executed upon depression of the switch. In the IBIT ARM mode, the AUTOPILOT switch may be engaged ON. If the INC/DEC pushbuttons are depressed during this period, the IBIT ARM display will be removed even though the system is still in IBIT ARM mode. When the MASTER TEST switch is depressed the display will indicate IBIT RUN and the DFCS BIT will commence as the AFC acronym begins to flash. After the DFCS IBIT has commenced, the AUTOPILOT switch cannot be ENGAGED ON and therefore will not be tested.



OBC commencement with nose down trim may result in a force link disconnect when the stick hits forward stick stop during the pitch parallel actuator checks.

Note

- An FCS CAUTION light at this point probably indicates a PQVM fault due to a lack of pitch and roll attitude inputs from the IMU. This fault will not affect DFCS IBIT results and can be extinguished with a MASTER RESET either before or after, but not during OBC.
- At least one IBIT must be performed with the wings at 20°, flaps extended and the autopilot engaged to fully exercise spoiler test logic and autopilot/ACLS.

- a. Pull ALPHA COMP cb RB1.

Verify LDG2 displayed in DCP under FAIL. Pulling the ALPHA COMP cb removes power from the landing gear handle position switch #2 relay resulting in a LDG2 FAIL code.

- b. OBC — Initiate (coordinate with RIO and plane captain).

PROFILE

- c. After ramps are extended - Select RAMPS to STOW.
- d. Verify RAMP lights go out and INLET lights illuminate.
- e. When OBC is completed:
 - (1) Verify FCS CAUTION light illuminated; AOAC and AC28 displayed in DCP under IBIT. AOAC and AC28 are detected as a result of the ALPHA COMP cb being pulled.
 - (2) Reset ALPHA COMP cb, both AICS cb's, and check INLET RAMPS switches — AUTO.
 - (3) Reinitiate complete normal OBC (AUTOPILOT switch — ENGAGE). Verify DFCS IBIT operation by flashing A/P REF legend and ACLS lights. Observe the following:
 - (a) 10 DFCS caution/advisory lights.
 - (b) Pitch trim check (slow longitudinal stick motion).
 - (c) Pitch parallel actuator check (rapid longitudinal stick motion).
 - (d) Individual spoiler operation (check in mirrors).
 - (e) Stab & rudder actuator check (horizontal tail and rudder movement).
 - (f) Autopilot disengage check.
 - (g) Rudder pedal shaker check.
 - (h) DCP display LED check.

The standard DFCS IBIT will check the following in order. All DFCS caution/advisory lights will illuminate and the ACLS and A/P REF advisories will flash upon commencement of the test. This will be followed by slow fwd/aft motion of the stick and stab (pitch trim) followed quick fwd/aft motion of the stab SAS actuators (no stick movement), and then rapid fwd/aft motion of the stick and stab (pitch parallel actuator). Following the rapid stick and stab motion the spoilers will extend individually in the order SP4R, SP3R, SP2R, SP1R, SP1L, SP2L, SP3L, and SP4L. Pilot should verify spoiler position indicator corresponds with spoiler deployment and note any discrepancies. This will be followed by rapid left/right motion of the differential stabilizer SAS actuators and left/right rudder SAS actuator checks. This will then be followed by AUTOPILOT switch disengagement, rudder pedal shakers, and the DCP display LED check.

- f. Attempt MASTER TEST switch — DFCS BIT with ROLL SAS switch deselected. Verify IBIT does not run.

IBIT should not run with any STAB AUG switch deselected. Deselection of the ROLL and/or YAW SAS should result in an ARI/SAS OUT caution light. Deselection of the PITCH SAS should not illuminate any caution lights.
- g. Check DCP fault codes using INC/DEC pushbuttons. Record IBIT fault codes and clear FAIL and FLT fault codes prior to takeoff.

Check the DCP fault codes FAIL/FLT/IBIT using INC/DEC pushbuttons. IBIT fault codes can only be cleared by running another IBIT. The FAIL codes can only be cleared by resolving the problem and depressing MASTER RESET. The FLT codes can only be cleared by simultaneous depression of the INC/DEC buttons for 6-7 seconds and is confirmed by a single line in the DCP display. These codes will not clear with the MASTER TEST switch in the IBIT ARM or IBIT RUN position.

PROFILE

ABC

39. Speedbrake switch.
- a. EXT-RET.
 - b. Verify stabilizers shift 1° nosedown (clean) or 3° nosedown (AIM-54 rails) on extension and opposite on retraction (ITS).

ABC

40. Flaps down.
- a. Verify stabilizer shifts 3° nose up (ITS).

ABC

41. Flight controls — Trim.

Verify full range of trim authority in all axes and power approach spoiler gearing with full left/right lateral trim and corresponding full left/right lateral stick (spoiler deflection should be reduced to 35° deployment with full trim into stick displacement). Careful attention should be given to the operation and accuracy of the control surface position indicator during this test. This gauge is utilized routinely to determine DFCS flight control functionality airborne and any inaccuracies or friction in the indicator will impact the ability to resolve DFCS operation. A useful technique is to trim full authority in one direction, observe the position indicator and then move the control stick/rudder pedals slightly in the same direction of trim and release and note any change in the position indicator due to inaccuracy/friction in the gauge.

- a. Trim — Full Nose Down, check 9° TED.
- b. Stick full aft — Check for free movement.
- c. Trim — Full nose up, check 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.
- g. Stick full left — Check power approach spoiler gearing and uniform 35° to 55° spoiler extension.
- h. Trim — Full right; check 6° differential tail split (16 to 18 seconds).
- i. Stick full right — Check power approach spoiler gearing and uniform 35° to 55° spoiler extension.

ABC

42. Flight controls — Cycle.

Verify full range of control surface authority. As above identify the operation and accuracy of the control surface position indicator. Note the 0.1 inch lateral stick deflection spoiler breakout in the power approach (PA) configuration. Spoiler breakout in the gear up configuration is 0.5 inch.

Observe the following:

- a. Longitudinal — 36° TEU to 9° TED horizontal tail (33° to 12° without ITS).
- b. Lateral — 24° total differential tail.
- c. Directional — 30° rudder.

PROFILE

- d. Longitudinal/Lateral combined — 35° TEU to 15° TED.
- e. Spoilers — 55° extension.

Note

A stabilizer vibration may occur when the control system linkage is held in contact with the tail stops fully engaged 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.

ABC

43. Spoiler checks.

- a. DLC — Check.

Verify DLC engagement/operation and stabilizer shift upon engagement and subsequently upon “up” DLC commands via the thumbwheel.

- (1) DLC — Engage. Verify stabilizer shifts 2¾° below trim. Inboard spoilers extend to 17½°.
- (2) Full up DLC. Verify stabilizer returns to trim. Inboard spoilers go to -4½°.
- (3) Full down DLC. Verify stabilizer remains 2¾° below trimmed position and inboard spoilers extend to 55°.
- (4) Stick 2 inches left (check spoiler gearing). Left wing outboard +30° and inboard +55°. Right wing both inboard/outboard -4½°.
- (5) Stick 2 inches right (check spoiler gearing). Right wing outboard +30° and inboard 55°. Left wing both inboard/outboard -4½°.
- (6) DLC — Disengage.

- b. SPOILER BK — Select.

SPOILER BK selection to verify ground roll braking operation.

- c. SPOILER BK/Throttle interlocks — Check.

- (1) SPOILER BK — Deselect.
- (2) Pull O/B SPOILER PUMP cb 2B3 (coordinate with RIO).

Pulling the O/B SPOILER PUMP cb will de-energize the outboard spoiler module. The SPOILERS caution light will not illuminate until a lateral stick sweep is performed which will be detected by the DFCS as a failure of the outboard spoiler actuators and result in isolation of both left and right outboard spoilers. The DCP will only report fault codes in the FAIL group of the left or right outboard spoiler pair in the direction of initial stick displacement. MASTER RESET will reset the spoiler control logic and a subsequent initial stick displacement in the opposite direction will result in the DCP reporting FAIL codes for the other side. Reset cb and a MASTER RESET will extinguish the SPOILERS caution light and remove DCP FAIL codes.

- (a) Verify no SPOILERS caution light.

PROFILE

A	44.	Radar altimeter	— Test.
A	45.	Displays	— CHECK.
A	46.	TACAN	— BIT.
A	47.	ARA-63	— BIT.
A	48.	Gunsight	— Check (manual mode).
	a.	Select A/A mode, Weapon select switch	— GUN.
	b.	Select manual mode via CAGE/SEAM switch.	
	c.	Set +34 mils. Verify the manual reticle is positioned over the HUD heading tick.	
	d.	Weapon select switch	— OFF.
AB	49.	Emergency disengage paddle.	
		The emergency disengage paddle will not disengage SAS operation nor will it deselect any STAB AUG switches.	
	a.	Paddle switch	— Hold Depressed.
	b.	Verify throttles in manual mode.	
	c.	Engines revert to SEC mode.	
A	50.	OXYGEN Monitor	— TEST.
		Release the TEST button as soon as the OBOGS light is illuminated. Verify OBOGS light is out within 20 seconds.	

- (b) Perform lateral stick sweep. Observe SPOILERS caution light, verify DCP FAIL fault codes SP3 and SP4 (L or R on initial lateral stick input).
- (c) Reset cb and perform MASTER RESET. Verify light and DCP fault codes removed.



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.

PROFILE

ABC

10.3.4 Taxi

51. Turn needle/slip indicator — Check.

10.3.5 Engine Runup

AB

52. Engine runup — Check at MIL, Read out to RIO.

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 holdback bar and the JBD. JBD cooldown requires both throttles at IDLE for 30 seconds and may be necessary during these checks.
- Shipboard use of excessive asymmetric thrust may damage the holdback.

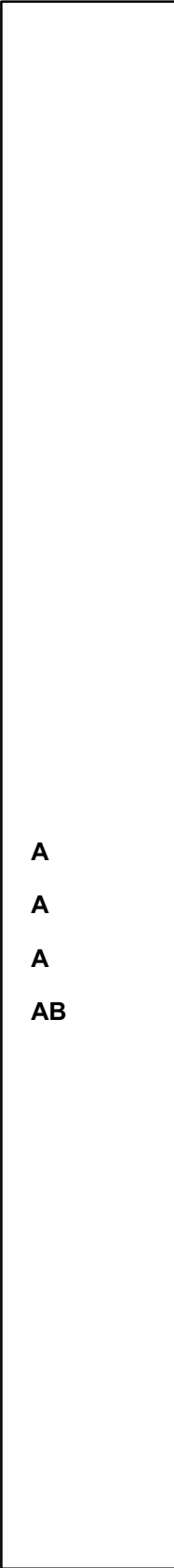
	Left	Right	Limits
NOZ position			3 to 10 nominal (closed)
OIL (psi)			25 to 65
RPM (%)			95 to 104 nominal (107.7 maximum)
EGT (°C)			935°
FF (pph)			9,000 to 12,000

Note

Ashore engine checks must be performed with opposing engine at IDLE for the brakes to hold.

- Verify hook stowed and RATS light out.
- Both engines MODE — SEC.
- Both throttles — MIL.
Note acceleration time (less than 10 seconds).
- Both engines MODE — PRI.
Record engine parameters.
- Hook handle — DOWN.
Verify RATS light and 3 to 6-percent rpm decay.

PROFILE



- 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 handle — UP.
Verify hook stowed and RATS light out.
- n. Perform AICS programmer reset.
- o. Throttles — MIL.
- p. Flight control wipeout.

10.3.6 Takeoff and Climb

- A** 53. Landing gear — Retract (9 to 15 seconds nominal).
- A** 54. Servo and radar altimeters — Check below 5,000 feet.
- A** 55. REFUEL PROBE switch — EXT-RET.
- AB** 56. AFTC — Check.

Note

- SEC mode transfer while in minimum AB may result in pop stalls. Non-emergency 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.

PROFILE

- e. Right throttle — Check basic engine power response.
- f. R ENG MODE switch — PRI.
- g. Cycle AICS cb's at a constant subsonic Mach.

Note

Cycling AICS cb's while airborne may illuminate the FCS CAUTION and ARI DGR lights.

10.3.7 Ten Thousand Foot Checks

AB

- 57. OXYGEN monitor — TEST.

Release the TEST button as soon as the OBOGS light is illuminated. Verify OBOGS light is out 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.

AB

- 58. ECS check (Airspeed 250 KCAS).

CAUTION

In CV environment, ensure external tanks are empty prior to ECS checks.

ECS check should be performed at altitudes 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. WCS switch — STBY (coordinate with RIO).
- d. AIR SOURCE pushbutton — OFF.

Cockpit pressurization will quickly bleed off and cabin pressure altimeter should indicate aircraft altitude.

PROFILE

- e. CABIN PRESS switch — DUMP.

Cockpit will completely depressurize.

- f. RAM AIR switch — INCR (35 to 50 seconds to fully open ram air door).

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 re-pressurized, which maintains canopy seal, airbags, and antenna waveguides pressurization. As canopy seal re-inflates, cockpit pressurization available from ram air will be much more apparent.

- h. RAM AIR switch — DECR/CLSD.

Observe reduction in cockpit airflow.

- i. CABIN PRESS switch — NORM.

- j. AIR SOURCE pushbutton — BOTH ENG.

- k. WCS switch — XMT (Coordinate with RIO).

10.3.8 Fifteen Thousand Foot Checks

ABC

- 59. Fuel transfer — Check.

AC

- 60. Basic SAS checks (Airspeed 300 KCAS).

Deselection of the ROLL and/or YAW SAS switch should result in an ARI/SAS OUT caution light. Deselection of the PITCH SAS switch should not illuminate any caution lights.

- a. Pitch pulse forward and aft — PITCH SAS OFF/ON.

Pitch pulse is executed with a partial fwd/aft motion and release of the control stick followed by observation of resultant aircraft motion. Observe increased damping of aircraft response with PITCH SAS ON.

- b. Full stick roll — ROLL SAS OFF/ON.

Note ARI/SAS OUT light when ROLL SAS OFF. Note full extension of down wing spoilers. Check for 14° of differential stab split with ROLL SAS OFF, and >20° of stabilizer split with ROLL SAS ON. Full stick roll acceleration with ROLL SAS OFF will be significantly less than with ROLL SAS ON because of reduced horizontal tail authority. In addition residual aircraft motion will be less dampened with the ROLL SAS OFF. Observe slight reduction in differential tail at high roll rates with ROLL SAS ON due to roll rate feedback limiting.

- c. Rudder pulse left and right — YAW SAS OFF/ON.

Note ARI/SAS OUT light when YAW SAS OFF. Rudder pulse is executed with a partial left/right motion and release of the rudder pedals followed by observation of resultant aircraft motion. Observe Dutch roll response with YAW SAS OFF. Yaw excursions should cease immediately upon engagement of YAW SAS ON.

PROFILE

AC

61. Wing-sweep and maneuver devices check (airspeed 0.5 Mach).
- a. Lateral trim check. Observe $<2^\circ$ differential tail split.
Trim aircraft for hands off level flight turn needle/ball and yaw string centered. Observe normal lateral trim requirement. Do not retrim during subsequent wing sweep checks. Aircraft horizontal stabilizer rigging should require $<2^\circ$ differential tail split to maintain wings level flight throughout wing program schedule. (<500 lb wing fuel split or wings empty).
 - b. Maneuver devices — EXT.
 - c. WING SWEEP MODE switch — AFT (check that wings stop at 50°).
 - d. Maneuver flaps partial up with thumbwheel. Ensure that devices retract.
 - e. WING SWEEP MODE switch — BOMB.
 - (1) Verify maneuver devices automatically retract and then wings sweep to 55° .
 - f. WING SWEEP MODE switch — MAN FULL AFT.
 - (1) Note whether aircraft requires retrim of rudder or differential stab to remain wings level/no sideslip.
 - (2) Release controls and measure elapsed time to 30° bank angle. If <6 seconds, reattempt check with wing fuel cells empty.
 - g. WING SWEEP MODE switch — AUTO.
 - h. EMERGENCY WING SWEEP handle — Cycle 22° , 68° , 22° .
 - (1) Verify spider detent is engaged, emergency WING SWEEP warning light out.
 - (2) MASTER RESET pushbutton — Depress, check WING SWEEP advisory light out.
 - i. Maneuver devices — EXT.
 - j. Accelerate to >0.79 Mach and check maneuver devices remain retracted (maneuver devices start automatic retraction at 0.68 ± 0.02 Mach).
 - k. Decelerate to <0.68 Mach and check maneuver devices remain retracted.
 - l. WING SWEEP MODE switch — AUTO. Verify wings are in AUTO mode.

ABC

62. ASYM LIMITER switch — Check (airspeed 300 KCAS).
- 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

63. High AOA Mach lever/AUTO MAN devices.
- a. Throttles — IDLE.

PROFILE

- b. Slowly increase aircraft AOA and allow aircraft to stabilize; maneuver devices extended at 10.5 units AOA.

This is the first comparison of ARI alpha nose-probe (radome) and ADD AOA side-probe (left fuselage) AOA inputs and any disparity could indicate potential limited DFCS functionality.

Note

The maneuver device AOA signal from the ARI alpha nose-probe to the CADC has a faster response rate than the signal from the ADD AOA side-probe to the 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/decreasing aircraft AOA and allowing aircraft to stabilize.

- c. Recover to <8 units AOA. Verify maneuver devices retract at 8 units AOA.

Maneuver devices should retract at 2 units less than extension to provide a “deadband” to reduce stress associated with automatic extension/retraction commands on the maneuver flaps/slats.

ABC

64. UA-ARI checks. Approaches to stalls.

- a. Clean stall with maneuvering devices extended.

- (1) Stabilize in level flight, speedbrakes out, 15 units AOA.
- (2) Verify maneuvering devices extended.
- (3) Slowly decelerate to buffet onset. Note AOA (light airframe buffet at 13 to 14 units AOA).
- (4) Differential Tail Fadeout (DTF) / Lateral Stick-to-Rudder Interconnect (LSRI) check.

DTF/LSRI functionality is active between approximately 10 to 28 units AOA. The functionality reduces full lateral stick differential tail authority from a 24° to 4° split as aircraft AOA and Mach increase.

- (a) Stabilize at 10-12 units AOA. Make full lateral stick input, note no initial rudder deflection in direction of lateral stick and full differential tail available (>20° split).
- (b) Continue deceleration to stabilize at 25-28 units AOA. Make full lateral stick input, note initial 19° rudder deflection in direction of stick input and reduced differential tail authority (10 ± 4° total split). Observe roll in direction of stick input.
- (5) Wing Rock Suppression (WRS) check.

WRS functionality is active between approximately 20 to 30 units AOA. The functionality is designed to prevent wing rock from starting and may only be marginally effective at reducing an established wing rock.

- (a) Stabilize at 22-25 units AOA.
- (b) Observe no wing rock.

PROFILE

- (c) Select ROLL SAS switch — OFF, initiate mild wing rock with small stick and rudder inputs.
 - (d) Select ROLL SAS switch — ON, hold stick/rudder centered and observe reduction or elimination of wing rock.
- (6) Low Speed Cross Control (LSXC) check.

LSXC functionality is effective above 30 units AOA and below 0.4 Mach. During this maneuver the pilot should slowly continue to decelerate to full aft stick with the nose less than 30° pitch attitude. The pilot should then input full left lateral stick and observe the 4° differential tail fadeout and full 19° rudder in the direction of stick. When the pilot inputs full right rudder pedal the differential tail fadeout will be overridden and allow a 20° differential tail split LWD and a full 30° right rudder as commanded. The low speed cross control functionality will provide for a sluggish right roll/yaw response with rudder at high AOA.

- (a) Continue deceleration to full aft stick, <30° pitch attitude (>30 units AOA).
- (b) Lateral stick — Full left. Observe 4° differential tail split LWD and 19° left rudder.
- (c) Rudder pedal — Full right (with full aft/left stick). Observe sustained 20° differential tail split LWD, 30° right rudder, and aircraft right roll/yaw response.

Note

Reduction to original authorities can occur if AOA falls below 30 units or yaw rate exceeds 20 deg/sec as the LSXC functionality is overridden.

- (7) Recover to <15 units AOA, retract maneuvering devices when proper DFCS control inputs and right roll/yaw response observed or when aircraft <30° nose down pitch attitude.
- b. Clean stall with maneuvering devices retracted.
- (1) Stabilize in level flight, speedbrakes out, 15 units AOA.
 - (2) Ensure maneuver devices retracted using thumbwheel, maintain power setting.
 - (3) Slowly decelerate to buffet onset and note AOA (light airframe buffet at 12 to 13 units, increasing to moderate intensity at 15 units AOA).
 - (4) Continue deceleration to 28 units AOA. Note any abrupt or significant rolloff tendencies.

10.3.9 Ten Thousand Foot Checks

- 65. Structural integrity check (airspeed 0.9 Mach at 10,000 feet).
 - a. High-speed dash — MIL THRUST.
 - b. High-g turn.
 - c. Anti-g valve operation.
 - d. Accelerometer — Check.

ABC

PROFILE

AB

10.3.10 Airstarts (Twenty Thousand Feet)

66. Radar power switch — OFF (coordinate with RIO).

AB

67. Spooldown airstart.

a. Stabilize at 300 KCAS.

b. Right throttle — OFF, then IDLE at 60-percent rpm.

Note

Sub-idle stall can be cleared by cycling the throttle to OFF and immediately returning it to IDLE.

c. Stabilize at 300 KCAS.

d. Left throttle — OFF, then IDLE at 60-percent rpm.

Note

- Sub-idle stall can be cleared by cycling the throttle to OFF and immediately returning it to IDLE.
- A left generator transient may cause a Mach fault illuminating the FCS CAUTION, ARI DGR, HZ TAIL AUTH, RUD AUTH and MACH TRIM lights. This should clear with a MASTER RESET.

AB

68. Radar power switch — XMT (coordinate with RIO).

10.3.11 Climb to Thirty-Five Thousand Feet

AB

69. Fuel management.

	Left	Right
FEED		
FUS		
WING		
EXT		
TOTAL		

AB

70. 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

71. Afterburner light-off — Check (airspeed 210 KCAS).

a. ASYM LIMITER switch — OFF.

b. Throttles — MAX AB (verify AB light-off within 10 seconds).

PROFILE

AB

- c. Throttles — Less than MIL.
- d. ASYM LIMITER switch — ON.

72. Wing sweep — Verify program.

Mach	Wingsweep
0.4	20°
0.7	21°
0.8	40°
0.9	60°
>0.93	68°

AB

73. Engine instruments (engine MIL power at 0.9 Mach) — Monitor and read out to RIO.

	Left	Right	Limits
OIL (psi)			25 to 65
RPM (%)			107.7 maximum
EGT (°C)			935°

10.3.12 High-Speed Dash (Thirty-Five Thousand Feet)

AB

74. Idle lockup — Check.

- a. Jam throttles — MAX AB.
- b. Both throttles to IDLE at 1.1 Mach. Verify less than 2-percent rpm decay.



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 and read out to RIO.

	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. Compare pitot-static instruments (pilot and RIO). Pilot should report Mach in increments of 0.1 Mach. RIO should indicate 0.1 Mach less than pilot's Mach indication.

	Pilot STBY	RIO STBY	Calibrated
Altitude			
Airspeed			

Note

A significant difference between front and rear air-speed indications may result in compressor stalls because of inlet ramp mispositioning.

g. Throttles — IDLE (MIL if idle-lockup check failed).



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.

10.3.13 Zoom Climb (Forty Thousand Feet)

AB

75. Pitch up to Flight level 400.

AB

76. Cabin pressurization and ECS — Check (approximately 17,000 feet at 40,000 feet).

10.3.14 Twenty Thousand Foot Checks

A

77. Autopilot modes check (airspeed 250 to 350 KCAS).

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° bank angle — Aircraft should return to 0° bank angle.

c. Altitude hold.

- (1) ALT hold — Select. Verify A/P REF legend appears.
- (2) A/P REF/NWS pushbutton — Depress. Verify A/P REF legend goes out.
- (3) Check for altitude control.
 - (a) ± 30 feet in level flight.
 - (b) ± 60 feet in 30° of bank angle.
- (4) Check for stick force breakout function.

PROFILE

A

- d. Ground track hold.
 - (1) GT hold — Select. Verify A/P REF legend appears.
 - (2) A/P REF — NWS pushbutton — Depress. Verify A/P REF legend goes out.
 - (3) Check A/P establishes crab into wind to hold selected track.
 - e. Emergency disengage paddle — Depress. Verify autopilot disengages, AUTOPILOT caution light illuminates, and clears with a MASTER RESET.
78. Air-to-air check (coordinate with RIO).
- a. Radar modes — Check.
 - b. PDCP — A/A, MASTER ARM switch - TNG.
 - c. Weapon select switch — PH (IFT).
 - (1) Attack steering — LAR — Vc.
 - (2) Collision steering.
 - d. Weapon select switch — SP (IFT).
 - (1) Attack steering — LAR — Vc.
 - (2) Collision steering.
 - (3) TCS HUD/VDI display.
 - e. Weapons select switch — SW (IFT).
 - (1) Attack steering — LAR — Vc.
 - (2) Collision steering.
 - f. WCS checks against suitable airborne target.
 - (1) VSL high.
 - (2) VSL low.
 - (3) Pilot VSL.
 - (4) MRL.
 - (5) PLM.
 - (6) PAL.
 - g. Gunsight — Check.
 - (1) Weapon select switch — GUN.
 - (2) Observe proper HUD display.
 - (3) Uncage gunsight.
 - (4) Fly level coordinated turn pulling enough g's to place the center of reticle 15 mils from the center of the ADDITIONAL along the horizontal line of the ADL.
 - (5) Results should be 3 g turn in 45 ± 6 seconds with reticle displaced 15 mils horizontally.
 - (6) Weapon select switch — OFF.

PROFILE

AB

79. Negative alpha/FOD check (airspeed 300 KCAS)

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.

- 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 a coordinated roll to upright wings level attitude.

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10.3.15 Fifteen Thousand Foot Checks

A

80. 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 (observe no fuel dump).

A

81. Fuel system transfer 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.

ABC

82. PA-ARI checks. DLC, autothrottles, and dirty stall.

- a. Approach configuration check.
 - (1) Perform landing checklist.
 - (2) DLC — Engage.
 - (a) Observe no significant lateral trim requirements.
 - (b) Observe no significant pitching with DLC commands.
 - (c) Observe proper stab motion with “up” DLC commands.

PROFILE

A C

- (3) AUTO THROTTLE/DLC.
 - (a) Response to longitudinal stick.
 - (b) Response to turn entry, steady rollout.
 - (c) Response to DLC (should be minimal).
 - (d) Response in HOT/NORM/COLD.
 - (e) AUTO THROT light.

- 1) Manual override.
- 2) CAGE/SEAM pushbutton.

b. Dirty Stall, 15,000 feet.

- (1) Slowly decelerate in level flight to 16.5 to 17.0 units AOA.
- (2) Throttles — MIL.
- (3) Continue to decelerate to a maximum of 25 units AOA (NATOPS limit is 25.6 units above 5,000 ft AGL). Check lateral control effectiveness at 2 unit intervals up to 20 units AOA.
- (4) Note pedal shaker at 20.5 ± 1.5 units AOA.
- (5) Note any abrupt or significant rolloff tendencies.

c. Attempt speedbrake extension at MIL power.

Verify throttle interlock does not permit speedbrake extension at MIL power.

83. PA-ARI checks. LSRI, yaw damping, and spiral mode stability.

a. Lateral Stick-to-Rudder Interconnect check.

- (1) Input lateral stick, ROLL SAS — ON;
Observe initial coordinating rudder in direction of lateral stick input.
- (2) Input lateral stick, ROLL SAS — OFF;
Observe no initial rudder in direction of lateral stick input.
- (3) ROLL SAS — ON.

b. Yaw Damping check.

- (1) Perform rudder pulse, YAW SAS — ON;
Observe deadbeat yaw damping (no overshoot).
- (2) Perform rudder pulse, YAW SAS — OFF;
Observe decreased yaw damping (approximately one overshoot).
- (3) YAW SAS — ON.

c. Spiral Mode Stabilization check.

Trim airplane to stabilized wings level with ROLL SAS OFF to neutralize SAS actuators. Re-engage ROLL SAS switch to activate lateral stick roll rate command functionality. Stabilize in a 10° bank angle and release stick. Aircraft should maintain this bank angle and

PROFILE

not deviate to double or half original bank angle in <20 seconds. This functionality will be degraded at steeper bank angles.

- (1) Trim laterally wings level, ROLL SAS — OFF.
- (2) Select ROLL SAS — ON and smoothly stabilize left and right 10° bank angle, hands off stick.
- (3) Observe approximately neutral spiral stability (test valid if time to double or half amplitude >20 sec).

A

84. Air-to-Ground check (coordinate with RIO).

WARNING

Recovery from 30° dive delivery profiles should be a 5 g pull, started no later than 4,000 ft AGL.

- a. Select PDCP — A/G, Weapon select switch — OFF.
- b. RIO select COMPTR/TGT attack mode and MK-84L.
 - (1) Verify symbology.
 - (2) Execute 30° dive 12,000 foot AGL roll-in.
 - (3) Designate target, verify solution.
 - (4) Maneuver, verify designator remains on target.
 - (5) Complete 30° dive.
- c. RIO selects COMPTR/PILOT attack mode.
 - (1) Verify symbology.
 - (2) Execute 30° dive 12,000 foot AGL roll-in.
 - (3) Fly impact point over target.
 - (4) Complete 30° dive.
- d. Air-to-ground GUN sight — COMPTR/PILOT check.
 - (1) Weapon select switch — GUN.
 - (2) RIO select A/G GUN switch — OFF.
 - (3) Dive angle greater than 10°.
 - (4) Verify symbology when in range (gun — 6,000 feet) diamond disappears.
- e. RIO select MANUAL attack mode.
 - (1) Verify symbology.
- f. Exit A/G.

PROFILE

ABC
ABC
ABC
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A
ABC
A
A

10.3.16 Approach and Landing

- 85. Landing Checklist complete.
- 86. ACLS/ARA-63 — Check.
- 87. Airspeed and AOA (15 units AOA) — Check.
 - a. AOA, INDEXER, HUD.
 - Gross weight _____ pounds.
 - Airspeed _____ KCAS

121 KCAS ± 4 KCAS at 42,000-pounds gross weight. Add 3 KCAS per 2,000 pounds over 42,000 pounds.
- 88. Approaches.
 - a. Perform normal landing approaches followed by lateral offset or overshooting approaches that require centerline correction to verify proper function of DFCS PA-ARI control laws.
- 89. Exhaust nozzle check.
 - a. Verify less than 26 percent.
 - b. Three to seven seconds after touchdown, nozzles 100 percent.
- 90. Walkaround inspection — Complete.

10.4 FUNCTIONAL CHECKFLIGHT PROCEDURES (RIO)

10.4.1 Prestart

- 1. ICS.
 - a. Normal.
 - b. Backup.
 - c. Emergency.
- 2. IND LT — TEST.
- 3. Seat adjustment — Check.
- 4. Canopy rigging.
 - a. Both cockpit handles same position during operation.
 - b. BOOST not required to close.
- 5. NAV MODE switch — ALIGN.
 - a. After displays are on, verify and/or enter alignment coordinates.

10.4.2 Poststart

- 6. Multifunction display.
 - a. Verify navigation display.
- 7. ALR-67 — BIT.

PROFILE

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 in both modes, and the primary or standby readings should agree within 75 feet. In addition, the allowable difference between primary mode readings of altimeters is 75 feet at all altitudes..

10.4.3 Taxi

A

9. BDHI — Cross-Check Heading With HUD.

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
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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 Ten Thousand Foot Checks

AB

16. ECS check.

a. Set radar power switch — STBY (prior to ECS check).

10.4.6 Fifteen Thousand Foot Checks

ABC

17. Structural integrity check.

a. Anti-g valve operation.

PROFILE

AB
AB
AB
A
A
A
AB
A

10.4.7 Twenty-Five Thousand Foot Checks

- 18. Radar power switch — OFF (prior to airstarts).
- 19. Radar power switch — XMIT (airstarts complete).

10.4.8 Climb to Thirty-Five Thousand Feet

- 20. Engine instruments — Record (MIL power/0.9 mach).

	Left	Right	Limits
OIL (psi)			25 to 65
RPM (%)			107.7 maximum
EGT (°C)			935°

- 21. D/L — Check.
- 22. Select assigned frequency and ADDRESS.
- 23. Receive D/L messages.
 - a. Steering symbols.
 - b. TBD target data.
 - c. Data-link messages.

10.4.9 High-Speed Dash (Thirty-Five Thousand Feet)

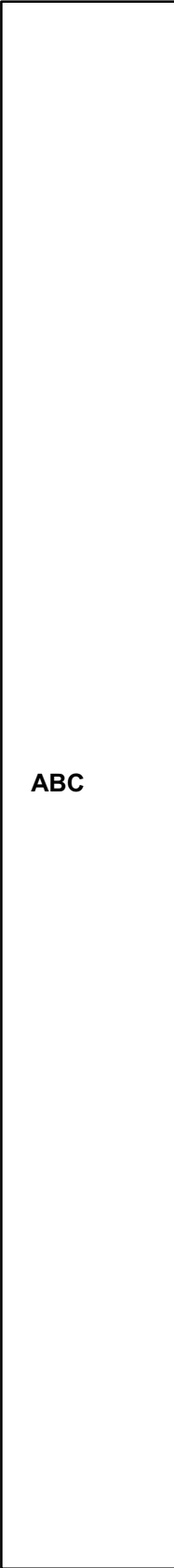
- 24. Engine instruments — Record.

	Left	Right	Limits
NOZ position (%)			50 to 60 (open)
OIL (psi)			25 to 65
RPM (%)			107.7 maximum
EGT (°C)			935°

10.4.10 Descent/Twenty Thousand Foot Checks

- 25. Air-to-air check
 - a. Radar modes
 - (1) PULSE.
 - (2) PD SRCH.
 - (3) RWS.
 - (4) TWS AUTO.

PROFILE



ABC

- (5) TWS MAN.
- (6) HRWS.
- b. MLC switch — OUT-AUTO-IN (PD SRCH).
- c. MASTER ARM (training mode check).
 - (1) Pilot select PH and TNG, RIO select missile preparation (coordinate with pilot).
 - (2) RIO verify weapons loadout on SMS after PREP timeout.
- 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.

26. Negative alpha/FOD check (20,000 feet, 300 KIAS)



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.

PROFILE

A

- 27. Air-to-ground check — coordinate with pilot.
 - 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.
 - f. HRM check.

ABC

- 28. Perform radar IBIT and record results.

A

- 29. NSV — SAHRS.
 - a. Pilot check HUD and VDI display and maneuver aircraft.
 - b. Radar antenna scan — Check.

10.4.11 Approach

A

- 30. Airspeed
 - a. Compare with pilot airspeed at 15 units AOA; record error _____ knots.

PROFILE

ABC

10.4.12 Landing

31. Radar — PS, or power switch — STBY.

ABC

10.4.13 In Chocks

32. INS/SAHRS and visual — Check and Update in Chocks (Vis Fix disabled if GPS is boxed).

a. Record closeout error.

	Δ Latitude	Δ Latitude	Δ Time	Groundspeed
INS				
SAHRS				

b. Initiate fix enable.

c. Observe aircraft symbol shift on PTID.

ABC

33. Call up maintenance current failures.

Record

ABC

10.4.14 Postflight

34. 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 KIAS 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 KIAS 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).

Note

Spoilers are activated to 62° of wing sweep, reducing aft fuselage structural loads during roll maneuvers.

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. With flaps down, the spoilers provide the majority of available roll control power.

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 System

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 200 deg/sec to reduce aft fuselage loads and to prevent roll coupling in the transonic speed range. The DFCS ROLL SAS differential tail authority has been tailored to reduce structural loads and provide expanded, simplified rolling maneuver envelopes defined in Chapter 4. ROLL SAS differential tail inputs are automatically faded out over the airspeed range from approximately 400 to 500 KIAS. An undesirable byproduct of the roll-rate limiting is an oscillatory roll rate perceived as a nonlinear roll response encountered in aggressive rolling maneuvers at medium subsonic speeds and higher. Because ROLL SAS provides structural protection, flight above 1.0 TMN 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. High AOA handling qualities are significantly improved by keeping ROLL SAS on (see paragraph 11.6).

Over the majority of the flight envelope, 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 1.0 TMN, 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), but high AOA maneuvering (above approximately 15 units AOA) should be avoided due to increased probability of departure from controlled flight.

At high AOA flight conditions, both the ROLL and YAW SAS are required to provide automatic rudder interconnect (ARI) functions which significantly improve the handling qualities, departure resistance, and recovery capability of the aircraft.

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 KIAS, 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).

Note

Although DFCS improves maximum roll rate capability at low airspeed and high AOA, these flight conditions 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.



Large sideslip angles generated during full lateral stick supersonic rolling maneuvers at high altitudes may result in engine stalls.

11.3.5 Roll Response

In the cruise configuration, the roll response to lateral stick inputs is generally satisfactory throughout the flight envelope. The increased roll acceleration and peak roll rate attainable with ROLL SAS on significantly improves the tactical maneuvering capability. However, at high airspeeds, the roll command augmentation (CAS) and roll rate limiting feature of the ROLL SAS can cause high roll accelerations and marked variations in roll rate during aggressive rolling maneuvers with large lateral stick inputs. This effect is most pronounced at high subsonic airspeeds (from approximately 0.7 to 0.93 Mach) and medium to low altitudes (below approximately 20,000 feet). This characteristic may lead to bank angle overshoots during maximum roll rate maneuvers

at high airspeeds. Smoother and/or smaller lateral stick inputs will reduce or eliminate this oscillatory roll response at these flight conditions.

At high angles of attack, the up-and-away (UA) UA-ARI control functions dramatically improve the roll response of the aircraft. The roll reversal characteristic experienced without ARI is eliminated throughout the majority of the available AOA range. Roll response is in the direction of commanded lateral stick up to and beyond 30 units AOA. Some variation in normal roll response may be seen due to aircraft control system and/or wing sweep and flap rigging tolerances, external store loading, or wing fuel imbalance. Maximum roll rate commanded by lateral stick decreases as AOA increases, decreasing to near zero above 30 units AOA, without pilot commanded coordinating rudder inputs. Proper sense roll response can be attained at increasingly higher AOA through use of pilot coordinating rudder. At very low airspeed and high AOA conditions (less than 0.4 Mach and above 30 units AOA), the Low Speed Cross Control feature (LSXC) can be safely utilized to obtain a transient roll maneuvering capability. This feature is enabled by applying rudder in the desired roll direction, while applying an opposite lateral stick input. Peak roll rate of approximately 60 deg/sec is available through the use of LSXC. If long duration inputs are utilized, the roll response may become oscillatory, with hesitations in bank angle and roll rate. Precise bank angle control is typically not possible with LSXC, but the feature can be effectively utilized during sustained slow speed / high AOA maneuvering such as a flat scissors engagement.

In the landing configuration, the power approach (PA-ARI) control functions and modified spoiler gearing provide a crisp roll response to pilot lateral stick inputs. Control gains are scheduled with AOA to provide a linear roll response of approximately 20 deg/sec roll rate per inch of lateral stick deflection. This responsiveness may lead to a tendency to overcontrol bank angle if large amplitude stick inputs are utilized. Therefore, relatively small stick deflections are required to perform these corrections. Once accustomed to the increased roll response in the landing configuration, pilot workload to perform lateral corrections and precisely maintain lineup will be significantly reduced, allowing the pilot to devote valuable time to controlling both glideslope and AOA.

11.3.6 Dutch Roll

Dutch roll is characterized by a wallowing, snaky motion of the nose that severely degrades heading and/or lineup control. Large lateral stick inputs can excite the Dutch roll mode of the aircraft in the cruise configuration, but the most severe degradation in flying qualities from the Dutch roll is in the approach configuration. The period of 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. In the landing configuration, the PA-ARI control functions provide a nearly deadbeat directional response. Precise lineup control is exhibited due to the increased Dutch roll damping and the automatic stick to rudder interconnect function which provides coordinating rudder inputs with lateral stick deflection. Additional pilot coordinating rudder inputs are typically not required during approach, but may be used for aggressive bank and/or lineup corrections if desired.

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 schedules in [Figure 2-63](#)). 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 airspeed, 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.

Trimming the aircraft laterally/directionally may be required to compensate for lateral asymmetry resulting from either asymmetric stores, wing fuel imbalance, or control surface rigging tolerances. Lateral trim requirements will result in a stick displacement and a corresponding differential tail split that will reduce the amount of effective differential tail authority in the direction of trim and increase the amount of effective differential tail authority opposite trim. As a result, aircraft response will be reduced for lateral stick deflections in the direction of trim and increased for lateral stick deflections opposite the direction of trim. The combined effects of lateral trim and any CG displacement associated with the asymmetry may result in increased departure susceptibility and severity. In addition, excessive lateral trim requirements will result in increased roll rates and structural loads during rolling maneuvers opposite the direction of trim. This is particularly evident at transonic and supersonic flight conditions. For this reason, lateral/directional trim requirements should be managed primarily

via directional yaw trim first then followed by lateral stick roll trim.



Excessive lateral trim requirements will result in increased roll rates and structural loads during rolling maneuvers opposite the direction of trim. This is particularly evident at transonic and supersonic flight conditions. For this reason, trim yaw first, then roll.

Changes in thrust settings normally require a trim change, particularly in the approach configurations. A reduction in power causes a slight nosedown pitch.

In the landing configuration, the DFCS includes a roll rate command function. Pilot lateral stick deflection commands a desired roll rate, which is provided through differential tail and spoiler inputs. Once this commanded roll rate is achieved, ROLL SAS inputs will stabilize the aircraft at the commanded rate. Likewise, any roll rate not commanded by lateral stick deflection (gust, turbulence, lateral asymmetry, etc.) is sensed as a roll rate error. The ROLL SAS will automatically provide inputs through the roll series servos to stop this uncommanded rate. Sufficient gain exists in this control function to essentially provide an "auto-trim" capability in the roll axis for many lateral asymmetry situations. Because of this characteristic, precise lateral trim may be slightly more difficult to achieve in the landing configuration. In some cases, it may be possible to slowly move lateral stick trim from left to right with no appreciable change in aircraft bank angle or roll rate. Because much of the lateral trim is now being provided through biasing of the roll series servos in one direction, the aircraft may subsequently exhibit an asymmetric roll rate in response to pilot lateral stick inputs. Should this bias become objectionable, the aircraft can be trimmed both laterally and directionally with the ROLL SAS OFF, reselecting ROLL SAS ON once trim is established. This action should eliminate any bias present in the roll series servos and provide symmetric roll response.

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. A 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 (ATLS)

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 afterburner 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. Although DFCS reduces this effect due to differential tail fadeout and automatic stick-to-rudder interconnect functions reduce this effect, departure could still result.

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 or stability augmentation system must control sideslip 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). At negative AOA, dihedral effect is negative such that a right rudder input will produce a left roll. In the PA configuration, negative AOA can be encountered at 1 g flight at the higher limit airspeeds for the configuration.

11.6.3 External 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. High AOA flight tests with all SAS on have shown that no higher AOA maneuvering limits are imposed with a fully operational DFCS system. 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 DFCS 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. With the ROLL SAS OFF, or with a complete ROLL SAS failure as indicated by illumination of the ROLL DGR, ARI DGR, and ARI/SAS OUT caution lights, maximum differential tail

authority commanded by lateral stick is $\pm 7^\circ$. High AOA maneuvering should always be conducted with both the ROLL and YAW SAS ON, as control functions in both axes are required to provide a fully operational UA-ARI. Departure inducing differential tail inputs are faded out at high AOA, while beneficial coordinating rudder inputs are automatically provided with lateral stick deflection to preserve proper sense roll response throughout the majority of the available AOA range. Roll rate feedback is provided to the roll and yaw axes to damp divergent wing rock above 20 units AOA and improve air-to-air tracking capability. Finally, yaw rate feedback to the differential stabilizer and rudders provides an enhanced departure/spin recovery capability by automatically commanding these control surfaces to oppose yaw rate buildup. Thus, above 30 units AOA and greater than 20° per second yaw rate, 19° rudder opposite and $\pm 5^\circ$ differential tail into the turn needle are commanded. Unless otherwise noted, the high AOA flight characteristics discussion assumes both ROLL and YAW SAS are ON.

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 may 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). This wing rock may be damped with rudders, but greater difficulty may be encountered with maneuver flaps and slats extended, particularly at low airspeeds. Damping of the wing rock mode is provided by the DFCS. However, in some cases minor wing rock may still develop during sustained high AOA maneuvering, particularly above 30 units AOA. 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.



- 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.

- Inoperative maneuver flaps/slats could be indicative of a malfunctioning primary AOA source.

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). The DFCS fades out differential tail inputs at high AOA while providing automatic coordinating rudder inputs through the lateral stick-to-rudder interconnect function (LSRI). Essentially, the DFCS uses lateral stability (dihedral effect) to roll the aircraft at high AOA. Proper sense roll response to lateral stick is generally exhibited up to and beyond 30 units AOA. Other factors such as external store loading, lateral asymmetry, and control surface rigging tolerances may degrade system performance enough to cause neutral to slightly adverse roll response (i.e. roll reversal) above 30 units AOA. Additional pilot coordinating rudder inputs at high AOA can reduce this tendency and improve roll response.

Note

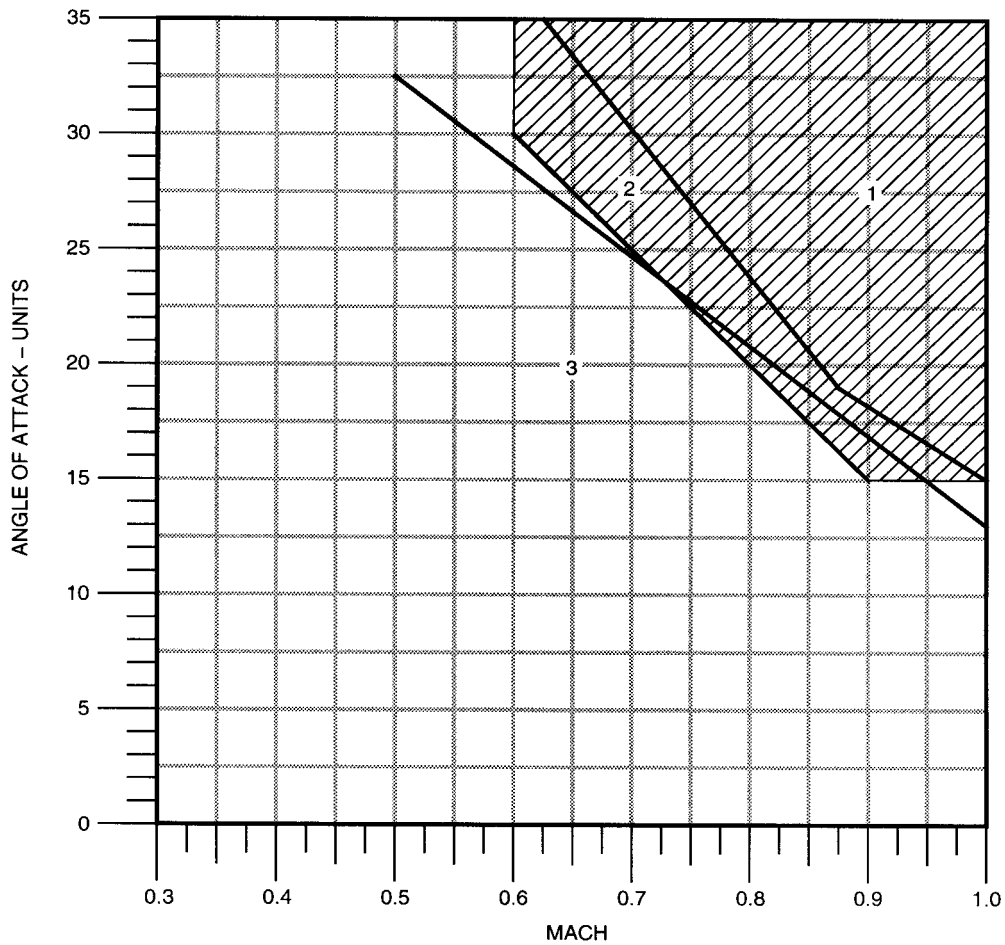
Through use of pilot coordinating rudder inputs, it is possible to command rudder deflection in excess of total control surface authority. If this occurs, the rudder pedal will “kick back” to reduce the pilot’s input while maintaining maximum rudder authority.

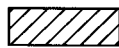
At extremely high AOA and low airspeed conditions (above 30 units AOA and less than 0.4 Mach), where rudder effectiveness is significantly reduced due to fuselage blanking effects, adequate roll rate may not be available through the combination of lateral stick and coordinating rudder. In this region, the low speed cross control (LSXC) feature can be utilized to cross control the aircraft (rudder in direction of roll, lateral stick opposite) and obtain a transient roll maneuvering capability. The LSXC permits up to 10° differential tail deflection by overriding the AOA scheduled differential tail fadeout and LSRI functions. It should be understood that a LSXC maneuver is basically an intentional departure from controlled flight and should not be utilized unless insufficient roll response is obtained with “proper sense” lateral stick and coordinating rudder. However, at these flight conditions the airspeed is low enough that rapid yaw rate buildup is not experienced. If the LSXC input is maintained for a long duration (more than about 3 seconds), a ratcheting roll response will occur causing hesitations in roll rate, bank angle, and yaw rate.

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



-  UNCOORDINATED LATERAL 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 GREATER THAN 10 SECONDS,
OR 50 ° /SEC YAW RATE NOT REACHED.

(AT)1-F50D-114-2L

Figure 11-1. Lateral-Control-Induced Departure Areas

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. If deceleration is continued to full aft stick deflection, AOA will stabilize at approximately 35° to 45° depending upon stores loading. 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.

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.

Satisfactory lateral and directional control is maintained beyond the AOA where the basic airframe directional stability becomes negative. Lateral stick and rudder inputs can be used to adjust and maintain desired bank angle throughout the stall. Control inputs are provided to suppress wing rock motion up to 30 units AOA , but some mild wing rock may still occur. Above 30 units AOA , the wing rock suppression feature is inhibited and rudder effectiveness decreases sharply. Large rudder or lateral stick inputs produce an increase in AOA as sideslip increases.

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 use of lateral stick to offset the random yawing and/or rolling motion may generate enough adverse yaw to cause a yawing/rolling departure. The controls should be released below 100 knots during the vertical stall to prevent inadvertent inputs that may lengthen recovery and/or cause a departure.

Control inputs should not be applied until the aircraft is nose down and accelerating through 100 knots. 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 AOAs 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.

11.6.10 DFCS Degraded Control Modes

The DFCS has the capability to function in several degraded modes of operation. Air sensor data failures, actuator failures, or DFCS computer failures can all affect the high AOA flying qualities of the aircraft. Failure modes which would significantly affect high AOA flight characteristics are discussed below. It should be understood that the failures listed do not comprise all possible failure modes, but are examples of those types which would have the most significant effect on high AOA flight.

11.6.10.1 Air Data Failures

Actual air data failures could occur at any point in the flight envelope due to associated failures of the SCADC, AICS, or AOA computer inputs to the DFCS. However, transient or nuisance air data sensor failures due to input miscompares (Mach number or AOA inputs) are more likely

to be experienced during maneuvering flight at high AOA than at low AOA or high airspeed conditions. In general, single failures of the air data sensors have negligible or only minor effects on high AOA flying qualities.

Failure of a single AOA input does not result in a functional downgrade, only a loss of redundancy, since the AOA input is triplex. Single failure of the Mach number inputs (SCADC or AICS) will downgrade the UA-ARI to a fixed gain Mach control mode. In this mode, the wing rock suppression and LSXC control functions are inoperative. Therefore, wing rock tendency will be increased and the aircraft will be difficult to roll above 30 units AOA. The differential tail fadeout, LSRI, and spin recovery functions remain operational.

Dual failure of either the Mach or AOA inputs causes loss of all UA-ARI functions except the spin recovery function. This will cause the aircraft to be more prone to wing rock and less resistant to all types of control-induced and asymmetric thrust induced departures. DFCS spin recovery capability is retained.

11.6.10.2 Actuator Failures

Failure of the pitch series servos or any of the spoiler actuators has little effect on high AOA flight characteristics. Single failure of any roll or yaw series servo will result in degraded UA-ARI performance (i.e., decreased departure resistance, increased wing rock tendency) in the associated axis due to the decreased control authority, however all UA-ARI functions are retained.

Dual failure of both roll or both yaw series servos results in a complete loss of all UA-ARI functions, and significantly degrades the high AOA flying qualities. With a dual roll series servo failure, all roll axis functions are inhibited and the yaw axis downgrades to “basic SAS” mode (loss of ARI functionality). In the event of a DFCS dual roll series servo failure or manually selecting the ROLL STAB AUG switch to OFF, the maneuvering limits described in Chapter 4 “Maneuvering Limits” must be observed. Failure of both yaw series servos, or manually selecting the YAW STAB AUG switch to OFF, inhibits all yaw and roll axis UA-ARI and SAS functions, resulting in a severe degradation in high AOA flying qualities.

WARNING

Maneuvering with YAW SAS OFF or inoperative shall not be conducted above 15 units AOA with landing gear retracted. The aircraft will be prone to departure from controlled flight.

11.6.10.3 DFCS Computer Failures

Each of the three DFCCs contains two distinct computer processors called computing segregations, one “A” segregation and one “B” segregation in each axis. Each segregation commands different series servo and/or spoiler sets. If a computing segregation fails, all actuators commanded by that segregation are rendered inoperative. Similarly, all sensor information associated with that segregation is declared invalid. Functionality loss associated with each of the segregations, and effect on high AOA flying qualities, are discussed below.

Pitch A - Half authority PITCH SAS, no inboard spoilers, single AOA failure, single Mach failure. Inoperative wing rock suppression and LSXC functions.

Pitch B - Half authority PITCH SAS, no outboard spoilers, single Mach failure. Inoperative wing rock suppression and LSXC functions.

Roll A - Half authority ROLL SAS/ARI, no inboard spoilers, single AOA failure. Degraded UA-ARI performance due to loss of the roll A series servo.

Roll B - Half authority ROLL SAS/ARI, single Mach failure. Degraded UA-ARI performance due to loss of the roll B series servo. Inoperative wing rock suppression and LSXC functions.

Yaw A - Half authority YAW SAS/ARI, single AOA failure. Degraded UA-ARI performance due to loss of the yaw A series servo.

Yaw B - Half authority YAW SAS/ARI, no outboard spoilers, single AOA failure. Degraded UA-ARI performance due to loss of the yaw B series servo.

Combined failure of any two segregations results in combined loss of all associated functions, actuators, and in most cases, additional failures. High AOA flying qualities are significantly degraded in all multiple segregation failure cases.

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.

A predominant stability characteristic of the F-14 is positive dihedral effect, which is the tendency for the aircraft to roll to reduce sideslip. This effectively serves to delay yaw rate buildup associated with loss of directional stability at high AOA.

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. DFCS will significantly enhance these recovery characteristics.

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 [Figure 11-1](#) and [Figure 11-2](#). The figures are applicable to DFCS with ROLL SAS OFF or a complete roll axis failure as indicated by illumination of the ROLL DGR, ARI DGR, and ARI/SAS OUT caution lights. Generally, the most severe departures are induced through the differential tail, which is commanded by lateral stick. Rudder inputs, asymmetric thrust, and inertia coupling can cause or contribute to the severity of departures.

In addition to the enhanced departure resistance, the DFCS automatically provides anti-spin rudder and differential tail inputs to the maximum ROLL and YAW SAS authority limits as a function of yaw rate. This increases aircraft spin resistance. Flight tests indicate that the aircraft will recover from high yaw rates without pilot-commanded lateral/directional control inputs, due to these automatic rudder and differential tail inputs. Refer to 11.7.8 for discussion of departure recovery characteristics.

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.

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.

11.7.1.4 Asymmetric Fuel/Stores

Flying qualities with asymmetric stores are most affected by the store weight imbalance which results in a redistribution of lateral control power (differential tail) due to the trim required. There are no significant differences due to aerodynamic asymmetries at high AOA. Therefore, rudder inputs generate similar aircraft response both into and away from the store(s). However, the aircraft response to large lateral stick inputs, at AOAs where lateral stick generates a roll response opposite to the direction of the input (roll reversal AOA), can vary significantly from the symmetric stores case depending on the amount of store asymmetry.

The maximum asymmetry which has been flight tested thus far is 189,000 in-lbs, which resulted in a lateral trim bias of 40 - 90% of available trim authority, depending on trim airspeed. This asymmetry is equivalent to a 900 lb wing fuel split.

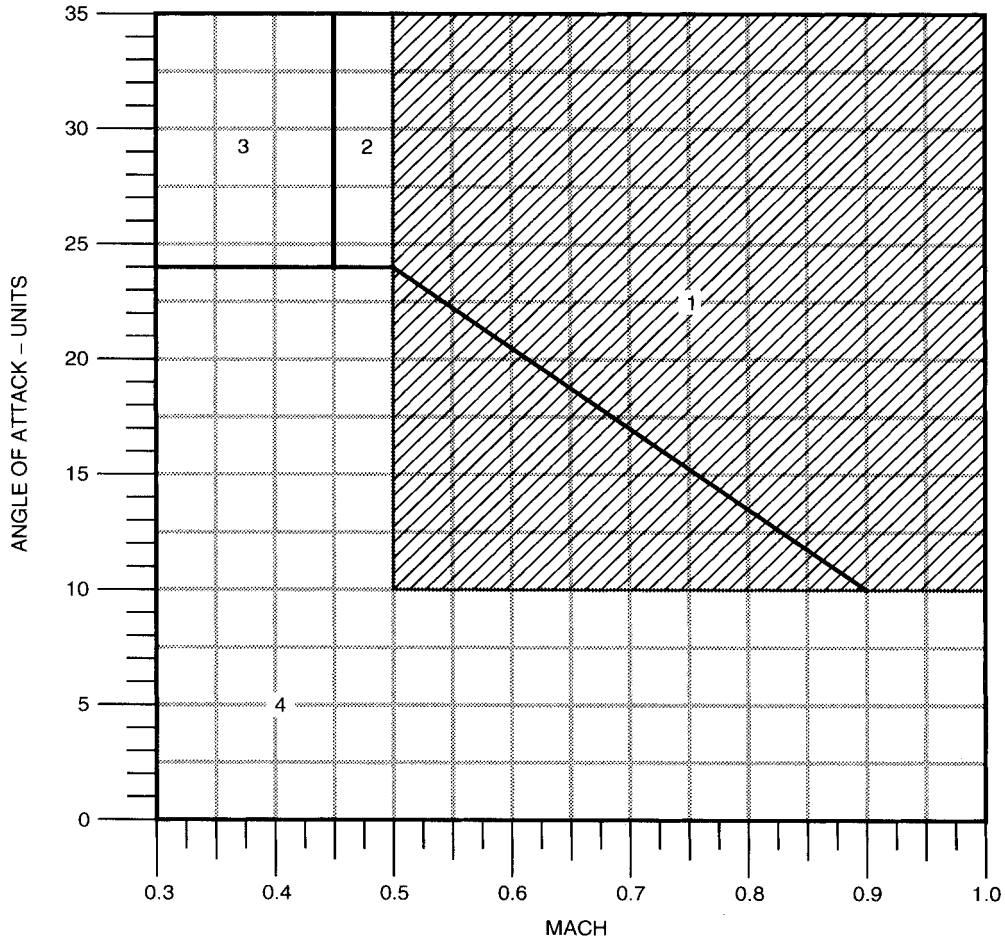
Due to the lateral trim required to offset the asymmetry, the amount of lateral stick displacement (and therefore differential tail) which can be commanded from the trimmed stick position is greater into the store asymmetry than away from the asymmetry. Aircraft response to large lateral stick inputs is thus amplified for stick deflections into the stores and reduced for stick deflections away from the stores.

Lateral stick-induced departures are caused by the inadvertent application of differential tail at high AOA. The greater the amount of differential tail commanded, the greater the aircraft response, and potentially the more severe the departure. Since the direction of a laterally induced departure is opposite to the direction of the lateral stick input, departures away from the store asymmetry can be more severe. For example, a right-wing heavy aircraft will depart faster in the nose-left direction. The degree of this asymmetric response varies in proportion to the amount of asymmetry, and also the magnitude and duration of the control input. This same effect is present during the use of cross controls (rudder in direction of roll, lateral stick opposite) to further augment roll response of the aircraft at high AOA and can lead to potentially more severe departures. Caution should be exercised when cross-controlling to increase high AOA roll response away from the store asymmetry. Use of cross controls to roll into the store asymmetry will be less effective than normal.

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 11-2. Cross-Control-Induced Departure Areas

11.7.2 Lateral Stick-Induced Departures

Roll and yaw in direction of lateral stick command is typically retained up to 30 units AOA, due to the combined effects of differential tail fadeout and lateral stick-to-rudder interconnect functions provided by DFCS. Maximum roll rate commanded by lateral stick decreases as AOA increases, decreasing to near zero above 30 units AOA without pilot commanded coordinated rudder inputs. Some variation in AOA at which neutral roll response occurs and/or mild roll reversal may be expected due to effects of external stores, wing fuel state, or flight control system rigging tolerances. During flight tests, only mild roll reversal departures were experienced. These departures were characterized by a mild roll and yaw opposite the lateral stick command. With maneuver flaps retracted, there was no appreciable degradation in departure resistance. No high AOA maneuvering restrictions regarding lateral stick inputs are required for flight with a fully operational UA-ARI.

11.7.3 Rudder-Induced Departures

Full rudder inputs at high AOA produce a roll and yaw rate in the direction of the rudder input. At moderate AOA (approximately 15 to 25 units), this response is oscillatory and a definite hesitation in roll and yaw rate will be noted for long duration inputs. Inertia coupling effects will also cause pitch rate and AOA oscillations. As AOA increases to 30 units, the response is less oscillatory but remains in the direction of the rudder input. Above 30 units AOA, rudder effectiveness is significantly reduced and little response is obtained from a full rudder input. The departure resistance features of the UA-ARI limit maximum yaw rate to less than 50 deg/sec over the majority of the high AOA flight envelope. However, at airspeeds above approximately 250 knots and low to moderate AOA (less than 25 units), rapid yaw acceleration can occur in response to a sustained full rudder input such that 50 deg/sec yaw rate can be initially exceeded. Flight test data indicate that yaw rates decreased to less than 50 deg/sec even when sustained full rudder inputs were maintained for 10 sec. Roll response using lateral stick alone in this airspeed and AOA range is typically sufficient, such that large rudder inputs should not be required to obtain desired roll performance.



Sustained large rudder inputs at high airspeeds (above 250 knots) can cause high yaw acceleration and yaw rate.

11.7.4 Multi-Axis Control-Induced Departures

Combined lateral stick and rudder control inputs can produce oscillatory aircraft response and high yaw rates at some flight conditions.

11.7.4.1 Cross Control-Induced Departures

Sustained cross control inputs produce oscillatory roll and yaw rates in the direction of the rudder input. The amplitude of the oscillations decreases as AOA increases. Differential tail fadeout and lateral stick to rudder interconnect functions limit maximum control authorities to $\pm 2^\circ$ differential tail and $\pm 11^\circ$ rudder, causing maximum yaw rate to remain below 50 deg/sec at all flight conditions. At very low airspeed and high AOA flight conditions (less than 0.4 Mach and above 30 units AOA), the low speed cross control function (LSXC) is enabled to provide a transient roll and yaw maneuvering capability. LSXC permits the pilot to command up to $\pm 10^\circ$ differential tail and $\pm 30^\circ$ rudder deflection during cross control maneuvers. Peak roll rate of approximately 60° per second is available through the use of LSXC. If long duration inputs are utilized, the roll response will become oscillatory, with hesitations in bank angle and roll rate. Precise bank angle control is typically not possible with LSXC, but the feature can be effectively utilized during sustained slow speed / high AOA maneuvering such as a flat scissors engagement. The spin recovery function will start to reduce these control authorities at approximately 20° per second yaw rate and will apply the maximum reduction in control authority back to the $\pm 2^\circ$ differential tail / $\pm 11^\circ$ rudder limits at approximately 25° per second yaw rate to preserve departure resistance.

11.7.4.2 Coordinated Control-Induced Departures

During flight tests, full sustained coordinated lateral stick and rudder inputs produced high roll and yaw rates in the medium to high airspeed regime (above 250 knots) at low to moderate AOA (less than 25 units). However, no tested condition resulted in sustained yaw rate above 50° per second. The roll and yaw rates are in the direction commanded and produce highly oscillatory, potentially disorienting motion with significant nose up coupling in the pitch axis. At these flight conditions, roll response due to a pure lateral stick input (no pilot-commanded coordinating rudder) is satisfactory and additional coordinating rudder should not be required to obtain desired roll performance. At lower airspeeds and/or increased AOA, coordinated lateral stick and rudder inputs produced a smoother, less

oscillatory roll and yaw response. In this flight regime, coordinating rudder can be used to supplement lateral stick for increased roll rate.



Sustained large rudder inputs at high airspeeds (above 250 knots) can cause high yaw acceleration and yaw rate.

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 thrust 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 DFCS spin recovery function automatically commands recovery differential tail and rudder inputs to oppose yaw rate buildup and reduces the severity of asymmetric thrust induced departures. These inputs are most effective if airspeed remains above 100 knots. Departures induced by asymmetric thrust are still capable of reaching 50°/sec yaw rate at low altitudes, however, the yaw rate onset is much less severe, allowing the pilot more time to counter rate.



The pilot's natural tendency is to oppose uncommanded roll with lateral stick, but this can aggravate the departure.

During maneuvering flight, uncommanded roll should be countered by rudder and a reduction in AOA. DFCS automatically provides coordinating rudder with lateral stick deflection which decreases departure susceptibility. See additional discussions on asymmetric thrust flight characteristics in this chapter.

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. Flight tests with legacy SAS (pre-DFCS) have shown aircraft rates in excess of 120° per second in roll and 70° per second in yaw. Pitch rates oscillate up to $\pm 30^\circ$ per second and lateral acceleration oscillates up to $\pm 0.8g$. 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 Inertia Coupling

Coupling occurs when motions in more than one axis interact. Combined motion on two axes will always result in motion in the third axis. 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. In flight tests with legacy SAS (pre-DFCS), 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. Most coupled departures in the F-14 are induced by combined high pitch and roll rates (causing a rapid departure in yaw). Typically, these departures are initiated at comparatively low AOA (below 15 units) where the aircraft is capable of generating both high pitch and roll rates. It should be noted that since the ROLL SAS will remain on, this will provide increased roll control authority, throughout the flight envelope.

Note

In flight tests, the DFCS did not prevent coupled departures from occurring. However, the DFCS spin recovery function prevented excessive yaw rate buildup.

No DFCS flight test departure maneuvers exceeded 70° per second yaw rate, and progression into the flat spin mode following this type of departure.



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 and AOA sustained between 0 and 30 units is indicative of a recovery in progress, as is positive 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 the pilot 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 or DFCS 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 with rudder.

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 11-3](#). Cockpit indications of yaw direction are the pilot's turn needle and the spin arrow displays on the PTID and MFD ([Figure 11-4](#)). Refer to paragraph 11.7.9.1 for a detailed discussion of spin arrow displays. An additional noninstru-

ment 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 PTID 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.

WARNING

Retarding throttles to idle during a departure or high AOA maneuvering may induce a compressor stall on the operating engine. If both engines are stalled, one engine must be immediately secured (while maintaining the correct departure/spin recovery inputs) to prevent turbine damage and provide maximum potential for a successful airstart.

Recovery from slightly higher yaw rates (approximately 60 to 70 deg/sec) is possible with forward stick and opposite rudder alone, due to the automatic anti-spin differential tail and rudder inputs provided by the spin recovery function. Above these yaw rates, additional pilot-commanded lateral stick into yaw rate/turn needle will likely be required to recover the aircraft. 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 or DFCS for recovery. A nose drop and an associated unload may occur. These are indications of a positive recovery in progress.

During flight tests with DFCS, a sustained mild "auto-roll" tendency was exhibited during recovery from some intentional departure maneuvers. This motion typically occurred when the pilot failed to input enough forward stick to reduce and maintain AOA below 20 units. With neutral controls or slightly forward stick only (no pilot rudder or lateral stick input), the aircraft can continue to roll and yaw mildly in the direction of the original departure. These rates are approximately 40 deg/sec in roll and 20 deg/sec in yaw. AOA is sustained between 20 and 25 units. Aircrew should

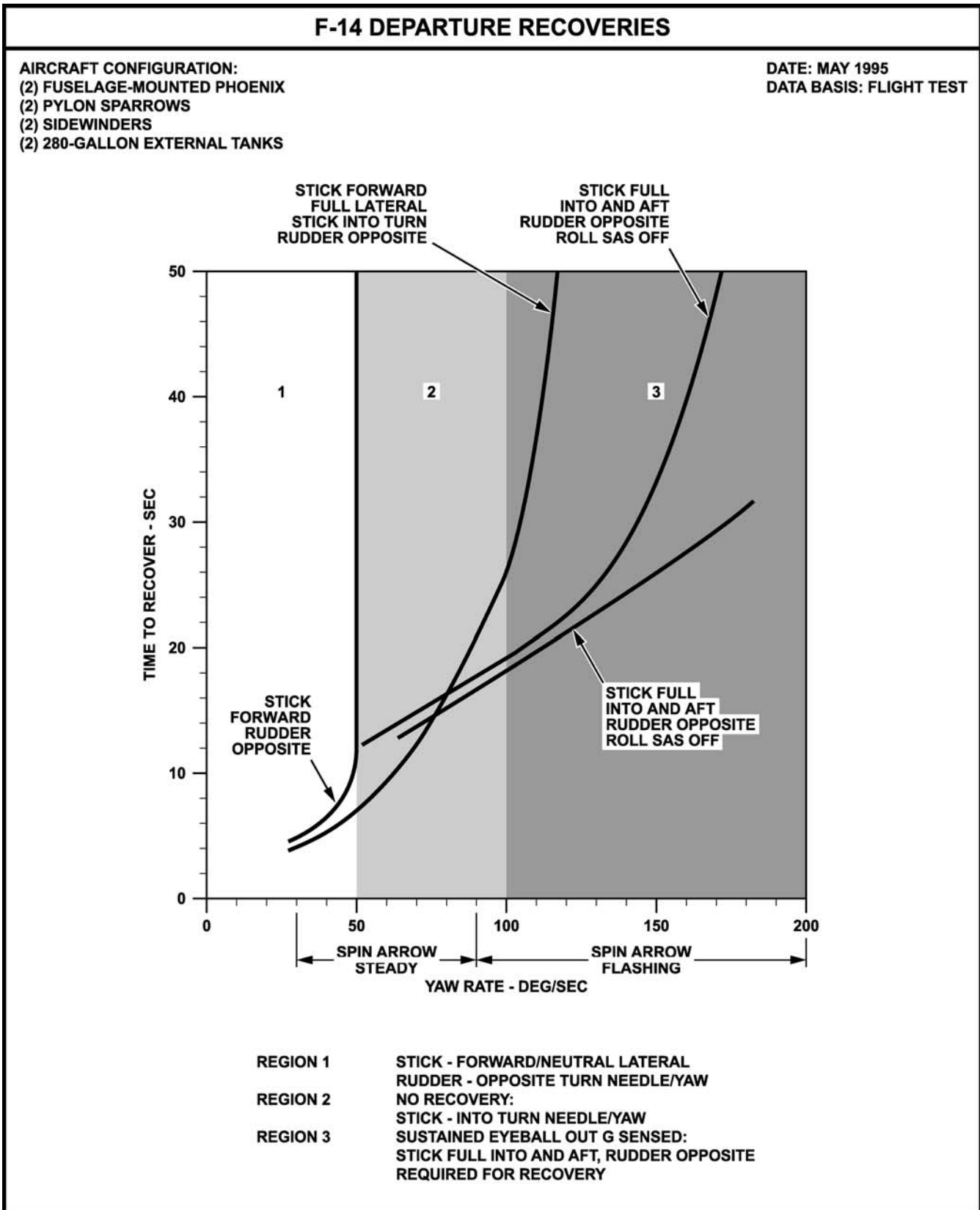


Figure 11-3. F-14 Departure Recovery Diagram

recognize that the departure is substantially recovered at this point, as indicated by the sustained AOA below 30 units, blanked spin arrow, and a nose low attitude with increasing airspeed. Any subsequent positive pilot control input will cause the aircraft to cease the auto-roll motion. This can be accomplished by applying enough forward stick to reduce and maintain AOA below 20 units, applying opposite rudder and/or lateral stick, or a combination of any of these three inputs.

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. The DFCS provides the capability to command full ROLL SAS ON differential tail authority for recovery as a basic feature of the UA-ARI. 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 some-what 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 these reasons, the control stick that was maintained aft and into the turn should be moved forward and into the turn when sustained eyeball-out g is no longer sensed or spin arrow yaw rate has decreased below 100 deg/sec. Further recovery can then be accomplished as previously described.

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 11-4) have priority and override all other display formats on the MFD1 and the PTID. 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.

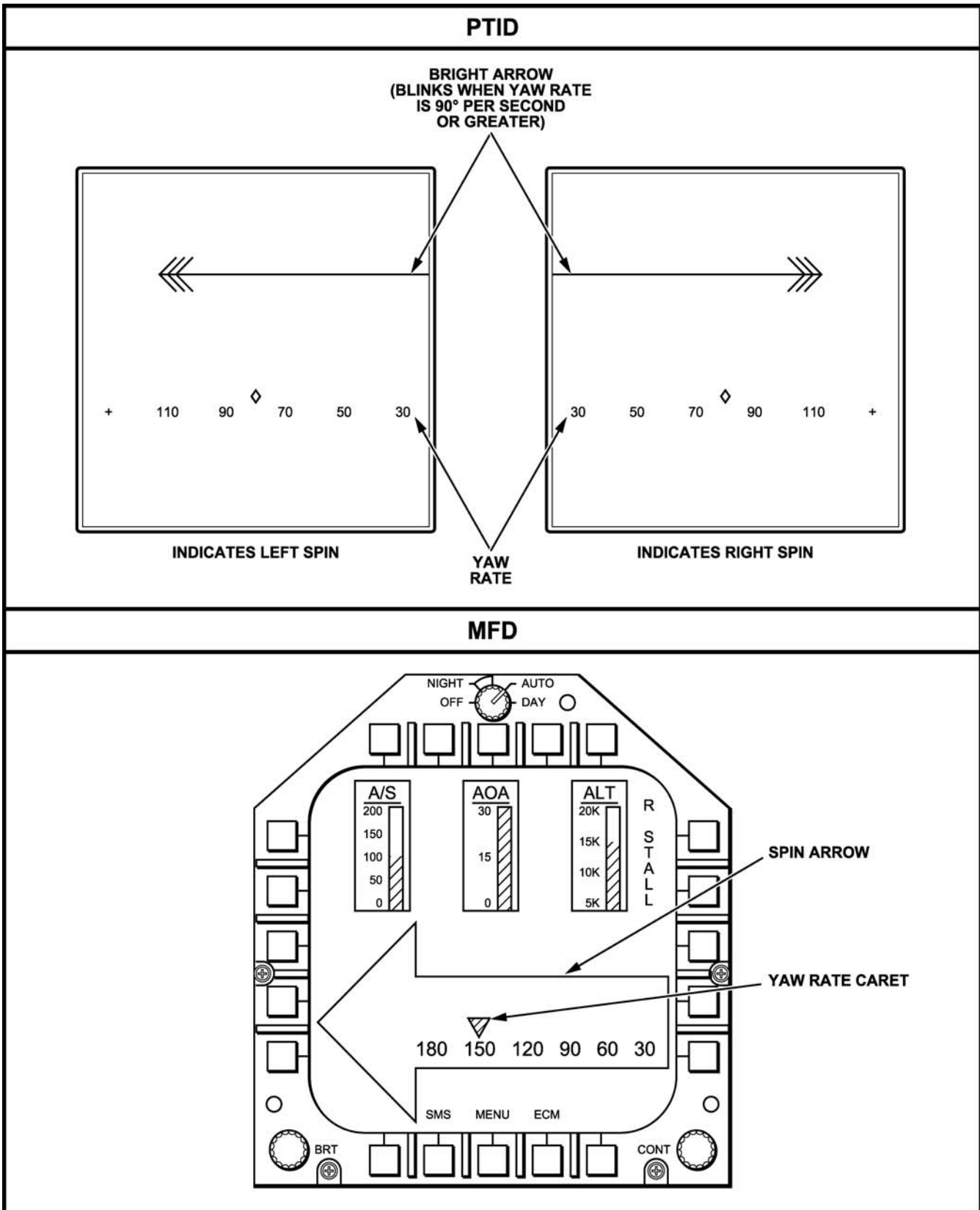
Note

- 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 11-5).

At yaw rates over 30° per second, the PTID 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.

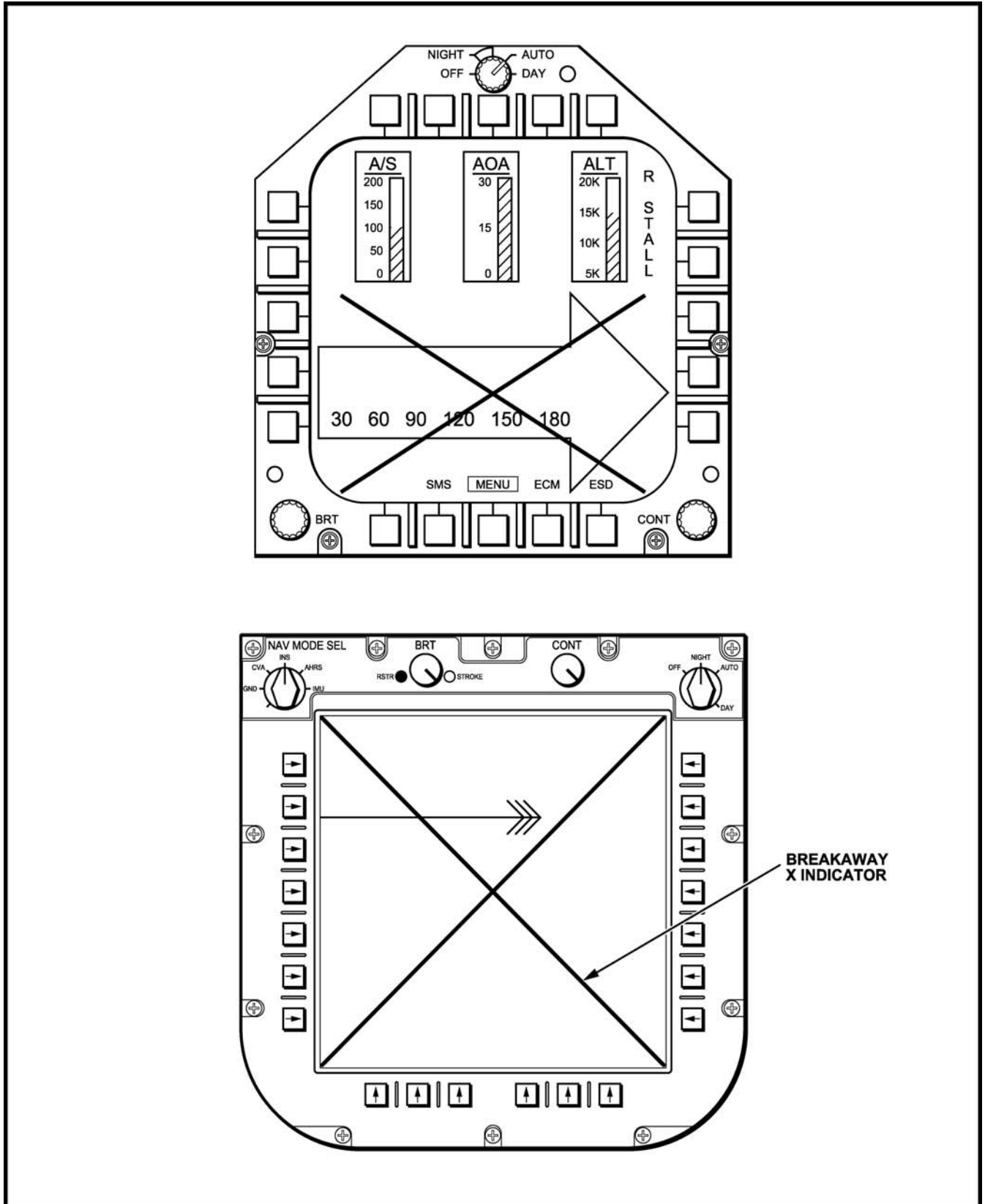
Note

- The primary reference for the spin arrow, the INS, is valid for yaw rates up to 300° per



CSC-F14D-1-11-002

Figure 11-4. Spin Arrow Displays



CSC-F14D-1-11-001A

Figure 11-5. MFD-1/PTID Right Spin Display (INS and SAHRS Failed)

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 PTID and a breakaway X is super-imposed over the spin arrow display (Figure 11-5).

The algorithm that provides yaw rate and direction of turn information for the spin arrow display has not been flight test validated at all aircraft attitudes and rates. Hence, the spin arrow may not operate properly at extreme aircraft attitudes and rates. The spin arrow has operated properly, providing accurate yaw rate and direction information to the aircrew, during flight test where nominal aircraft departures were encountered.

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, resulting in inertia coupling 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 (eye-ball-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 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. Inertia coupling effects will cause a nose down pitch and AOA decrease any time roll and yaw rates are generated in opposite directions. A cross control input at low AOA, where the aircraft still rolls in the direction of lateral stick, is capable of producing this type of motion. The motion was very disorienting, uncomfortable, and confusing. Neutralizing controls would produce a recovery from this departure; use of aft stick would speed recovery.



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° .



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.



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.



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 Baseline Flight Characteristics

The aircraft exhibits a sluggish pitch response to longitudinal stick inputs. Frequent power adjustments are required in conjunction with longitudinal stick inputs to properly maintain glideslope on approach. DLC is very effective for making glideslope corrections while at the same time minimizing the need for nose movement and/or power corrections. During full flap takeoffs, more longitudinal stick is required to rotate the aircraft as compared to either the flaps up or maneuver flap takeoff configurations. Pitch sensitivity and over-rotation tendency is more pronounced with maneuver flaps or flaps up, particularly with aft CG locations.

The PA-ARI control functions combine to provide a crisp roll response and essentially deadbeat dutch roll damping. Additionally, the PA spoiler gearing relationship is modified to eliminate the non-linear roll response by moving the spoiler breakout point to only one-tenth inch lateral stick deflection. The aircraft is very responsive to lateral inputs and some tendency to overcontrol bank may be experienced. The DFCS also provides automatic coordinating rudder inputs with lateral stick deflection such that the vast majority of lateral corrections can be made with "feet on the floor." An undesirable by-product of this improved

coordination is a minor pitch up in response to moderate to aggressive lateral inputs, which requires pilot compensation to maintain constant AOA. This effect is more pronounced with DLC off. Finally, the spiral mode is neutrally damped, such that the aircraft will tend to hold a constant bank angle once established in a turn.

11.8.2 Crosswind Landings

Crosswind landings may be accomplished using either the sideslipped or crabbed technique, up to the crosswind limit (20 knots). The PA-ARI roll rate command function and revised spoiler gearing affect crosswind landing flight characteristics. The DFCS commands ROLL SAS inputs to achieve a commanded roll rate which is proportional to the pilot's lateral stick input. During a sideslipped approach ("wing down, top rudder"), the pilot applies a constant lateral stick input which is not intended to command roll rate, in order to hold the aircraft in a steady slip. To accommodate this technique, ROLL SAS inputs are faded out as the pilot applies rudder pedal. However, the spoiler gearing schedule results in nearly immediate spoiler breakout with lateral stick deflection from trim (one-tenth inch lateral stick input). This spoiler breakout may result in an unpredictable or overly sensitive roll response during tightly controlled tasks such as fine lineup corrections late in the approach. Because crabbed approaches are flown without this offset lateral stick input and do not exhibit this characteristic, pilots may find this technique easier. Method of crosswind approach is pilot's option.

11.8.3 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. For this reason, with the landing gear handle down, DFCS incorporates rudder pedal shaker beginning at approximately 21 units AOA to alert the pilot. 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. Lateral stick inputs result in significantly reduced adverse yaw and continue to provide excellent roll response up to 25 units AOA. Above 25 units AOA, the ARI is disabled and DFCS control laws revert to basic SAS in each axis. 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 11-6 shows stall speeds for standard day temperature at sea level with slats/flaps extended and gear down.

Note

Maximum allowable AOA gear down is 20.6 units below 5,000' AGL and 25.5 above 5,000' AGL.

11.8.4 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.

11.8.5 Asymmetric Thrust Flight Characteristics

11.8.5.1 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 significant thrust asymmetry. 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.

F-14B /D

AIRCRAFT CONFIGURATION
ALL DRAG INDEXES
WING SWEEP

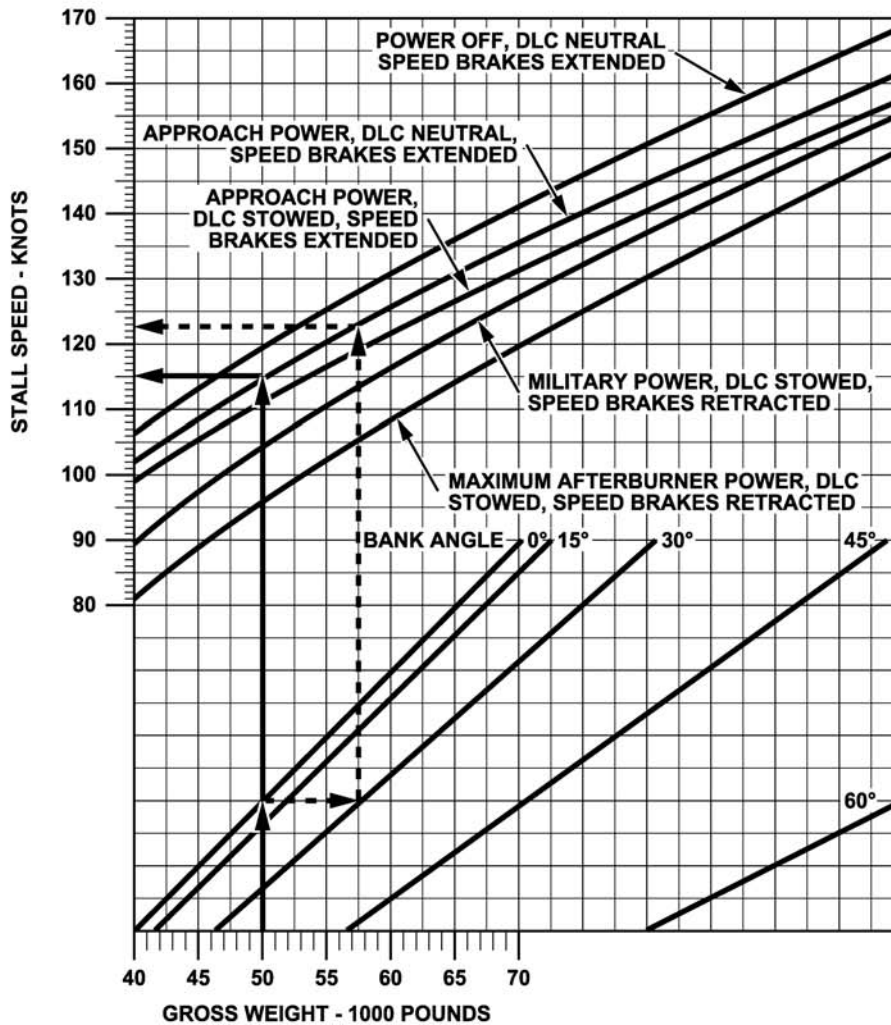
FLAPS/SLATS EXTENDED: GEAR DOWN

DATE: JANUARY 1990
DATA BASIS: ESTIMATED

ENGINES:
(2) F110-GE-400

REMARKS
ICAO STANDARD DAY

FUEL GRADE:JP-5(JP-4, JP-8)
FUEL DENSITY: 6.8 (6.5, 6.7) LB/GAL



CSC-F14D-1-11-003B

Figure 11-6. Stall Speeds for Wing Rock at 25 Units AOA

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 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 11-7. Even if the takeoff is aborted, significant runway lateral deviations may occur before the aircraft is brought back under control.

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 11-7. Minimum Control Speed, Ground (V_{MCG})

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 11-8. Rudder is the primary control for countering yaw because of asymmetric thrust. Beneficial coordinating rudder is automatically applied with a lateral stick input and helps to limit yaw rate and sideslip buildup. However, pilot commanded rudder remains the required recovery control for the DFCS. 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 and the potential for a cocked nosegear if takeoff is continued.

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.

11.8.5.2 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 11.8.5.3 and 11.8.5.4. For additional discussion of asymmetric thrust flight characteristics, see paragraph 11.8.5.

11.8.5.3 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

SEA LEVEL — STANDARD DAY

AIRCRAFT CONFIGURATION:
 FLAPS UP OR DOWN
 ALL GROSS WEIGHTS

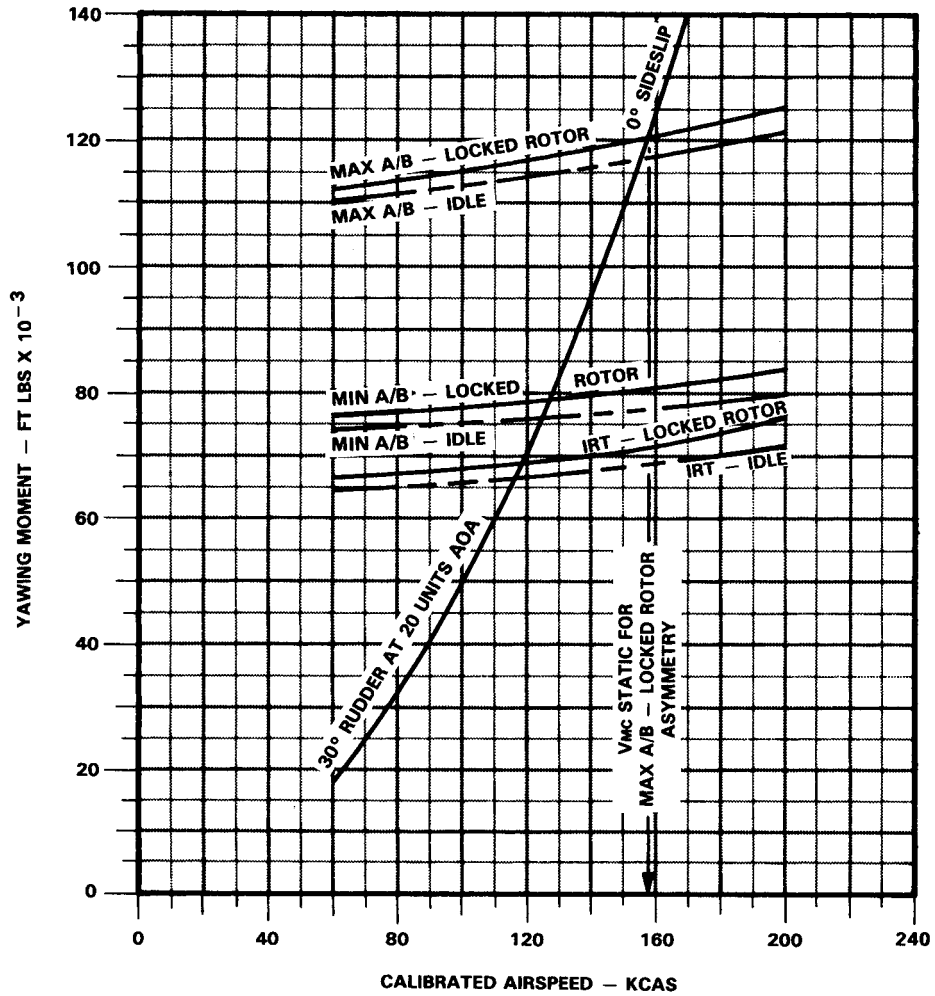
DATE: JANUARY 1990
 DATA BASIS: ESTIMATED

REMARKS

ENGINE(S): (2) F110-GE-400
 LOCKED ROTOR: $N_1 = \text{ZERO RPM}$; $N_2 = \text{ZERO RPM}$

FUEL: JP-5 (JP-8, JP-4)
 FUEL DENSITY: 6.8 (6.7, 6.5) lb/gal

STATIC MINIMUM CONTROL AIRSPEED — VMC STATIC



0-F50D-271-0

Figure 11-8. Rudder Effectiveness

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.

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 center-line. 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.

11.8.5.4 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 air-speed 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 touch-down 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.

11.8.6 Degraded Approach Configuration

Refer to Chapter 15 for degraded approach emergency procedures.

11.8.6.1 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.

11.8.7 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 degra-

ation 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.

11.8.8 SAS Off

Approach characteristics with either ROLL or YAW SAS OFF will be significantly degraded compared to the baseline PA-ARI flying qualities. Failure of either ROLL or YAW SAS (or selecting either ROLL or YAW STAB AUG switch OFF) will revert the DFCS from the PA-ARI control mode to “basic SAS” control mode (loss of ARI functionality). Directional damping and roll response to lateral stick inputs will both be significantly reduced compared to baseline performance.

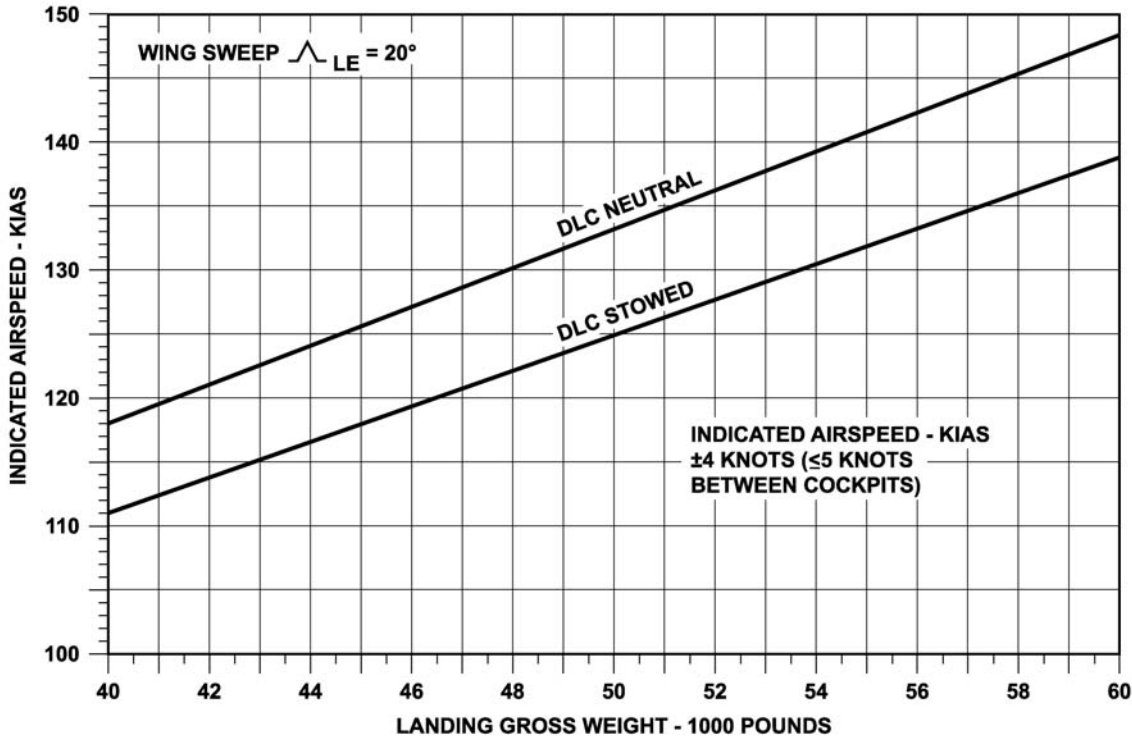
11.8.9 Aft Wing-Sweep Landings

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 $\geq 51^\circ$, each 1-unit increase in approach AOA reduces approach airspeed by approximately 5 knots. Airspeeds for various configurations are shown in [Figure 11-9](#).

AIRCRAFT CONFIGURATION:
ALL DRAG INDEXES

DATE: SEPTEMBER 1994
DATA BASIS: 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 AIRSPEED			
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 AIRSPEED		
WING SWEEP (DEGREES)	15 UNITS AOA (KIAS)	17 UNITS AOA (KIAS)
51	55	45
60	58	48
68	60	50

Figure 11-9. Landing Approach Airspeed (15 Units AOA)

CSC-F14D-1-11-004

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/slat 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.

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, enabling rudder to 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).

If speedbrakes are not available, thrust requirements on glideslope are decreased and judicious throttle management is more critical.

WARNING

If maneuver flaps are used, the pilot must ensure that the maneuver flap thumbwheel is not actuated during the approach.

11.8.10 DFCS Degraded Control Modes

The DFCS is capable of operation in numerous degraded mode control configurations. Description of all possible degraded modes is not practical; however, several of these modes are listed below with a description of resulting functionality and effect on approach flying qualities.

11.8.10.1 DFCS Computer Failures

Each of the three DFCCs contains two distinct computer processors called computing segregations, one "A" segregation and one "B" segregation in each axis. Each segregation commands different series servo and/or spoiler sets. If a computing segregation fails, all actuators commanded by that segregation are rendered inoperative. Functionality loss due to failure of each of the segregations and effect on takeoff and landing flight characteristics are as follows:

Pitch A - Half authority PITCH SAS, no inboard spoilers, no DLC. Slightly decreased pitch damping, decreased roll performance.

Pitch B - Half authority PITCH SAS, no outboard spoilers, no DLC. Slightly decreased pitch damping, decreased roll performance.

Roll A - Half authority ROLL PA-ARI/SAS, no inboard spoilers, no DLC. Decreased roll performance.

Roll B - Half authority ROLL PA-ARI/SAS. Slightly decreased roll performance.

Note

Autopilot control modes, including ACLS, are not available with any pitch or roll segregation failed.

Yaw A - Half authority YAW PA-ARI/SAS. Decreased directional damping. This may only be apparent during moderate to aggressive maneuvering, since the gain in the yaw channel B is doubled to compensate for the loss of the yaw A series servo. Full YAW SAS performance is thus retained up to the authority limit of the remaining yaw series servo (+9.5° rudder).

Yaw B - Half authority YAW PA-ARI/SAS, no outboard spoilers, no DLC. Decreased directional damping, but only for aggressive maneuvers as previously described for the yaw A segregation. Decreased roll performance.

A normal landing approach can be flown with any single segregation failure. Combined failure of any two segregations results in combined loss of all associated functions, actuators, and in most cases, additional failures. Failure of both pitch or both roll segregations results in loss of all spoilers and severely degraded roll performance. Failure of both roll or both yaw segregations results in loss of PA-ARI and downgrade to "basic SAS" mode in the remaining axes. This will be manifested by significantly decreased roll performance and significantly decreased directional damping. A straight-in approach with as little crosswind as possible is recommended. Lateral stick inputs may require coordinating rudder to obtain adequate roll response and to minimize dutch roll disturbances.

11.8.10.2 DFCS Air Data Failures

Failure of the Mach number or AOA inputs to the DFCS results in degraded mode operation for several PA-ARI control functions. These control modes still provide excellent flying qualities such that a normal approach can be flown, but are somewhat degraded from the fully operational PA-ARI performance.

A DFCS Mach failure will always occur due to failure of the SCADC, but may also occur independently from a SCADC failure. Mach failure results in a nearly transparent degrade in directional damping, which may become noticeable at conditions slower than on-speed. A single AOA failure results in no degradation in flying qualities, only a loss of redundancy, since the input is triplex. Dual AOA failure results in decreased directional damping, decreased roll performance, and decreased spiral mode damping.

Note

Significant PA-ARI functionality is retained with dual Mach or dual AOA failures as compared to UA-ARI. For this reason, ROLL DGR and ARI/SAS OUT caution lights will be automatically extinguished upon selection of the landing gear handle from the up to the down position.

11.8.10.3 Series Servo Failures

Reduced authority and rate damping performance will be experienced in the affected axis. Failure of both roll or both yaw series servos results in loss of PA-ARI and downgrades the DFCS to the "basic SAS" control mode in the remaining axes. Decreased roll performance and decreased directional damping will be exhibited. A normal approach can be flown with any single failure, a dual pitch, or a dual roll series servo failure. In case of dual failure of the yaw series servos, recommend a straight-in approach using smooth lateral inputs with coordinating rudder to minimize dutch roll disturbances.

11.8.10.4 Spoiler Failures

As described under DFCC computer failures, failure of four of the six segregations will result in loss of a spoiler set (inboard or outboard) and associated decreased roll performance. DLC is not functional with any inboard spoiler failure, but is available with any or all outboard spoilers failed. Failure of any single spoiler panel will result in “mirror-image” spoiler operation of the remaining spoilers, as long as the failed spoiler responds to the automatic isolation command (returns to stowed position). For example, failure and successful isolation of the Left #4 spoiler panel also results in automatic isolation of the Right #4 spoiler panel. Symmetric, but slightly degraded roll performance will be evident. A normal approach can be flown in this case. If a spoiler failure results in a stuck-up spoiler, normal control of the “mirror-image” panel will be automatically restored to provide maximum roll control power to counter the rolling moment induced by the stuck-up spoiler. Refer to Spoiler Malfunction emergency procedures for landing in this configuration.

11.8.10.5 Sensor Failures

Single failure of any DFCS sensor input does not result in a flying qualities downgrade, only a loss of redundancy, since all sensor inputs are triplex. Dual failure of a sensor input causes loss of the functions associated with that sensor. A list of these sensor inputs and associated dual failure functionality loss are as follows:

Pitch Rate - No PITCH SAS. Decreased pitch damping. A normal approach can be flown.

Roll Rate - No ROLL SAS, no PA-ARI. Decreased roll performance and decreased directional damping. A normal approach can be flown.

Yaw Rate - No YAW SAS, no PA-ARI. Decreased roll performance and significantly decreased directional damping. Recommend straight-in approach using smooth lateral inputs with coordinating rudder to minimize dutch roll disturbances.

Lateral Acceleration - No YAW SAS, no PA-ARI. Decreased roll performance and significantly decreased directional damping. Recommend straight-in approach using smooth lateral inputs with coordinating rudder to minimize dutch roll disturbances.

Lateral Stick Position - No ROLL SAS, no PA-ARI, no spoilers. Severely degraded roll performance and decreased directional damping. Recommend straight-in approach with as little crosswind as possible. Lateral stick inputs may require coordinating rudder to obtain adequate roll response.

Rudder Pedal Position - No pedal fadeout for lateral stick to rudder interconnect or roll rate command functions in the PA-ARI control mode. These pedal fadeout features are incorporated to improve the pilot's ability to command a steady sideslip condition during a slipped (i.e., wing-down-top-rudder) crosswind approach. With a pedal position failure, precisely controlling bank angle during a slipped approach is more difficult than with the baseline system. A crabbed technique is recommended.

Landing Gear Handle Position - No PA-ARI, downmode to UA-ARI control mode for all flight configurations. During normal operation, mode switching between the PA-ARI and UA-ARI control modes is controlled by sensing of the landing gear handle position. If a dual failure of this triplex input fails, the DFCS can no longer accurately determine the actual gear handle position. The fail-safe condition in this case is to revert to the UA-ARI (i.e., gear up) control mode. This results in decreased roll performance and decreased directional damping. A normal approach can be flown.

Note

If a dual failure of the landing gear handle position input to the DFCS occurs, the ARI/SAS OUT caution light will illuminate when flaps are lowered past the 25° position. This indicates loss of normal PA-ARI function.

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 right 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. Raising the flaps only causes the spoilers to move from the “drooped” position to the zero position, retaining power approach spoiler gearing. This configuration is not flight tested in DFCS.

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 11-10). A landing with the maximum possible asymmetry of 20°/68° will require 13 to 14 units AOA to 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 11-10).

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.

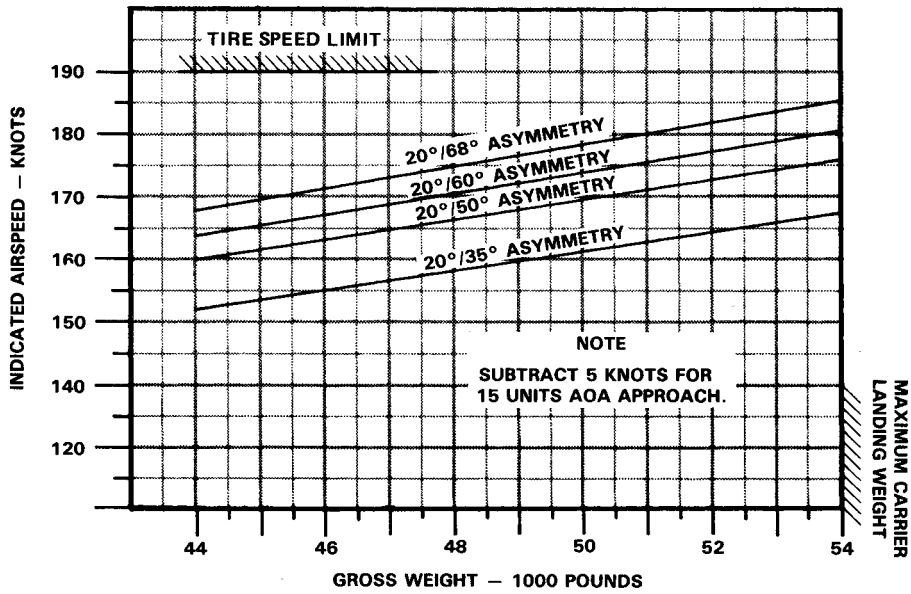
11.10 DUAL HYDRAULIC FAILURES BACKUP FLIGHT CONTROL MODULE FLIGHT CHARACTERISTICS

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.

DATE: AUGUST 1986
 DATA BASIS: FLIGHT TEST

**FLAPS UP APPROACH AIRSPEED (14 UNITS AOA)
 FLATS / SLATS RETRACTED**



**LANDING APPROACH AIRSPEEDS (15 UNITS AOA)
 MAIN FLAPS / SLATS EXTENDED; AUXILIARY FLAPS RETRACTED**

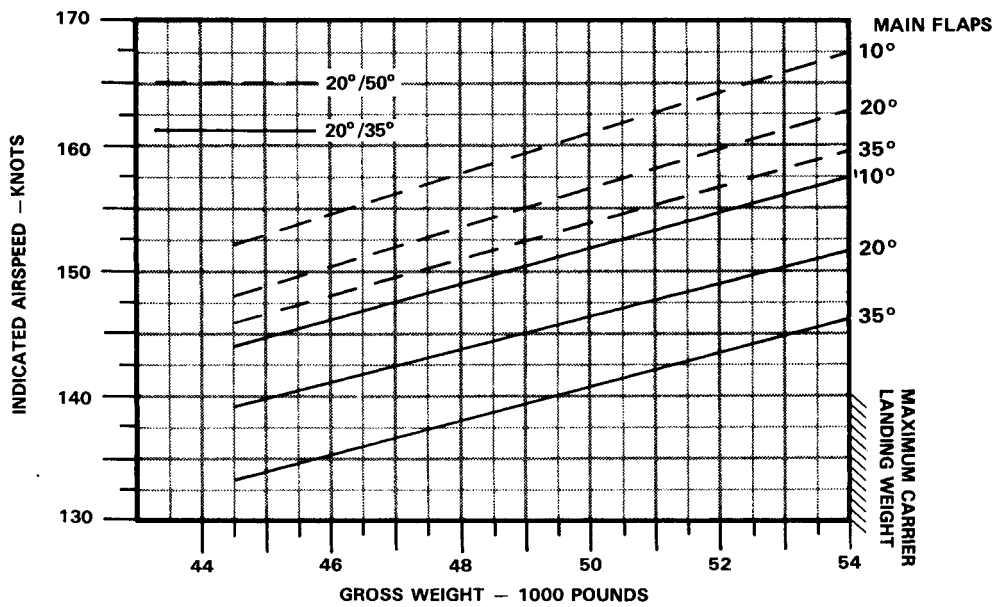


Figure 11-10. Asymmetric Wing-Sweep Landing Approach

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The second factor is the capabilities of the remaining flight control system. The inboard spoilers, speed-brakes, and auxiliary flaps are inoperative, and the in-board 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 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 stabilizers 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 $+10^\circ$ 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 is 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 over-shoots 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 stabilizers 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 ($< \pm 1$ 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 thumb-wheel, 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 air-speed 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 AOA 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 rec-

ommended 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.
- Do not return to the 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.

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. 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 zero fuel gross weight position. The limit for zero fuel gross weight 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 zero fuel gross weight 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 zero fuel gross weight 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 zero fuel gross weight position. Wing-mounted AIM-7/9s move the zero fuel gross weight 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 zero fuel gross weight 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 zero fuel gross weight 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 zero fuel gross weight cg locations up to 18.6-percent MAC, normal static margin is restored and normal flying qualities are regained. For zero fuel gross weight 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



READ AND HEED

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. This section discusses the preplanned, likely courses of action and recommended procedures for certain emergencies. 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

TABLE OF CONTENTS

	<i>Page No.</i>
CHAPTER 12 — GROUND EMERGENCIES	
12.1	ON-DECK EMERGENCIES 12-1
12.1.1	Engine Fire on the Deck 12-1
12.1.2	Abnormal Start 12-1
12.1.3	START VALVE Light After Engine Start 12-1
12.1.4	Uncommanded Engine Acceleration on Deck 12-1
12.1.5	Ground Egress Without Parachute and Survival Kit 12-2
12.1.6	Emergency Entrance 12-2
12.1.7	Weight-On-Off Wheels Switch Malfunction 12-2
12.1.8	Binding/Jammed Flight Controls On Deck 12-4
12.1.9	Brake Failure at Taxi Speed 12-4
CHAPTER 13 — TAKEOFF EMERGENCIES	
13.1	ABORTED TAKEOFF 13-1
13.1.1	Aborted Takeoff Checklist 13-1
13.2	SINGLE-ENGINE FAILURE FIELD/CATAPULT LAUNCH/WAVEOFF 13-2
13.2.1	Angle-of-Attack/Endspeed Consideration 13-2
13.2.2	Rate of Climb Consideration 13-2
13.2.3	Stores Jettison Considerations 13-2
13.2.4	Aircrew Coordination 13-2
13.2.5	Single-Engine Failure Field/Catapult Launch/Waveoff 13-3
13.3	BLOWN TIRE DURING TAKEOFF 13-3
13.3.1	Blown Tire During Takeoff; Takeoff Aborted or After Landing Touchdown 13-3
13.3.2	Blown Tire During Takeoff; Takeoff Continued or After Landing Go-Around 13-3
CHAPTER 14 — IN-FLIGHT EMERGENCIES	
14.1	COMMUNICATIONS FAILURE 14-1
14.1.1	Flightcrew Attention Signals 14-1
14.1.2	COMM-NAV Emergency Procedures 14-1
14.2	PITOT-STATIC SYSTEM FAILURES 14-1
14.3	EMERGENCY JETTISON 14-2
14.4	FIRE LIGHT AND/OR FIRE IN FLIGHT 14-4
14.5	ENGINE EMERGENCIES 14-5
14.5.1	Compressor Stall 14-5
14.5.2	Airstarts 14-7
14.5.3	Single-Engine Flight Characteristics 14-11
14.5.4	Engine Overspeed (N ₁ or N ₂ OSP Legend) 14-12
14.5.5	Engine START VALVE Light 14-12

	<i>Page No.</i>
14.5.6	Engine Transfer to SEC Mode 14-12
14.5.7	Uncommanded SEC Mode Rpm Decay 14-13
14.5.8	Uncommanded Engine Acceleration Airborne (No Throttle Movement) 14-15
14.5.9	Exhaust Nozzle Failed (No Nozzle Response to Throttle Movement) 14-15
14.5.10	Stuck/Jammed Throttle(s) 14-15
14.5.11	AICS Malfunctions 14-16
14.5.12	INLET ICE Light 14-17
14.5.13	Oil System Malfunction 14-17
14.5.14	RATS Operation In Flight 14-17
14.6	FUEL SYSTEM MALFUNCTIONS 14-18
14.6.1	Fuel Pressure Caution Lights/Low Fuel Pressure Warning Tone 14-18
14.6.2	L or R FUEL LOW Light 14-18
14.6.3	Fuel Transfer Failures 14-18
14.6.4	Uncommanded Dump 14-19
14.6.5	Fuel Leak 14-19
14.6.6	Fuel Imbalance/Fuel Quantity Balancing 14-20
14.7	ELECTRICAL FAILURE 14-20
14.7.1	Generator Failure 14-20
14.7.2	Double Generator Failure 14-20
14.7.3	Double Transformer-Rectifier Failure 14-22
14.7.4	TRANS/RECT Light 14-22
14.7.5	Electrical Fire 14-22
14.7.6	Total Electrical Failure 14-24
14.8	ECS MALFUNCTIONS/FAILURES 14-25
14.8.1	ECS Leak/Elimination of Smoke and Fumes 14-25
14.8.2	COOLING AIR Light 14-27
14.8.3	TARPS ECS Lights Illuminate 14-27
14.8.4	SENSOR COND Light Illuminated and/or PUMP Phase Circuit Breakers Popped or APG-71 PM Acronym 14-28
14.8.5	Cockpit Temperature Control Malfunction 14-28
14.8.6	Cockpit Overpressurization on Deck 14-28
14.8.7	CABIN PRESS Light 14-28
14.8.8	WSHLD HOT Light 14-28
14.9	OXYGEN SYSTEM FAILURE 14-29
14.9.1	OBOGS Light 14-29
14.9.2	B/U OXY LOW Light (Both Cockpits) 14-29
14.9.3	B/U OXY LOW Light (Pilot Only) 14-30
14.9.4	B/U OXY LOW Light (RIO Only) 14-30
14.10	LAD/CANOPY LIGHT AND/OR LOSS OF CANOPY 14-30
14.10.1	LAD/CANOPY Light With RIO CANOPY Light/Canopy Loss 14-30
14.10.2	LAD/CANOPY Light Without RIO CANOPY Light 14-31
14.11	HYDRAULIC SYSTEM MALFUNCTIONS 14-31
14.11.1	Combined Pressure Approximately 2,400 to 2,600 Psi 14-31
14.11.2	Flight Pressure Approximately 2,400 to 2,600 Psi 14-31
14.11.3	Combined Pressure Zero 14-32
14.11.4	Flight Pressure Zero 14-33
14.11.5	Both Combined and Flight Pressure Zero 14-33
14.11.6	Backup Flight Module Malfunction 14-35
14.11.7	Low Brake Accumulator Pressure 14-35

	<i>Page No.</i>
14.12	FLIGHT CONTROL FAILURES OR MALFUNCTIONS 14-35
14.12.1	Controllability Check 14-35
14.12.2	Uncommanded Roll and/or Yaw 14-37
14.12.3	DFCS Flight Control Failures or Malfunctions 14-38
14.12.4	Rudder Authority Failure 14-40
14.12.5	Horizontal Tail Authority Failure 14-42
14.12.6	Spoiler Malfunction 14-42
14.12.7	FLAP Light 14-45
14.12.8	Flap and Slat Asymmetry 14-46
14.12.9	WING SWEEP Lights 14-47
14.12.10	Unscheduled Wing Sweep 14-47
14.12.11	CADC Light 14-47
14.12.12	AUTOPILOT Light 14-48
14.12.13	Weight On-Off Wheels Switch Malfunction 14-48
14.13	DEPARTURE/SPIN 14-49
14.13.1	Vertical Recovery 14-49
14.13.2	Upright Departure/Flat Spin 14-49
14.13.3	Inverted Departure/Spin 14-50

CHAPTER 15 — LANDING EMERGENCIES

15.1	DUAL-ENGINE LANDING, ONE OR BOTH ENGINES IN SECONDARY MODE 15-1
15.2	SINGLE-ENGINE LANDING PRIMARY MODE 15-1
15.3	SINGLE-ENGINE LANDING SECONDARY MODE 15-3
15.3.1	Single-Engine Landing — SEC Mode 15-4
15.4	LANDING GEAR EMERGENCIES 15-6
15.4.1	Landing Gear Emergency Lowering 15-6
15.4.2	Landing Gear Malfunctions 15-8
15.4.3	LAUNCH BAR Light 15-9
15.5	BLOWN-TIRE LANDING 15-10
15.6	FLAP AND SLAT LANDING EMERGENCIES 15-10
15.6.1	No-Flaps and No-Slats Landing 15-10
15.6.2	Auxiliary Flap Failure 15-10
15.7	WING-SWEEP EMERGENCIES 15-11
15.7.1	Aft Wing-Sweep Landings 15-11
15.7.2	Asymmetric Wing Sweep 15-11
15.8	AFT HUNG ORDNANCE LANDINGS 15-16
15.8.1	Landing with Aft Hung Ordnance 15-17
15.9	FIELD ARRESTMENTS 15-17
15.9.1	Field Arresting Gear 15-17
15.9.2	Short-Field Arrestment 15-18
15.9.3	Long-Field Arrestment 15-18
15.9.4	Engaging Speeds 15-18

	<i>Page No.</i>
15.10 BARRICADE ARRESTMENT	15-18
15.11 ARRESTING HOOK EMERGENCY DOWN	15-21
15.12 FORCED LANDING	15-21
15.13 GROUND ROLL BRAKING FAILURE	15-21

CHAPTER 16 — EJECTION

16.1 EJECTION	16-1
16.1.1 Ejection Envelope	16-1
16.1.2 Ejection Preparation	16-5
16.1.3 Ejection Initiation	16-6
16.2 MANUAL BAILOUT	16-6
16.3 SURVIVAL/POSTEJECTION PROCEDURES	16-6
16.3.1 Manual Man/Seat Separation	16-7
16.3.2 Survival Kit Deployment	16-7
16.3.3 Parachute Steering	16-9
16.3.4 Parachute Landing Preparation	16-9
16.3.5 Raft Boarding	16-9

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

GROUND ROLL BRAKING FAILURE

- *1. ANTI SKID SPOILER BK switch ... Check
- *2. MASTER RESET pushbutton ... Depress

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. PITCH, ROLL, and
YAW STAB AUG switches 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. Altitude Below 35,000 Feet
 - b. CABIN PRESS switch DUMP
- *4. RAM AIR switch OPEN

LAD/CANOPY LIGHT WITH RIO'S CANOPY LIGHT/ CANOPY LOSS

- *1. Canopy BOOST CLOSE
(canopy remaining)

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)
- *5. MASTER RESET Depress

UPRIGHT DEPARTURE/FLAT SPIN

- *1. Stick Forward/Neutral
Lateral, Harness-Lock
- *2. Throttles Both IDLE
- *3. Rudder Rudder-Opposite
Turn Needle/Yaw/Spin Arrow

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 Rudder-Opposite
Turn Needle/Yaw/Spin Arrow

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)


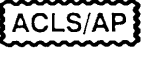

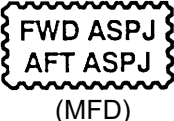
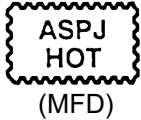
WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS






WARNING

***WARNING LIGHT AND/OR DISPLAY LEGEND
(HUD HUD/MFD, MFD) DISPLAY LEGEND**

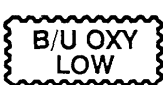




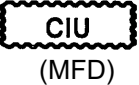
CAUTION

ADVISORY


LIGHT/LEGEND	CAUSE	ACTION
	AAA tracking radar detected.	As briefed.
	ACLS or autopilot disengagement.	Take control for manual landing approach.
AAI ZERO (MFD)	Improper IFF interrogator operation.	As briefed.
	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 AP reference mode.
ARI DGR	Indicates degraded ARI performance.	<ol style="list-style-type: none"> 1. MASTER RESET — Depress. 2. If light remains illuminated, aggressive maneuvering should be terminated. 3. Remain below 1.0 TMN.
ARI/SAS OUT	Loss of ROLL or YAW SAS, and all ARI functions	<ol style="list-style-type: none"> 1. Ensure ROLL and YAW STAB AUG switches — ON. 2. MASTER RESET — Depress. If light remains illuminated: <ol style="list-style-type: none"> 3. Leave STAB AUG switches — ON. To take advantage of any remaining capability that the DFCS may be able to provide. Terminate aggressive maneuvering and remain below 1.0 TMN.
	Improper ALQ-165 position.	As briefed.
	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.

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	Autopilot or reference failure.	1. MASTER RESET pushbutton — Depress.
	Autothrottle has been disengaged.	1. Assume manual/boost control. 2. Satisfy APC interlocks. 3. Reengage APC AUTO.
AUX FIRE EXT (MFD)	Low-extinguisher agent pressure.	Report to maintenance.
	Totalizer less than preset value.	Pilot option.
	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.
	Operating in auxiliary brake mode, antiskid failure, or parking brake set.	1. Turn antiskid off. 2. Cautious brake application. 3. Release emergency brake.



Warning, Caution, Advisory Lights/Displays (Sheet 2 of 15)



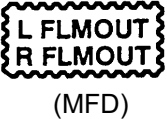
WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	Backup oxygen less than 200 psi.	<p>B/U OXY LOW light (both cockpits):</p> <ol style="list-style-type: none"> 1. BACKUP OXY PRESS — Check. <p><i>If BACKUP OXY PRESS < 200 PSI:</i></p> <ol style="list-style-type: none"> 2. Cabin alt — Less than 10,000 Feet. 3. Oxygen supply — OFF. 4. Oxygen masks — Release One Side. <p><i>Before landing:</i></p> <ol style="list-style-type: none"> 5. Oxygen masks and supply — ON. 6. Emergency oxygen — Activate. <p><i>If BACKUP OXY PRESS > 200 psi:</i></p> <ol style="list-style-type: none"> 2. BACKUP OXY PRESS — Monitor. <p>B/U OXY LOW light (pilot only):</p> <ol style="list-style-type: none"> 1. BOS CONTR/B/U OXY LOW cb — Check In (7A4). 2. BACKUP OXY PRESS — Check. <p>B/U OXY LOW Light (RIO Only):</p> <ol style="list-style-type: none"> 2. BACKUP OXY PRESS — Check.
	Cabin pressure failure.	<ol style="list-style-type: none"> 1. Oxygen mask — ON. <p><i>If below 15,000 feet.</i></p> <ol style="list-style-type: none"> 2. CABIN PRESS — Cycle.
	CADC failure.	<ol style="list-style-type: none"> 1. MASTER RESET — Depress 2. CADC cb's (LA2, LB2, LC2, LD2) — Cycle. 3. MASTER RESET — Depress. <p><i>If light still remains illuminated:</i></p> <ol style="list-style-type: none"> 4. Remain below 1.5 Mach.
	Canopy not locked.	<ol style="list-style-type: none"> *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.
	Controls and displays hot.	<ol style="list-style-type: none"> 1. Select cabin air. 2. WCS switch OFF.
	Improper operation of converter-interface unit.	Expect loss of CIU inputs/outputs.

Warning, Caution, Advisory Lights/Displays (Sheet 3 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
CIU HOT (MFD)	Converter-interface unit overheated.	Pull cb's 3E7, 4E1, 4E2.
CLSN (HUD)	RIO has collision steering selected.	Pilot option.
COOLING AIR (IN FLIGHT)	Indication of possible bleed duct failure forward of the pressure primary heat exchanger and 400°F modulating valve.	<ol style="list-style-type: none"> 1. AIR SOURCE — OFF. 2. OBOGS — BACKUP. <p><i>If associated with any other direct or indirect indication of ECS malfunction:</i></p> <ol style="list-style-type: none"> 3. Perform ECS Leak/Elimination of Smoke and Fumes Procedure. <p><i>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:</i></p> <ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 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). <p><i>If light goes out:</i></p> <ol style="list-style-type: none"> 5. Throttles — IDLE. 6. ECS — As Desired. <p><i>If light remains illuminated</i></p> <ol style="list-style-type: none"> 7. Secure systems.
	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.



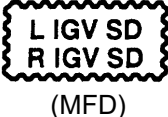

Warning, Caution, Advisory Lights/Displays (Sheet 4 of 15)




WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
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.
ENG FIRE EXT (MFD)	Low-extinguisher agent pressure.	Report to maintenance.
	Engine mode control in secondary.	<p><i>If engine transfers to sec mode:</i></p> <ol style="list-style-type: none"> 1. Throttle — Less Than MIL. 2. ENG MODE SELECT — Cycle. <p><i>If PRI mode restored.</i></p> <ol style="list-style-type: none"> 3. Maintain constant subsonic airspeed in level flight. 4. Affected L or R AICS cb — Cycle. <p><i>If engine remains in SEC:</i></p> <ol style="list-style-type: none"> 3. ENG MODE SELECT — SEC. 4. Avoid abrupt throttle movements. 5. Land as soon as practicable.
 * (HUD/MFD)	Fire/overheat condition in engine nacelle.	<p><i>If HUD/MFD message:</i> 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.</p> <p><i>If FIRE warning light and message:</i></p> <ol style="list-style-type: none"> *1. Throttle (affected engine) — IDLE. *2. AIR SOURCE — OFF. *3. OBOGS — BACKUP. <p><i>If light goes OFF and no secondary indications:</i></p> <ol style="list-style-type: none"> *4. MASTER TEST — FIRE DET TEST. <p><i>If light remains illuminated, FIRE DET TEST fails, or other secondary indications:</i></p> <ol style="list-style-type: none"> *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.





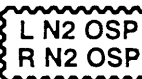
WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	DFCS failure has occurred. With no other lights, indicates loss of redundancy only.	<ol style="list-style-type: none"> 1. MASTER RESET — Depress. <p><i>If light remains illuminated:</i></p> <ol style="list-style-type: none"> 2. Airspeed — Remain below 600 knots or 1.3 TMN and adhere to the following limitations: <ol style="list-style-type: none"> a. Above 0.5 TMN, no cross control inputs permitted above 10 units AOA. b. With maneuvering devices retracted, coordinate all lateral stick inputs above 0.6 TMN and 15 units AOA.
	Flap position disparity with a commanded position or flap/slat asymmetry.	<ol style="list-style-type: none"> 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. <p><i>If after landing/takeoff flap transition, or reillumination after above procedures:</i></p> <ol style="list-style-type: none"> 1. MASTER RESET — Depress. 2. If light still illuminated, check FLAP handle and indicator position, then proceed with appropriate steps below. <p><i>Flap handle up and flaps not fully retracted</i></p> <ol style="list-style-type: none"> 1. Flap handle — EMER UP. <p><i>Flap handle up and flaps indicating full up:</i></p> <ol style="list-style-type: none"> 1. Flaps — Cycle. <p><i>Flap handle down and flaps not fully extended:</i></p> <ol style="list-style-type: none"> 1. Wing-sweep — Ensure at 20°. <p><i>Flap handle down and flaps down:</i></p> <ol style="list-style-type: none"> 1. Wing-sweep — Ensure at 20°. 2. MASTER RESET — Depress. <p><i>Flap and slat asymmetry:</i> Refer to Chapter 14.</p>
	Engine flameout.	<p>Check engine gauges.</p> <p><i>If invalid, report anomaly to maintenance.</i></p> <p><i>If valid, perform the following:</i></p> <ol style="list-style-type: none"> *1. Throttle — IDLE or Above. *2. BACKUP IGNITION switch — ON. <p><i>If hung start or no start:</i></p> <ol style="list-style-type: none"> *3. Throttle — Cycle OFF, Then IDLE.






WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
<p>L FLMOUT R FLMOUT (MFD)</p>	Engine flameout.	<p><i>If still hung or no start:</i> *4. ENG MODE SELECT — SEC.</p> <p><i>If one engine is operable, perform a cross-bleed airstart.</i></p> <p><i>If both engines flamed out/inoperative or crossbleed not possible:</i> *5. Airspeed — 450 Knots. 6. OBOGS — BACKUP.</p> <p><i>When start complete:</i> 7. BACKUP IGNITION — OFF. 8. ENG MODE SELECT — PRI. 9. OBOGS — ON.</p> <p><i>When primary mode restored:</i> 10. Maintain constant subsonic Mach in level flight. 11. Affected AICS cb — Cycle.</p>
<p>L FUEL LOW R FUEL LOW</p>	Usable fuel in L and AFT or R and FWD fuselage tanks 1,000 pounds.	<ol style="list-style-type: none"> DUMP switch — OFF. Fuel distribution — Check. <p><i>If wing and/or external fuel remaining:</i></p> <ol style="list-style-type: none"> WING/EXT TRANS — ORIDE. Land as soon as practicable.
<p>L FUEL PRESS R FUEL PRESS</p>	Sump tank boost pump discharge less than 9 psi.	<ol style="list-style-type: none"> Both throttles — MIL Power or Less. Restore aircraft to 1.0g flight. <p><i>If both lights remain on:</i></p> <ol style="list-style-type: none"> Increase positive g's to > 1.0g. Descend below 25,000 feet. Maintain cruise power settings or less. Land as soon as possible. <p><i>If one light remains on:</i></p> <ol style="list-style-type: none"> No afterburner above 15,000 feet. Fuel distribution — Monitor. Land as soon as practicable.
<p>L GEN R GEN</p>	Generator failure and/or disconnected from its ac bus.	<ol style="list-style-type: none"> Generator — OFF/RESET, Then NORM. <p><i>If generator does not reset:</i></p> <ol style="list-style-type: none"> Generator — TEST. <ol style="list-style-type: none"> GEN light off — distribution system. GEN light illuminated — IDG or GCU.
<p>GPS FAIL (MFD)</p>	GPS failure.	Non-GPS primary navigation modes in use (INS navigation mode).
<p>HOT TRIG</p>	Firing logic met. Pilot's trigger will fire weapon when squeezed.	Pilot option.

Warning, Caution, Advisory Lights/Displays (Sheet 7 of 15)






WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	Combined or flight pump discharge pressure 2,100 psi or less.	Refer to Chapter 14 for appropriate procedure.
	CADC failure or failure of actuators to follow schedule.	<ol style="list-style-type: none"> 1. MASTER RESET — Depress. <i>If light remains illuminated:</i> <ol style="list-style-type: none"> 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.
	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.
	Computer malfunction or ramp mispositioning.	<ol style="list-style-type: none"> *1. Avoid abrupt throttle movements. *2. Decelerate below 1.2 TMN. *3. Affected INLET RAMPS — STOW. <i>If RAMPS light remains illuminated:</i> <ol style="list-style-type: none"> 4. Throttle — 80 percent or Less. 5. Affected AICS cb — Pull. 6. Affected INLET RAMPS — AUTO. 7. Land as soon as practicable. <i>If INLET light only illuminated, attempt AICS program reset:</i> <ol style="list-style-type: none"> 4. Decelerate below 0.5 TMN. 5. Affected AICS cb — Cycle. <i>If INLET light goes off:</i> <ol style="list-style-type: none"> 6. Affected INLET RAMPS — AUTO. <i>If INLET LIGHT remains illuminated:</i> <ol style="list-style-type: none"> 6. Affected AICS cb — Pull. 7. Affected INLET RAMPS — AUTO. 8. Remain below 1.2 TMN.

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	Icing condition exists in inlet or ENG/ PROBE ANTI-ICE switch is on.	<ol style="list-style-type: none"> Select ORIDE/ON. <i>When clear of icing conditions:</i> <ol style="list-style-type: none"> 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.
	With RIO CANOPY light, canopy unlocked.	<ol style="list-style-type: none"> *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.
	Without RIO CANOPY light, ladder not stowed.	<ol style="list-style-type: none"> 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.	<ol style="list-style-type: none"> 1. Landing gear — Leave Down. 2. Obtain visual inspection. <i>If nosegear cocked, refer to Landing Gear Malfunction guide.</i> <i>If launch bar down or visual inspection not available:</i> <ol style="list-style-type: none"> 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.	<p>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.</p> <p>If not associated with a RATS check, record FEMS data and abort.</p>




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.
	Actuated by any caution light on caution panel.	Push to reset after discrete MSG noted.
 (MFD)	Improper operation of mission computer.	Backup operation selected automatically.
 (MFD)	Mission computer overheated.	Backup operation selected automatically.
 (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. <i>If overspeed continues:</i> 2. ENG MODE SELECT — SEC. <i>If overspeed condition persists:</i> 3. Throttle — OFF. 4. Refer to Single-Engine Cruise Operations. 5. Land as soon as practicable.
 (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. <i>If overspeed continues:</i> 2. ENG MODE SELECT — SEC. <i>If overspeed condition persists:</i> 3. Throttle — OFF. 4. Refer to Single-Engine Cruise Operations. 5. Land as soon as practicable.

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	Nosewheel steering is engaged.	Disengage when appropriate.
	Engine oil temperature limits exceeded or high scavenge oil temperature.	<p><i>On deck:</i></p> <ol style="list-style-type: none"> 1. Throttle — OFF. <p><i>In flight:</i></p> <ol style="list-style-type: none"> 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.
	L or R oil press <11 psi.	<ol style="list-style-type: none"> 1. Throttle (affected engine) — IDLE. <p><i>If oil pressure below 15 psi, above 65 psi, or engine vibration:</i></p> <p><i>If shutdown feasible:</i></p> <ol style="list-style-type: none"> 2. Throttle (affected engine) — OFF. 3. Refer to Single-Engine Cruise Operation (Chapter 14). <p><i>If shutdown not feasible:</i></p> <ol style="list-style-type: none"> 2. RPM — Set Minimum Rpm. 3. Avoid high-g or large throttle movements. 4. Land as soon as practicable.
	Low percent oxygen.	<ol style="list-style-type: none"> 1. BACKUP OXY PRESS — Check.
	Indicates inoperative pitch channel or PITCH SAS failure.	<ol style="list-style-type: none"> 1. MASTER RESET — Depress. 2. If light remains illuminated — No limitations.





Warning, Caution, Advisory Lights/Displays (Sheet 11 of 15)

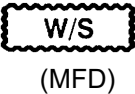

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	Computer/mechanical malfunction or RAMPS ramp mispositioning.	Refer to INLET light.
RATS	RATS operation enabled.	1. Tailhook — DOWN. <i>If conditions permit:</i> 2. ANTI ICE CONTR HOOK CONT/ WSHLD/AIR cb — Pull (8C2).
RCV	ALQ-165 is receiving threat identification signal.	As briefed.
 (HUD/MFD)	Airspeed >225 KIAS with flaps down. Airspeed >2.4 M. Total temperature >388° F.	1. Reduce speed. 2. Check FLAP handle. 3. MASTER RESET.
RDP FAN	Radar data processor fan failure.	Expect overheat.
	Radar operation on ground is possible.	Radar POWER switch to STBY (as applicable).
RDR HOT (MFD)	Radar system overheated.	Select STBY.
	Warning or caution message(s) being displayed on MFD.	As appropriate to displayed message(s).
	Indicates inoperative roll channel and degraded roll authority.	1. MASTER RESET — Depress. 2. If light remains illuminated, aggressive maneuvering should be terminated. 3. Remain below 1.0 TMN.

Warning, Caution, Advisory Lights/Displays (Sheet 12 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	CADC failure or failure of actuator to follow schedule.	<ol style="list-style-type: none"> 1. MASTER RESET — Depress (10 seconds). 2. If light remains illuminated — Above 250 Knots, Restrict Rudder Inputs to < 10°.
	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.
	Steady — Tracking radar detected.	As briefed.
	Flashing — Missile launch detected.	
	Improper operation of KY-58, JTIDS not keyed.	As briefed.
SENSOR COND	Overheat or pump loss in radar coolant loop.	<ol style="list-style-type: none"> 1. RADAR COOLING — OFF. 2. RDR — OFF. 3. APG-71 PUMP PH A, B, C cb — Pull. <p><i>If other conditions exist that may indicate an ECS malfunction, either directly or indirectly, perform ECS leak/elimination of smoke and fumes procedures:</i></p> <ol style="list-style-type: none"> 4. Land as soon as practicable.
SHOOT	Target meets LAR requirements.	As briefed.
SMS HOT (MFD)	Store management system (MFD) overheated.	Expect loss of SMS.
	Symmetric spoiler detector has locked down spoilers.	<p><i>If associated with abnormal roll and/or yaw:</i></p> <ol style="list-style-type: none"> 1. Counter roll with at least 1 inch of lateral stick. 2. Visually check spoiler position/operation. <p>Refer to Chapter 14.</p>

Warning, Caution, Advisory Lights/Displays (Sheet 13 of 15)

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
	Starter solenoid air valve open after engine start.	<ol style="list-style-type: none"> 1. Ensure ENG CRANK — OFF. 2. AIR SOURCE — OFF. <p><i>If on deck:</i></p> <ol style="list-style-type: none"> 3. Throttle — OFF. <p><i>If airborne:</i></p> <ol style="list-style-type: none"> 3. ENG START cb — Pull (RF1). 4. OBOGS — BACKUP.
 (HUD/MFD)	Engine stall and/or overtemperature.	<ol style="list-style-type: none"> *1. Unload aircraft (0.5g to 1.0g). <p><i>If greater than 1.1 Mach:</i></p> <ol style="list-style-type: none"> *2. Both throttles — MIL. <p><i>When 1.1 Mach or less:</i></p> <ol style="list-style-type: none"> *3. Both throttles — Smoothly to IDLE. Check EGT and FEMS engine data for TBT to determine validity of stall message. <p><i>If EGT above 935°C and/or engine response abnormal:</i></p> <ol style="list-style-type: none"> *4. Throttle (stalled engine) — OFF. <p><i>If EGT normal and/or airstart successful:</i></p> <ol style="list-style-type: none"> 5. Perform engine operability check.
 (MFD)	Turbine blade overtemperature.	<ol style="list-style-type: none"> 1. Throttle — IDLE. Check EGT gauge and FEMS engine data on MFD for TBT to determine validity of overtemperature message. <p><i>If still overtemperature:</i></p> <ol style="list-style-type: none"> 2. Throttle — OFF.
TRANS/RECT	Lack of dc output from either or both T/R.	<ol style="list-style-type: none"> 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.
	Landing gear not down with flaps down and either throttle ≤ 85 percent.	Lower gear.

WARNING/CAUTION/ADVISORY LIGHTS/DISPLAY LEGENDS		
LIGHT/LEGEND	CAUSE	ACTION
 <p>W/S (MFD)</p>	<p>Failure of both wing-sweep channels or spider detent disengaged.</p>	<p><i>Advisory light only, no loss of normal control:</i></p> <ol style="list-style-type: none"> 1. MASTER RESET — Depress. <p><i>WING SWEEP light and W/S legend, no automatic or manual control:</i></p> <ol style="list-style-type: none"> 1. Airspeed — Decelerate to 0.9 or Less. 2. Check spider detent engaged. 3. MASTER RESET — Depress. <p><i>If WING SWEEP light and W/S caution legend illuminate again:</i></p> <ol style="list-style-type: none"> 4. WING SWEEP DRIVE NO. 1 and WG SWP DR NO. 2 MANUV FLAP cb — Pull. 5. Emergency WING SWEEP handle — Comply With Schedule. <p>Refer to Chapter 14.</p>
<p>WING SWEEP</p>	<p>Failure of one wing-sweep channel.</p>	<p>Advisory light only:</p> <ol style="list-style-type: none"> 1. MASTER RESET — Depress.
<p>WSHLD HOT</p>	<p>Center windshield temperature 300°F.</p>	<ol style="list-style-type: none"> 1. WSHLD AIR — OFF. <p><i>If light remains illuminated:</i></p> <ol style="list-style-type: none"> 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.
 <p>YAW DGR</p>	<p>Indicates inoperative yaw channel and degraded yaw authority.</p>	<ol style="list-style-type: none"> 1. MASTER RESET — Depress. 2. If light remains illuminated, aggressive maneuvering should terminated. 3. Remain below 1.0 TMN.

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.



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.



A catastrophic Hot Start will occur if the affected throttle is not immediately secured following a loss of electrical power during an engine start with the RPM below forty percent. Air flow will be cut off and fuel will continue to be scheduled to the engine with the ignitors firing, causing a rapid and severe rise in EGT that will not be observed on the EIG due to power loss.

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.



- 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.

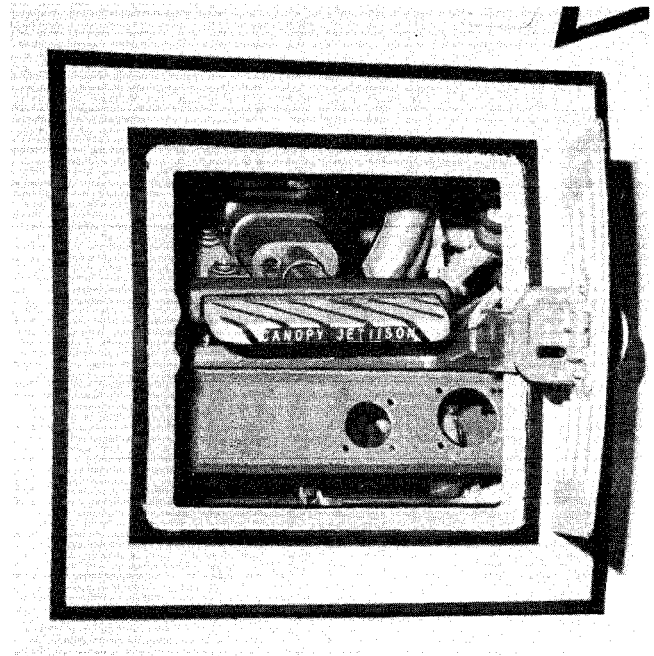
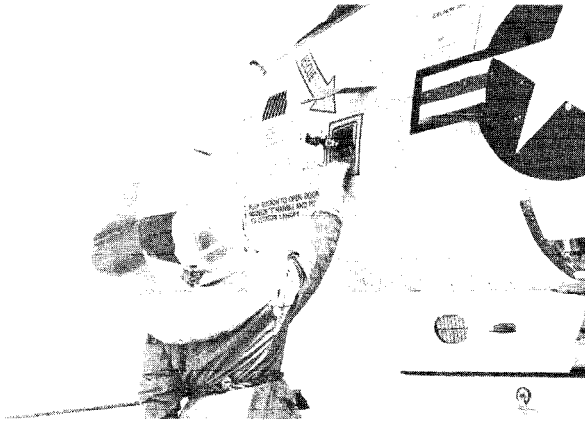
12.1.7 Weight On-Off Wheels Switch Malfunction

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

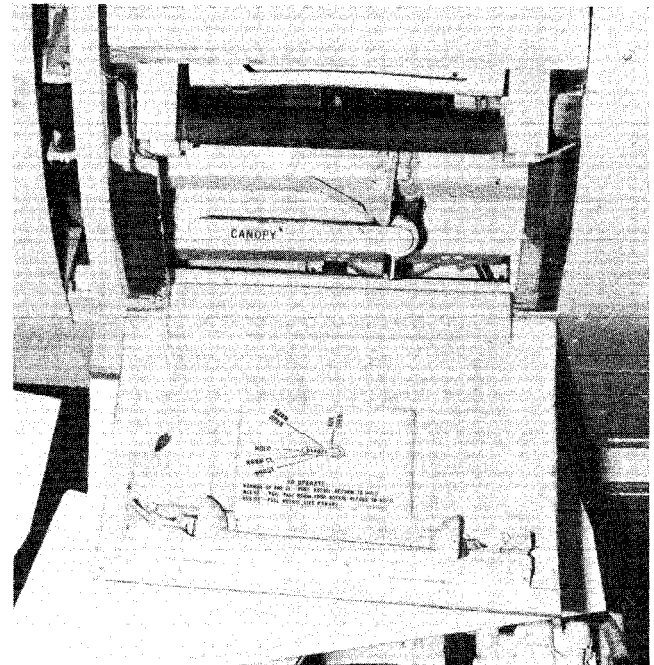
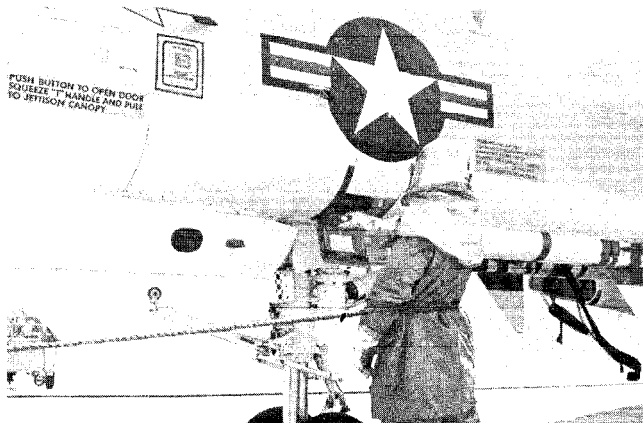
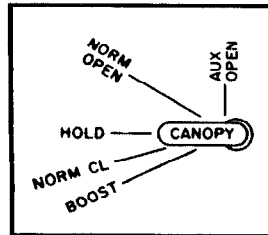
Failure of the left or right WOW switches to the in-flight mode can cause loss of engine ejector air to the IDGs and hydraulic heat exchangers causing thermal disconnect and/or heat damage to the generators and aircraft hydraulic systems.

1. PUSHBUTTON TO OPEN DOOR.
2. SQUEEZE T-HANDLE AND PULL TO JETTISON CANOPY.



NORMAL COCKPIT ENTRANCE

IT IS PREFERABLE TO USE THE NORMAL COCKPIT ENTRANCE PROCEDURE. HOWEVER, IF IT IS INOPERATIVE OR TIME IS CRITICAL --- JETTISON.



CSC-F14D-1-12-001A

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).



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.



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.



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.)



Normal brakes are not available with parking brake handle pulled. If parking brake accumulator pressure is depleted, aircraft brakes are isolated from brake pedal master cylinders. Parking Brake handle must be pushed in to restore normal brake operation.



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.

*6. Right engine — OFF (if required).



Aircrew should expect hot brakes following heavy gross weight, high speed aborts. Application of the parking brake could cause the brake assembly to fail and result in a brake fire.

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-F 14AAP-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.



- 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.



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. Pilot may need to turn off ECS briefly to effectively communicate.

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. Attempt to pass notes.
4. 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.
- Pitot-static failures will generally be detected by the DFCS and may result in an FCS CAUTION light as another secondary indication. If the condition causing the failure is resolved, the fault may be cleared with a MASTER RESET.

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.



- 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.

EMERG STORES JETT PUSHBUTTON — DEPRESS.		ANGLE- OF- ATTACK UNITS
FLIGHT CONDITION		
CATAPULT (15 KNOTS EXCESS)		
Transition From Catapult	MRT AB	14.0 13.0
MILITARY POWER CLIMB		
All Drag Index	Sea Level Combat Ceiling	6.0 9.5
MAXIMUM POWER CLIMB		
All Drag Indexes	Sea Level Combat Ceiling	5.0 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)	4	4	4	—	4	(i) VERIFY ON DURING LTS CHECK PRESTART - PILOT ①
ACM (PILOT)	4	4	4	—	4	(i) SEQUENCE JETTISON SELECTED STATIONS ② ④ ⑤
SELECTIVE (RIO)	4	4	4	—	4	② ③ ⑤
<p>NOTE</p> <ul style="list-style-type: none"> • FUZING SAFED IN ALL JETTISON MODES. (DOES NOT PRECLUDE INADVERTENT ARMING OF MECHANICAL FUZES.) • SIDEWINDER CANNOT BE JETTISONED. 						
<p>INTERLOCKS</p> <p>① WEIGHT OFF WHEELS (EITHER RIGHT OR LEFT MAIN GEAR)</p> <p>② LANDING GEAR HANDLE UP</p> <p>③ MASTER ARM SWITCH ON</p> <p>④ ACM COVER UP</p> <p>⑤ STATION SELECT</p>			<p>(i) JETTISON SEQUENCE</p> <p>STATIONS 1B, 8B, 2, 7, -4D, -5D, -4A, -5A, -4C, -5C, 4B, -5B, -3D, -6D, -3A, -6A, -3C, -6C, -3B, -6B</p> <p>NOTE</p> <ul style="list-style-type: none"> • 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. Station select switches — 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 directional 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 2-84](#) 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-air-speed 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/RE-SET 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 augmentor 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, spool-down 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: spool-down, crossbleed, and windmill. Spool-down 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.

Spool-down 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 2-84](#) 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.

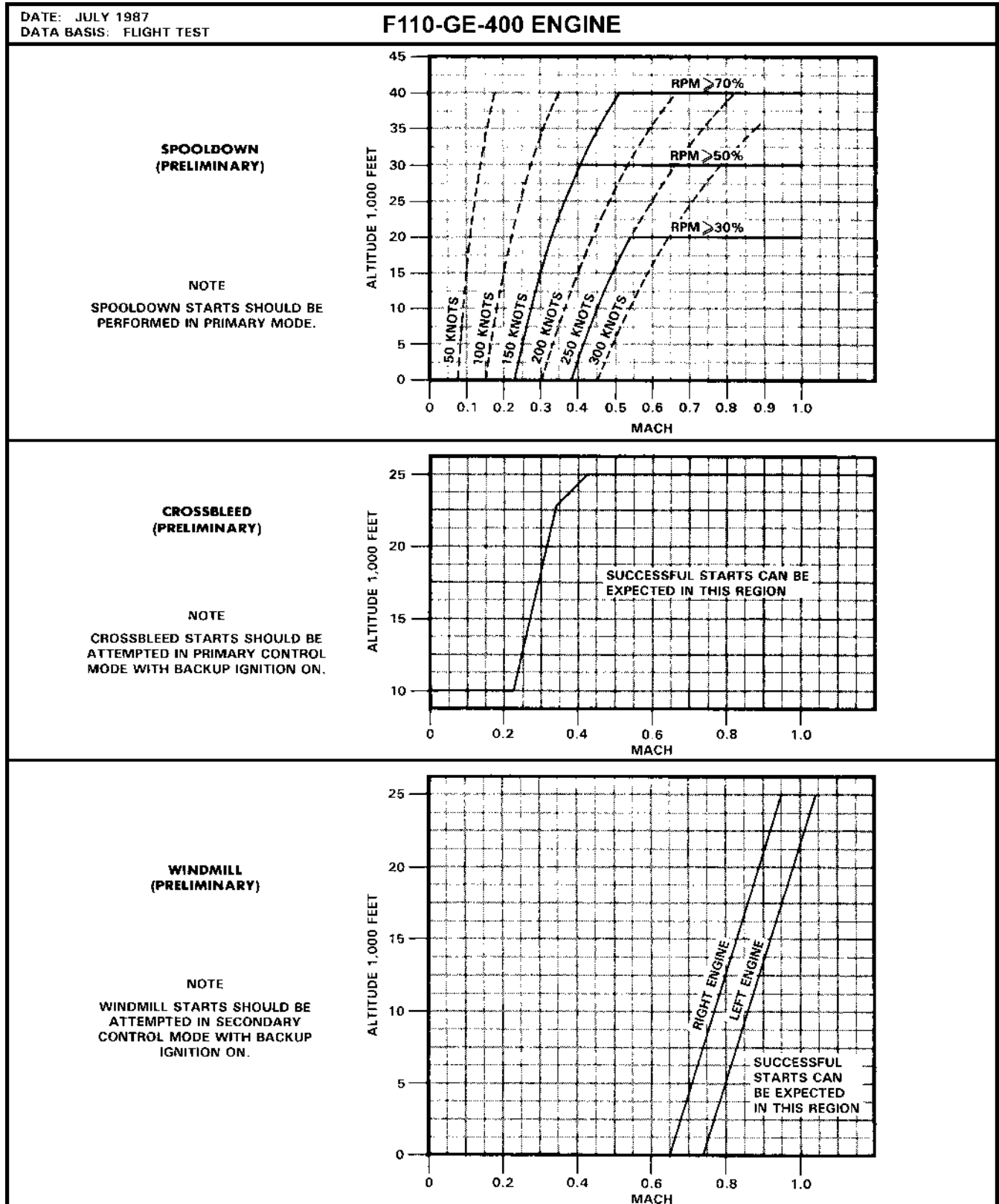


Figure 14-3. Airstart Envelope

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:



- 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.



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).



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. Light-offs can take as long as 45 seconds.

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 degrees 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.

Note

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.



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 (N₁ or N₂ 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 N₂ 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.



Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See [Figure 2-84](#) 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



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).

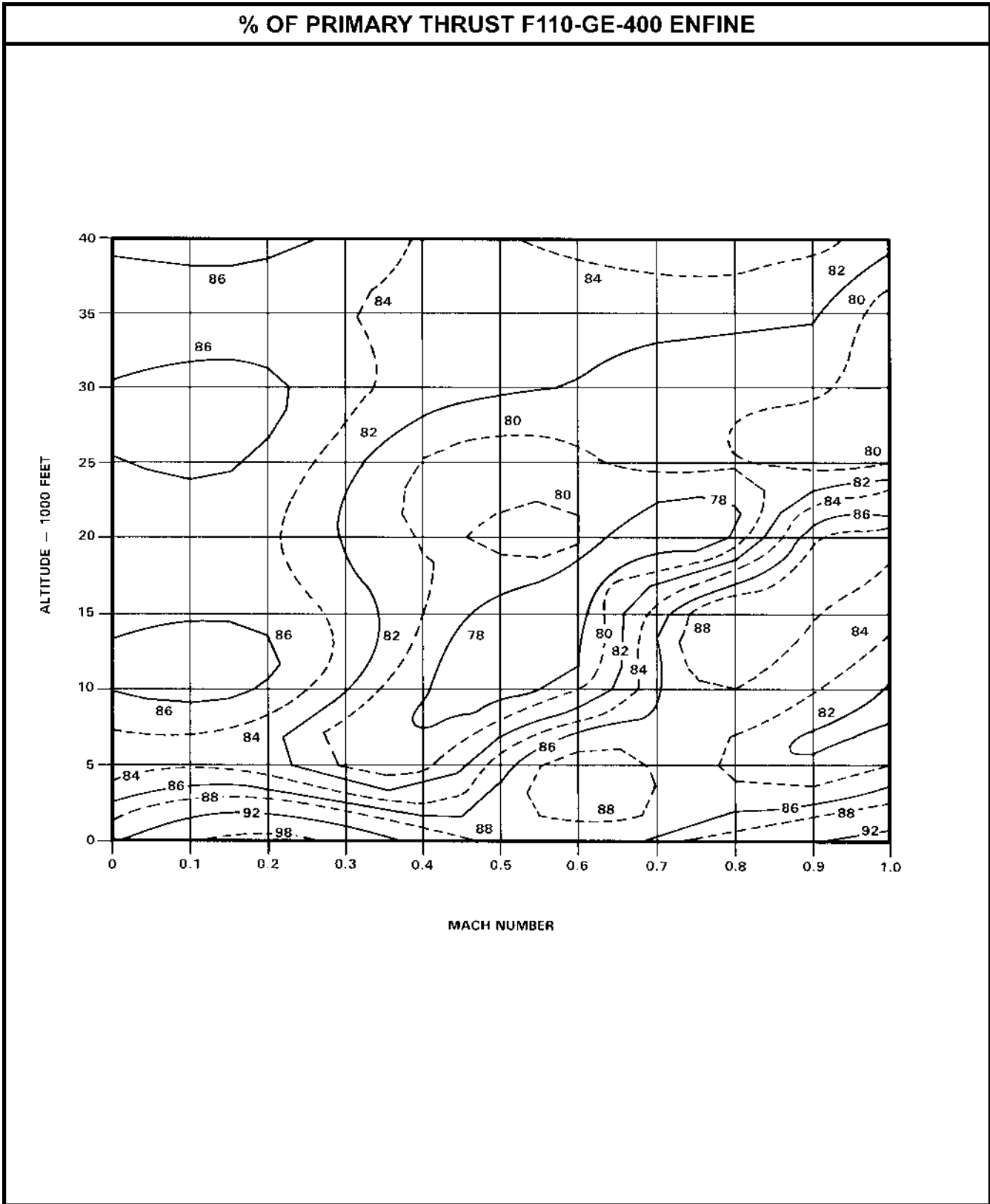
If PRI mode is restored:

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).



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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 the 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.
5. If WING SWEEP advisory light is illuminated — Wing sweep drive cb's — Pull (LD1 and LE1).

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).

Note

Pulling the AICS cb while airborne may illuminate the FCS CAUTION and ARI DGR lights. Above about 600 knots, the PITCH SAS and ROLL DGR lights will also be illuminated. These should clear with a MASTER RESET following a programmer reset.

7. Affected INLET RAMPS switch — AUTO.
8. Land as soon as practicable.

If INLET light only is illuminated, attempt AICS programmer reset:

4. Decelerate below 0.5 TMN.
5. If WING SWEEP advisory light is illuminated: Wing sweep drive cb's — Pull (LD1 and LE1).

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 (LE 1) cb's are pulled.

6. Affected L or R AICS cb — Cycle (LF1, left or LG1, right).

Note

Pulling the AICS cb while airborne may illuminate the FCS CAUTION and ARI DGR lights. Above about 600 knots, the PITCH SAS and ROLL DGR lights will also be illuminated. These should clear with a MASTER RESET following a programmer reset.

If INLET light goes off:

7. 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.

7. Affected L or R AICS cb — Pull (LF1, left or LG1, right).

Note

Pulling the AICS cb while airborne may illuminate the FCS CAUTION and ARI DGR lights. Above about 600 knots, the PITCH SAS and ROLL DGR lights will also be illuminated. These should clear with a MASTER RESET following a programmer reset.

8. Affected INLET RAMPS switch — AUTO.
9. Remain below 1.2 TMN.

When AICS programmer reset attempts are completed:

12. Wing sweep drive cb's — Reset (LD1 and LE1).

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.

CAUTION

The formation of ice on pitot-static sensors may result in DFCS detected failures that may not clear with a MASTER RESET.

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:

4. Rpm — Set Minimum Rpm.
5. Avoid high-g or large throttle movements.
6. 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.

If after 1 minute light is still illuminated:

3. Throttle (affected engine) — OFF.
4. Refer to Single-Engine Cruise Operations, paragraph 14.5.3.2.
5. Relight engine for landing, if necessary.
6. Land as soon as possible.

If light goes out, land as soon as practicable.

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.
- With ANTI ICE CONTR HOOK CONT/ WSHLD/AIR cb (8C2) pulled, approach indexers will flash.

14.6 FUEL SYSTEM MALFUNCTIONS**14.6.1 Fuel Pressure Caution Lights/Low Fuel Pressure Warning Tone**

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 flame-out occur. The first indication of this condition may be a fuel pressure light or an aural tone (engine stall warning tone).

14.6.1.1 L and/or R FUEL PRESS Light(s) and Warning Tone

1. Both throttles — MIL Power or Less.
 2. Restore aircraft to 1.0g flight.
- If both lights and warning tone 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 and the warning tone 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 and the warning tone remains on:

3. No afterburner above 15,000 feet.
4. Fuel distribution — Monitor (balance if required).
5. Land as soon as practicable.

If migration occurs after balancing, as indicated by a 100 to 300 PPM increase on the inoperative side or a 100 to 300 PPM decrease on the operative side above expected burn rate according to indicated fuel flow:

6. FUEL PRESS ADVSY CB - PULL (8F1).

Note

Pulling the FUEL PRESS ADVSY CB will cause the engine crossfeed valve to close and the inoperative side fuselage motive flow shutoff valve to open. This will reduce the amount of fuel transfer from the operative side to the inoperative side.

Note

The L or R FUEL PRESS light and warning tone will extinguish when the FUEL PRESS ADVSY CB is pulled.

7. Maintain cruise power or less.
8. Fuel distribution - monitor (balance if required).

WARNING

If the sump tank interconnect valve has failed, selecting AFT or FWD on the 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 PPM increase on the inoperative side), immediately return the feed switch to NORM.

9. Land as soon as possible.

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

Wing and external fuel will not transfer with refuel probe switch in ALL EXTD. If probe extension required, select FUS EXTD to enable transfer.

Note

Fuel management panel will be inoperative if FUEL MGT PNL cb (RD1) is out.

1. Fuel Management Panel cb—Check in (RD1).

14.6.3.1 Wing Fuel Fails To Transfer

If wing fuel fails to 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**Note**

Descending below freezing level may thaw possible frozen valves.

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 RAM 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).

WARNING

Pulling the FUEL FEED/DUMP circuit breaker (RE1) isolates the right and left fuel systems. It also deactivates the function of the feed switch, the automatic balance functions, and the fuel dump system. Should single engine operation subsequently become necessary, useable fuel will be limited to only what is available on the operating side.

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 until the wings are empty.

If leak is not stopped, it is in engine/nacelle area, proceed immediately with next step.

3. FUEL FEED/DUMP cb — Pull (RE1).

WARNING

Pulling the FUEL FEED/DUMP circuit breaker (RE1) isolates the right and left fuel systems. It also deactivates the function of the feed switch, the automatic balance functions, and the fuel dump system. Should single engine operation subsequently become necessary, useable fuel will be limited to only what is available on the operating side.

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.

14.6.6 Fuel Imbalance/Fuel Quantity Balancing**WARNING**

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

Note

With a high quantity in the FWD/RT Fuel system, the greater static head pressure, particularly in nose-up attitudes, can cause overfilling of the AFT/LT fuel system. To prevent this, the feed switch should be returned to NORM before the AFT/LT tape reaches 6,200 pounds.

1. Both throttles - MIL power or less.
2. FEED SWITCH - select high fuselage tape side.

WARNING

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

If fuel imbalance increases:

3. FEED SWITCH - NORM

WARNING

If the sump tank interconnect valve has failed closed, selecting AFT or FWD on the FUEL FEED SWITCH could result in rapid increase of the fuel imbalance. If this occurs (as indicated by an imbalance increase of 100 to 300 PPM) immediately return the FEED SWITCH to NORM.

4. Determine useable fuel and land as soon as possible.

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 DFCS 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.



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.

4. Land as soon as practicable.

ESSENTIAL BUSES NO. 1 (1 KVA MODE)

AICS RAMP STOW	FIRE EXTINGUISHING	PILOT LCD LIGHTS
ANGLE OF ATTACK IND	FLOOD LIGHTS	PITCH/ROLL TRIM
ALTITUDE LOW WARNING	FUEL QUANTITY INDICATOR	PROBE LIGHT
BACKUP CONTR/B/U OXY LOW	HYDRAULIC PRESSURE	RADAR ALTIMETER
BACKUP IGNITION	INDICATION	RUDDER TRIM
BACKUP OXY PRESSURE IND	ICS	STANDBY ATTITUDE
BAROMETRIC ALTIMETER	IFF/SIF	STORE MANAGEMENT
CONSOLE LIGHTS (PILOT)	INSTRUMENT BUS FEEDER	PROCESSOR
DC ESSENTIAL NO. 1 FEEDER	INSTRUMENT LIGHTS	TAIL/RUDDER/FLAP INDICATOR
DC TEST	JETTISON (EMERGENCY)	TURN AND SLIP INDICATOR
ENGINE INSTRUMENT GROUP	MAIN LANDING GEAR SAFETY	VHF/UHF RADIO 1 & 2
ENGINE INSTRUMENT GROUP	RELAYS	VOICE SECURITY EQUIPMENT
WHITE LIGHTS	OBOGS CONTR	WHEELS POSITION
ENGINE START	OBOGS CONCENTRATOR	INDICATIONS
FIRE DETECTION	PANEL FLOODLIGHTS	WING POSITION INDICATIONS

ESSENTIAL BUSES NO. 2

AICS	CABIN PRESSURE	ENGINE STALL TONE
AICS LOCKUP POWER	CADC	EXHAUST NOZZLE
AIR SOURCE CONTROL	CANOPY LIGHT	EXTERIOR LIGHTS CONTROL
ALPHA COMPUTER	CIU	FLAP/SLAT CONTROL SHUTOFF
ALPHA HEATER	CURSOR CONTROL	FLIGHT CONTROL AUTHORITY
ANNUNCIATOR PANEL POWER	DC ESSENTIAL NO. 2 FEEDER	FUEL DUMP
ANTI-ICE CONTROL	DEKI LIGHTS	FUEL FEED
ANTI-ICE PROBE	DFCS	FUEL MANAGEMENT PANEL
ANTI-SKID POWER	DFCS BUS FEEDER	FUEL PRESSURE LIGHT
ARMAMENT GAS	DISPLAY PROCESSOR	FUEL TRANSFER OVERRIDE
ARRESTING HOOK CONTROL	ECS TEMPERATURE CONTROL	FUEL VENT VALVE
AUTOMATIC DIRECTION	EJECTION COMMAND	FUEL LOW LIGHT
FINDER	INDICATOR	GENERATOR LIGHTS
AUXILIARY FLAP/FLAP	EMERGENCY GENERATOR TEST	GPS
CONTROL	ENGINE AFTC	GROUND ROLL BRAKING
BDHI	ENGINE ANTI-ICE	INDICATOR
BINGO POWER	ENGINE ANTI-ICE VALVES	HUD
BLEED AIR LIGHT	ENGINE OIL COOLING	
BLEED DUCT	ENGINE SECONDARY MODE	

Figure 14-5. Emergency Generator Distribution (Sheet 1 of 2)

ESSENTIAL BUSES NO. 2 (continued)		
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 LIGHTS
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 COMPUTER

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 DFCS 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/or 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 DFCS 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 CONTROL	MONITOR BUS CONTROL
AIRBORNE SELF-PROTECTION JAMMER	FLIGHT HYDRAULIC BACKUP	MULTI-FILTER ASSEMBLY
AIR SOURCE CONTROL	GROUND POWER COOLING INTERLOCK	MULTI-FUNCTIONAL DISPLAYS 2 AND 3
ALE-39 CHAFF/FLARE	GROUND TEST	NFO CONSOLE LIGHT
ALR-67	GUN POWER	OUTBOARD SPOILER CONTROL AND PUMP
AMC BIT	HUD CAMERA	POSITION LIGHTS
AN/AWW-4	HV POWER SUPPLY	RADAR COMPONENTS
ANNUNCIATOR PANEL DIM CONTROL	IFF AIR-TO-AIR	RECONNAISSANCE EQUIPMENT
ANTENNA HYDRAULIC SERVO	INS BATTERY POWER	RIGHT DC TEST
ANTENNA LOCK	INTERFERENCE BLANKER	RIGHT MAIN TRANSFORMER RECTIFIER
ANTI-COLLISION LIGHT	INTEGRATED TRIM	SAHRS
ASW 27	INTERRUPTION FREE DC BUS	SEAT ADJUST
AUTO THROTTLE	IRST	SOLENOID POWER SUPPLY
BEAM PS	JTIDS DATA PROCESSOR AND BATTERY HEATER	STATION 1, 1A, AND 8 AIM-9 COOLING POWER
BOL CHAFF DISPENSERS	LEFT/RIGHT AICS HEATER	STATION 1, 3, 4, 5, 6, AND 8 DECODER RELAY POWER
BRAKE ACCUMULATOR SHUTOFF VALVE	LEFT MAIN TRANSFORMER/RECTIFIER	STEADY POSITION LIGHTS
COUNTING ACCELERATOR	LIQUID COOLING	STORES MANAGEMENT PROCESSOR
DATA LINK	MASTER ARM	STORM FLOOD LIGHTS
DATA PROCESSORS	MASTER TEST	SUPPLEMENTAL POSITION LIGHTS
DATA STORAGE SET	MDL	TELEVISION CAMERA SET
DEHYDRATOR	MISSILE POWER RELAY UNIT	
DEU	MISSION COMPUTER NO. 1	
DIGITAL DISPLAY ENABLE		
ELECTRONIC COOLING		

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. PITCH, ROLL and YAW STAB AUG switches — 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.



An electrical fire may affect the CADC and AICS systems causing random movements of the wings and ramps.

If conditions permit:



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 2-84 for oxygen breathing time remaining.

3. 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:

4. Pull cb's of affected equipment.
5. All generators — NORM.

If cause of fire cannot be isolated:

6. Secure all unnecessary equipment.
7. EMERG generator switch — NORM.
8. Land as soon as possible.



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.



All DFCS functions and spoilers will be lost. This will have an adverse effect on flying qualities. Terminate aggressive maneuvering immediately and remain subsonic. Expect minimal damping of oscillations in pitch and yaw and severely degraded roll control with flaps extended. Perform controllability check.

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:

- a. Airspeed indicator.
- b. Altimeter (STBY mode).
- c. Cabin pressure altimeter.
- d. Vertical velocity indicator.
- e. Arresting hook (emergency extension only).
- f. Standby attitude gyro (3 minutes).
- g. Emergency wing sweep.
- h. Landing gear.
- i. Main flaps/slats.
- j. Standby compass.
- k. Backup oxygen system (above 10,000 feet MSL).



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.



- 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 2-84](#) 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 and other hot air leaks 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 2-84](#) 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 2-84](#) 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 powerwhile 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:

7. 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 2-84](#) 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/LANTIRN POD CONT (9E1)
 - b. RECON ECS CONT AC (2G4)
 - c. RECON HTR/LANTIRN PWR 3 PH (2C3)

- d. RECON POD (1E2)
 - e. RECON CONTR/LANTIRN POD PWR (9E2)
 - f. RECON POD DC PWR NO 2 (9E3)
 - g. 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.



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).



High-cockpit temperature and smoke during ground operation indicates ECS cooling fan shut-down. 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).



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.



Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See OBOGS emergency procedure. See [Figure 2-84](#) 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.



Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See [Figure 2-84](#) for oxygen breathing time remaining.

14.9.1 OBOGS Light

1. BACKUP OXY PRESS — Check.



Oxygen breathing time on BACKUP is limited and requires immediate mission planning. See [Figure 2-84](#) for oxygen breathing time remaining.

2. OBOGS concentrator and OBOGS control cb's — Check in (3C4, 7A1).

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)

3. 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 commu-

nications 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 data 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.



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. Airspeed and altitude — Below 200 Knots/15,000 Feet.
3. Seats and visors — Down.
4. If canopy has departed aircraft, perform controllability check.
5. 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 — 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 refuel PROBE switch — EXTD (in carrier environment).

CAUTION

Wing and external fuel will not transfer with refuel probe switch in ALL EXTD. If probe extension required, select FUS EXTD to enable transfer.

3. Wing sweep — Set at 20°.
4. L INLET RAMPS switch — STOW (less than 1.2 Mach).

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.

5. Left AICS cb — Pull (LF1).

Note

Pulling the AICS cb while airborne may illuminate the FCS CAUTION and ARI DGR lights. Above 600 knots, the PITCH SAS and ROLL DGR lights will also be illuminated. These should clear with a MASTER RESET following programmer reset.

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 hand-pump. 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 (BI-DI) OFF.

1. Wing sweep — Set at 20°.
2. R INLET RAMPS switch — STOW (less than 1.2 Mach).
3. Right AICS cb — Pull (LG1).

Note

Pulling the AICS cb while airborne may illuminate the FCS CAUTION and ARI DGR lights. Above 600 knots, the PITCH SAS and ROLL DGR lights will also be illuminated. These should clear with a MASTER RESET following programmer reset.

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).

CAUTION

Wing and external fuel will not transfer with refuel probe switch in ALL EXTD. If probe extension required, select FUS EXTD to enable transfer.

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.

Note

Complete loss of combined hydraulic pressure will result in the following caution lights due to the loss of a single channel SAS actuator function: PITCH SAS, ROLL DGR, YAW DGR, ARI DGR, and SPOILERS lights.

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.
- o. One-half authority of SAS/ARI actuators in pitch, roll, and yaw.

6. LDG GEAR — Emergency lower. Refer to Landing Gear Emergency Lowering, paragraph 15.4.1
7. Hook — Emergency down. Refer to Arresting Hook Emergency Down, paragraph 15.11.
8. AUX FLAP/FLAP CONTR cb — Pull (8G3).
9. Flaps (no auxiliary flaps) — DN.
10. Brake accumulator (handpump) — Check.
11. ANTI SKID SPOILER BK switch — SPOILER BK (OFF for CV).
12. EMERG FLT HYD switch — HIGH (on final committed to landing).

WARNING

Do not return to AUTO (LOW) mode once module is selected on (HIGH or LOW) with operating flight hydraulic system.

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.

Note

Complete loss of flight hydraulic pressure will result in the following caution lights due to the loss of a single channel SAS actuator function: PITCH SAS, ROLL DGR, YAW DGR, and ARI DGR lights.

The following important equipment is inoperative:

- a. One-half authority of SAS/ARI actuators in pitch, roll, and yaw.
 - b. ACLS.
 - c. R AICS.
 - d. 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 total in HIGH mode 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, no SAS/ARI).
- b. Rudders (slightly reduced rate, no SAS/ARI).
- c. Main flaps and slats (reduced rate, via thumb-wheel or flap handle).
- d. Outboard spoilers.

- e. Hydraulic handpump.
- f. Landing gear (emergency actuation available).
- g. Hook extend (emergency actuation available).
- h. Refuel 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.



- 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 air-speed 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. LDG GEAR handle — EMERG DN.
- 11. Maneuver flaps — Extend With Thumbwheel.
- 12. MANEUVER FLAPS cb — Pull (LE1).

- 13. Hook — EMERG DN.
- 14. Brake accumulator — Check.

Established on final, committed to landing:

- 15. EMERG FLT HYD switch — HIGH.



- Aggressive nose movement in close can rate limit the stabilizers, resulting in low altitude loss of control. Do not use APCS.
- Inboard spoilers can be expected to float, causing uncomfortable lateral stick requirements for level flight. Do not trim out lateral forces.



- 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.
- Prolonged operation of the BFCM in the HIGH mode may cause failure of the module. The LOW mode should be selected as soon as practicable following a waveoff or bolter and the HIGH mode reselected on the subsequent approach.

If wings are 20°:

- 16. Fly straight-in approach at 15 units AOA and 180 knots.

If wings are greater than 20°:

- 17. Fly straight-in approach at 15 units AOA.

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



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 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).



Complete loss of hydraulic fluid through the wheelbrake hydraulic lines will render parking brake ineffective.



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

There are a myriad of possible causes to binding flight controls. Unfortunately, unless the cause is a foreign object jammed in the cockpit controls and visible to the pilot, it may be impossible for the aircrew to determine the true cause. If the aircraft is in a controllable state, execute the Controllability Checklist. If the aircraft is uncontrollable, an attempt should be made to release pressure on the flight controls so that any potential foreign objects may be dislodged. If the controls are still inhibited, apply negative g, flight conditions permitting, to forcefully dislodge the object. In the low altitude environment, applying negative g may not be possible. As always, the aircrew must decide if such an action will further jeopardize the aircraft. Finally, the pilot should use whatever force necessary in the direction of the bind in order to break any jamming foreign object. If unsuccessful, the aircrew should conduct a controllability check using alternative means to maneuver the aircraft to determine suitability for a safe landing. Consider using different axes to coordinate aircraft movement. Yaw through rudder displacement or asymmetric thrust can be substituted for roll commands via lateral stick and vice versa. Aircraft configuration (flap setting, wing sweep), airspeed/ thrust, or sideslip may assist in inducing pitch commands in the event of inhibited control stick. The aircrew should thoroughly investigate all possible alternative control methods at a sufficient altitude to allow safe ejection should the aircraft depart controlled flight. Do not delay eject decision if approaching edge of the ejection envelope. If the aircraft is suitable for landing with restricted rudder pedal authority, consider an arrested landing.

14.12.1 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:

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
8. 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:

1. Turn needle and ball position.
2. AOA.
3. Buffet.
4. Yaw string position.
5. Flight control positions.
6. Trim settings.
7. Roll-off.
8. 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.)

- 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 (hard-over), 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 (LD1 and LE1).

Note

- Failure to pull wing sweep drive circuit breakers (LD1 and LE1) could result in inadvertent maneuver device retraction or wing sweep during approach.
 - Wingsweep warning, wingsweep advisory, and flap caution lights will illuminate with both wing sweep drive circuit breakers pulled (LD1 and LE1).
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. 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.

14.12.2 Uncommanded Roll and/or Yaw

Note

- If uncommanded roll and/or yaw occurs during high AOA maneuvering (above 15 unit), assume departure from controlled flight and apply appropriate departure and/or spin recovery procedures.
- 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. Rudder hardover.

- *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 — 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.

14.12.3 DFCS Flight Control Failures or Malfunctions

Figure of DFCS caution lights:

PITCH SAS	ROLL DGR	YAW DGR
FCS CAUTION	ARI DGR	ARI/SAS OUT

DFCS caution lights fall into 3 levels of severity.

Loss of redundancy — The FCS CAUTION light indicates some loss of DFCS redundancy. If FCS CAUTION is on alone, then no DFCS authority or function has been lost. It indicates that some sensor or function has been determined faulty but that other sensors or functions are redundantly providing all the input necessary to enable the DFCS to use full authority to provide all designed functions. The AFC acronyms in continuous monitoring (CM) will also give some indication of which axis or sensor has been declared invalid. Emergency procedures recommend limited supersonic operations and adhering to high angle of attack maneuvering limitations (Figure 4-8) because a subsequent sensor failure may abruptly restrict DFCS authority at a point that it is needed for departure resistance or supersonic stability.

Loss of some authority — The failure of certain sensors or control surface actuators will cause some loss of authority in part of the DFCS. If enough sensors or actuators become faulty, then a light in addition to the FCS CAUTION light will illuminate. The light will indicate which axis or function has become degraded. Loss of some authority will illuminate one of the caution lights in the top row or the ARI DGR light. The basic SAS and primary features of the system are operating with some loss of authority. Some failures may not be readily apparent to the aircrew until particular parts of the envelope are reached. Check of acronyms in CM can help to define the exact nature of the degrade. For degraded authority in roll, yaw or ARI, aggressive maneuvering should be terminated and speed reduced to subsonic if the lights do not clear with MASTER RESET.

Complete loss of SAS in an axis or ARI — A complete loss of authority in the roll or yaw axis or in the ARI will be accompanied by the ARI/SAS OUT light. Determination of which axis or function is lost depends upon what additional lights are illuminated. For example, complete loss of ARI function is indicated by illumination of both ARI lights (the ARI DGR and ARI/SAS OUT). Selecting roll or yaw STAB AUG switches off will disable all ARI but will illuminate only the ARI/SAS OUT light. Adhere to SAS OFF limits.

Similarly in roll and yaw axis, illumination of both lights in an axis (i.e., ROLL DGR and ARI/SAS OUT) indicates complete loss of authority in the associated axis (Roll axis). With the complete loss of ROLL or YAW SAS or ARI,

aggressive maneuvering should be terminated. Departure resistance and landing characteristics may be significantly degraded. Refer to Chapter 11 for high AOA flight characteristics. Consideration should be given to performing a straight in approach to a landing.

In the pitch axis, it is not always possible to resolve whether the loss is partial or total. Regardless, the difference in flying qualities is small and no flight restriction is applied due to PITCH SAS degrades.

14.12.3.1 FCS CAUTION Light

Note

Verify maintenance file fault reporting acronyms (RIO) to troubleshoot system for maintenance debrief.

1. MASTER RESET pushbutton — Depress

If light remains illuminated:

WARNING

- The DFCS has lost redundancy, but has not lost any authority.
 - The DFCS is potentially one failure away from losing authority and may degrade to ROLL SAS OFF or YAW SAS OFF characteristics with a subsequent failure
2. Airspeed — Remain below 600 knots or 1.3 TMN and adhere to the following limitations:
 - a. Above 0.5 TMN, no cross control inputs permitted above 10 units AOA.
 - b. With maneuvering devices retracted, coordinate all lateral stick inputs above 0.6 TMN and 15 units AOA.

14.12.3.2 PITCH SAS degrade

PITCH SAS failures do not significantly degrade performance in the longitudinal axis, and incur no flight envelope restrictions. It is possible that the spoilers may be inoperative with a complete failure of the pitch axis.

14.12.3.2.1 PITCH SAS Light

1. MASTER RESET pushbutton — Depress.

- If light remains illuminated — No limitations.



- The spoilers may be inoperative (ground roll braking) with a complete failure of the pitch computer.
- If spoilers are inoperative the degradation in the roll axis may be severe and a careful slow flight should be conducted to determine whether a CV approach should be attempted. Refer to spoiler failure procedure.

Note

- The PITCH SAS light will illuminate with any degrade to authority. Additional failures or a complete loss of SAS functions in the pitch axis may not provide any further warning.
- The autopilot will not be operational with a complete PITCH SAS failure.

14.12.3.3 ROLL SAS, YAW SAS, or ARI degrade

When the roll or yaw axes become degraded, the affected axis and ARI will operate with reduced authority. Single series actuator failure or any other degrade to authority is indicated by the ROLL DGR or YAW DGR light in conjunction with the ARI DGR light. This indicates that affected axis and ARI has less than normal authority. This may not be readily apparent to the pilot at all flight conditions. However, since the control system has malfunctioned and lost authority, departure resistance may be significantly reduced. Certain air data failures can cause the ARI to degrade without loss of authority in either the roll or yaw axis. For all Roll, Yaw and ARI degrades, supersonic flight and aggressive maneuvering should be terminated. Precautionary flight restrictions are imposed as listed below.

14.12.3.3.1 ROLL DGR Light, YAW DGR Light and/or ARI DGR Light

- MASTER RESET pushbutton — Depress.
- If light remains illuminated, aggressive maneuvering should be terminated.
- Remain below 1.0 TMN.

Note

Rudder pedal shakers inop if YAW B fail.

14.12.3.4 ROLL SAS, YAW SAS, or ARI failure

More serious failures that shut down all inputs in the roll or yaw axis will light the ARI/SAS OUT light along with the ROLL DGR or YAW DGR light. If all ARI functions are lost then both ARI DGR and the ARI/SAS OUT light will illuminate. Failure of both roll or yaw series actuators will also illuminate the ARI/SAS OUT light. The ROLL STAB AUG switch will remain in the ON position. In the DFCS, the switch is “over center”.

Complete ROLL SAS failures create a very significant loss of the DFCS capabilities. CV landings with ROLL SAS failures can be accomplished with moderate effort provided all spoilers are operating. If spoilers are inoperative the degradation in the roll axis may be severe and a careful slow flight should be conducted to determine whether a CV approach should be attempted. Refer to spoiler failure procedures, section 14.12.6.

A second yaw series failure or a complete loss of yaw axis authority is indicated when the ARI/SAS OUT light illuminates in addition to the YAW DGR light. The YAW STAB switch is not automatically positioned to OFF. CV landings with total YAW SAS failure require increased attention to control of directional oscillations especially in turbulence and/or during lineup corrections. Severely decreased yaw damping will be evident throughout the envelope.

14.12.3.4.1 ARI/SAS OUT Light (with ROLL DGR, YAW DGR or ARI DGR Light)

- Ensure ROLL and YAW STAB AUG switches — ON.
- MASTER RESET pushbutton — Depress.

If lights remain illuminated:

- Leave STAB AUG switches — ON

To take advantage of any remaining capability that the DFCS may be able to provide. Terminate aggressive maneuvering and remain below 1.0 TMN.



Maneuvering with YAW SAS OFF or inoperative shall not be conducted above 15 units AOA with landing gear retracted.

4. Perform Controllability Check procedure.



- If spoilers are inoperative the degradation in the roll axis may be severe and a careful slow flight should be conducted to determine whether a CV approach should be attempted. Refer to spoiler failure procedure.
- CV landings with total YAW SAS failure require increased attention to control of directional oscillations especially in turbulence and/or during lineup corrections.
- Rudder pedal shakers inop if YAW B fail.

Note

ROLL DGR and ARI/SAS OUT lights may automatically extinguish upon selection of gear handle down. This is indicative of a DFCS dual air data failure (AOA or Mach sensor inputs). These failures inhibit ROLL SAS and ARI functions in cruise configuration, but not in the landing configuration.

14.12.3.5 STAB AUG Transients

1. MASTER RESET pushbutton — Depress
2. Airspeed — Decelerate below 400 knots or 1.0 TMN.
3. STAB AUG switches — All OFF.

Note

With ROLL or YAW STAB AUG OFF, the ARI/SAS OUT light will be illuminated.

4. STAB AUG switches — Reset (reset individually to isolate failure).
5. Perform Controllability Check procedure.

14.12.3.6 Single PITCH or ROLL STAB Light

1. MASTER RESET pushbutton — Depress.

14.12.4 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.

14.12.4.1 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°.



- 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.

14.12.4.2 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.
 - 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 cg. 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.
 - 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. ASYM thrust limiter SW—Off (if required).

WARNING

Asymmetric thrust limiter should only be disabled if required to assist/maintain control.

9. 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.

14.12.4.3 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 DFCS, 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.

14.12.5 Horizontal Tail Authority Failure

Lateral stick input 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 limit.

14.12.5.1 HZ TAIL AUTH Light

1. MASTER RESET pushbutton — Depress (10 seconds).

If light remains illuminated above 400 KIAS/0.9 IMN: ■

2. ROLL STAB AUG switch — OFF.

Note

ARI/SAS OUT light will illuminate.

3. Restrict lateral control inputs above 400 KIAS/0.9 IMN to one-quarter throw.



Above 400 KIAS/0.9 IMN there is a danger of torsional overstress to the fuselage with large lateral stick deflections.

4. Reduce airspeed and remain below 400 KIAS/0.9 IMN.

Below 400 KIAS/0.9 IMN:

5. ROLL STAB AUG switch — ON.

Note

At low airspeeds, lateral control effectiveness may be reduced.

6. Do not select OV SW after landing.

14.12.6 Spoiler Malfunction

Spoiler monitoring and fault isolation is internal to the DFCS. DFCS should recognize and disable any malfunctioning spoiler and permit other spoilers to operate normally. DFCS will therefore automatically maintain greater control authority in event of a spoiler malfunction.

For malfunctions where failed spoilers are successfully commanded to trail, straight-in full flap CV approaches can be accomplished with minor degradation in handling qualities. The control capability remaining with a failed up spoiler is influenced by flap position, SAS operation, and availability of the remaining spoilers.

14.12.6.1 SPOILERS Caution Light/Spoiler Malfunction/Spoiler Stuck Up



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.
- 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.



With wings forward of 62°, excessive horizontal tail differential may cause severe structural damage.

If spoiler(s) fail down:

3. Perform Controllability Check procedure, paragraph 14.12.1.

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 and ROLL SAS OFF 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 14.12.1, using maneuvering flap/slat (preferred) or no flap configuration only.

Note

If controllability is unsuitable for landing approach due to a complete loss of spoilers, consideration may be given to attempting a Power On Reset (POR) in an attempt to regain at least one spoiler set. See DFCS POR procedures paragraph 14.12.6.3.

If controllability satisfactory:

5. Perform maneuver flap/slat or no flap straight-in approach at or above minimum control airspeed.

If controllability still unsatisfactory:



With both INBD and OUTBD spoiler control cb's pulled, all opposing spoiler control will be lost.



Marginal control or loss of control may be experienced due to removal of a spoiler set with multiple failures present.

Note

If 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 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 (8G9 for INBD, 9C5 for OUTBD).

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 9C5 pulled.
- With cb's 8G9 and 9C5 pulled, ground roll braking is not available. Reset on landing rollout if desired.

14.12.6.2 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.

14.12.6.3 DFCS Power On Reset (POR)

If controllability is unsuitable for landing approach due to complete loss of spoilers or other major flight control malfunction, consideration may be given to attempting a flight control computer reset in an attempt to regain adequate controllability for landing. A POR will reinitialize the DFCS computers, interpreting the current sensor information as valid. This can create a potentially hazardous situation under conditions where a dual sensor failure occurred prior to restoring power. When the DFCS reinitializes, it is possible for the failed signals to be interpreted as valid and the remaining good signal to be interpreted as invalid. Therefore, careful consideration should be given before executing a POR airborne, since it can result in erroneous DFCS commanded control deflections. Aircrew must be alert for erroneous uncommanded SAS and/or spoiler control inputs following an airborne POR.

WARNING

If a dual failure has been declared that will not clear with a MASTER RESET, performing a power on reset (POR) to clear the failure can result in erroneous uncommanded SAS and/or spoiler control inputs.

Note

As with any controllability check, a POR should be performed above 10,000 ft AGL and in the cruise configuration between 250 and 300 knots if possible to minimize the potential effects of transient series servo actuator inputs.

1. BOTH SPOILER CONTR cb's — Pull (8G9, INBD and 9C5, OUTBD).
2. PITCH, ROLL, and YAW STAB AUG switches — OFF.
3. ROLL A DC, YAW B DC, and YAW A DC cb's (8B4, 8B5, and 8B6) — Cycle (RIO). Observe PITCH SAS, ROLL DGR, YAW DGR, FCS CAUTION, ARI DGR, ARI/SAS OUT, SPOILERS, HZ TAIL AUTH, RUDDER AUTH, and AUTOPILOT caution lights illuminated.

Note

Attempt to reset cb's 8B4, 8B5, and 8B6 simultaneously to optimize DFCS power-up sequence.

4. MASTER RESET pushbutton — Depress.

Observe all lights extinguished with the exception of ARI/SAS OUT light due to ROLL and YAW STAB switches OFF.

WARNING

- If the system continues to display any DFCS related caution lights following MASTER RESET, this could be indicative of a recurring flight control malfunction.
- If a SPOILERS caution light will not extinguish following the execution of a POR, selection of ROLL STAB AUG switch ON can result in erroneous uncommanded SAS control inputs.
- When attempting to individually reset PITCH, ROLL, and YAW STAB AUG switches, be prepared to isolate the affected STAB AUG switch OFF if any uncommanded SAS inputs are observed.

Note

- Minimize control stick inputs during or following MASTER RESET as this can result in the SPOILERS caution light with SPOILER CONTR cb's pulled.
 - More than one MASTER RESET may be required to extinguish all caution lights.
5. Individually select PITCH, ROLL, and YAW STAB AUG switches – ON.

If any uncommanded SAS control inputs:

6. Affected STAB AUG switch – OFF.

WARNING

If uncommanded ROLL SAS inputs are observed following a POR, reselection of the SPOILER CONTR cb's can result in full spoiler deflection and an out of control aircraft.

7. If uncommanded ROLL SAS control inputs, DO NOT reset SPOILER CONTR cb's.
8. Perform Controllability Check procedure.

If no uncommanded ROLL SAS control inputs:

6. Reset SPOILER CONTR cb's.
7. Perform Controllability Check procedure.

14.12.7 FLAP Light**14.12.7.1 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).

14.12.7.2 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.

14.12.7.3 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 14.12.8.

14.12.7.4 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 14.12.8.

14.12.7.5 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 14.12.8.

14.12.7.6 FLAP Handle Down and Flaps Down

2. Wing sweep — Ensure at 20°.
3. 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 14.12.8.

14.12.8 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 7 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 minimum safe AOA if landing is elected.

14.12.9 WING SWEEP Lights**14.12.9.1 Advisory Light Only - No Loss of Normal Control**

1. MASTER RESET pushbutton — Depress.

14.12.9.2 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.

14.12.10 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).
 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 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.

14.12.12 AUTOPILOT Light

- 5. MASTER RESET pushbutton — Depress.

14.12.13 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 over-speed 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:

14.12.13.1 In Flight — 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 thrust and lift caused by nozzles opening and 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.

14.12.13.2 In Flight — 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.
- Circuit breakers must be reset simultaneously (within 0.1 sec) once on deck or a secondary fault may be incurred which will inhibit ground roll braking.

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 — Rudder-Opposite Turn Needle/Yaw/Spin Arrow.

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 — Rudder-Opposite Turn Needle/Yaw/Spin Arrow.

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.



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.



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 engines' rpm 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 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 BI-DI 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

Use of maximum AB during waveoff or bolter is prohibited and provides little or no improvement over minimum AB. If unable to control yaw rate (possible ATLS failure), immediately reduce power to minimum AB or MIL.

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 (ATLS on) will improve waveoff performance (minimize altitude loss) from high sink rates.

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 (BI-DI) off.

5. Reduce gross weight/minimize lateral asymmetry into the inoperative engine as required.
6. Speedbrakes — RET (on final approach).
7. LDG GEAR handle — DN (if combined hydraulic pressure zero — EMERG DN).
8. Hook — As Required.
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.

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 effect 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:



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



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 is 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:



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 — Verify Out.
7. Wing sweep — Set at 20°.



If hammering (cavitation) is experienced in the hydraulic system, component rupture is imminent. Turn the HYD TRANSFER PUMP switch (BI-DI) off.

8. External stores — Jettison for Shipboard Recovery.
9. Fuel — Dump or Burn (reduce as much as practicable).
10. Speedbrakes — RET (on final approach).
11. LDG GEAR handle — DN (if combined hydraulic pressure zero — EMERG DN).
12. Hook — As Required.



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.

WARNING

Extreme caution must be exercised when performing turns into a 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 effect a recovery.

19. Final approach airspeed — 13 Units (CV), (field landing slow to 15 units, no flaps at touchdown).

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.

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.

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 Down	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 Down	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 fail 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

8. Obtain visual in-flight check if possible.

If still unsafe and visually confirmed unsafe, or gear position cannot be confirmed:

9. Refer to [Figure 15-1](#) (as appropriate).

15.4.2 Landing Gear Malfunctions

1. Remain below 280 knots.
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.



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 touch-down. 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.



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).



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.



- 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. This possibility shall be reduced by using the brake pedals to prevent rollback as the arresting gear reaches full extension and by setting the parking brake after the aircraft has stopped.
- 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.

WARNING

Setting the FLAP handle to the DN position inflight may create or aggravate a flap asymmetry condition and could make the aircraft uncontrollable.

Note

If outboard spoilers are needed for ground-roll braking, FLAP handle must be lowered at least 5° on landing rollout.

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.
- Aircrew should expect hot brakes following high speed landings. Application of the parking brake could cause the brake assembly to fail and result in a brake fire.

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.



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 the 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 11-9](#) for approach airspeeds.
7. Fly straight-in approach at 15 units AOA (up to 17 units for field landings with wings aft of 50°).



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.

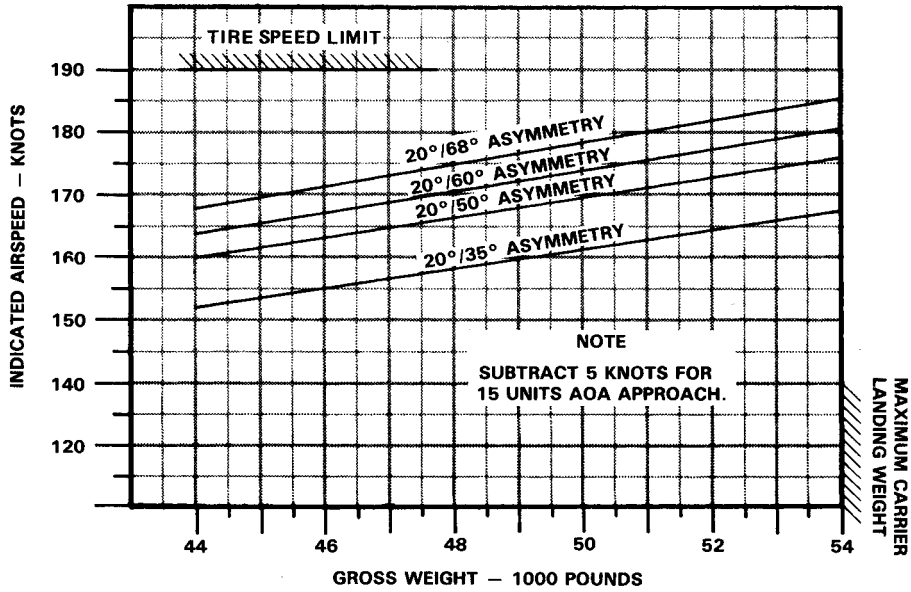
15.7.2 Asymmetric Wing Sweep

Refer to Chapter 11 for asymmetric wing-sweep design limitations and flight characteristics.

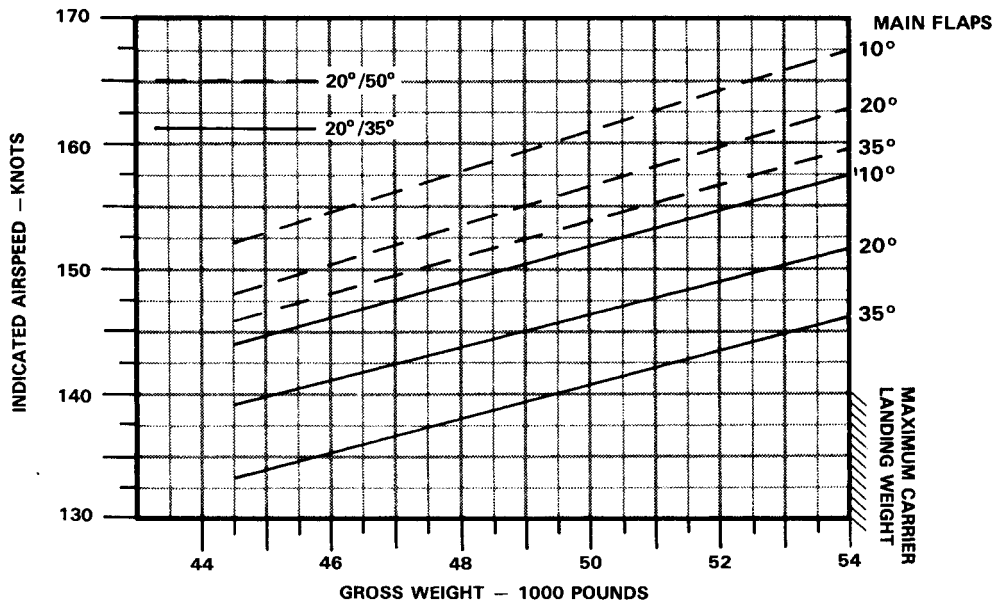
With asymmetric wing-sweep emergency condition, divert field landing is preferable to a CV landing attempt. Aircrew must fully consider approach speed and aircraft controllability characteristics prior to attempting CV arrestment. See [Figure 15-2](#) for recommended approach airspeed for 14 or 15 units AOA with asymmetric wing configurations.

DATE: AUGUST 1986
 DATA BASIS: FLIGHT TEST

**FLAPS UP APPROACH AIRSPEED (14 UNITS AOA)
 FLATS / SLATS RETRACTED**



**LANDING APPROACH AIRSPEEDS (15 UNITS AOA)
 MAIN FLAPS / SLATS EXTENDED; AUXILIARY FLAPS RETRACTED**



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. 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.

7. 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 62° spoiler cutout and right wing is 20°, perform Asymmetric Wing Sweep Unacceptable for Landing procedure, paragraph 15.7.2.2.

8. 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.
- Upon lowering the landing gear an uncommanded but controllable roll transient may occur because of spoiler gearing change from cruise to PA.
 - 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 lineup 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 15.7.2.1.

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 wingsweep 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°.



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.



Wing rock and wing stall may occur at 16 to 16½ 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.



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.



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 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).

Note

- 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 result 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. Check SMS for hung stores. 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.

If hung ordnance exceeds 1,000 pounds:

2. Wing sweep — Set at 25° if \leq 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 field arrestment guide (Figure 15-3) 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, 1¼-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 is 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. Wing sweep 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.

15.13 GROUND ROLL BRAKING FAILURES

- *1. ANTISKID SPOILER BK switch — Check.
- *2. MASTER RESET pushbutton — Depress.

CAUTION

Ground roll braking may fail to extend spoilers on touchdown due to a momentary miscompare of the weight-on-wheels switches. MASTER RESET should restore normal ground roll braking operation.

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 the pilot that the 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

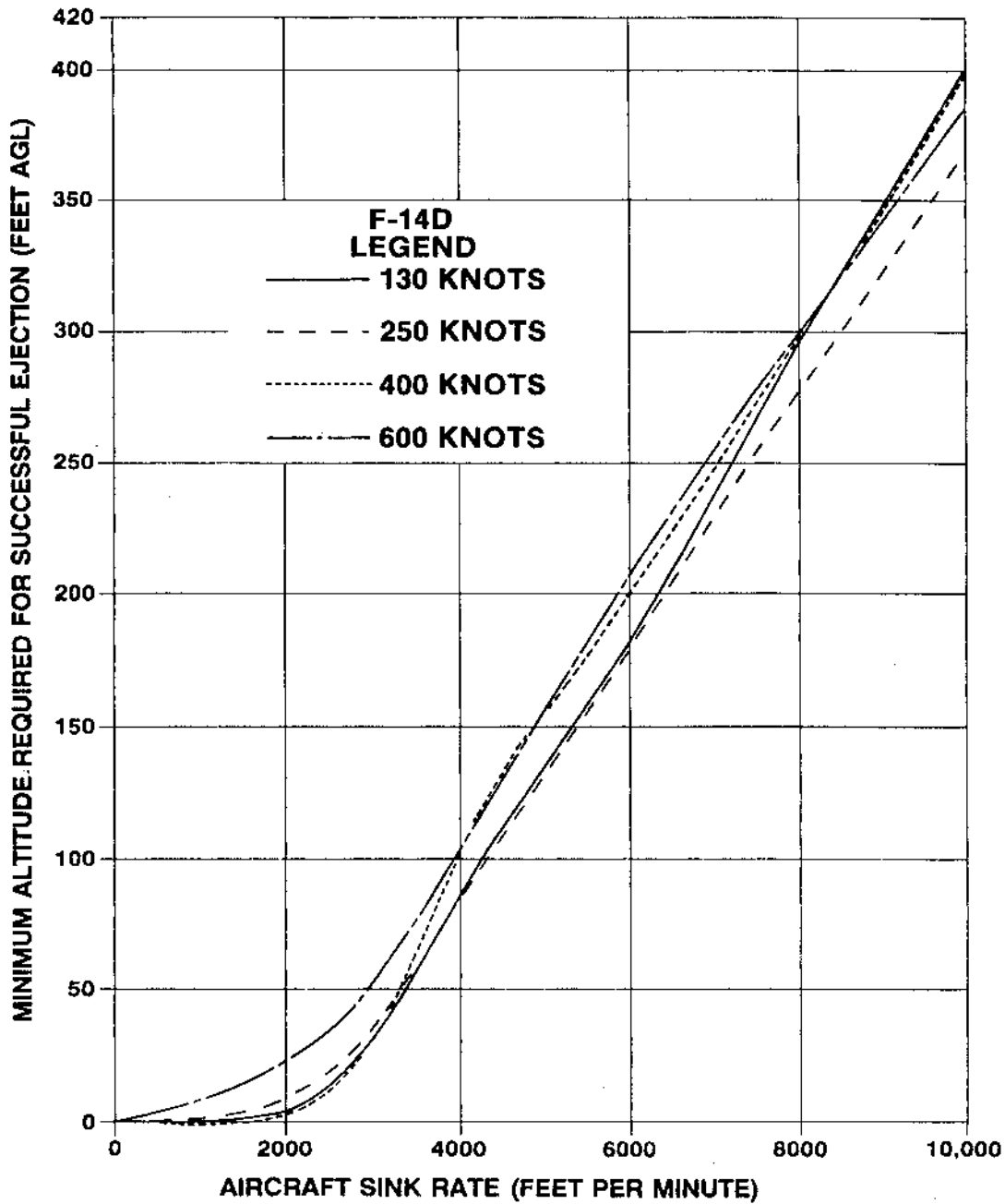
Figure 16-1 shows minimum ejection altitude for a given airspeed and sink rate, bank angle, and dive angle. For all ejections, it is recommended that airspeed be reduced as much as practicable; however in uncontrolled situations, do not delay ejection because the aircraft is not within the published 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](#).

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 an increased risk of injury.

1. General Injury Risks:
 - a. Ejection 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.

MINIMUM EJECTION ALTITUDE AIRSPEED AND SINK RATE EFFECTS

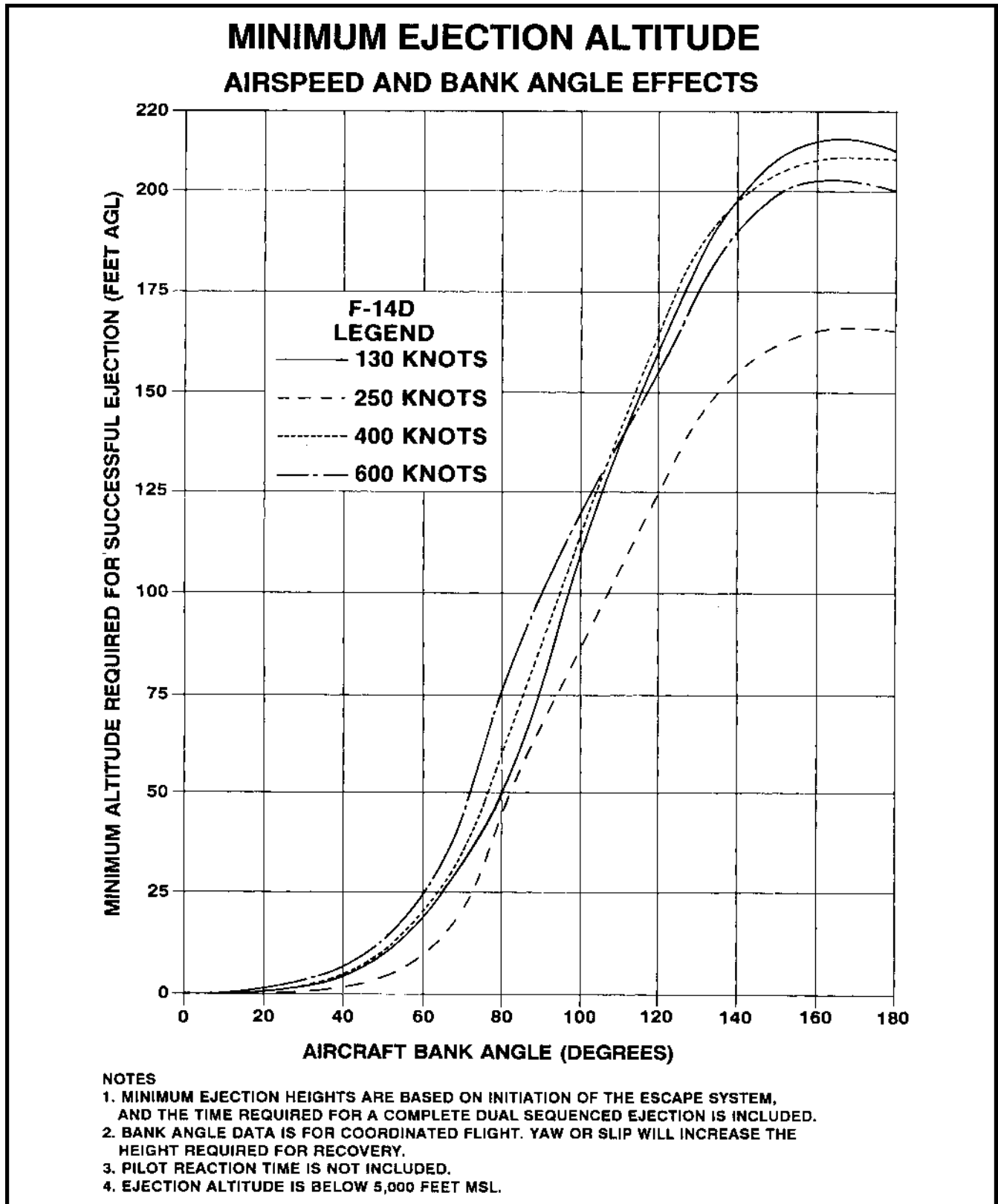


NOTES

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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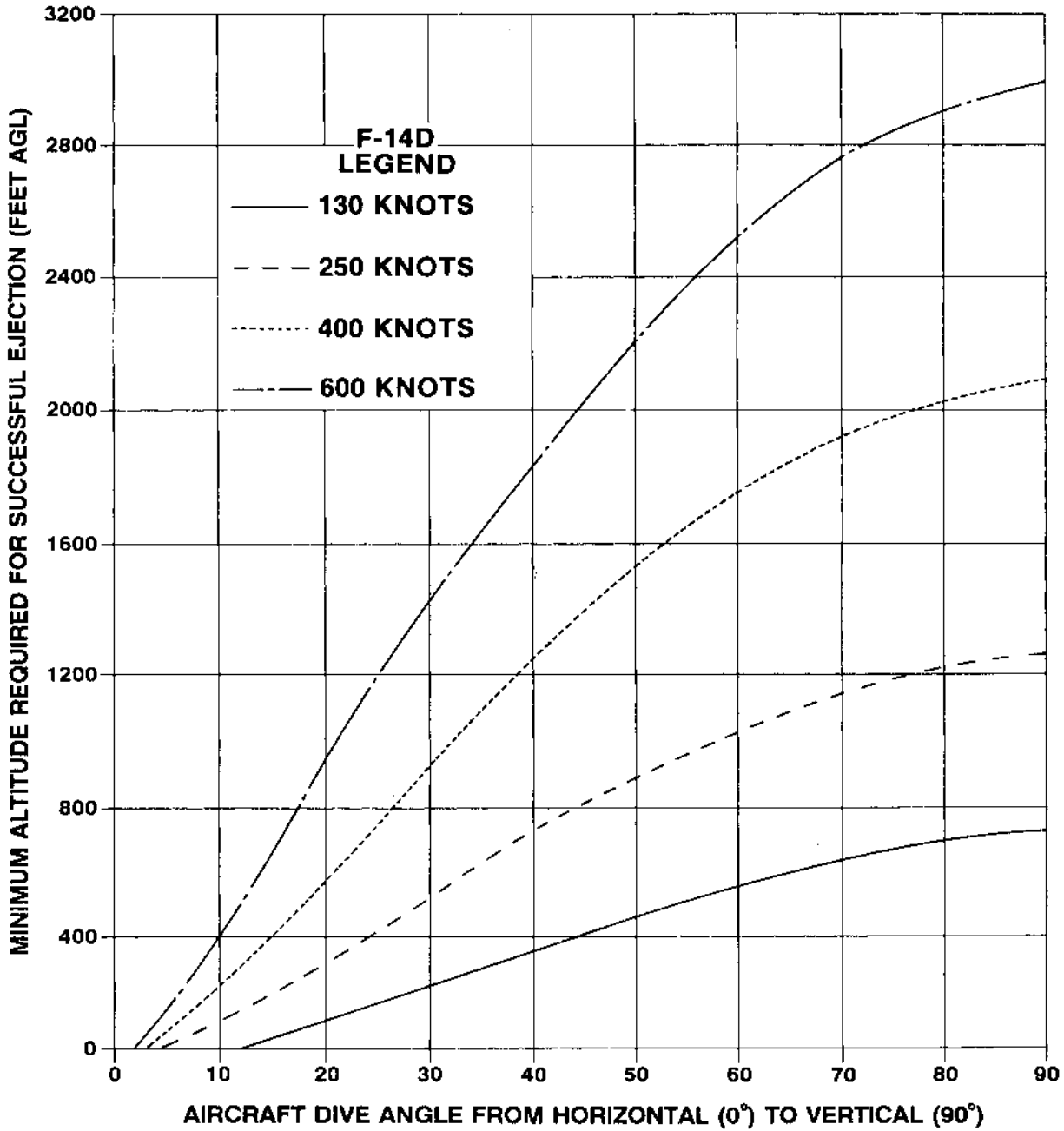
Figure 16-1. Minimum Ejection Altitude (Sheet 1 of 3)



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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)

- 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:
- 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.
 - Lighter weight occupants are at a greater risk of injury during ejections above 300 KIAS due to instability during drogue deployment.
 - 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:
- Larger occupants may not attain sufficient altitude for parachute full inflation in zero-zero cases or at extremely low altitudes and velocities.
 - 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:

- Zero to 250 KIAS—Safe ejection (injury improbable).
- 250 to 600 KIAS—Hazardous ejection (appreciable forces are exerted on the body, making injury probable).
- Above 600 KIAS—Extremely hazardous ejection (excessive forces are exerted upon the body, making serious injury or death 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:

- Place aircraft in safe envelope and attitude for ejection.
- Warn other crewmember.
- EJECT CMD lever — Select (RIO).
- IFF/SIF — EMERG/7700 (RIO).
- Position report — Transmit.
- Check altimeter.
- Assume proper ejection position (see [Figure 16-2](#)).
 - Head pressed back against headrest
 - Chin slightly elevated (10° up).
 - Back straight.
 - Hips against seat back.
 - Thighs flat on seat survival kit.
 - Outside of thighs pressed against side of seat.
 - Elbows and arms pressed firmly against body.
 - Feet on rudder pedals, heels on deck.
 - Visor down, oxygen mask tightened, helmet secure.

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.

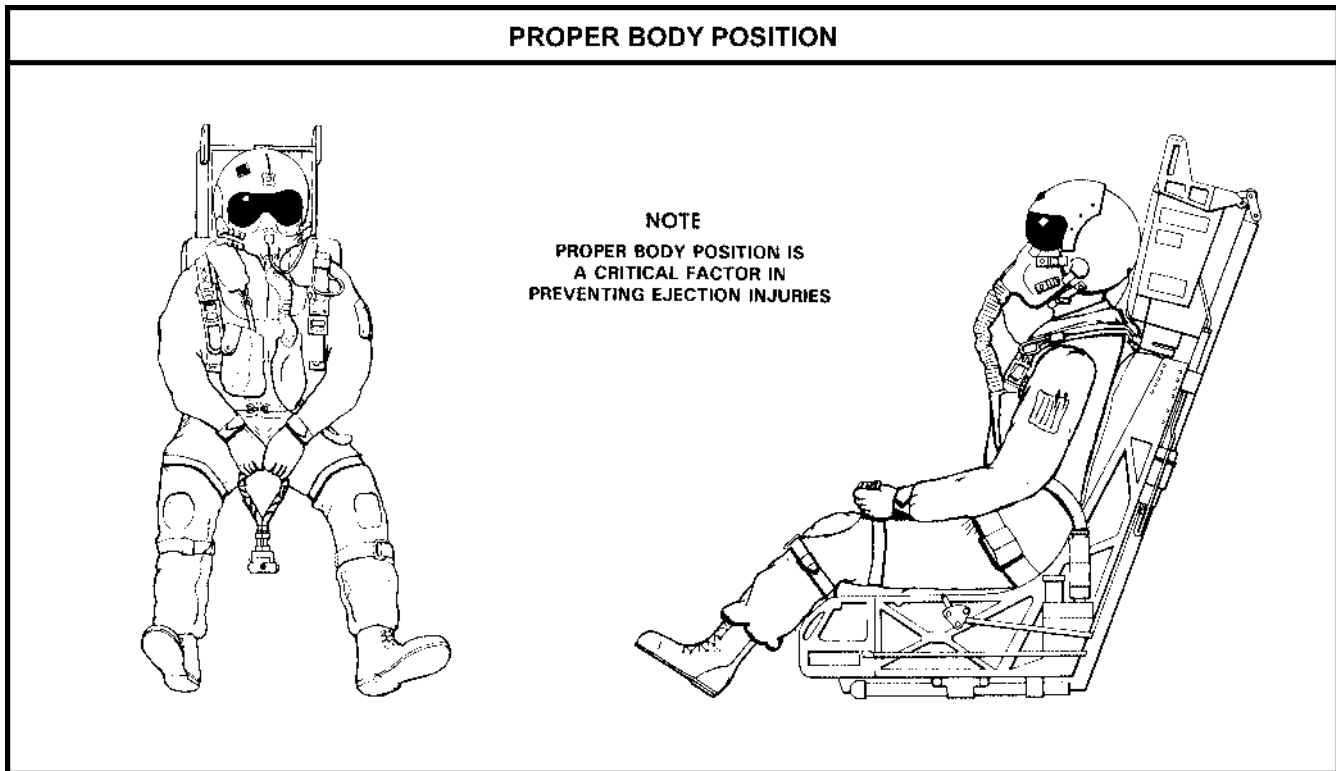


Figure 16-2. Proper Ejection Position

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 CO₂ cylinder.

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.

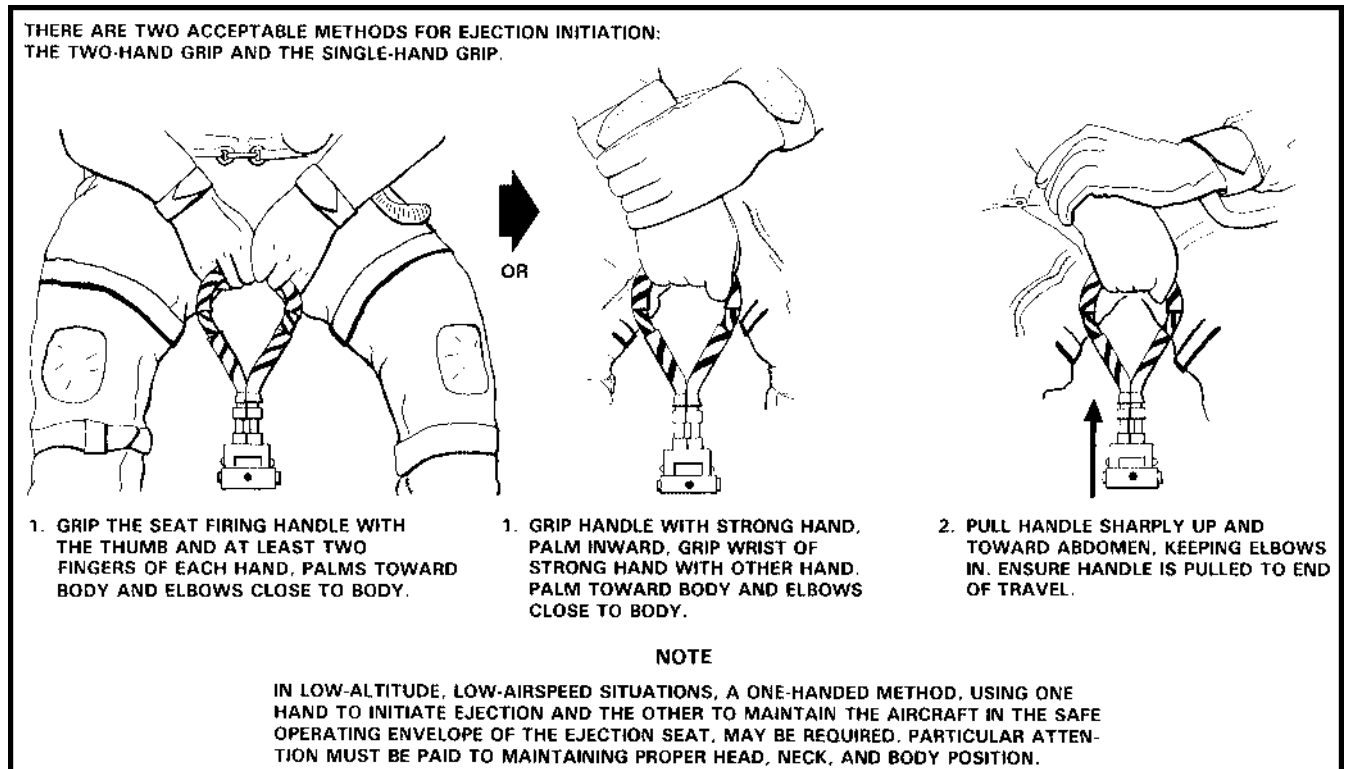


Figure 16-3. Ejection Initiation

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.

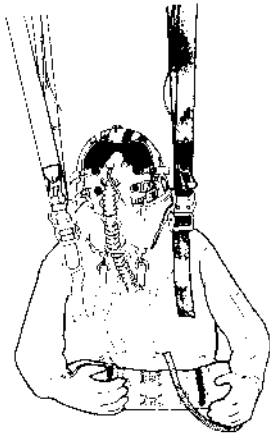
16.3.2 Survival Kit Deployment

Note

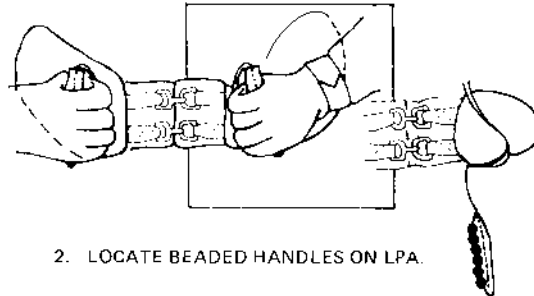
Survival kit deployment is not recommended in an overland ejection situation. The kit can be opened after landing by removing the closure pins from the cones.

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.

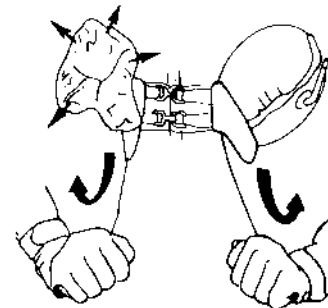
LPU INFLATION



1. IMMEDIATELY FOLLOWING OPENING SHOCK, CHECK CONDITION OF PARACHUTE. IF THERE IS NO DAMAGE/MALFUNCTION. . . .



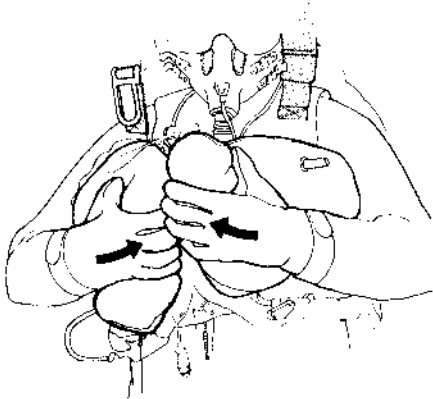
2. LOCATE BEADED HANDLES ON LPA.



3. PULL BEADED HANDLES DOWN AND STRAIGHT OUT TO INFLATE.

WARNING

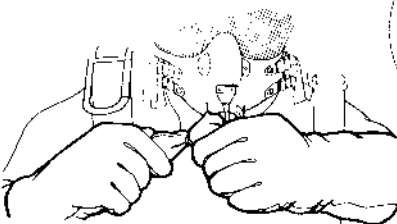
ALTHOUGH THE FLU-8 AUTOMATIC INFLATION DEVICE IS DESIGNED TO INFLATE THE LPA UPON WATER CONTACT, MANUAL INFLATION REMAINS THE PRIMARY MODE OF OPERATION. AUTOMATIC ACTUATION IS INTENDED FOR DISABLED OR UNCONSCIOUS SURVIVORS OR IF THERE IS INSUFFICIENT TIME TO MANUALLY ACTIVATE THE LPA.



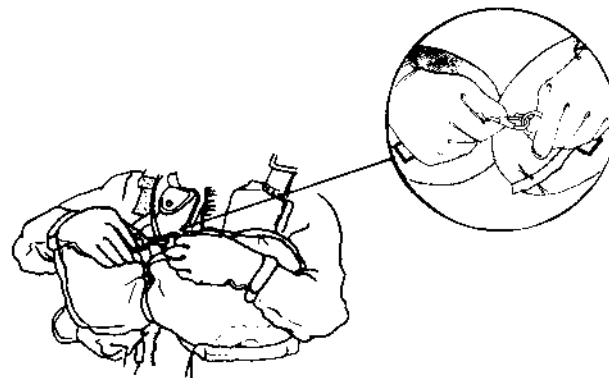
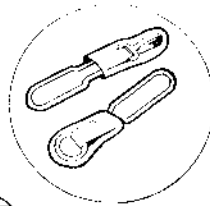
4. SQUEEZE LPA WAIST LOBES TOGETHER TO HELP RELEASE VELCRO ON COLLAR LOBE OR MANUALLY RELEASE VELCRO ON COLLAR, IF NECESSARY, TO ACHIEVE COMPLETE COLLAR LOBE INFLATION.



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

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 CO₂ 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 (stem); grasp the stem, 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 capsizes 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 the 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, DFCS, 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 DFCS. 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 Digital Flight Control System

The DFCS 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 DFCS control panel arms the mode and displays the A/P REF advisory on the pilot MFD No. 1. A/P REF indicates that an DFCS 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 DFCS 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 warmup; 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 selfcheck 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 lockon 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.

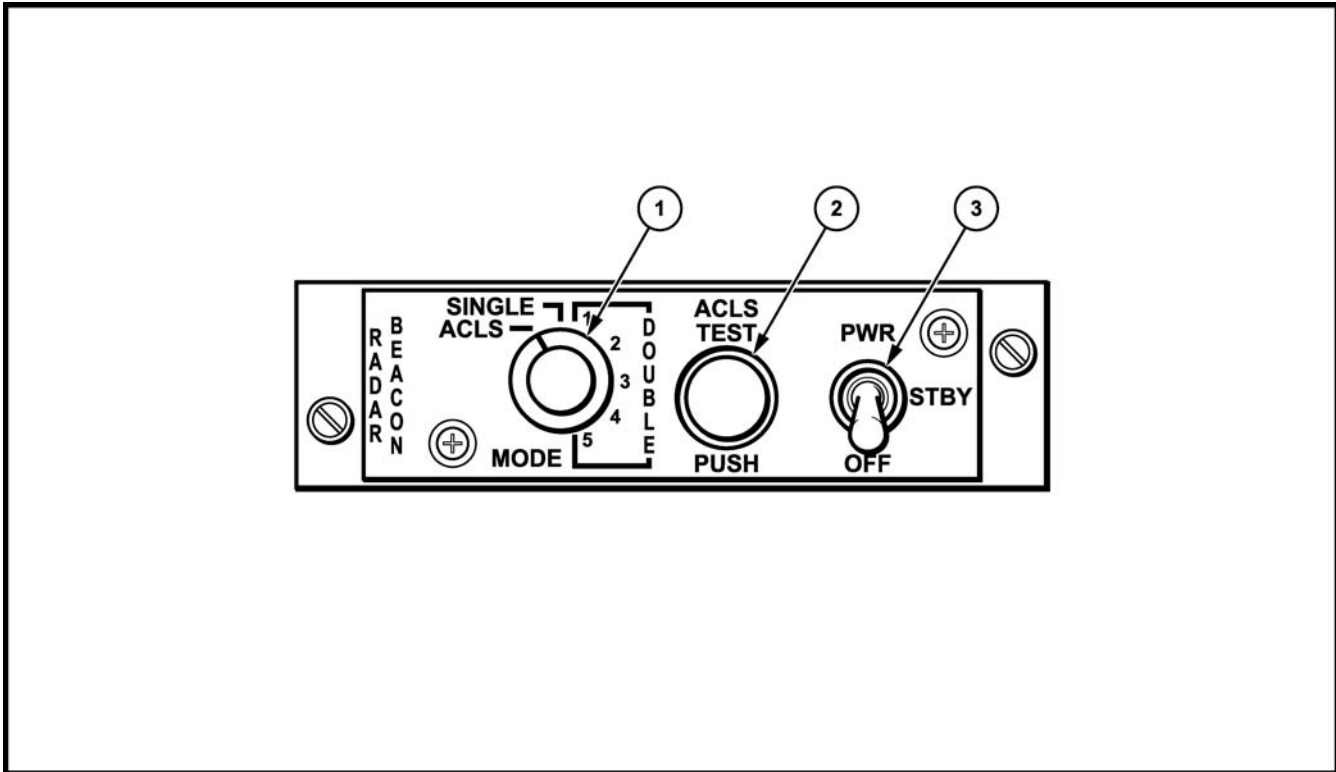
17.2.6 ACLS/ILS Displays (MFD and HUD)

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 20 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.



CSC-F14D-1-17-001

NOMENCLATURE	FUNCTION
<p>① MODE switch</p>	<p>SINGLE — Limits beacon response to single pulse of any code group received.</p> <p>DOUBLE — Beacon response set to one of five double-pulse interrogations.</p> <p>ACLS — Enables augmentor operation.</p> <div style="border: 2px solid black; padding: 5px; text-align: center; margin: 10px 0;"> <p>WARNING</p> </div> <p>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.</p>
<p>② ACLS TEST PUSH light/pushbutton</p>	<p>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.</p> <p>Flashing — Indicates AN/SPN-42 is sweeping through aircraft but has not locked on.</p> <p>Intermittent (or no light) — During self-test, indicates a fault in the ACLS mode only.</p>

Figure 17-1. Radar Beacon Panel (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>③ Power switch</p>	<p>PWR — With radar beacon mode selector in ACLS, enables I-band replies to Ka-band interrogations.</p> <p>STBY — Used for warmup with radar beacon MODE switch in SINGLE or DOUBLE.</p> <p style="text-align: center;">Note</p> <p>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.</p> <p>OFF — Turns off all power to radar beacon.</p>

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)

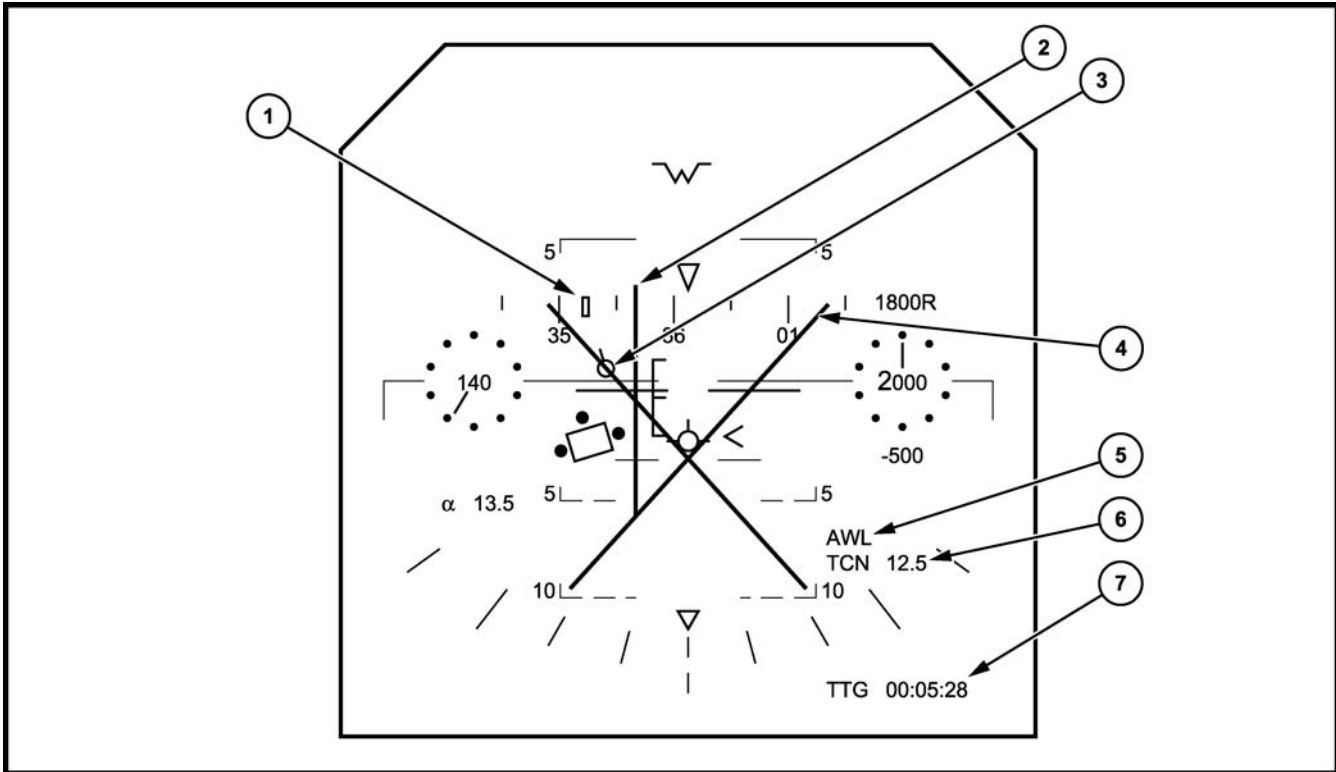
The aircraft ILS uses the AN/ARA-63 receiver decoder to process AN/SPN-41 confirmation. This system is used for manual instrument landing approaches or as an independent monitor during final approach with the ACLS. The AN/ARA-63 decoder panel (Figure 17-3) is located on the pilot right-side outboard 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.

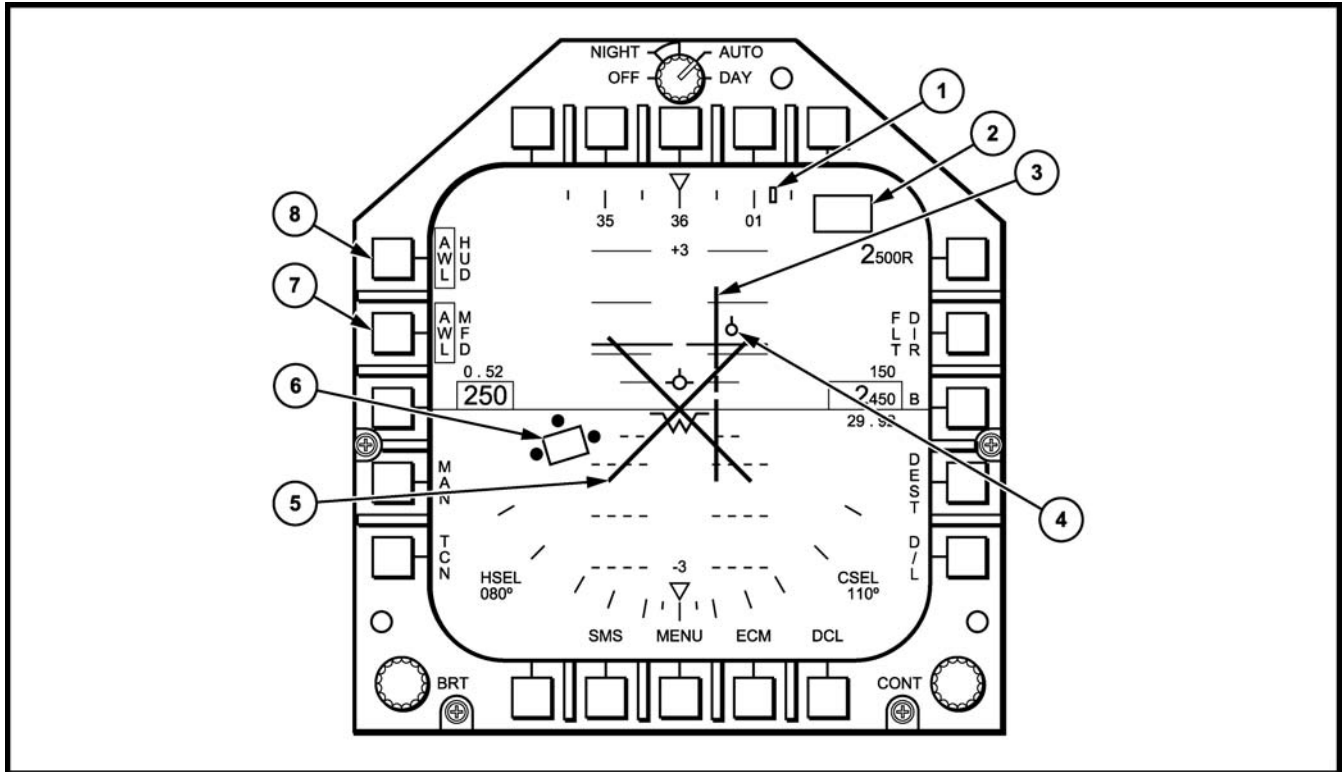
The ILS performs a self-test when the BIT pushbutton on AN/ARA-63 decoder panel is depressed and held. Response to the ILS self-test is displayed, providing ILS or BOTH is selected on HUD and MFD. The correct ILS landing mode display on the HUD and VDI display during system checkout shows the vertical 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.



CSC-F14D-1-17-002A

NOMENCLATURE	FUNCTION
<p>① Command Heading Marker</p>	<p>HUD Symbology – TLN Gear Up Basic Format</p>
<p>① Command Heading Marker</p> <p>② ILS Precision Course Vectors</p>	<p>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.</p>
<p>② ILS Precision Course Vectors</p> <p>③ ACLS Tadpole</p>	<p>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.</p>
<p>③ ACLS Tadpole</p> <p>④ Waveoff</p>	<p>Provides ACL Steering commands driven by the SPN-42 data link.</p>
<p>④ Waveoff</p> <p>⑤ All Weather Landing Steering Legend</p>	<p>A large “X” will appear flashing in the center of the display to indicate a waveoff data link discrete command.</p>
<p>⑤ All Weather Landing Steering Legend</p> <p>⑥ TACAN Range</p>	<p>Indicates the selection of AWL Steering.</p>
<p>⑥ TACAN Range</p> <p>⑦ Clock/Timer</p>	<p>Indicates distance to the TACAN station.</p>
<p>⑦ Clock/Timer</p>	<p>Indicates time-to-go to selected destination (TACAN) if selected from HSD CLK pushbutton.</p>

Figure 17-2. ACLS/ILS Steering (Sheet 1 of 3)



CSC-F14D-1-17-003C

NOMENCLATURE	FUNCTION
<p>① Command Heading Marker</p>	<p>VDI Symbology – AWL Steering Mode</p>
<p>② D/L Message Window</p>	<p>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.</p>
<p>③ ILS Precision Course Vector</p>	<p>Provides certain ACLS commands that are uplinked to aircraft via the data link system.</p>
<p>④ ACL Steering Indicator</p>	<p>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.</p>
<p>⑤ Waveoff</p>	<p>Provides ACL Steering commands driven by the SPN-42 data link.</p>
<p></p>	<p>During carrier landings, a large “X” will appear flashing in the center of the display to indicate a waveoff data link discrete command.</p>

Figure 17-2. ACLS/ILS Steering (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
<p>6 Flight Director</p>	<p>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).</p>
<p>7 MFD AWL Display Option pushbutton</p>	<p>Permits option to display AWL (both ACL and ILS), ILS, ACL, 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, ILS, ACL and NO STEERING information on the MFD in that order.</p>
<p>8 HUD AWL Display Option pushbutton</p>	<p>Permits option to display AWL (both ACL and ILS), ILS, ACL, 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, ILS, ACL, and NO STEERING information on the HUD in that order.</p> <p style="text-align: center;">Note</p> <p style="text-align: center;">The RIO is inhibited from deselecting AWL steering once selected from any MFD.</p>

Figure 17-2. ACLS/ILS Steering (Sheet 3 of 3)

17.3 SURFACE SUBSYSTEMS

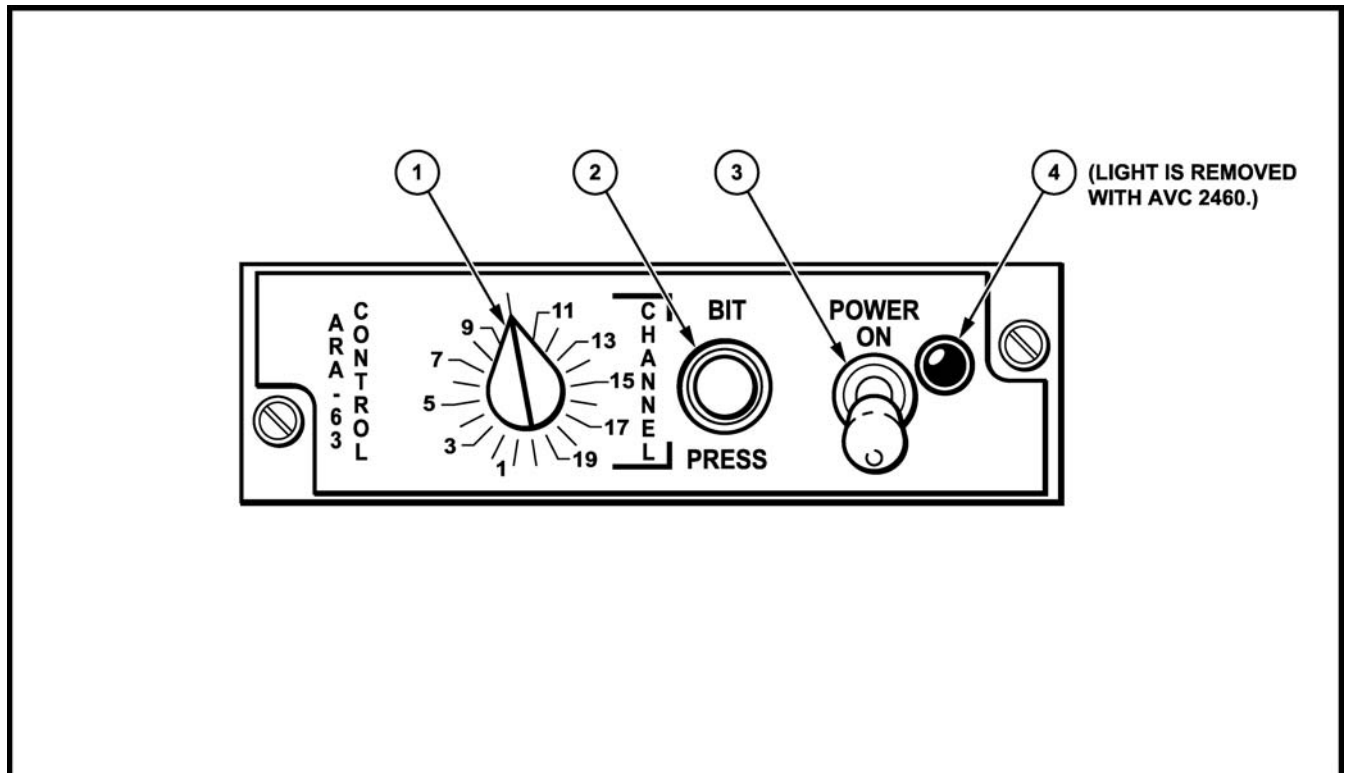
17.3.1 Automatic Landing System (AN/SPN-42)

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).



CSC-F14D-1-17-004

NOMENCLATURE	FUNCTION
<p>① CHANNEL selector</p>	<p>Twenty possible channel selections by rotation of selector knob.</p>
<p>② BIT PRESS-to-test button</p>	<p>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.</p>
<p>③ POWER switch (lock-lever)</p>	<p>ON – Activates receiver decoder for all-weather carrier landing. OFF – Turns system off. Lock-lever switch must be lifted to OFF.</p>
<p>④ Indicator light (light is removed with AVC 2460)</p>	<p>Lights when AN/ARA-63 is on.</p>

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

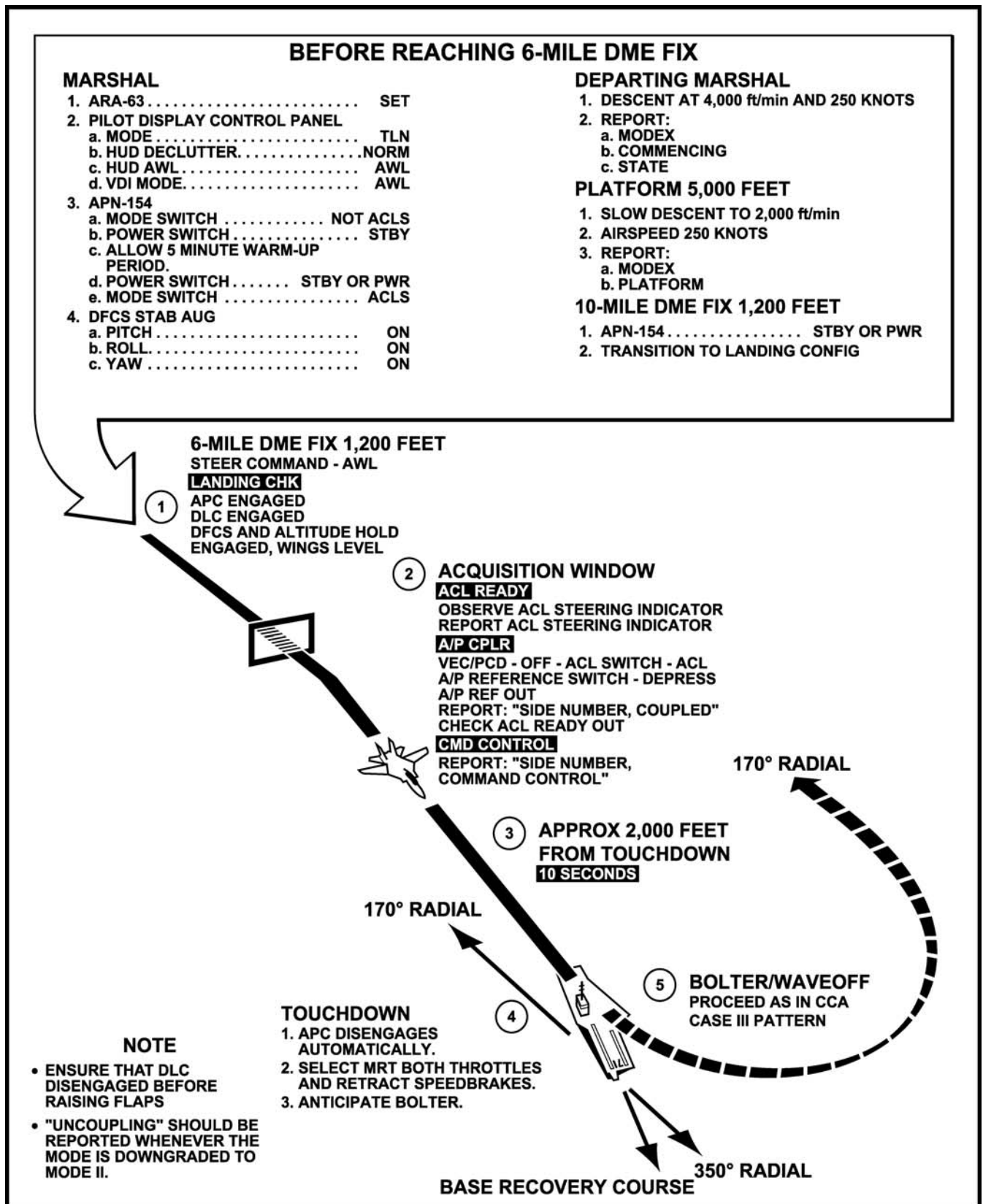
When DATA LINK is selected, the D/L vector display is added to the basic landing display. Command heading relative to the heading tape is added to the HUD and VDI display along with commanded altitude and airspeed on the right and left side of the VDI display. Data-link vector information is available 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.



CSC-F14D-1-17-005A

Figure 17-4. ACLS Mode I and II Approaches

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 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 displays the ACL RDY 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

- ACLS Mode I/IA approaches are authorized with AN/SPN-46 systems.
- 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 displays the A/P CPLR advisory and indicates that the pilot has the option of coupling the DFCS to data-link commands of pitch and bank. At this time, the aircraft should be in a landing configuration with APC, DLC, DFCS, and altitude hold engaged.

Note

The radar should be in STBY or PULSE search to avoid beacon interference problems.

The DFCS should be armed in the ACL relief mode with the A/P REF displayed, indicating that a pilot relief mode (in this case, ACL) has been selected but not engaged. The pilot can couple the DFCS to the data link by means of the autopilot engage button on his control stick, at which time, if the DFCS is functioning properly and the ACL interlock is true, the AP REF legend will go out. The pilot should report coupled; at which time, the controller will send a discrete command control message that displays the CMD CONTROL advisory. The NTDS begins transmitting data-link, pitch and bank commands to the aircraft. The autopilot actuates the appropriate control surface to execute the desired command, while the autothrottle (APC) maintains approach angle of attack by controlling the throttle setting.

Note

Care should be taken not to couple up in even a slight climb. If above reference altitude when initial pitch commands are sent, the resulting nose down correction is likely to cause a force link disconnect resulting in automatic decouple and an inability to perform mode IA approaches until maintenance action is performed.

Whenever the aircraft exceeds the Mode I flightpath control envelope, the system automatically sends a signal to uncouple the DFCS (A/P CPLR legend 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 DFCS

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 DFCS 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-foot altitude and ½-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 DFCS holds the aircraft's attitude to touchdown unless the pilot elects to override the DFCS either by maneuvering the control stick or by manually disengaging the DFCS and assuming control. Aircraft may also be disengaged by momentarily depressing the A/P REF / NWS pushbutton located on the control stick (this will not illuminate a MASTER CAUTION light). If the aircraft bolters or if the pilot decides to go around, the DFCS is disengaged automatically by means of overriding the control stick, and the pilot enters the bolter/waveoff pattern.

Note

- The paddle switch will only disengage the autopilot; the DLC as well as PITCH and ROLL SAS will remain engaged.
- The paddle switch will still revert throttles to MANUAL mode and the engines to emergency SEC mode with weight-on wheels. The paddle switch may revert the engines to the emergency SEC mode in flight with a WOW failure.

- The paddle switch will illuminate the MASTER CAUTION light.

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, receives LANDING CHK, and arrives at the ACLS radar acquisition gate. When the lock-on discrete (ACL RDY) message is received, the pilot continues to fly the aircraft manually (using APC as desired) in response to VDI and/or HUD displays.

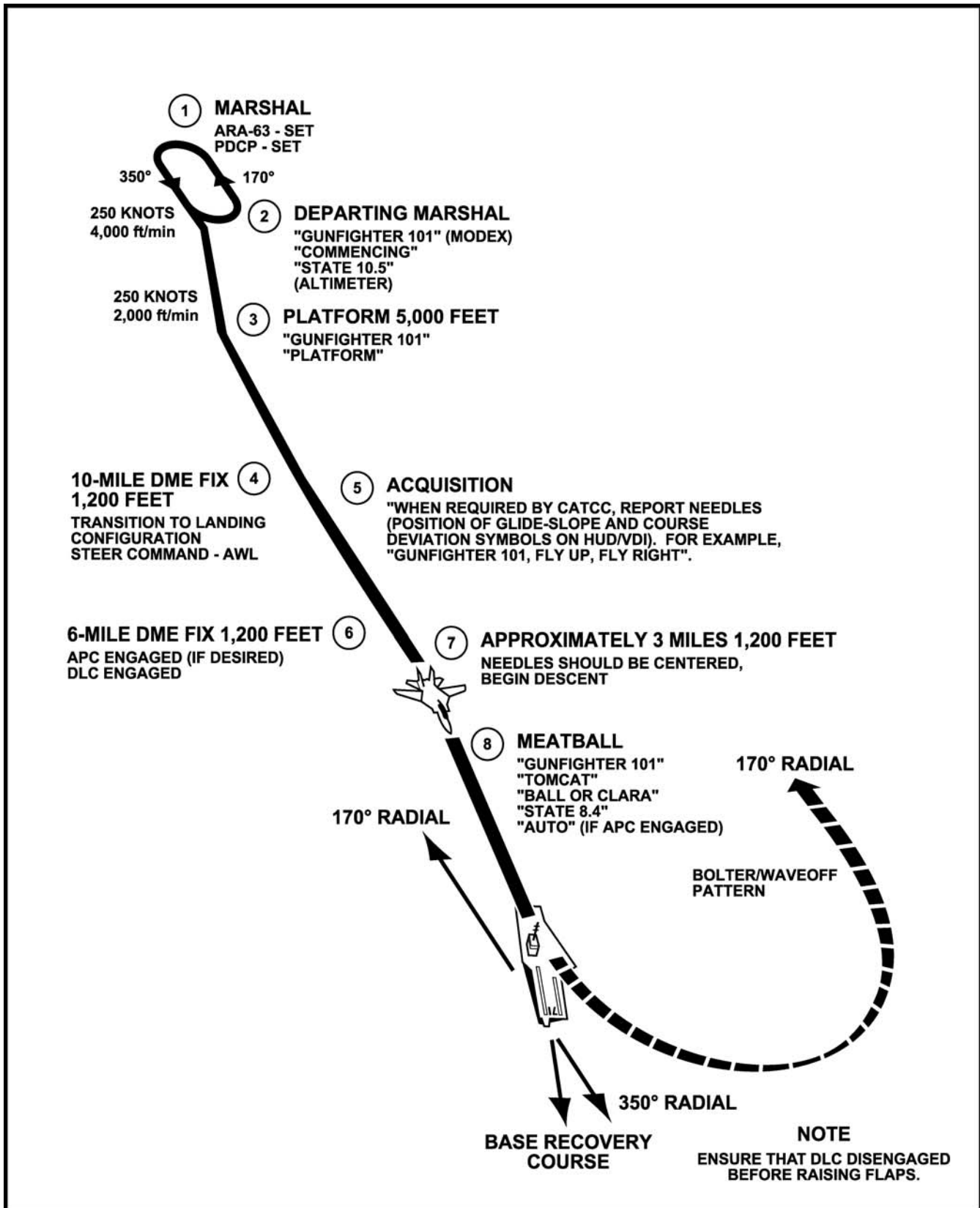
If there is an equipment failure, the system (CATCC) will send a voice discrete signal that turns on the VOICE advisory, and the AN/SPN-42 error information displayed will be invalid and thus removed. The pilot then expects to receive standard voice commands and will probably use the redundant ILS information 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 or the LSO. Approaches are terminated at weather minimums (200-foot altitude and ½-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.



CSC-F14D-1-17-006

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

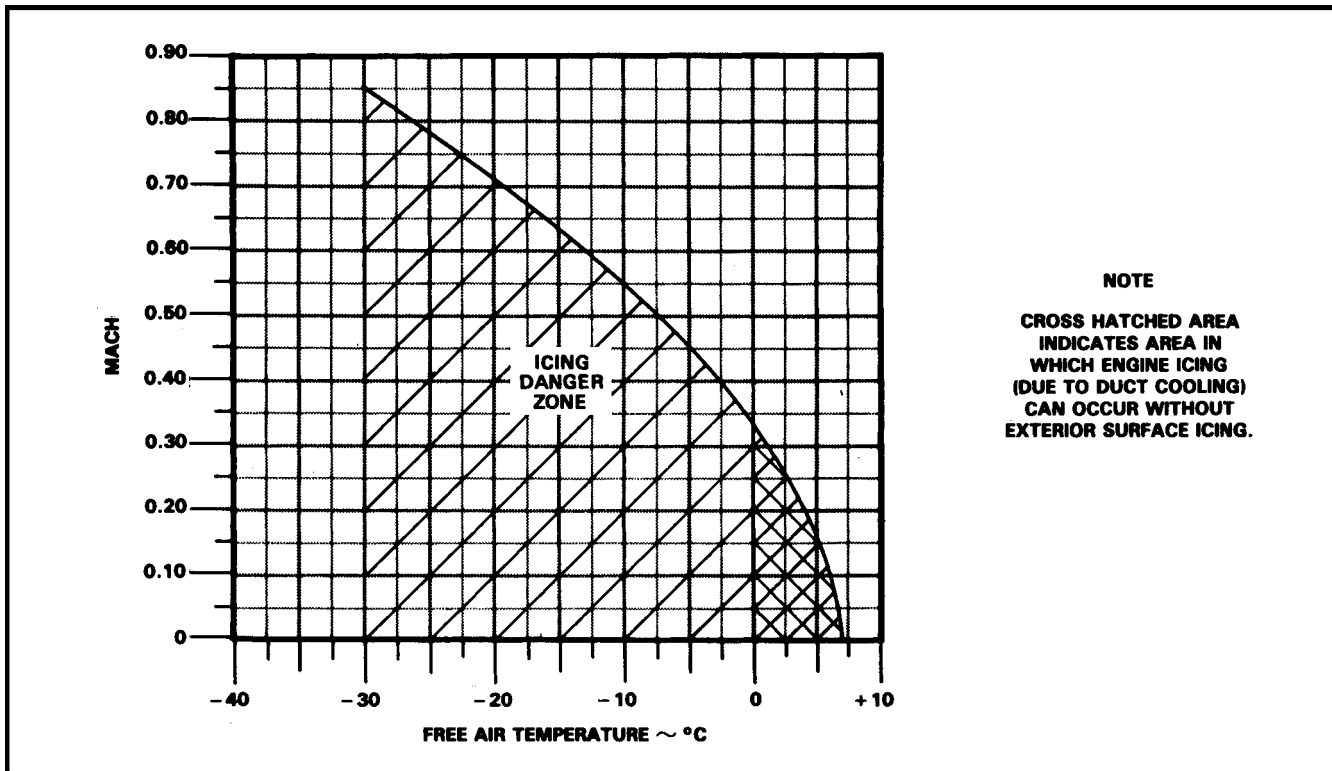
Whenever rain is encountered, turn ANTI-ICE switch to AUTO/OFF.

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.



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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 (in knots) is represented by the following mathematical formulas: 9 times the square root of the tire inflation pressure (in psi) 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 side-force coefficients become almost nonexistent.

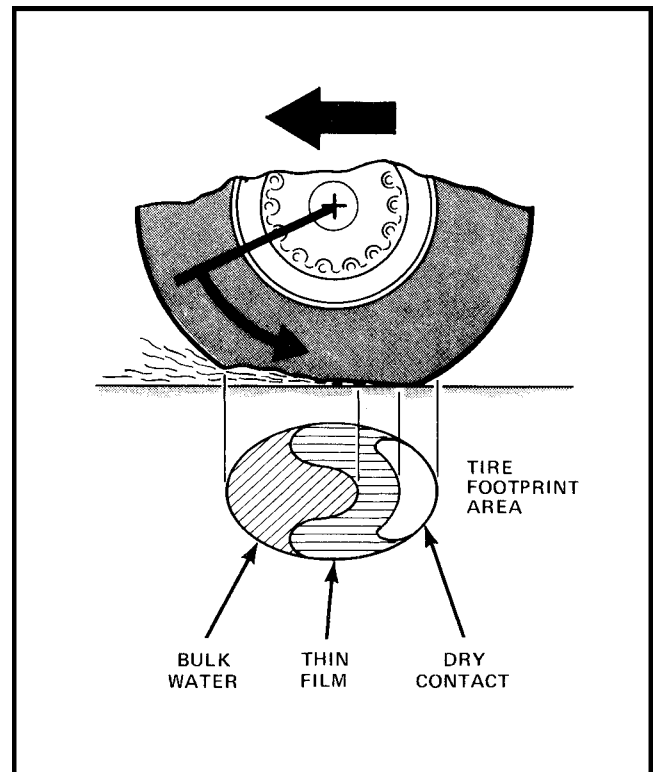
18.2.2 Viscous Hydroplaning

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 on 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.



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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 autopilot functions of DFCS 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, highspeed 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.



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.



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.



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 F/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.

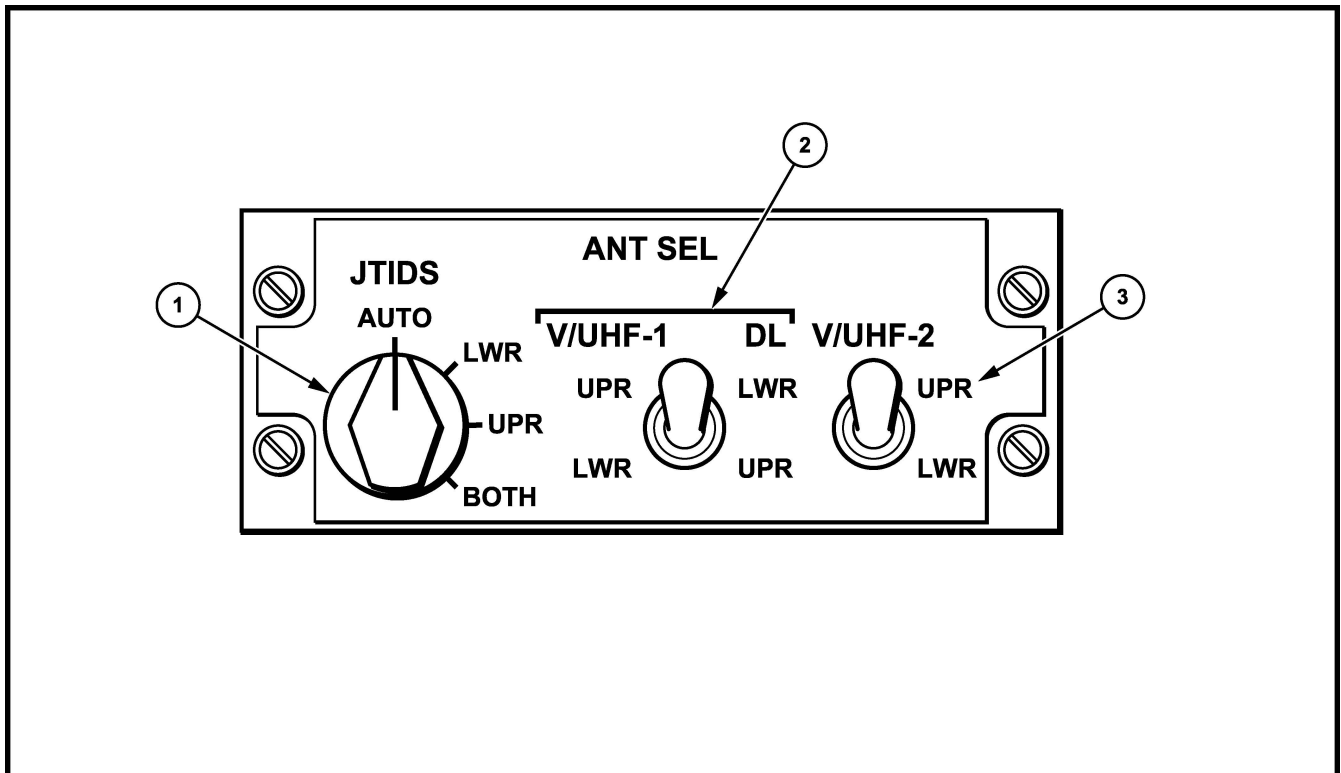
JTIDS will not interfere with any of the V/UHF communication radios or data link because it uses a higher frequency band. TACAN compatibility, which is in the same frequency band (L-band) as JTIDS, is performed internally by JTIDS.

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.).

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

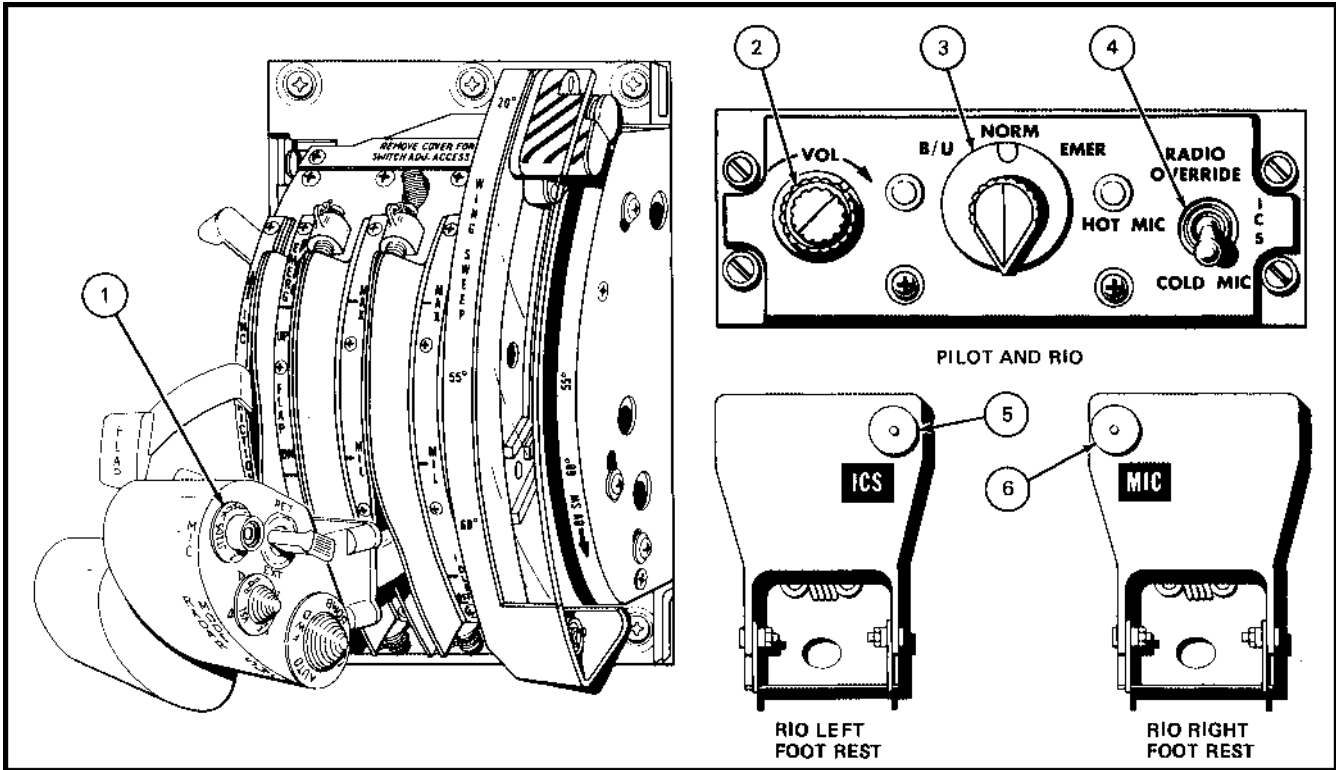
Figure 19-1. Communications and Associated Equipment



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NOMENCLATURE	FUNCTION
<p>① JTIDS antenna select switch</p>	<p>AUTO — Enables JTIDS to transmit on the upper antenna and to receive on either the upper or lower antenna depending upon signal strength.</p> <p>LWR — Enables JTIDS to transmit and receive on the lower antenna.</p> <p>UPR — Enables JTIDS to transmit and receive on the upper antenna.</p> <p>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.</p>
<p>② V/UHF-1 DL antenna select switch</p>	<p>UPR/LWR — Selects upper V/UHF 1 and lower D/L antenna.</p> <p>LWR/UPR — Selects lower V/UHF 1 and upper D/L antenna.</p>
<p>③ V/UHF-2 antenna select switch</p>	<p>UPR — Selects upper V/UHF 2 antenna.</p> <p>LWR — Selects lower V/UHF 2 antenna.</p>

Figure 19-2. Antenna Select Panel



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NOMENCLATURE	FUNCTION
<p>① Pilot's COMM switch</p>	<p>ICS — Permits intercommunication when COLD MIC is selected on function selector. Overrides V/UHF communications.</p> <p>JTIDS — Keys the JTIDS terminal for voice communications.</p> <p>V/UHF 1 — Keys ARC-182 radio for operation.</p> <p>V/UHF 2 — Keys ARC-182 radio for operation.</p>
<p>② VOL control</p>	<p>Controls intercommunication audio level at that cockpit station. Audio level at other station not affected; however in EMER volume is controlled by other station.</p>

Figure 19-3. Intercommunication Controls (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>③ Amplifier selector</p>	<p>B/U — (Backup) used to bypass a fault amplifier and uses a backup output amplifier at own station.</p> <p>NORM — (Normal) used when all amplifiers are functioning properly.</p> <p>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.</p>
<p>④ Function selector</p>	<p>RADIO OVERRIDE — Attenuates non critical radio audio to emphasize intercommunication when urgent.</p> <p>HOT MIC — Intercommunication without keying.</p> <p>COLD MIC — Intercommunication only when pilot actuates COMM switch on inboard throttle or RIO actuates keying switch on left foot rest.</p>
<p>⑤ RIO's ICS button (left foot rest)</p>	<p>Permits intercommunication if COLD MIC is selected on the function selector control. Overrides V/UHF communications.</p>
<p>⑥ RIO's MIC button (right foot rest)</p>	<p>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).</p>

Figure 19-3. Intercommunication Controls (Sheet 2 of 2)

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.

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.



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 from dc essential bus No. 1. Approximately 1 minute of warmup is required in order to achieve normal operating temperature.

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/ TA-CAN 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 Low-altitude landing gear up warning	1,000 Hz tone, modulated at 2 pulses per second, lasting 5 seconds or until altitude is increased/limit bug is lowered. Continuous tone below low-altitude index setting with landing gear handle up. Tone terminates 5 seconds after landing gear handle is placed in down position.
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

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, multi-channel, 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)

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. RT 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

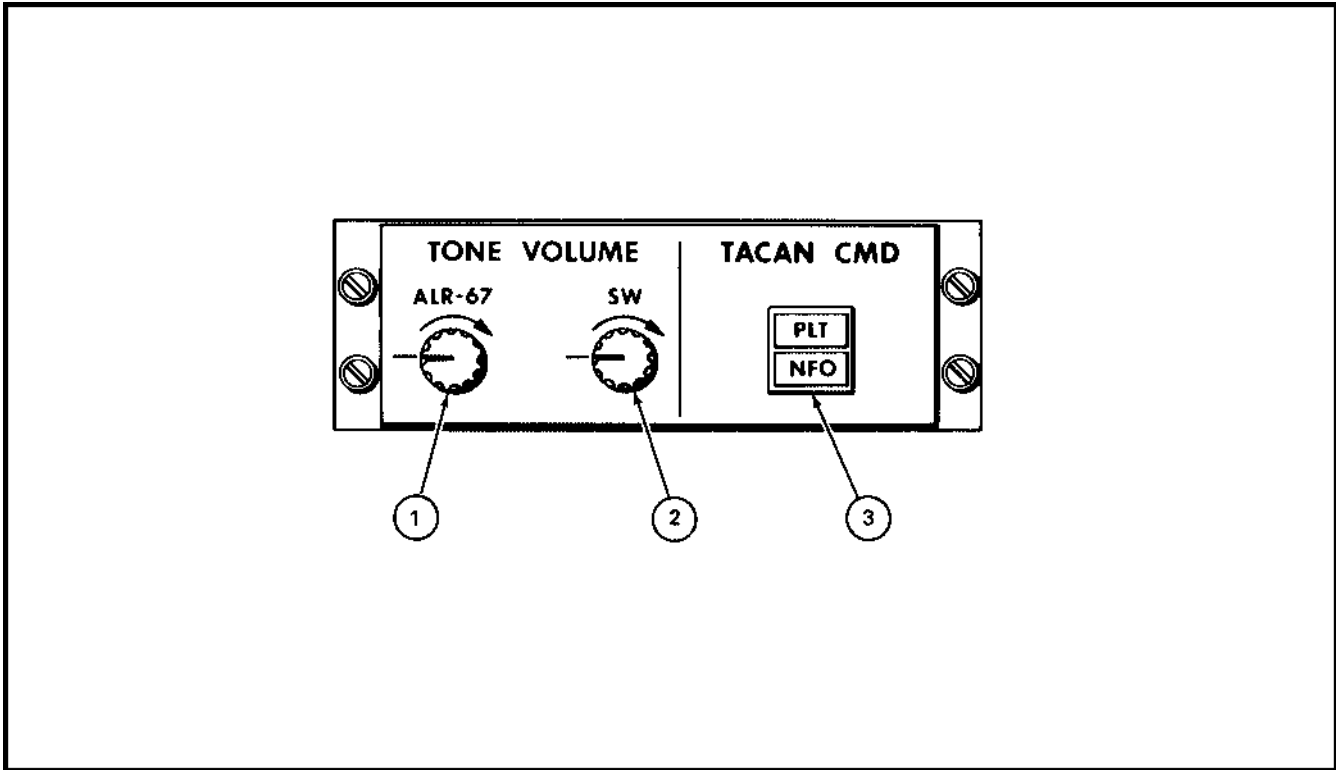
If readouts 061 or 651 display, select other antenna and key transmitter for 5 seconds, then repeat steps 1 through 3.

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.

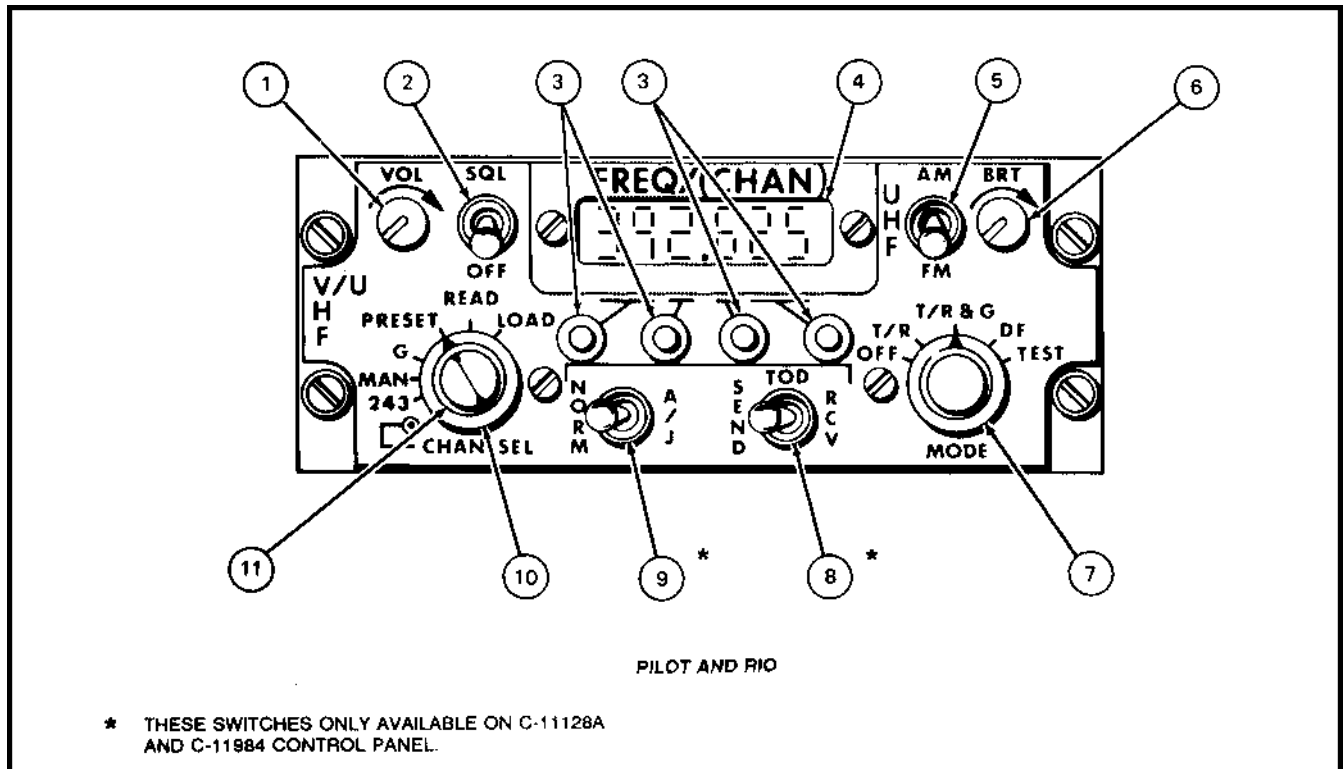
The ARC-182's Have Quick II system is compatible with older Have Quick I systems.



0-F50D-100-0

NOMENCLATURE	FUNCTION
<p>① ALR-67 volume control</p>	<p>Clockwise rotation increases tone in pilot's headset. Provides threat alert, status and warning tones representing received threat radar signals.</p>
<p>② SW (Sidewinder) volume control</p>	<p>Clockwise rotation increases missile tone in pilot's headset. Counterclockwise rotation turns tone to low.</p>
<p>③ TACAN CMD control switch/indicator</p>	<p>Illuminates when selected PLT or NFO, indicating crewman in command of TACAN.</p>

Figure 19-5. Pilot TONE VOLUME/TACAN CMD Panel



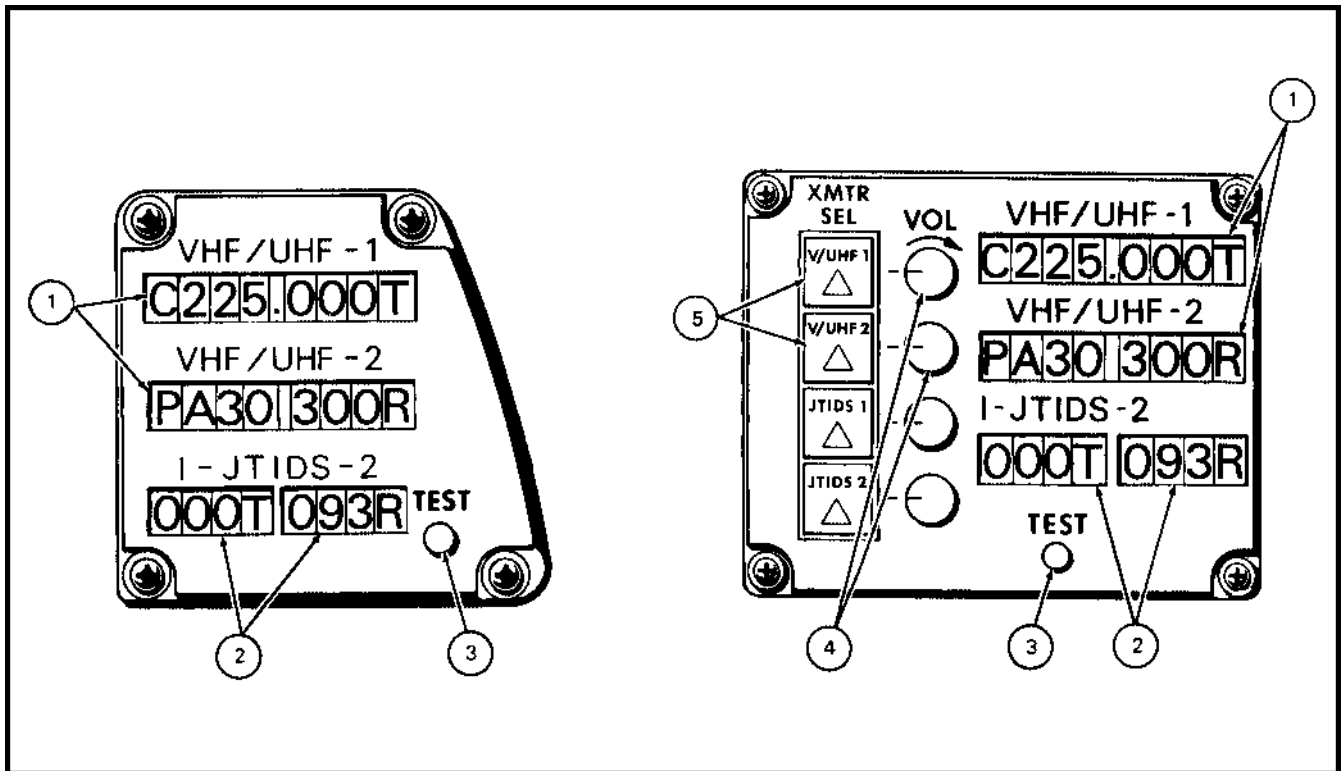
0-F50D-473-0

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	<p>OFF — Secures V/UHF radio, unless frequency mode switch is set to 243.</p> <p>T/R — Energizes transmitter and main receiver.</p> <p>T/R&G — Energizes transmitter main, and guard receivers.</p> <p>DF — Provides automatic direction finding from 108 to 399.975 MHz.</p> <p>TEST — Indicates built-in-test (BIT) RT; displayed on FREQ/(CHAN) indicator. Refer to Built-In-Test this chapter. Generates 1020 Hz un-attenuated tone.</p> <p>RCV — Allows reception of TOD messages on preset channel selected.</p> <p>SEND — Allows transmission of TOD messages on preset channel selected.</p> <p>NORM — Used for normal V/UHF communications.</p> <p>A/J — Provides jam resistant communications.</p> <p>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.</p> <p>MAN — Permits manual selection of an operating frequency using the frequency tuning switches. Transmitter and receiver are disabled during a frequency change.</p> <p>G — Tunes the receiver-transmitter to the guard frequency in the band to which the RT was last tuned.</p> <p>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.</p> <p>READ — Displays the frequency (rather than channel) of preset channel selected.</p> <p>LOAD — Automatically places the displayed frequency into the memory for the selected preset channel.</p>
⑧ TOD switch	
⑨ NORM/AJ switch	
⑩ CHAN SEL mode switch (outer dial)	
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)



1-F50D-474-0

NOMENCLATURE	FUNCTION
<p>① VHF/UHF-1 and -2 frequency/channel indicator</p>	<p>Displays information for each radio (pilot and RIO) as follows:</p> <ul style="list-style-type: none"> • 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.
<p>② 1-JTIDS-2 channel indicator</p>	<p>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.</p>
<p>③ TEST button</p>	<p>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.</p>

Figure 19-7. Radio Frequency/Channel Indicator (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
<p>④ VOL control</p>	<p>Enable RIO to adjust level of audio signal. Clockwise rotation increases audio level.</p>
<p>⑤ XMTR SEL buttons</p>	<p>Enables RIO to select desired radio for voice communications (V/UHF or JTIDS).</p> <p style="text-align: center;">Note</p> <p>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.</p>

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.

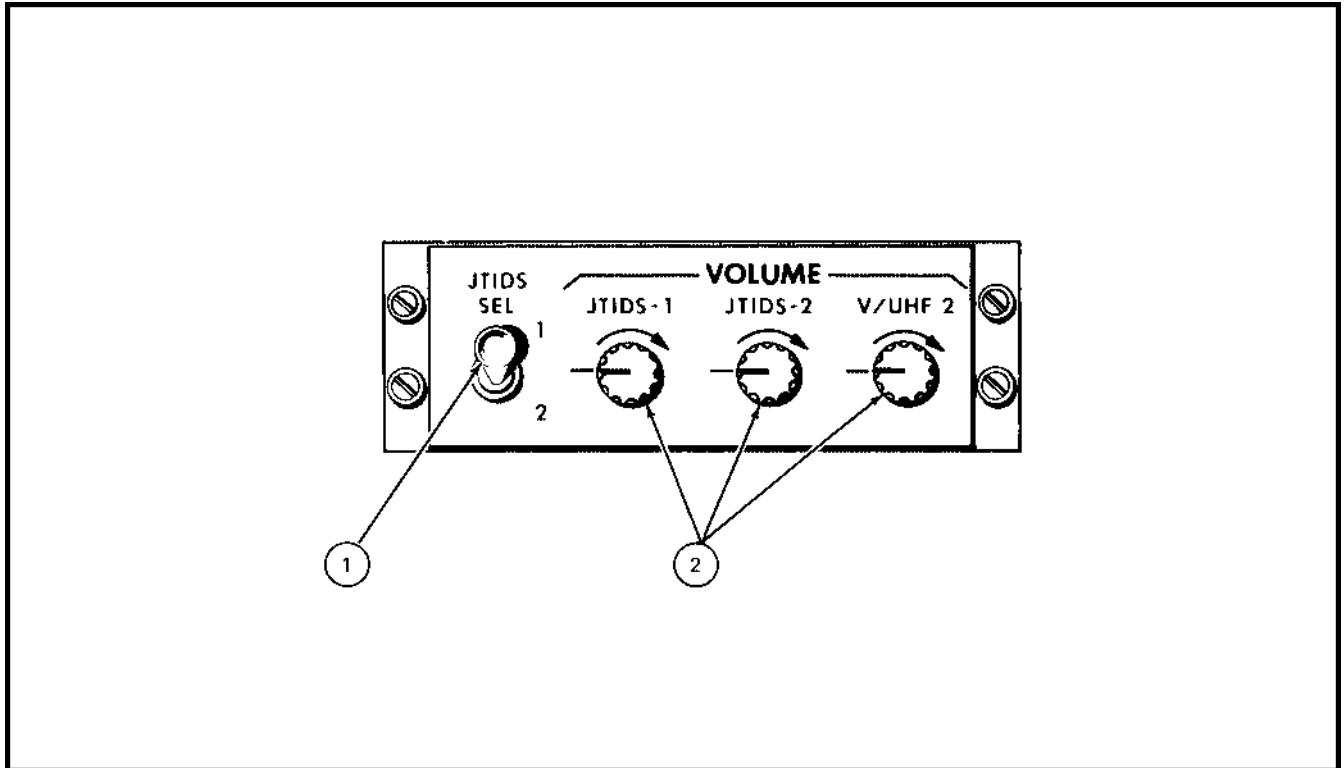
2. TRAINING

- 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 (WOD/MWOD)

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 I 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](#).



0-F50D-476-0

NOMENCLATURE	FUNCTION
<p>① JTIDS SEL switch</p>	<p>Selects JTIDS 1 or 2 voice channel for pilot's voice transmissions. Both channels are always selected to receive.</p>
<p>② JTIDS-1, JTIDS-2, V/UHF-2 volume control</p>	<p>Clockwise rotation increases audio level of received transmission (Pilot only).</p>

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 WODs 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.

19.3.4.12.1 To synchronize and load Time/Date from GPS system, perform the following steps:

1. Select OWN A/C format and verify GPS is fully aligned (FOM = 1), GPS is boxed and navigation mode is INS/GPS.
2. Select GPS Status Format and verify RCV TOD is not boxed.
3. On the VHF/UHF ARC-182 Control Panel:
 Mode Switch T/R
 Frequency Select Switch 300.025
 NORM/AJ NORM
 TDD switch MAN
 WAIT 10 SECONDS
4. On the GPS Status Page select RCV TOD. Verify it remains boxed for 5 SECONDS.
5. On VHF/UHF ARC-182 Control Panel:
 NORM/AJ Switch AJ
 Verify Frequency Indicator A00.25
 If a ? is displayed, lockup has not occurred.

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 A/J is selected, then TOD has not been received or entered. The error display for each error is shown in Figure 19-11.

ERROR DISPLAY	FREQUENCY MODE CONTROL	CONTROL ERROR
‡XX.XXX	MAN	Invalid MWOD and Date
?XX.XXX	MAN	Invalid Net Number
XXX.XXX	MAN	No TOD
X.X	PRESET	Invalid MWOD and Date
‡X X	PRESET	Invalid Net Number
?X, X	PRESET	No TOD
The "X"s in the error display column represent digits 0 to 9.		

Figure 19-11. Have Quick II Error Codes

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.
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 (RFCI)

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 sure 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 vice 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, KY-58/Z-AHP circuit breaker (7C3).

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 cipher 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 1½ 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.

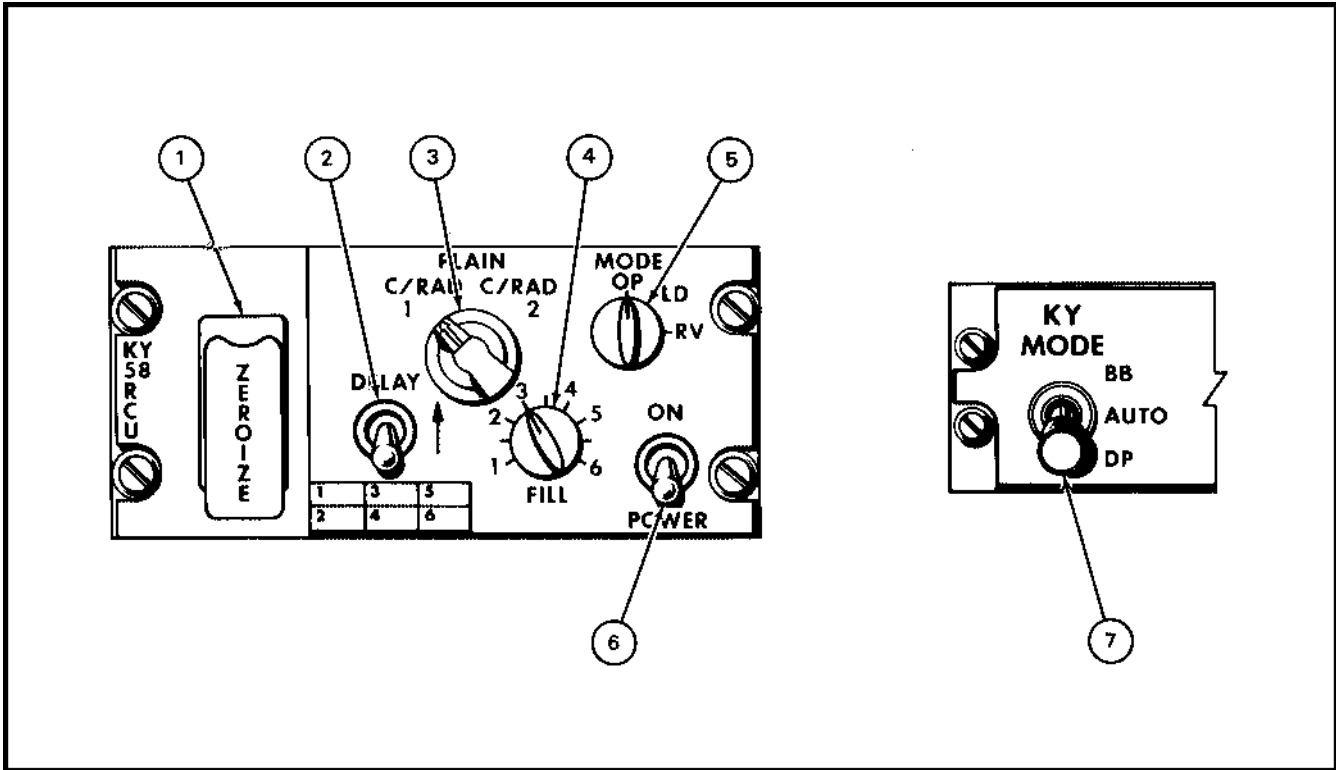
19.5.4 After Landing

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.



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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 — 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 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/ stats 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 transmit 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: surveillance, two-way AIC, and F/F. These modes are integrated into the aircraft controls and displays utilizing the PTID, DD, MFDs (TSD, VDI, and HSD formats) and DEU. Refer to NAVAIR 01-F14AAD-1A for the detailed operation of the PTID, 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 (DDP)

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 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 (SDU)

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 (LCU)

The LCU issued 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 on 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 crypt 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 (DTD)

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 DD 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 R/T 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 R/T 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 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), PTID, DD, MDL, and DEU enable the crew to interface with the aircraft weapon system to support JTIDS functions.

19.6.3 Mission Data Loader (MDL)

The MDL replaces the DSS in the rear cockpit and the DSS is installed in the nosewheel well. It consists of a receptacle that is mounted in the aircraft and a removable data transfer module (DTM) cartridge. The DTM cartridge provides storage for the navigational database, including tactical waypoints, flight plan waypoints, reversionary waypoints, GPS almanac data, and JTIDS initialization data. The DTM cartridge is loaded via Tactical Aircraft Mission Planning System (TAMPS).

19.6.3.1 Navigational Database Operation

The MDL navigational data and GPS almanac data are automatically loaded on power up. Any changes to the tactical waypoints and flight plan waypoints will be recorded on the DTM cartridge. The flight plan data can be reloaded via the RLD pushbutton on the Flight Plan format; however, any manual changes to the flight plans will be lost. Once updated tactical waypoints are permanently changed in the MDL DTM if it is in place.

19.6.3.2 JTIDS Initialization Data

Upon selection of DOWNLOAD on the DEU, the mission computer requests the JTIDS initialization data stored on the DTM, processes it, and transfers it to the JTIDS terminal. The exchange of JTIDS initialization data is performed between the MDL, 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 communications functions will not be available.

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 PPL, 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

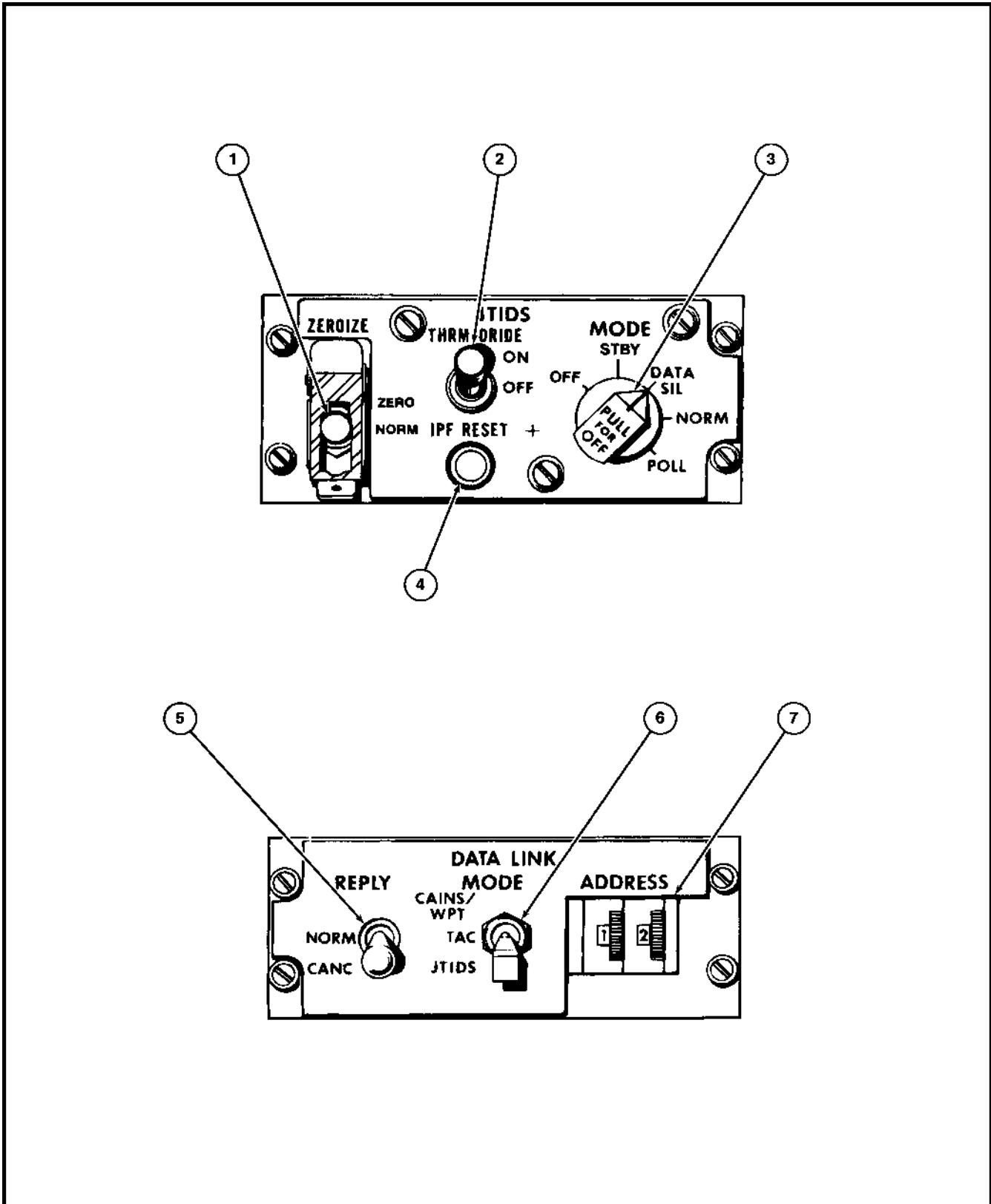
1. Verify STBY is selected on the JTIDS control panel and crypto has been loaded.
2. Verify/install the MDL cartridge.

Note

- With aircraft power ON, the MDL 28 VDC C/B (9G3) should be disengaged before installing or removing the MDL from its receptacle. Failure to remove the power can erase or damage the MDL 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 load 1/2/3, then execute the load, then ENTR (initiates MCS download of MDL JTIDS load to the JTIDS system).
3. MFD3 — Verify MDL 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 MDL — Verify MDL installed and powered up.
 - c. NO LOAD - MDL FAIL — MDL fail; try to clear failure.
 - d. LOAD ERROR-JTIDS — Bad JTIDS load; net operations will be affected.



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Figure 19-13. JTIDS Control Panels (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
<p>① ZEROIZE switch</p>	<p>ZERO — Zeroizes the crypto variables in the interface unit and the MDL JTIDS initialization load.</p> <p>NORM — Normal switch position (spring loaded).</p>
<p>② THRM ORIDE switch</p>	<p>ON/OFF — Enables manual override of thermal shutdown. Indicated by a JTIDS HOT on the MFD caution advisory window.</p>
<p>③ JTIDS MODE switch</p>	<p>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.</p> <p>STBY — The JTIDS/Link-16 functions are off, the battery will hold crypt for up to 48 hours and initialization data for 5 minutes.</p> <p>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.</p> <p>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.</p> <p>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.</p>
<p>④ IPF RESET switch</p>	<p>Re-enables Link-16 transmission when they are shut down by an IPF detected failure.</p>
<p>⑤ REPLY switch</p>	<p>NORM — Enables Link-4 reply message transmission (no JTIDS function)</p> <p>CANC — Inhibits Link-4 reply message transmission (no JTIDS function)</p>
<p>⑥ DATA LINK MODE switch</p>	<p>TAC — Selects Link-4 (AN/ASW-27C) as the primary link system. The following JTIDS functions operate in this mode.</p> <ul style="list-style-type: none"> • Synchronization • Ownship PPLI messages are transmitted (Ownship System Status messages are inhibited) • JTIDS voice (transmit and receive) • JTIDS navigation updates • TACAN <p>JTIDS — Selects Link-16 (AN/URC-107) as the primary link system. All Link-4 functions are disabled.</p>

Figure 19-13. JTIDS Control Panels (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
<p>7 ADDRESS thumbwheel</p>	<p>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.</p> <p style="text-align: center;">Note</p> <p>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.</p> <p>Selects fourth and fifth least significant octal digit for Link-4 address.</p>

Figure 19-13. JTIDS Control Panels (Sheet 3 of 3)

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. Time synchronization from GPS
 - a. Verify GPS is boxed and FOM = 1 on OWN A/C format.
 - b. On the JTIDS control panel, mode selection = NORM.

- c. On the DEU, select DOWNLOAD for JTIDS.
- d. OWN A/C format on MF03, select JTIDS.
- e. On DEU, set RLY/NTR to ON.
- f. Set NET ENTR: ENT

This may take several minutes to accomplish. Confirm on MFD : MENU : JTIDS that time synched to UTC and a G prefix appears. If ineffective, proceed to step 4.

4. DEU (time entry, JTIDS COMM page, TIME pushbutton) — Enter hours, minutes, seconds, and select ENT.
5. MFD3 (own-aircraft data page) — Verify correct time.
6. 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).
7. DEU (net entry, JTIDS MODE page) — Press NET ENTR pushbutton and ENT.
8. 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, PTID, JTIDS data readout pages, or IRST summary page. JTIDS must be selected on the DATA LINK control panel to process PPLI messages.

9. 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:

2. 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.	As appropriate.
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.	
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.	
Take over communications.	Tap earphones, followed by lead change signal.	Execute.

Figure 19-14. In-Flight Communications (Sheet 1 of 4)

MEANING	SIGNAL	RESPONSE
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.
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.

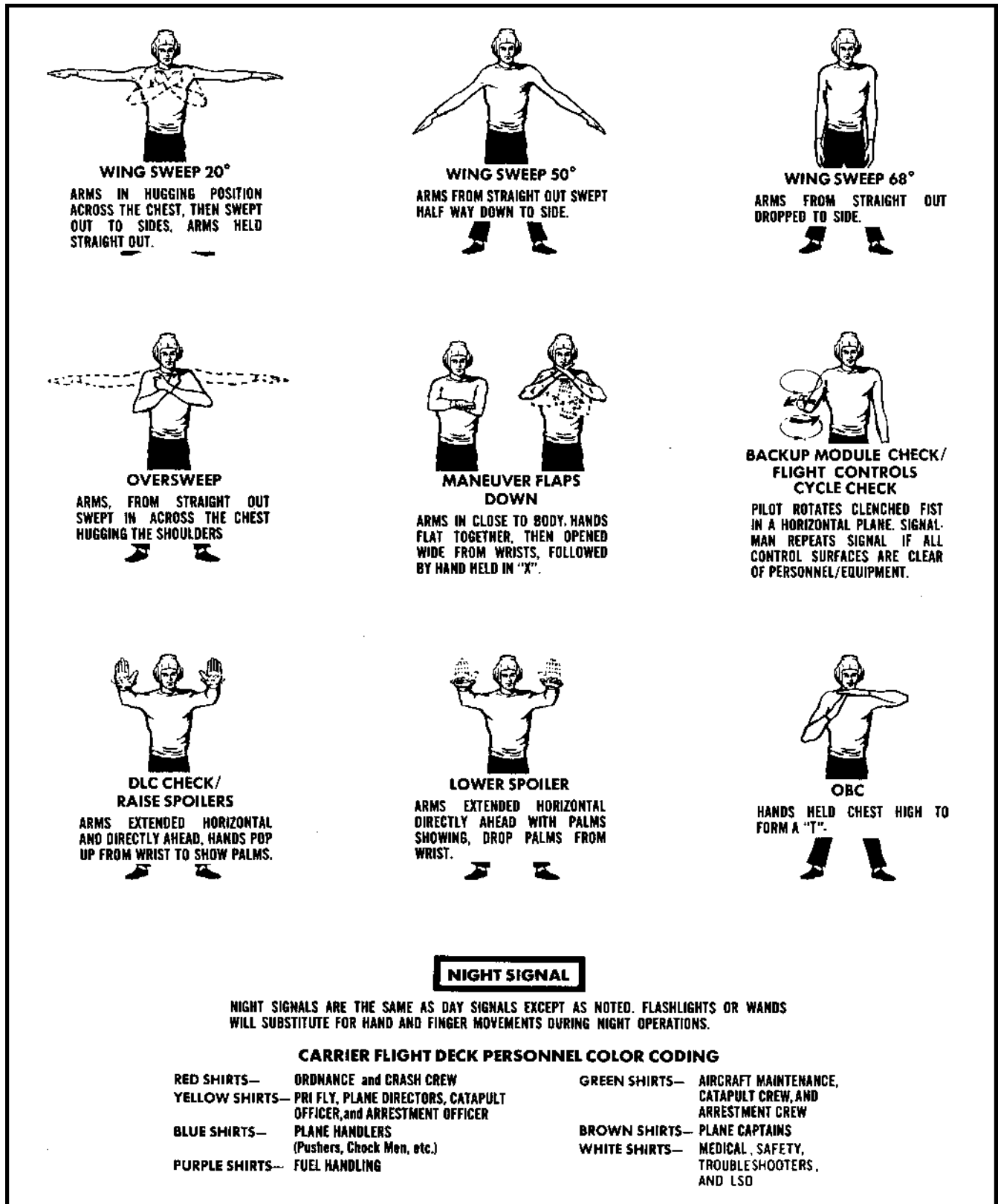
Figure 19-14. In-Flight Communications (Sheet 2 of 4)

MEANING	SIGNAL	RESPONSE
FORMATION (continued)		
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.
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 terminal 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.

Figure 19-14. In-Flight Communications (Sheet 3 of 4)

MEANING	SIGNAL	RESPONSE
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.
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)



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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 Miniaturized Airborne GPS Receiver (MAGR) provides precise position information to the ASN-139 and the MCS. It uses the Global Positioning System (GPS) constellation of satellites to very accurately fix the aircraft's position in three dimensions, and provides a source of velocity information that can be used for in-flight alignments of the INS. Under normal circumstances, the MAGR provides position and velocity updates to the ASN-139 and MCS at one second intervals. Position accuracy can be maintained to within approximately 16 meters (spherical error probability) under the most severe dynamic conditions.

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. Flight planning and waypoint information can also be downloaded from the Mission Data Loader in the RIOs cockpit. 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 PTID can also provide most navigation displays to the RIO. A BDHI in each cockpit can display aircraft heading from the SAHRS, TACAN range and bearing, and UHF/ADF bearing.

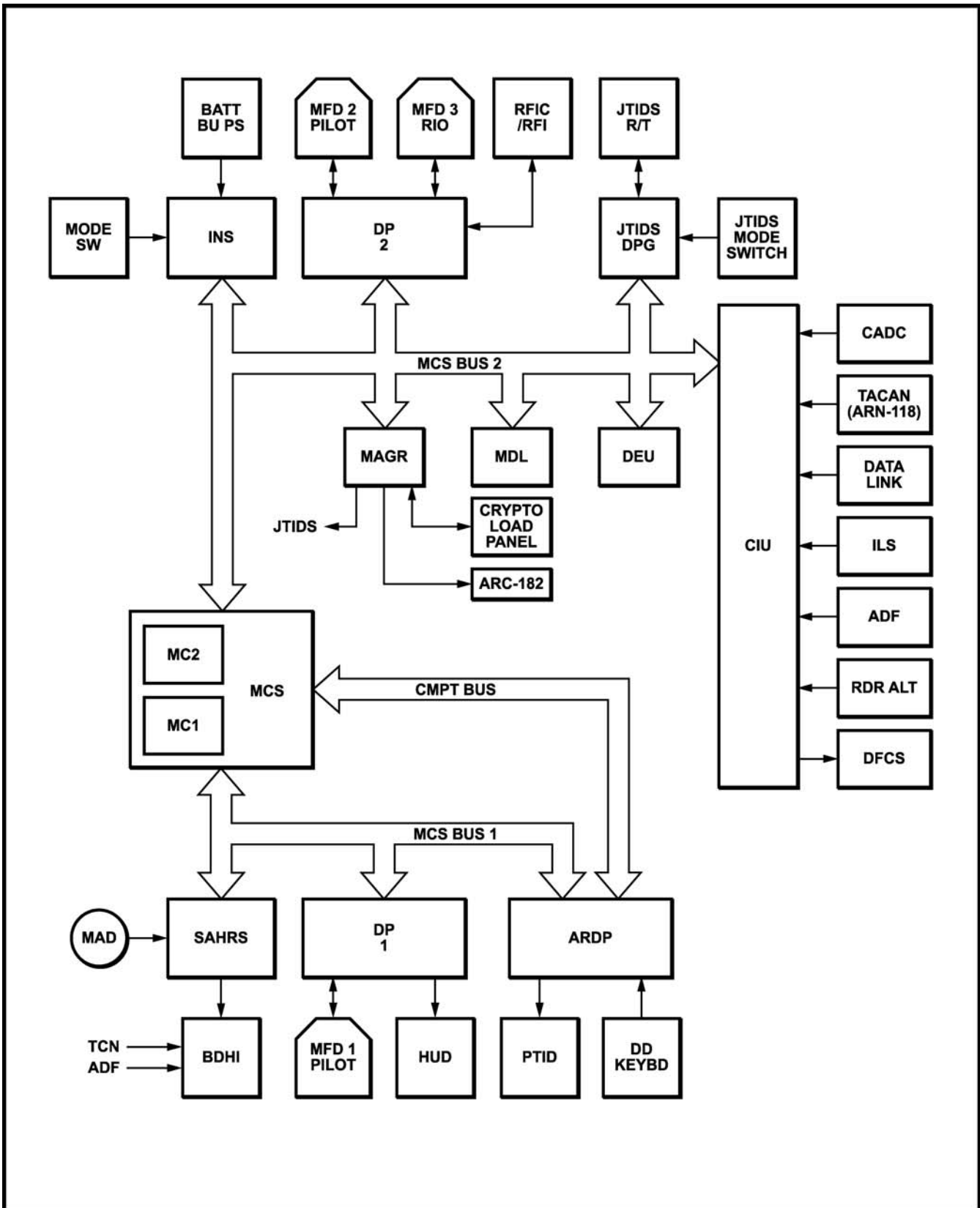
Navigation information from equipment not on the standard data bus is converted to the proper format by the CIU. These units and the information they provide are as follows:

1. Standard 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 DFCS.

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.



CSC-F14D-1-20-001A

Figure 20-1. Navigation System

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.

Note

The DFCS uses IMU data to monitor the pitch and roll rate gyros. An IMU invalid signal, or selection of the NAV MODE selector to OFF will result in a DFCS PQVM fault. The indications of this fault are the FCS CAUTION light accompanied by AFC PS and RS acronyms. This is a redundancy degrade only, no functionality is lost. Depressing MASTER RESET will clear fault indications once the IMU valid signal is restored and the NAV MODE selector is not in the OFF position.

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 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, attitude, and time tagging data is provided in digital form to the MCS. Analog outputs of roll and pitch are provided to the DFCS 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 INS PH A, B, and C 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 the INS BATT PWR circuit breaker 1I7.

20.1.2 Miniature Airborne GPS Receiver (MAGR)

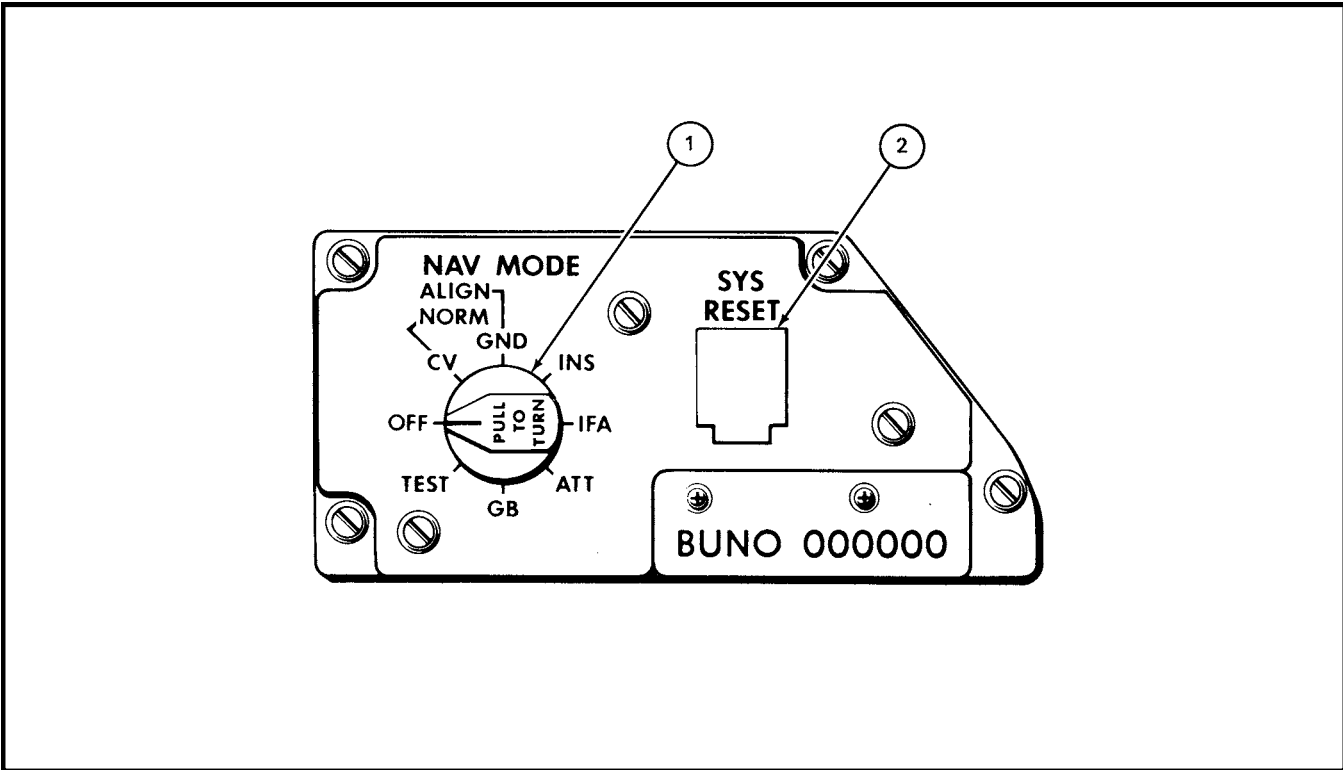
The MAGR is a 5-channel GPS receiver and data processor, located in the MC2/ASPJ Bay. The MAGR uses the signals from four satellites to provide navigation information. The fifth channel is used to sequentially monitor all of the satellites in view to ensure that the best four are always used in the solution. Each MAGR channel precisely tracks one satellite's signals and demodulates the navigation message. This message includes timing and satellite position information, as well as diagnostic information about satellite health. The MAGR measures the signal transmission time to obtain pseudo-range and the Doppler shift of the carrier signal to measure delta-range. Pseudo-range is the calculated distance to a satellite uncorrected for errors due to MAGR clock bias, atmospheric delays, and receiver noise. Delta-range is a measure of the relative velocity between the satellite and the GPS antenna. The MAGR filters the pseudo-range and delta-range measurements to obtain true position, velocity, and time information.

Radio Frequency signals (L-Band) from the GPS satellites are sensed by the AS/4336A Dual-Frequency GPS Antenna, which is located on the turtleback. A splitter-amplifier in the GPS antenna line provides GPS signals to weapon station B for LANTIRN pod use.

To accelerate the satellite acquisition process, the MAGR uses stored almanac data. The almanac data is stored in the MAGR in nonvolatile memory, supported by an internal battery. If this battery is removed or is low, the MAGR requests almanac data from the MCS.

Note

- If valid almanac data is not available, the MAGR will initiate a cold-start sky search for visible satellites. Search and acquisition may take over 20 minutes. With valid almanac data, search time may be reduced to as little as 30 seconds. If a cold start is performed, the almanac is downloaded from the satellite navigation message and stored for future use.
- GPS satellite acquisition time may be affected by a number of conditions, particularly L-band RF interference and line of sight obstructions, as well as the currency of the almanac data. On deck, aircraft proximity to large structures as a hangar or an aircraft carrier island superstructure may delay or prevent satisfactory satellite acquisition until the aircraft is moved.



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NOMENCLATURE	FUNCTION
<p>① NAV MODE selector</p>	<p>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.</p> <p>ALIGN GND — Initiates alignment for shore base operations. Own aircraft latitude and longitude required for initialization.</p> <p>INS — Selects GPS/INS navigation or INS navigation if GPS unavailable.</p> <p>IFA — Selects INS/GPS navigation. Can be used to align the INS using GPS or other valid source of true heading.</p> <p>ATT — Selects the IMU backup navigation mode. May require entry of aircraft true heading at least one time, via the DEU Own Aircraft format.</p> <p>GB — Gyro Bias mode, not functional.</p> <p>TEST — Provides Built-In-Test for installation and functional verification (on deck only).</p> <p>OFF — Secures system function.</p>
<p>② SYS RESET switch</p>	<p>Resets transient failures in the data processor and mission computers.</p>

Figure 20-2. NAV MODE Select/Computer Reset Panel

The MAGR provides a UTC synchronization signal to JTIDS and ARC-182 “Have Quick II” radio sets. The JTIDS receives the UTC via data bus message. The JTIDS references it to a precise 1-Hertz discrete sent by the MAGR. The “Have Quick II” radios receive the UTC (“mickey”) as a serial input on separate, direct-wired lines when RCV TOD (PB 3) is depressed on the GPS Status format.

The MAGR is powered by 115 VAC through the GPS circuit breaker (3E2). MAGR power is software controlled through the DPs via PB 4 (PWR ON/OFF) on the GPS Status Format. The MAGR is energized on either internal or external power, and is energized by default if both DPs are failed. The MAGR also uses three C-cell equivalent alkaline batteries to support power-off memory storage and internal time keeping.

20.1.3 AN/USN-2(V) Standard Attitude Heading Reference System (SAHRS)

Aircraft with AFC 919 incorporated utilize the Navigation Guidance System (NGS) SAHRS. It is a self-contained strapdown all-attitude INS that uses a single monolithic laser gyro to sense angular rates for all three axis and three single-axis accelerometers for acceleration measurements. It uses an improved SSA (502A6) and replaces the flux valve with a Magnetic Azimuth Detector (MAD) (502A5). NGS SAHRS interfaces in the same manner to other systems as the existing SAHRS system.

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.

Note

The DFCS uses SAHRS as a backup for the INS data to provide autopilot capability in the event of a failed IMU. Any SAHRS invalid signal airborne will be detected and logged on the DCP following flight. In addition to an actual SAHRS failure, this may be caused by selection of SAHR MODE of SLV, DG, or EC via the NAV SYSTEM AID MFD format shown in [Figure 20-18](#).

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 DFCS, 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 SAHRS A, B, and C circuit breakers (113, 115, and 116). It may also use 28-VDC power from the interrupt-free bus via SAHRS DC circuit breaker (9I3) if ac power is not available. Refer to Chapter 2 for the alphanumeric circuit breaker listing.

20.1.4 Mission Computer System (MCS)

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, MAGR, and SAHRS data. It accepts navigation initialization data from the DEU or the DD and sub-mode selections from the MFDs, providing this information to the INS, MAGR, 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.

20.1.5 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.

20.1.5.1 Data Entry Unit (DEU)

The DEU allows the RIO to manually enter the initial navigation information required for INS and SAHRS alignments, GPS initialization, and for waypoint location. Such required data inputs include latitude, longitude, altitude, waypoint type, date, time, 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.

20.1.5.2 Digital Display (DD)

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, barometric altimeter setting, date, and time; and control of JTIDS navigation functions. Use of the DD for entry of navigation is provided in paragraph 20.3, Navigation System Operation.

20.1.5.3 GPS Initialization

MAGR initialization is improved when aircraft position, velocity, Zulu Time of Day (ZTOD), and date are provided by the MCS. The correct time and date may also be entered manually via the DEU OWN A/C format. Once the GPS begins navigation, ZTOD and date are provided to the MCS by the MAGR and the ZTOD and date buttons on the DEU are removed. The MAGR maintains ZTOD and date with its internal batteries when aircraft power is removed.

Note

Incorrect ZTOD or date values can delay or prevent satisfactory satellite acquisition. Correct values should be verified on the GPS Status format and manually entered via the DEU if necessary.

20.1.6 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.

20.1.7 Programmable Tactical Information Display (PTID)

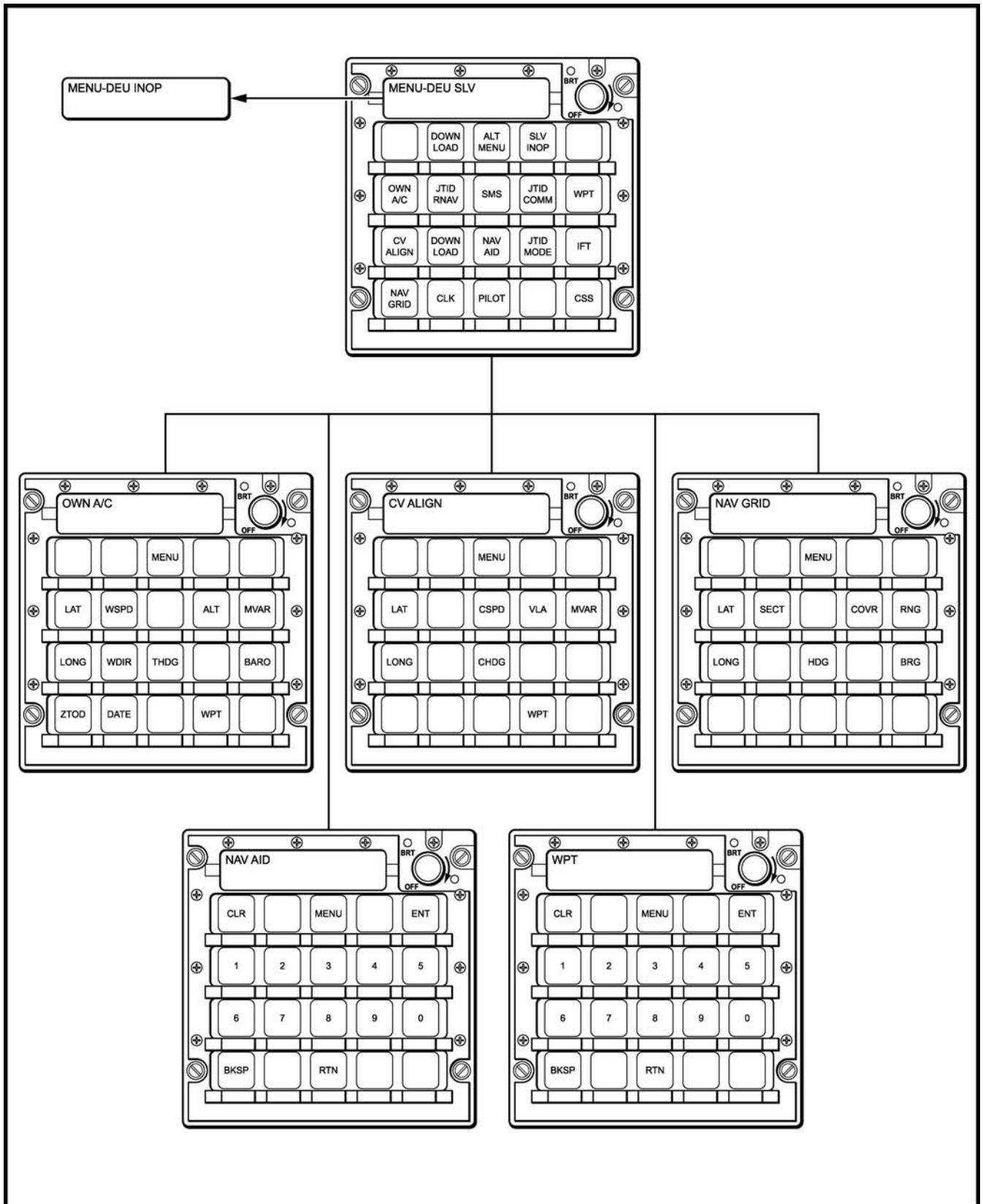
The PTID provides the RIO an alternate means of display for many of the alphanumeric and graphic outputs of the navigation system. Information is transmitted from the MCS to the APG-71 and then to the PTID. Selection of display data is made via the DD.

20.1.8 Converter Interface Unit (CIU)

The CIU accepts all non-data, 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 DFCS. These navigation aids, as they pertain to the navigation system, are described in the following paragraphs.

20.1.9 Standard Central Air Data Computer (SCADC)

The SCADC 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 SCADC 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 SCADC is provided in Chapter 2.



CSC-F14D-1-20-002B

Figure 20-3. DEU Navigation Formats

20.1.10 AN/ARN-118 Tactical Air Navigation (TACAN) System or AN/URC-107 Joint Tactical Information Distribution System (JTIDS)

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 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 20.3.9.3, Navigation System Updates, 20.3.9.4, Continuous Position Updating, and 20.3.9.2, 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.

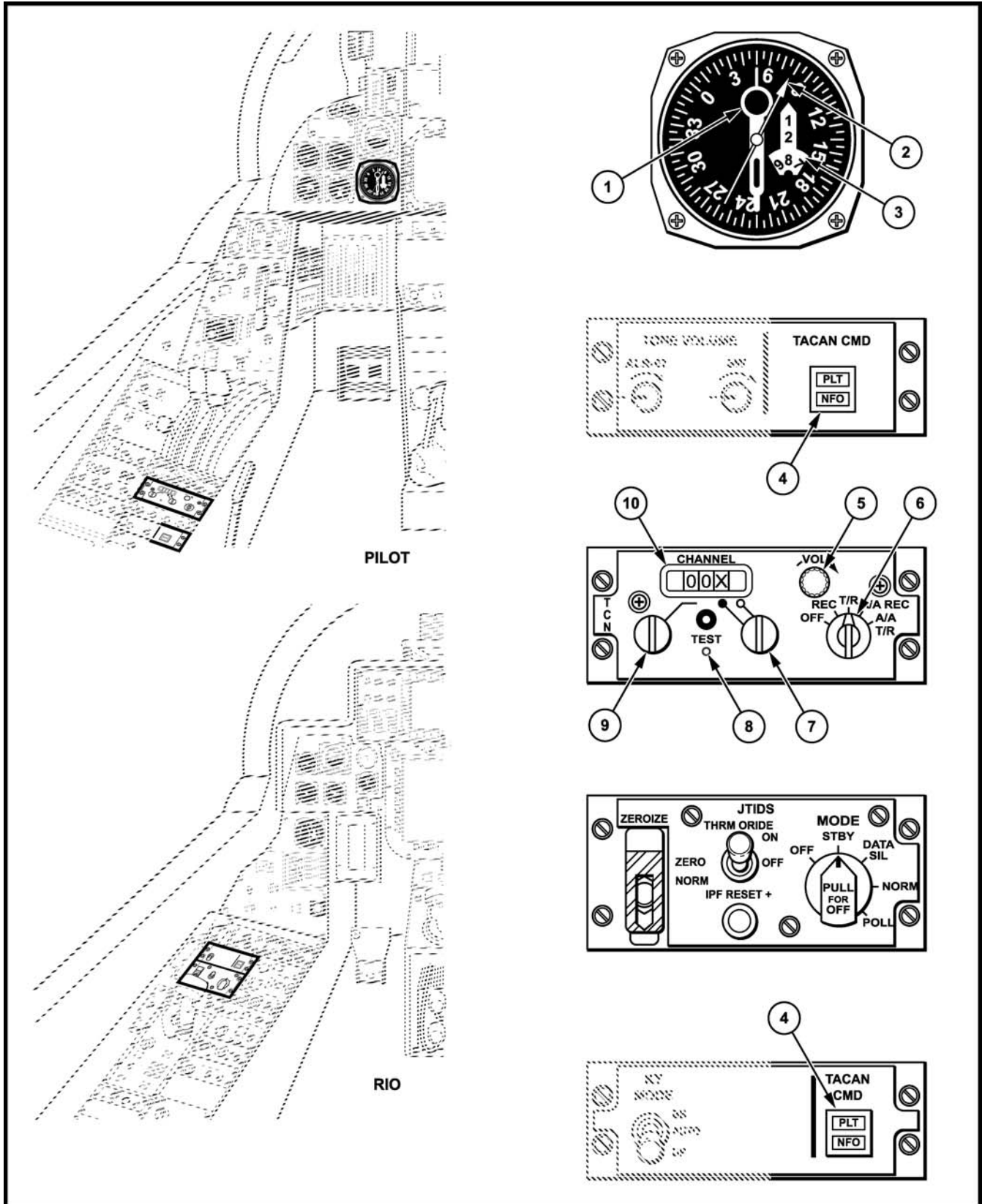
The TACAN has a memory feature that allows tracking to continue uninterrupted by momentary loss of received signals. A range signal that has been tracked for at least 10 seconds will be retained in memory for 13 to 17 seconds after signal loss; a bearing signal tracked for at least 15 seconds is retained 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 JTIDS RT PH A circuit breaker (3D5), 28 VDC from dc essential bus No. 2 via BDHI/ JTIDS DPG circuit breaker (8E7), and 26 VAC from the 26-volt essential bus through JTIDS / DPG / BDHI INST PWR 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 JTIDS RT PH B and C circuit breakers (4D3 and 4D4). Refer to Chapter 2 for the alphanumeric circuit breaker listing.

20.1.10.1 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.



CSC-F14D-1-20-003A

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)	Selects pilot/RIO TACAN control for BDHI display. Alternate action lighted push-button 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	<p>OFF — Power not applied to TACAN</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p style="text-align: center;">Note</p> <ul style="list-style-type: none"> • 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	Initiates 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)

20.1.10.2 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 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.

20.1.11 AN/ASW-27C Data Link (D/L)

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.

20.1.12 UHF Automatic Direction Finder (ADF)

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.

20.1.13 Bearing Distance Heading Indicator (BDHI)

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.

20.1.14 AN/URC-107 Joint Tactical Information Distribution System (JTIDS)

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 participant's PPLI message. With data from multiple participants with equal or better position plus the navigation data from the INS, GPS, 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 20.1.10 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.

When 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.

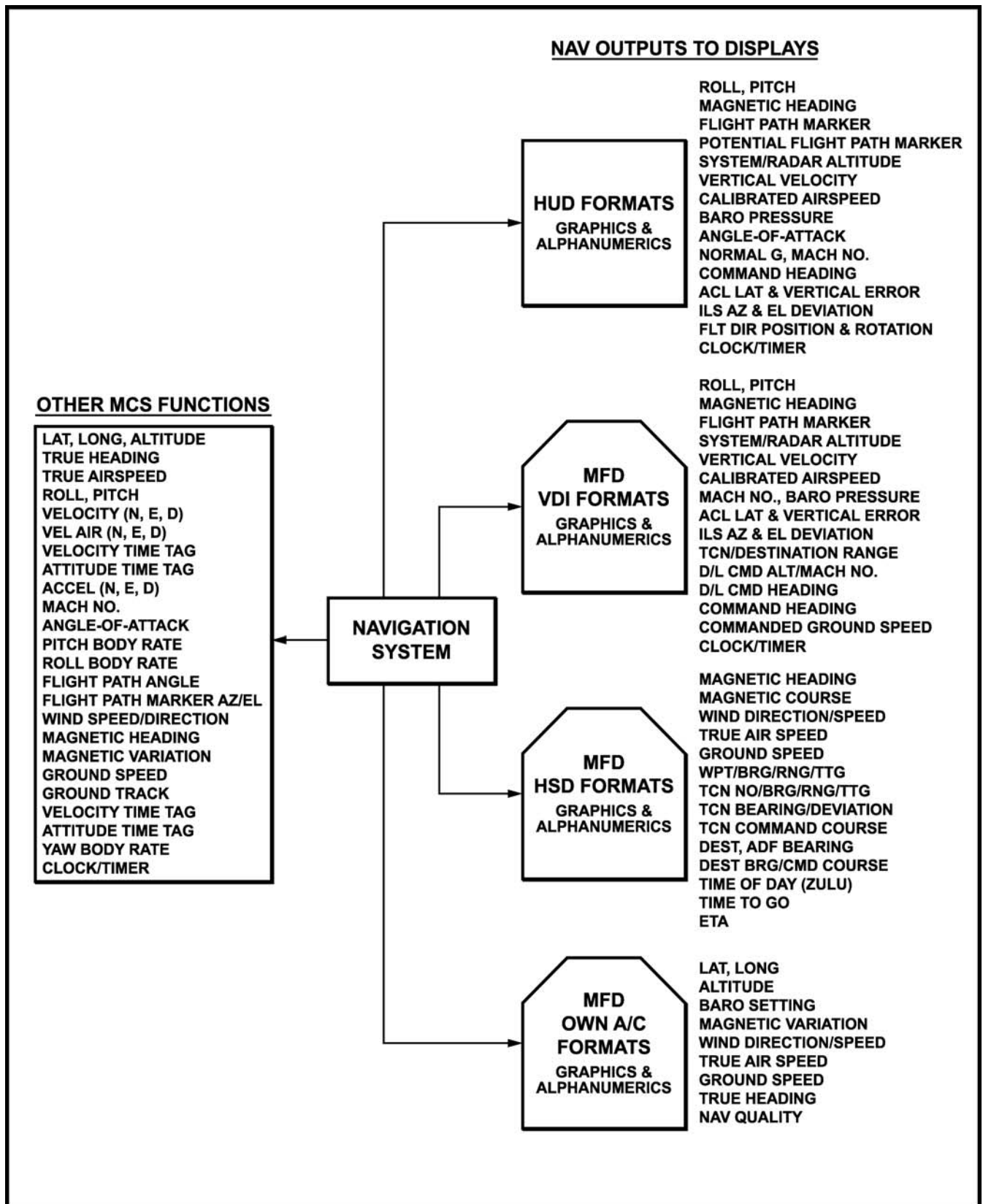
Tabular information relating to alignment, waypoints, GPS status, flight plans, and own aircraft can be displayed on the MFDs.

The navigation information provided by the various display selections is described in the paragraphs that follow.

20.2.1.1 HUD TLN Basic

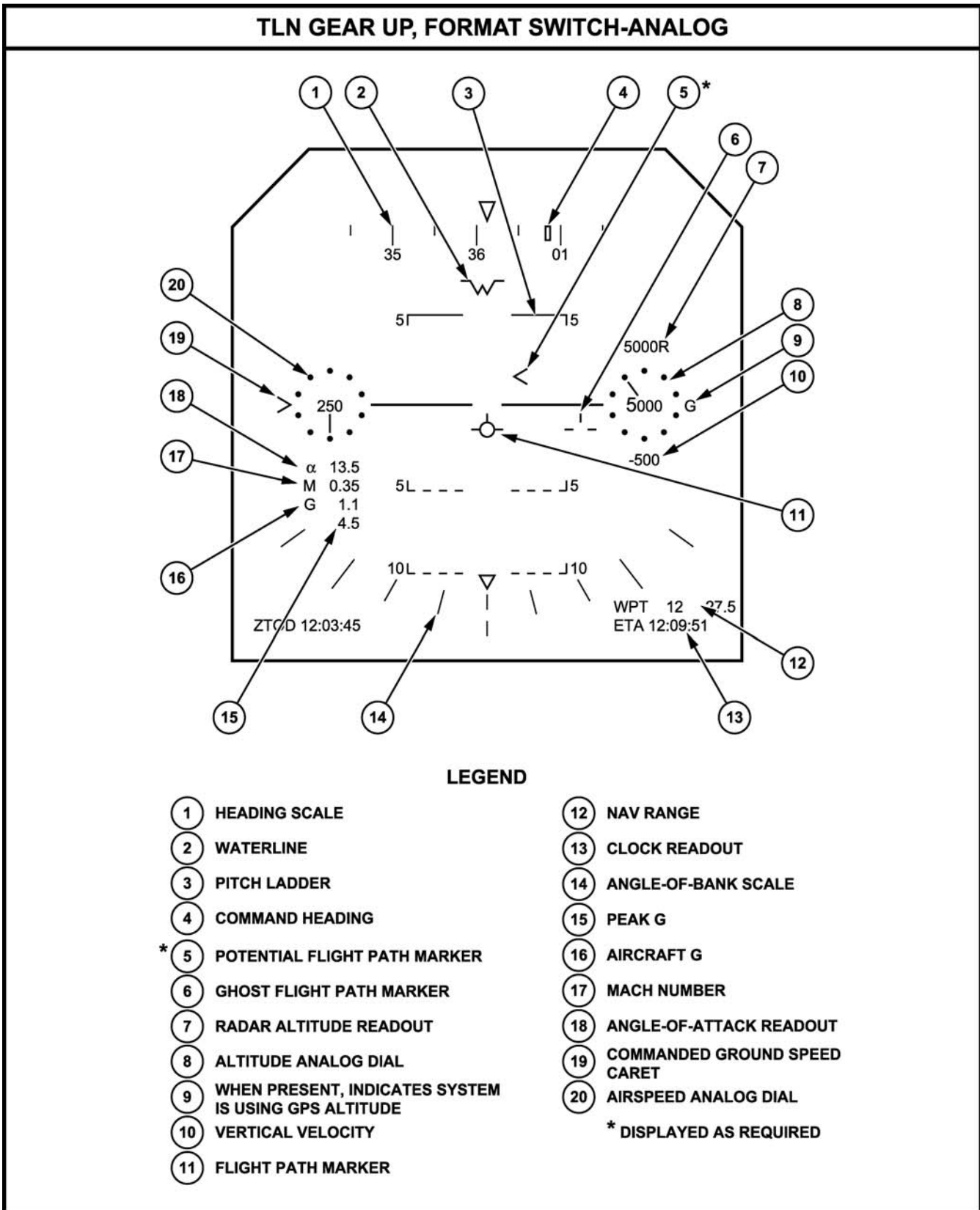
The HUD provides primary flight and navigation information in graphic and numeric form in a portion of the pilot's field of view through the windscreen encompassing $\pm 10^\circ$ in azimuth and elevation ([Figure 20-6](#)). A repeat of this information can be displayed on the MFD by selecting the HUD pushbutton on the MENU1 format, or on DD by depressing MFK and RPTSPL then HUD.

In addition to the information in [Figure 20-6](#), other HUD formats provide indications of glideslope and center-line errors for ACL and ILS steering modes as well as flight director steering information and commanded heading.



CSC-F14D-1-20-004B

Figure 20-5. Navigation System Data Distribution



CSC-F14D-1-20-005A

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 $\pm 45^\circ$ 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), GPS, AUTO, 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. 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 selected waypoints or to a selected TACAN station are provided.

In addition to the information shown in Figure 20-9, other HSD formats provide AUTO, GPS, TACAN, data-link, destination, and manual steering displays (see paragraph 20.3.9.2, Display Steering Modes).

20.2.1.4.1 HSD Waypoint Data Buffers

Both the left and right data buffers behave differently depending on the choice of steering mode. The left data buffer (next to PB 5) always displays waypoint information. This waypoint information changes slightly based on steering mode and the waypoint displayed. The right data buffer displays either TACAN information or another waypoint buffer.

The data buffers will only display waypoint information for the 100 tactical waypoints and any defined waypoints in the active flight plan. If a flight plan is active, when the inky-dink (increment-decrement) scrolls upward through 100, it will jump to the first waypoint in the active flight plan (i.e., 101, 201, 301, etc.). When scrolling down through 1, it will jump to the last defined waypoint in the active flight plan (i.e., 115, 237, 524, etc.).

If both data buffers are displaying waypoint information, the inky-dink arrow's focus is assigned to the desired buffer by pressing the pushbutton next to that buffer (i.e., PB 5 or PB 11). The buffer with the inky-dink focus will be displayed with a box around it, and the waypoint number displayed in that buffer will be displayed between the inky-dink arrows. If the steering mode is changed to one which displays TACAN information on the right, the inky-dink and box will be automatically assigned to the left buffer, since they have no meaning for a TACAN station.

Note

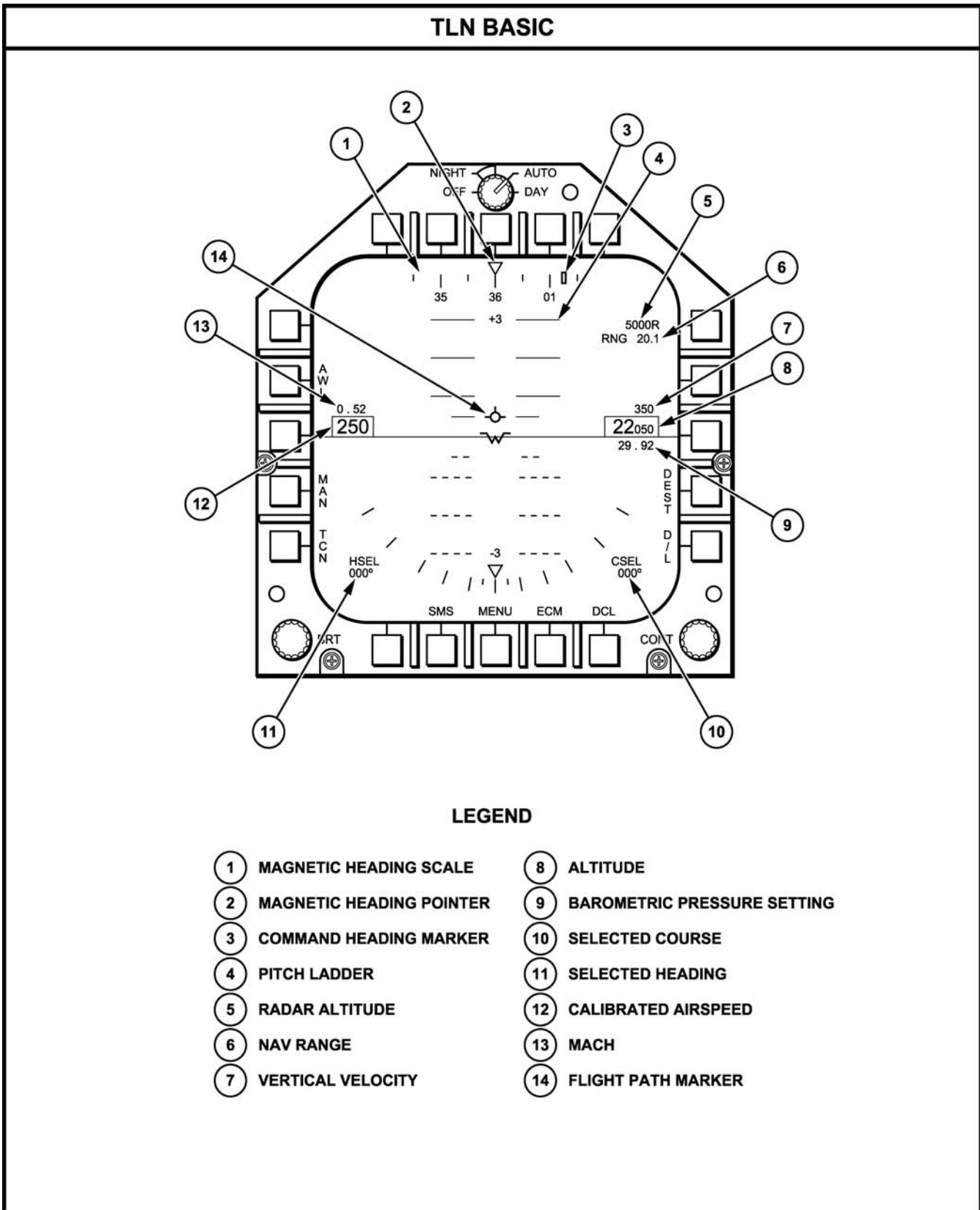
A box around a waypoint buffer merely shows where the inky-dink is assigned. It is unrelated to which waypoint is selected for steering.

If a waypoint is desired as the steer point (DEST, GPS, or AUTO steering), that waypoint should be selected with the inky-dink arrows in one of the data buffers, and ENT (PB 15) selected. The waypoint selected with ENT will always be the one with the inky-dink focus.

20.2.1.4.1.1 Left Buffer Behavior

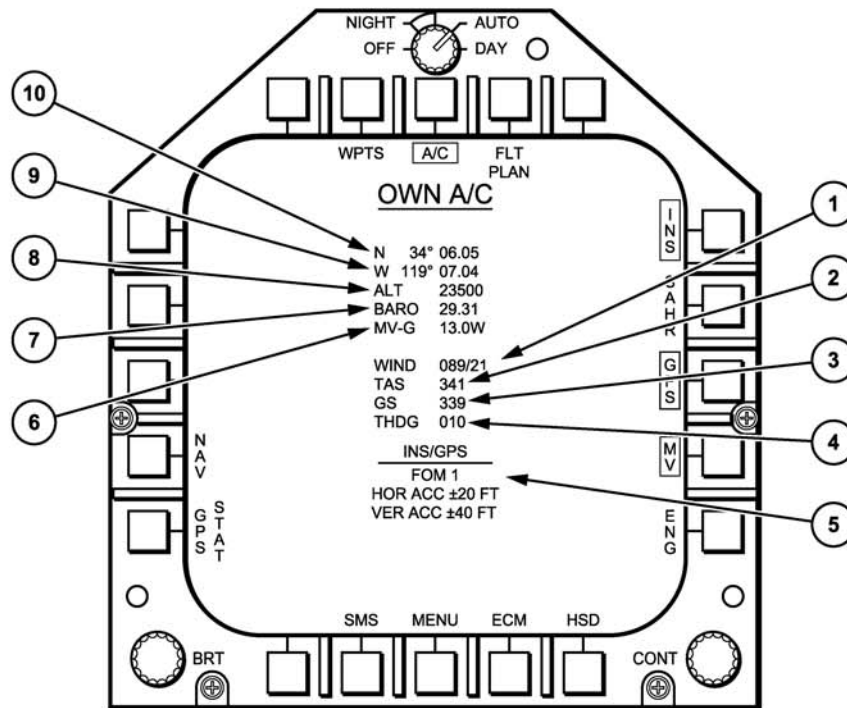
The left data buffer always shows waypoint information. Normal display information includes waypoint number, bearing, range, and time to go to the waypoint. Additionally, if a flight plan waypoint is selected, and that waypoint has a valid name defined, the waypoint name will appear above the waypoint number (up to five characters).

If the steering mode is DEST or AUTO, and a route waypoint is selected, the bearing will be replaced with the word ROUTE, and the range and time-to-go indications will be shown along the route information to the route target (if defined) or to the end of the route.



CSC-F14D-1-20-027A

Figure 20-7. MFD VDI (TLN Basic) Navigation Outputs

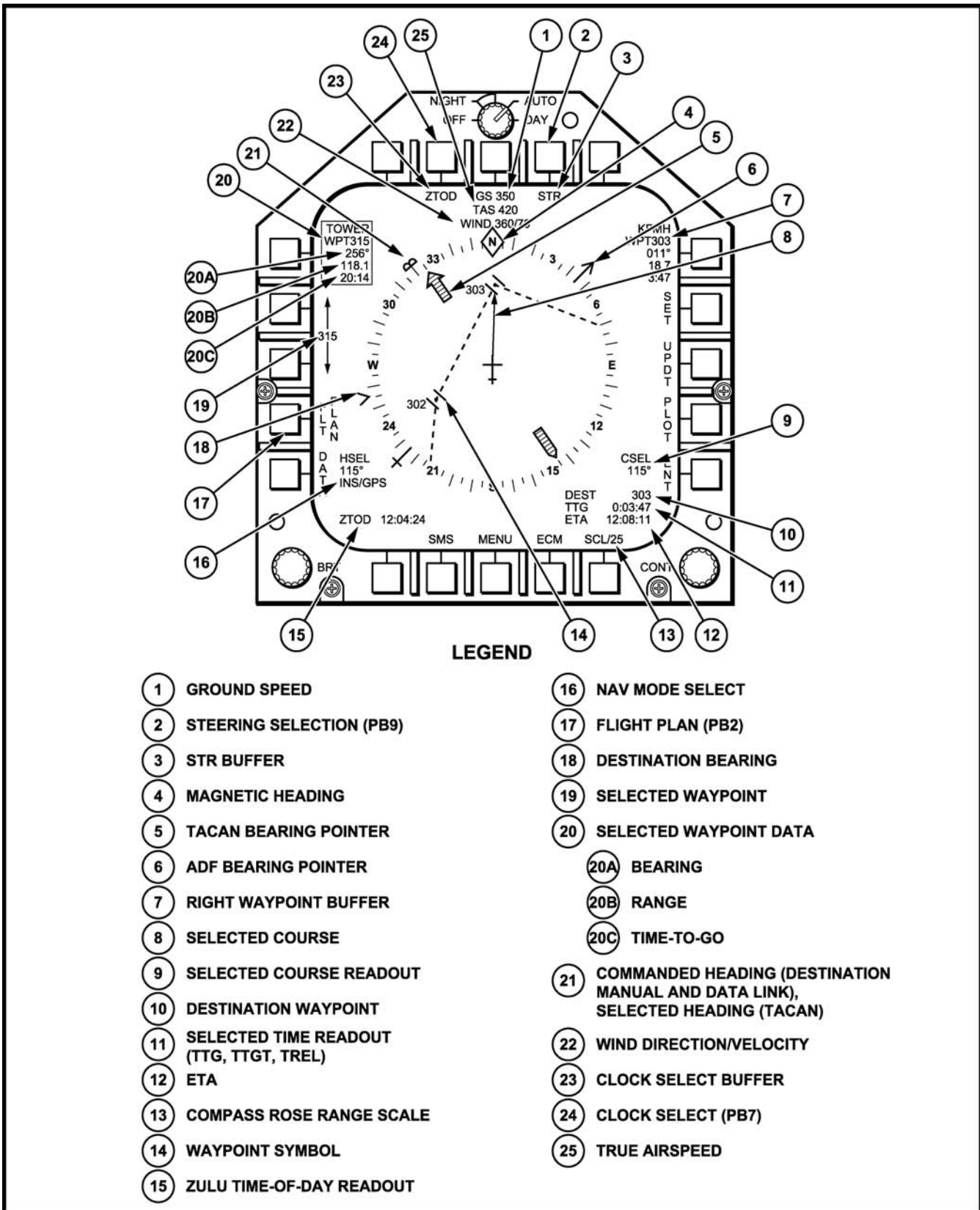


LEGEND

- | | |
|---------------------------------|-------------------------------|
| ① WIND DIRECTION/VELOCITY | ⑥ MAGNETIC VARIATION |
| ② TRUE AIRSPEED | ⑦ BAROMETRIC PRESSURE SETTING |
| ③ GROUND SPEED | ⑧ BAROMETRIC ALTITUDE |
| ④ TRUE HEADING | ⑨ OWN AIRCRAFT LONGITUDE |
| ⑤ NAVIGATION SOURCE AND QUALITY | ⑩ OWN AIRCRAFT LATITUDE |

CSC-F14D-1-20-006A

Figure 20-8. Own-Aircraft Basic Data Format



CSC-F14D-1-20-007A

Figure 20-9. MFD HSD Format — Navigation Outputs

20.2.1.4.1.2 Right Buffer Behavior

The right data buffer either displays direct steering waypoint information (waypoint number, bearing, range, time to go, and name if a flight plan waypoint), or it displays TACAN steering information (channel, bearing, range, time to go), depending on steering mode.

In DEST, GPS, or AUTO steering, the right buffer displays waypoint information. In all other steering modes, the right buffer displays TACAN steering information.

20.2.1.5 Navigation Clocks and Timers

To facilitate navigational timekeeping and sequencing, several clock and timer displays are available to the aircrew on the HSD format and HUD Display. Figure 20-9 illustrates the HSD clock readout. The HSD format clock and timer displays are reconfigured automatically to coincide appropriately with the HUD clock selection. One clock or timer may be displayed on the HUD, and all options are selected via Clock Select (PB 7) on the HSD format. All clock functions that reference a time of day require ZTOD (Zulu Time Of Day) information provided by the GPS if available or by manual entry via the DEU.

Note

In the prime INS/GPS navigation mode, the MAGR updates ZTOD in the MCS only once per second. Including typical latencies to receive, transfer, format and display ZTOD, the value presented to the aircrew may lag the true ZTOD transmitted by GPS (i.e., “run slow”) by 1 to 2 seconds.

20.2.1.5.1 Zulu Time of Day (ZTOD)

Zulu Time of Day is an actual time-of-day reference in an HH:MM:SS format. ZTOD is always displayed in the lower left corner of the HSD format and is the default clock display on the HUD. It is displayed on the HUD when the Clock Select legend is “ZTOD”.

20.2.1.5.2 Time Remaining Functions

Three time remaining functions are provided to present a cue of the time required to reach a specific steerpoint: Time to Go (TTG), Time to Target (TTGT), and Time to Release (TREL). These three functions are mutually exclusive; that is, only one of the three will be displayed or made available for selection by the aircrew. The available time remaining function is selected automatically by the MCS, depending on

the steering mode selected, information available and phase of flight. The three modes are defined in the following table:

Function	Description
TTG	Time-to-Go represents (in an HH:MM:SS format) the time remaining to reach the current steerpoint at the current ground speed. Time-to-Go is the default time remaining function and the default display for the clock buffer of the HSD format. It is displayed on the HUD and the HSD format when the Clock Select legend is “TTG”. It does not account for time to turn to a direct heading.
TTGT	Time-to-Target is available when navigating along an active flight plan with a defined route and a target waypoint. Time-to-Target represents (in an HH:MM:SS format) the time remaining to reach the designated target waypoint along the flight plan route at the current ground speed. When TTGT is available, it automatically replaces TTG as the time remaining selection. It is displayed on the HUD and the HSD format when the Clock Select legend is “TTGT”.
TREL	Time-to-Release is available when an air-to-ground weapon is selected and a target has been designated via CTGT, CWPT, or COAP mode (see Weapon Attack Modes section of the F-14D A/G Tactical Manual, NWP 55-5-F-14, Vol. II, NAVAIR 01-F14AAD-1T-1). Time-to-Release represents (in an HH:MM:SS format) the time remaining until an automatic bomb release point is reached. When TREL is available, it automatically replaces TTG and TTGT as the time remaining selection. It is displayed on the HUD and the HSD format when the Clock Select legend is “TREL”.

20.2.1.5.3 Estimated Time of Arrival (ETA)

Estimated Time of Arrival represents (in an HH:MM:SS format) the ZTOD at which a specific steerpoint will be reached. When TTGT is the available time remaining function, ETA is calculated by adding TTGT to ZTOD and represents time over target following the active flight plan route. Otherwise, ETA is calculated by adding TTG to ZTOD, and represents time over waypoint if you went present position, direct to waypoint. ETA is the default display for the timer buffer of the HSD format. It is displayed on the HUD when the Clock Select legend is “ETA”.

20.2.1.5.4 Elapsed Timer (ET)

The ET represents (in a MM:SS format) the time elapsed since the MCS timer was started. It is displayed on the HUD and the HSD format when the Clock Select legend is "ET". While ET is running, other clock and timer modes still may be selected on the HUD and the HSD format. Conversely, if ET is not running, it may still be selected for display.

The ET timer is controlled via the DEU as follows:

1. From the main menu format, depress CLK to select the Clock format.
2. Depress ET to select the ET mode.
3. To start the ET timer depress STRT and ENT.
4. To stop the ET timer, depress STOP and ENT.
5. To reset the ET timer, depress ET, ENT, then STOP, ENT

20.2.1.5.5 Countdown (CD) Timer

The CD timer represents (in a MM:SS format) the time to go to zero since the MCS timer was started from a preset value. It is displayed on the HUD and the HSD format when the Clock Select legend is "CD". While CD is running, other clock and timer modes still may be selected on the HUD and the HSD format. Conversely, if CD is not running, it may still be selected for display. The default value for the CD timer is 06:00.

The CD timer is controlled via the DEU as follows:

1. From the main menu format, depress CLK to select the Clock format.
2. Depress CD to select the CD mode.
3. To enter a CD time value, depress CD TIME to select the CD Time Entry format. Use the numeric keypad and other control keys to enter the desired count-down time value.
4. To start the CD timer, depress STRT and ENT.
5. To stop the CD timer, depress STOP and ENT.
6. To reset the CD timer to the previous timer start value, depress STOP and ENT a second successive time.

20.2.1.6 Navigation Data Display Summary

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, flight plan management, in-flight navigation, sensor selection, degraded mode operation, and tactical navigation. Tactical navigation includes: range and bearing to selected waypoints; display of TACAN, GPS, destination, and automatic waypoint steering; autopilot steering; AWL aircraft control; position updating; and surface waypoint position determination. 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 GPS Operation

The Navigation Satellite Timing and Ranging (NAVSTAR) Global Positioning System (GPS) is a radio navigation system using satellites in twelve hour orbits to provide timing signals derived from onboard atomic clocks. These signals can be used to triangulate a three dimensional position near the earth using an appropriate receiver. The receiver detects the timing signals, compares them to its own clock then converts the time obtained into a distance to the satellite using the speed of light as a conversion factor. By obtaining signals from four satellites, the receiver can determine position in three dimensions plus identify its own small clock error.

The satellites transmit two different GPS signals in combination on two different frequencies. C/A-code (Coarse/Acquisition code) is used to help the receiver acquire the GPS signal and provide hand-over information to the primary navigation signal, the P-Code. GPS signals use two frequencies, L1 (1575.42 MHz) and L2 (1227.60 MHz); C/A-Code is normally transmitted only on L1, and P-Code (or Y-Code, see below) is transmitted on both L1 and L2. Dual frequencies allow the receiver to make an estimate of ionospheric refraction, and help to improve overall GPS jamming tolerance.

Both the C/A-Code and P-Code contain a navigation message with information about satellite position, time, the health of the satellite, and the complete constellation almanac. A Hand-Over Word is included in the navigation message that tells a receiver tracking C/A-Code which part of the P-Code sequence the satellite is currently transmitting. The theoretical accuracy of both C/A-Code and P-Code signals is similar. The advantage of P-Code is derived from its transmission on two frequencies, and the subsequent ionospheric refraction estimate that is possible thereby.

DISPLAY	NAVIGATION DATA DISPLAYED
Own Aircraft Inflight	Latitude Longitude Altitude Barometric Setting Magnetic Variation Wind Direction/Speed True Airspeed Groundspeed True Heading GPS Figure of Merit Horizontal and Vertical of Current Navigation Mode
Own Aircraft Ground Align	Latitude Longitude Altitude Barometric Setting Magnetic Variation Groundspeed True Heading Align Time/Quality North/East Velocities GPS Figure of Merit
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) Clock/Timer Fly-To Caret
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 21-10. Navigation Data Display Summary (Sheet 2 of 2)

The GPS utilizes a cryptographic scheme to convert the P-Code signal into a Y-Code signal. By encrypting the primary navigation signal, GPS can be rendered impervious to “spoofing” – the intentional transmission of a false signal to mislead recipients. This function is termed “Anti-Spoof” (A-S), and its use is mandated for all US military GPS users. The MAGR will automatically switch to this mode if the appropriate crypto-codes are loaded (see paragraph 20.3.1.3).

Note

The MAGR is unclassified even when the crypto-keys are loaded.

20.3.1.1 GPS Accuracy

The quality of the received signals and the orientation of the satellites determine the actual quality of the position estimate provided by GPS. Jamming, obstructions, and multipath can degrade the quality of the received signal, while satellite constellation geometry can introduce position errors (termed Geometric Dilution of Precision – GDOP). The MAGR is designed to minimize these errors.

The GPS system provides two levels of accuracy. The Precise Positioning System (PPS) is capable of accuracy better than 16 meters Spherical Error Probable (SEP) (i.e., 50% of the time the calculated position will be within a sphere 16 meters in radius centered on the actual position). It is intended for military use only. PPS also provides time with an error of less than 100 nanoseconds.

Standard Positioning System (SPS) accuracy is variable. When the satellites transmit their timing signals, small, continuously varying errors are injected into the navigation message of both the C/A-Code and the P/Y-Code signals to reduce the position and time accuracy a receiver calculates. The size of the errors are encrypted and also sent as part of the satellite transmission. A PPS receiver requires that the matching crypto-codes be loaded to resolve the error. These are the same crypto-codes used for the Anti-Spoof function.

The injected errors, termed “Selective Availability (SA)”, are controlled by the US Air Force on behalf of the Department of Defense (DoD) so that, in a conflict, an enemy will not be able to use the system. In peacetime, the DoD guarantees SPS precision will not exceed 100 meters horizontally with 95% confidence (i.e., the horizontal position will be within 100 meters at least 95% of the time). In peace, SA is turned off; thus, SPS and PPS solutions have the same accuracy.

Note

It is not necessary to receive P-Code (or Y-Code) in order to make use of the Precise Positioning

System. Nor does receipt of P-Code guarantee that PPS is in use. C/A-Code contains all the information required to provide a PPS solution. All that is necessary is that the appropriate crypto-codes be loaded into the receiver so that the error message can be decrypted.

The receiver outputs a Figure of Merit (FOM) that provides, in a single digit number, a rough indication of the overall quality of the navigation solution. FOM ranges from 1 to 9, and includes estimates of signal quality and GDOP. A properly operating GPS receiver, in PPS mode, will normally display a FOM of 1, an operating SPS receiver (i.e., the MAGR when the crypto-codes are not loaded) will display a FOM of 4, and a functional receiver without a navigation solution will display a FOM of 9. Intermediate values will appear, especially when the receiver first begins to track satellites, and when degradation due to jamming or signal loss occurs. The MCS receives the FOM from the MAGR and outputs it for display on OWN A/C format of the MFD. The MCS and INS use FOM to assign appropriate weighting to the GPS solution in the overall NSV.

20.3.1.2 GPS Status Format

The GPS Status format displays the GPS parameters as depicted in [Figure 20-11](#). All readouts (except MODE) will be blanked while the GPS is performing a commanded BIT. MODE will show “TEST”. MAGR power, transmission of UTC synchronization to the HAVE QUICK radios, and display of the MAGR status are controlled from the GPS Status format.

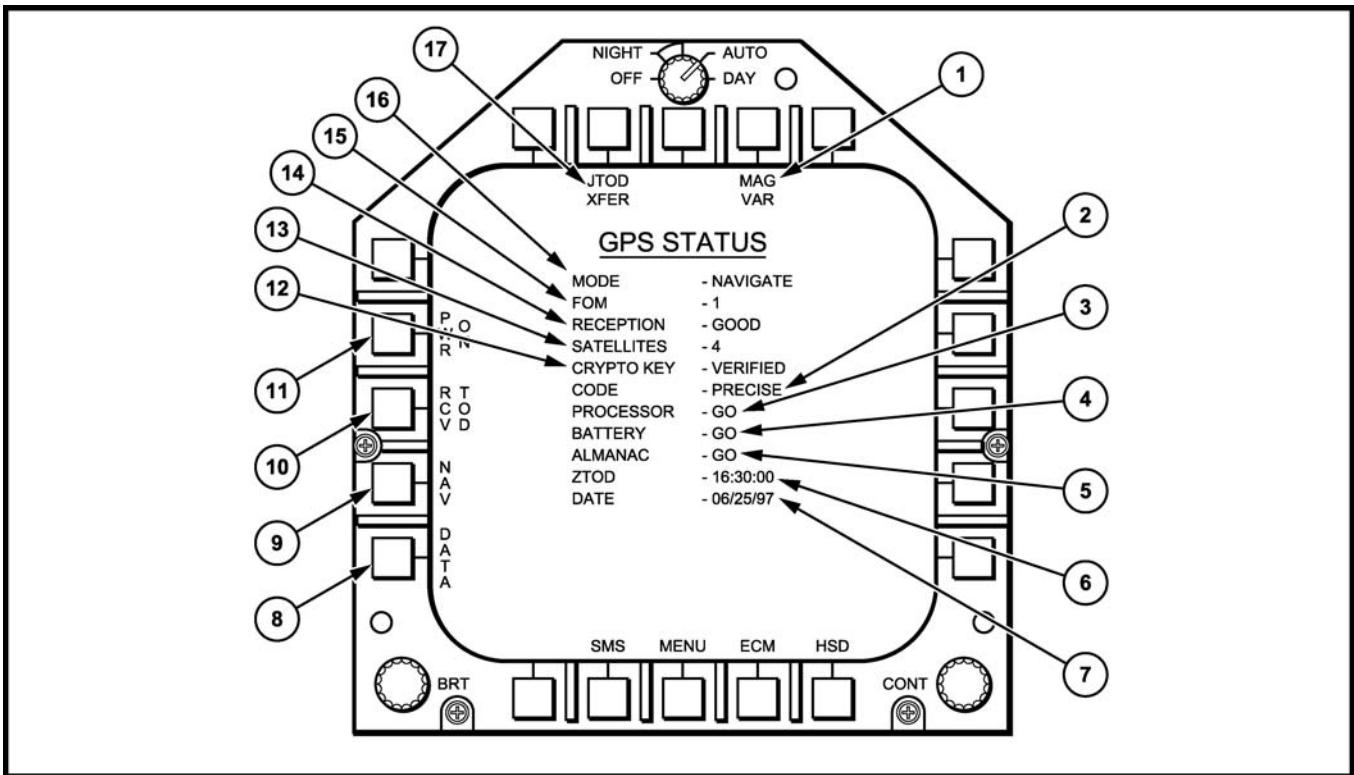
The MAGR power is toggled on and off by depressing PWR (PB 4) on the GPS Status format. The appropriate ON or OFF status legend is also displayed. The default selection is PWR ON.

Note

The PWR ON legend only indicates that the MAGR has been energized. Boxing the GPS legend (PB 13) on the OWN A/C or NAV System Aid format makes GPS data available to the navigation system.

The UTC time of day is made available to the ARC-182 “Have Quick II” radios by momentarily depressing RCV TOD (PB 3) while the MAGR is in the NAVIGATE mode. RCV TOD is inoperative in the TEST and INITIALIZE modes, and is not available with MAGR power off (see Chapter 19 for radio time sync operation).

When the MAGR is operating at its peak performance, the GPS Status format will look like the display in [Figure 20-11](#). The figure legend contains the possible ranges for the GPS Status Format Parameters.



CSC-F14D-1-20-018A

	PARAMETER	RANGES	REMARKS
1	MAG VAR		Not operable in D03B.
2	CODE	PRECISE COARSE	Type of code the MAGR is tracking. PRECISE indicates that the MAGR is using P or Y Code, COARSE indicates that the MAGR is using C/A Code. COARSE will not be observed, or observed very briefly as the receiver acquires satellites, if the receiver is operating normally.
3	PROCESSOR	GO NO GO NOT READY	The operational status of the MAGR processor. GO indicates that data bus communication between the MAGR and the MCS exists and the processor is operating properly. NO GO indicates that the processor failed a start-up or commanded BIT or a continuous self-test. NOT READY indicates that data bus communication between the MAGR and the MCS has not been established.
4	BATTERY ¹	GO LOW	MAGR battery operational status. GO indicates a satisfactory battery power level. LOW indicates that the battery has failed or has a marginal power level. Battery power is only required to maintain MAGR memory when the MAGR is powered off. Report any LOW indications to maintenance.

Figure 20-11. GPS Status Format (Sheet 1 of 3)

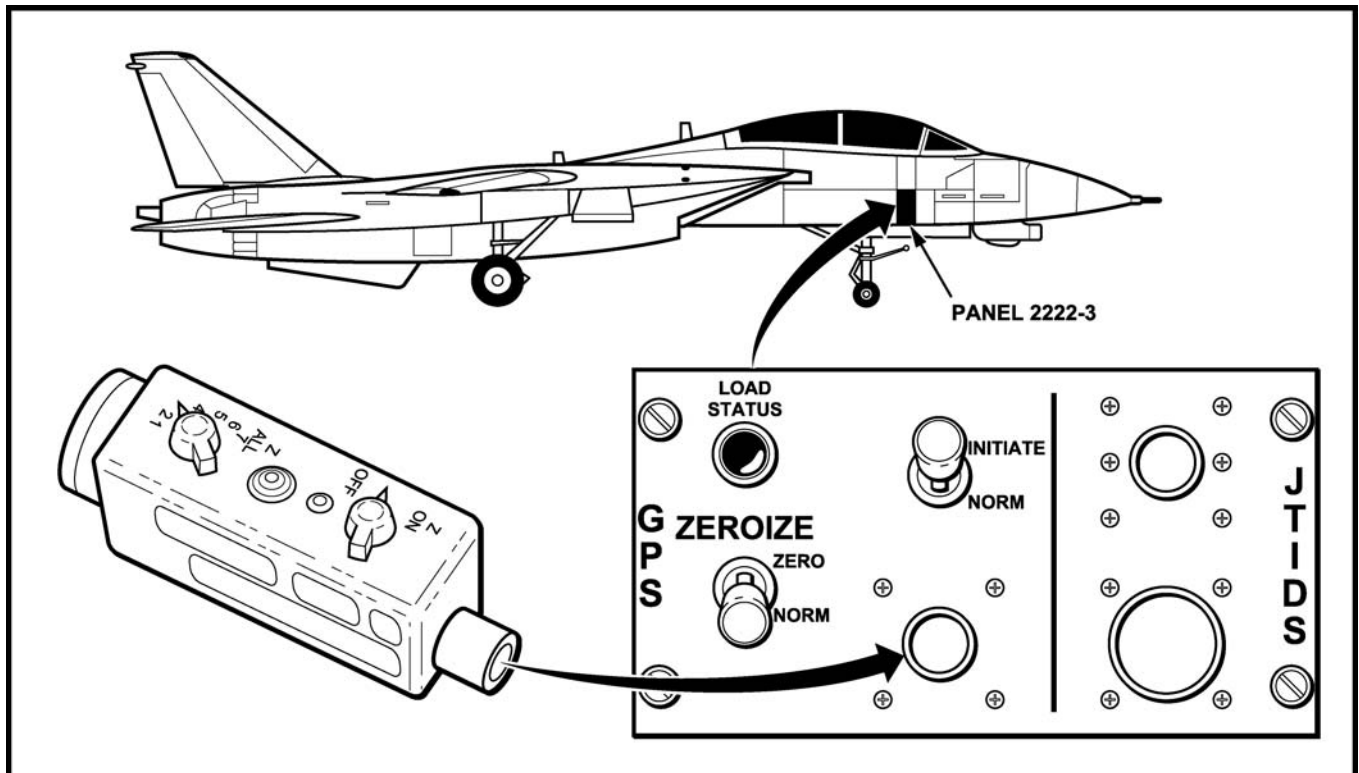
	PARAMETER	RANGES	REMARKS
5	ALMANAC	GO NO DATA MDL NOT READY MDL FAIL	<p>The status of the MDL almanac data available to the MAGR. GO indicates that the valid MDL almanac data is available. All other conditions indicate that valid almanac data is unavailable. NO DATA indicates that almanac data is not present on the MDL or is more than one month old. MDL NOT READY indicates that there is either no data bus communication or no cartridge in the MDL. MDL FAIL indicates that an MDL failure is preventing access to almanac data.</p> <p style="text-align: center;">Note</p> <p>If valid almanac data is not available, either within MAGR memory or on the MDL, the MAGR will initiate a cold start sky search for visible satellites. Search and acquisition may take over 20 minutes. Once satellites are received, the MAGR will extract the Almanac from the GPS navigation message and store it in volatile memory for future use.</p>
6	ZTOD	HH:MM:SS	In NAVIGATE mode, indicates Zulu Time of Day. In the INITIALIZE mode, momentarily indicates the time of MAGR initialization. A blank field is displayed if no valid time is available.
7	DATE	MM/DD/YY	In the NAVIGATE mode, indicates the current date. MM/DD/YY is displayed if no valid date is available or the MAGR is not in NAVIGATE mode.
8	DATA (PB 1)		Returns the OWN A/C Basic format with DEU slaved for Own A/C data entry.
9	NAV (PB 2)		Returns the Navigation format.
10	RCV TOD (PB 3)		Depressing RCV TOD pushtile provides time to the ARC-182 "Have Quick II" radios.
11	PWR (PB 4)		Selecting PWR pushtile toggles MAGR power ON or OFF. Default is power on.
12	CRYPTO KEY	VERIFIED UNVERIFIED INCORRECT PARITY ERROR NO KEYS [BLANK]	The status of the GPS crypto keys. VERIFIED indicates that the loaded key matches that used by the satellites. UNVERIFIED indicates that the loaded key has not yet been verified through comparison with the satellites. INCORRECT indicates that the loaded key is incorrect. PARITY ERROR indicates that the MAGR detected a parity error in the loaded key – the key should be reloaded. NO KEYS indicates that no key is loaded. The crypto key is BLANK until NAVIGATE mode is entered.

Figure 20-11. GPS Status Format (Sheet 2 of 3)

	PARAMETER	RANGES	REMARKS
13	SATELLITES	0, 1, 2, 3, 4	The number of satellites being tracked with maximum available precision. Four satellites are normally needed for navigation. If altitude is available from the MCS, a three satellite solution will provide horizontal position and velocities.
14	RECEPTION	GOOD DEGRADE [BLANK]	GOOD indicates clear GPS reception of four satellites. DEGRADE indicates partial track of at least one satellite. If degraded reception persists, MAGR FOM and estimated Horizontal and Vertical GPS position errors will increase. The RECEPTION field is blank if the MAGR is not in NAVIGATE mode.
15	FOM	9 to 1	MAGR Figure of Merit. FOM is a numerical indicator of receiver accuracy and system integrity. It should not be used for decisions concerning position accuracy (use the Horizontal and Vertical Error estimates on the Own A/C format). FOM is based on a number of factors that contribute to the overall system including, and tends to be conservative with regard to system accuracy: <ul style="list-style-type: none"> ● MAGR receiver state (e.g., code tracking, carrier tracking, acquisition, etc.) ● Carrier to noise ratio ● Satellite geometry (GDOP) ● Satellite range accuracy ● Ionospheric measurement or modeling error ● MAGR aiding ● MAGR Position Error estimates
16	MODE	TEST INITIALIZE NAVIGATE [BLANK]	With PWR ON, TEST appears for about 30 seconds as the MAGR self-test is run (provided MAGR was off for at least 30 seconds). INITIALIZE then appears for about five seconds, then NAVIGATE appears. With PWR OFF, this field is BLANK. <p style="text-align: center;">Note</p> When a commanded BIT is run from the OBC NAV format, TEST will appear for up to 3 minutes during the Initiated BIT.
17	JTOD XFER		Enables synchronization of JTIDS using GPS time. Available only when JTIDS is operational and GPS is in "NAVIGATE".

Note: 1. The battery is used to maintain GPS Almanac and Crypto Keys in volatile memory when the primary power is off.

Figure 20-11. GPS Status Format (Sheet 3 of 3)



CSC-F14D-1-20-052A

Figure 20-12. Crypto Loading Panel Location

20.3.1.3 GPS Crypto Keys

The MAGR crypto key is loaded by maintenance personnel via the Crypto Load Panel on the right-hand side of the aircraft (Figure 20-12). The required codes are changed daily, but multiple codes may be loaded into the MAGR at one time. If the codes do not match the keys in the satellite, the MAGR will still operate, but in SPS mode only.

20.3.2 Navigation Modes

The navigation system can operate in four basic states (primary, secondary, tertiary and backup), depending on the selection of navigation sensors. A summary of these states and the navigation sensor data used for the various modes is provided in Figure 20-13. The primary mode couples the MAGR and the INS to derive an extremely accurate navigation solution. In all other modes, if GPS information is available, it is used directly to update the NSV position in the MCS due to its inherent accuracy. Navigation State Vector velocity and heading are updated by INS, SAHRS, GPS, or external sources, in order of priority. Either the INS or SAHRS provides attitude, accelerations, and angular rates for NSV computations. In all modes, the functions and outputs normally provided by the navigation system are made available to the maximum extent possible.

The navigation system automatically selects the best operating mode based on available sensors, unless

overridden by manual aircrew selections. Navigation sensors used are listed in the lower center legend of the NAV (Navigation) System Aid format (see Figure 20-14). With a fully operational system, this legend should read "INS/GPS".

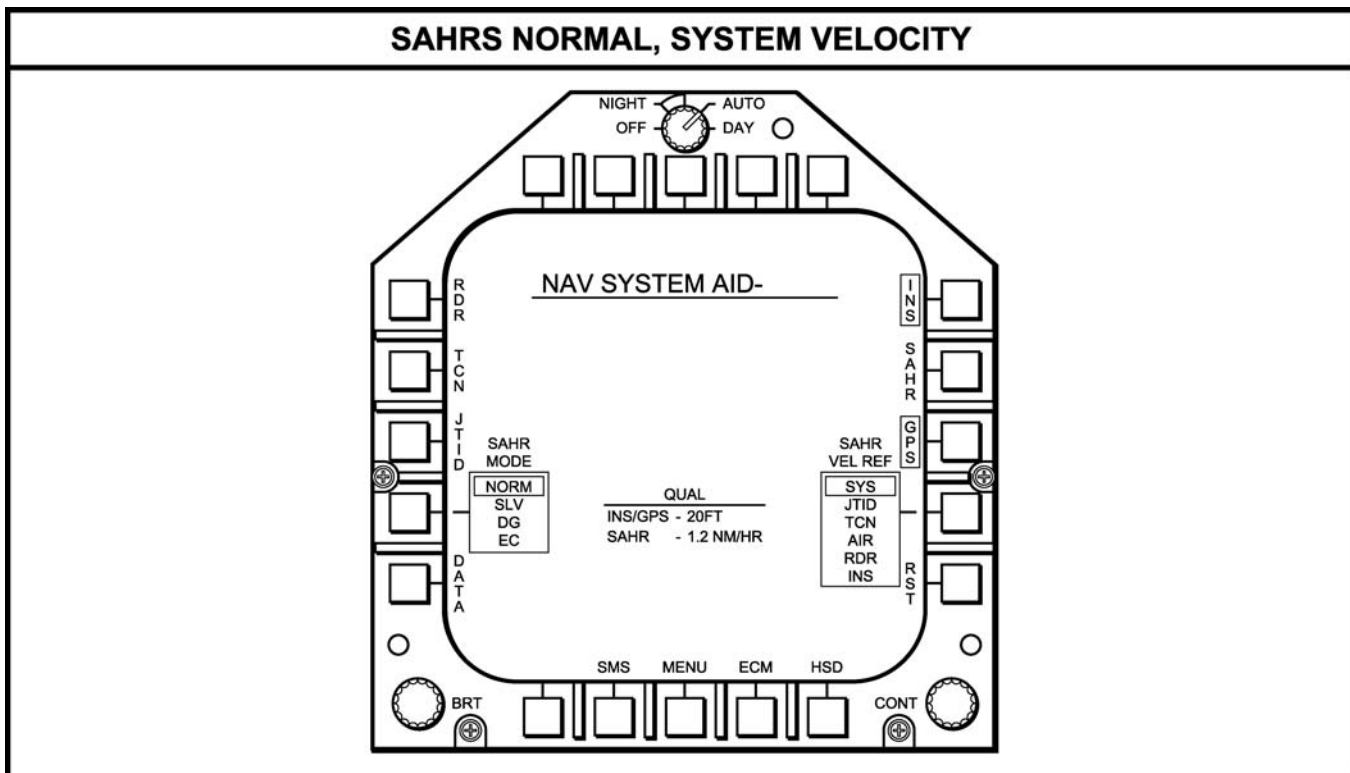
Manual selections are made via the INS, SAHR, and GPS legends on the OWN A/C or NAV System Aid format. Manual selection of INS or SAHRS is indicated by an "M" on the OWN A/C or NAV System Aid format, adjacent to the sensor legends. The absence of an "M" indicates automatic mode selection is available. Normally INS will be automatically selected. Automatic deselection of GPS is indicated by a dash-boxed GPS legend on the OWN A/C or NAV System Aid formats (Figure 20-8 and Figure 20-14), indicating that automatic reselection is available. The inability to box a legend corresponding to a specific navigation sensor indicates that the sensor is unavailable for selection.

Note

- During aircraft start, GPS should automatically box once a FOM of 4 is achieved. GPS will be boxed (dashed) on start up.
- If the MAGR degrades to a FOM of 8 or 9, it will declare its output invalid to the MCS, resulting in automatic deselection of GPS (dashed box) and downgrading of the navigation mode.

MODE	HSD	NAV MODE SWITCH	OWN AC DATA PAGE	POSITION SOURCE	VELOCITY SOURCE	ATTITUDE SOURCE
Primary	Provides superior navigation under all flight conditions.					
	INS/GPS	IFA	INS & GPS boxed	INS	INS	INS
	INS*	INS	INS boxed	INS	INS	INS
*For non-GPS equipped aircraft or GPS powered off or unboxed.						
Secondary	Provides satisfactory navigation in maneuvering flight					
	GPS/INS	INS	INS & GPS boxed	GPS	INS	INS
Tertiary	Provides adequate navigation in non-maneuvering flight.					
	GPS/SAHRS	—	GPS boxed	GPS	SAHRS	SAHRS
	GPS/IMU	ATT	GPS boxed	GPS	IMU	IMU
Backup	Provides marginal navigation for emergency purposes. Heading based on GPS N & E Velocity.					
	GPS	OFF	GPS boxed	GPS	GPS	NA

Figure 20-13. Navigation Modes and Navigation Sensor Data



CSC-F14D-1-20-015A

Figure 20-14. NAV System Aid Format

20.3.2.1 Primary Navigation

20.3.2.1.1 INS/GPS Mode Operation

INS/GPS mode is the primary navigation mode. This mode is the default selection when the system achieves an alignment with the NAV MODE switch in IFA (In Flight Alignment) with valid GPS information available. This is the recommended mode when all systems are operating normally, as it provides the most accurate navigation solution available. In this mode, the INS uses GPS horizontal position and velocity information, combining it with its own navigation solution for the best combination of the two. INS/GPS mode horizontal position accuracy typically is within 20 feet when the MAGR has achieved a FOM of 1, and remains extremely stable during dynamic maneuvering flight.

In INS/GPS mode, the INS horizontal channel is continually updated using GPS information. The MAGR provides GPS position, velocity, and quality data directly to the INS, bypassing the MCS. The INS uses GPS information in its Kalman filter to correct and optimize its own horizontal navigation solution, which is then sent to the MCS for Navigation State Vector (NSV) computations. GPS information is not used directly for NSV updates. In turn, the INS provides its own position and velocity coordinates to the MAGR, which allows it to extrapolate aircraft and satellite positions more accurately during maneuvering flight, antenna masking, signal dropouts, and jamming. NSV attitude and heading are provided directly by the INS.

During INS/GPS operations on deck, the parking brake may be released and the aircraft taxied without interrupting an alignment in progress. In flight, an alignment can be accomplished with align quality similar to that possible with a ground alignment. The only restriction is that the aircraft should not be maneuvered in a manner that masks the GPS antenna from available satellites for more than a few seconds early in the alignment.

Because of the high degree of position accuracy in the INS/GPS mode, one-fix INS position updates are unavailable.

20.3.2.1.2 INS/GPS Mode Selection

The INS/GPS mode is entered when the INS and GPS legends are automatically selected (boxed) on the OWN A/C or NAV System Aid format, and IFA is selected on the NAV MODE switch. Selection of this mode is verified with the display of "INS/GPS" on the lower left of the HSD format, OWN A/C format, and NAV System Aid format.

If a GPS QUAL CAW is posted, the INS/GPS mode will be automatically deselected after a 30-second delay. The INS will then operate in its inertial mode without GPS

updates, and an ALIGN SUSPENDED computer message will be displayed. However, INS information will continue to be sent to the MAGR for GPS aiding. If the MAGR sufficiently recovers for at least 8 seconds, INS/GPS mode will be reselected automatically, provided the NAV MODE switch remains in the IFA position.

Whenever INS/GPS mode is available but not selected, GPS/INS mode will be displayed on the OWN A/C page as the current NAV mode. This will occur if the INS has completed alignment and the MAGR is in NAVIGATE mode and is boxed but INS, vice IFA, is selected using the NAV MODE switch.

In flight, if IFA is selected on the NAV MODE switch, but the MAGR is not available or deselected, the INS will align to the external velocity reference source selected on the IFA format, with considerably reduced quality (see paragraph 20.3.2.3).

20.3.2.1.3 SAHRS Velocity Referencing

Once the SAHRS is aligned, it generates its own velocity outputs similar to the INS. However, SAHRS velocities are not as accurate as INS velocities, with errors in each axis ranging between 5 and 10 feet per second. Furthermore, these errors are subject to additional drift over time. Poor SAHRS alignment and/or performance will cause the NSV attitude and heading and SAHRS velocities to degrade quickly. An indication of poor SAHRS performance may be the appearance of an ATTITUDE, VELOCITY or POSITION CAW (Caution/Advisory/Warning).

SAHRS performance is improved by referencing it to a velocity source external to the SAHRS. However, GPS is unavailable as an external velocity reference source. Although NSV velocities may be modified with available GPS information within the MCS, the SAHRS itself does not couple with nor is it directly aided by the MAGR. By default, if no external velocity source is selected, SAHRS will use its own inertially derived velocity.

Note

- A SAHRS external velocity reference source should always be selected, even when a good INS alignment has been achieved and the INS is known to be operating satisfactorily.
- After a system reset, SAHRS velocity reference becomes unboxed. Reselection of a SAHRS velocity reference following a system reset is highly recommended to maintain the best possible SAHRS navigation solution in case of degraded navigation mode operation.

Available external velocity sources are selected by depressing SAHR VEL REF on the NAV System Aid format. The listed sources are:

SAHRS VELOCITY SOURCES	
SYS	System NSV velocity, computed using all valid velocity sources. SYS is recommended if GPS is selected, since it is the only source that includes GPS information
TCN	TACAN-relative computed velocity
JTID	JTIDS computed velocity.
AIR	True airspeed, computed by the SCADC and compensated for winds.
RDR	Radar-relative computed velocity.
INS	INS inertial velocity. If GPS is not selected, INS provides the best reference velocity.

20.3.2.2 Secondary Navigation

20.3.2.2.1 GPS/INS Mode

GPS/INS is the next best mode. GPS/INS is selected with the NAV MODE switch in INS after achieving a complete alignment, and then boxing GPS. This mode does the filtering of GPS with INS information in the MC. The main difference between GPS/INS and INS/GPS is that in the latter, the velocities input to the NSV are more accurate and the INS is continuously updated by the MAGR. Good long-term navigation performance may be expected in GPS/INS. However, dynamic response will not be as precise as with the prime INS/GPS mode, and with extensive dynamic maneuvering this accuracy will degrade. Navigation accuracy in GPS/INS mode is nevertheless superior to an inertial-only mode.

In GPS/INS mode, the NSV position is derived directly from GPS information. Navigation State Vector velocity, attitude, and heading are provided directly by the INS. There is no direct transfer of data between the INS and the MAGR.

GPS/INS mode is entered when INS and GPS are selected on the OWN A/C or NAV System Aid format, and the NAV MODE switch is placed in INS. Selection of this mode is verified with the display of “GPS/INS” on the lower left of the HSD format. These conditions will also generate an IFA AVAILABLE computer message.

If the MAGR FOM increases, the MCS will continue to use GPS position information. If the MAGR declares its

output invalid to the MCS (FOM > 7), GPS/INS mode will be automatically deselected and the boxed GPS legend on the OWN A/C or NAV System Aid format will appear dashed. The navigation system will then operate in the inertial-only INS mode (see paragraph 20.3.2.2). If the MAGR recovers to FOM ≤ 7, GPS/INS mode will be reselected automatically, provided that GPS was not deselected manually.

20.3.2.2.2 INS Mode

The INS mode provides the most accurate navigation solution if GPS information is unavailable, and is the default non-GPS navigation mode. INS mode operation is the same as that in previous F-14D configurations without GPS, with a performance typically within 1 nm per hour. Navigation State Vector updates are derived from weighted mixes of INS and SAHRS inputs.

The INS mode is entered at the completion of an INS alignment when the NAV MODE switch is placed in INS, or automatically if the aircraft becomes airborne and the NAV MODE switch is still in an align position, provided sufficient alignment quality has been achieved. Selection of this mode is verified with the display of “INS” on the lower left of the HSD format.

Note

Selection of INS on the NAV MODE switch with a displayed alignment quality of 5.0 or higher will result in entry into the IMU (Inertial Measurement Unit) mode (see paragraph 20.3.2.4.2).

20.3.2.2.3 INS Velocity-Aided IFA Mode

The INS Velocity-Aided IFA mode aligns the INS in flight without GPS velocity or position information, using a selectable external velocity reference source. Since INS IFA mode uses the current system position information, a one-fix position update is recommended before selecting INS IFA mode.



INS performance following a non-GPS in-flight alignment depends on the accuracy of the selected velocity reference source. Therefore, INS IFA mode is recommended only if mission accomplishment is otherwise jeopardized.

Available external velocity sources are JTID, SYS, and AIR. The preferred velocity sources, in order of priority, are:

EXTERNAL VELOCITY SOURCES	
JTID	JTIDS information, available to the MCS only when operating in a JTIDS network. INS IEA with quality JTIDS information typically requires 12 to 15 minutes. The quality of a JTIDS INS IEA will increase with the number of JTIDS participants.
SYS	System velocity represents a weighted mix of all available velocity sources. It is subject to errors in any of the involved velocity sources.
AIR	Air data provided by the SCADC. Accuracy depends on that of the computed or entered winds. Because of the potential for poor accuracy, the INS ALGN CMPLT computer message may never be displayed. AIR should be selected only as a last choice and only when the INS is degraded enough to prevent mission accomplishment. This takes up to 35 minutes.

The INS IFA mode is entered if INS is selected on the OWN A/C or NAV System Aid format, the NAV MODE switch is placed in IFA, and GPS is not available. In INS IFA mode, "INS" is displayed on lower left of the HSD format, so selection of this mode must be verified by referencing the IFA format. See [Figure 20-15](#). Specific INS IFA procedures are:

1. From the OWN A/C format, select SAHR as a valid source of true heading. If reasonable SAHRS heading information is not available, then enter the best estimated true heading from the DEU OWN A/C format.
2. Select IFA on the NAV MODE switch. The IFA format will appear.

Note

To ensure good initial alignment, straight and level flight should be maintained from 1 to 5 minutes after IFA is selected on the NAV MODE switch.

3. From the IFA format, select a velocity source from JTID, SYS, or AIR selections.
4. Observe the alignment progress on the IFA format.

5. Place the NAV MODE switch to INS when the INS ALGN CMPLT computer message is displayed, or if the aircraft is to be maneuvered dynamically.

Note

Because of the extensive time required for an INS IFA (up to 35 minutes), the NAV MODE switch may be placed to INS before the INS ALGN CMPLT message is displayed. Either the INS mode or IMU mode will be selected automatically, depending on the quality of the alignment when INS is selected on the NAV MODE switch.

6. Verify the navigation mode legend on the lower left of the HSD format.

Note

Selection of INS on the NAV MODE switch with a displayed alignment quality of 5.0 or higher will result in entry into the IMU mode (see paragraph 20.3.2.4.2).

20.3.2.3 Tertiary Navigation

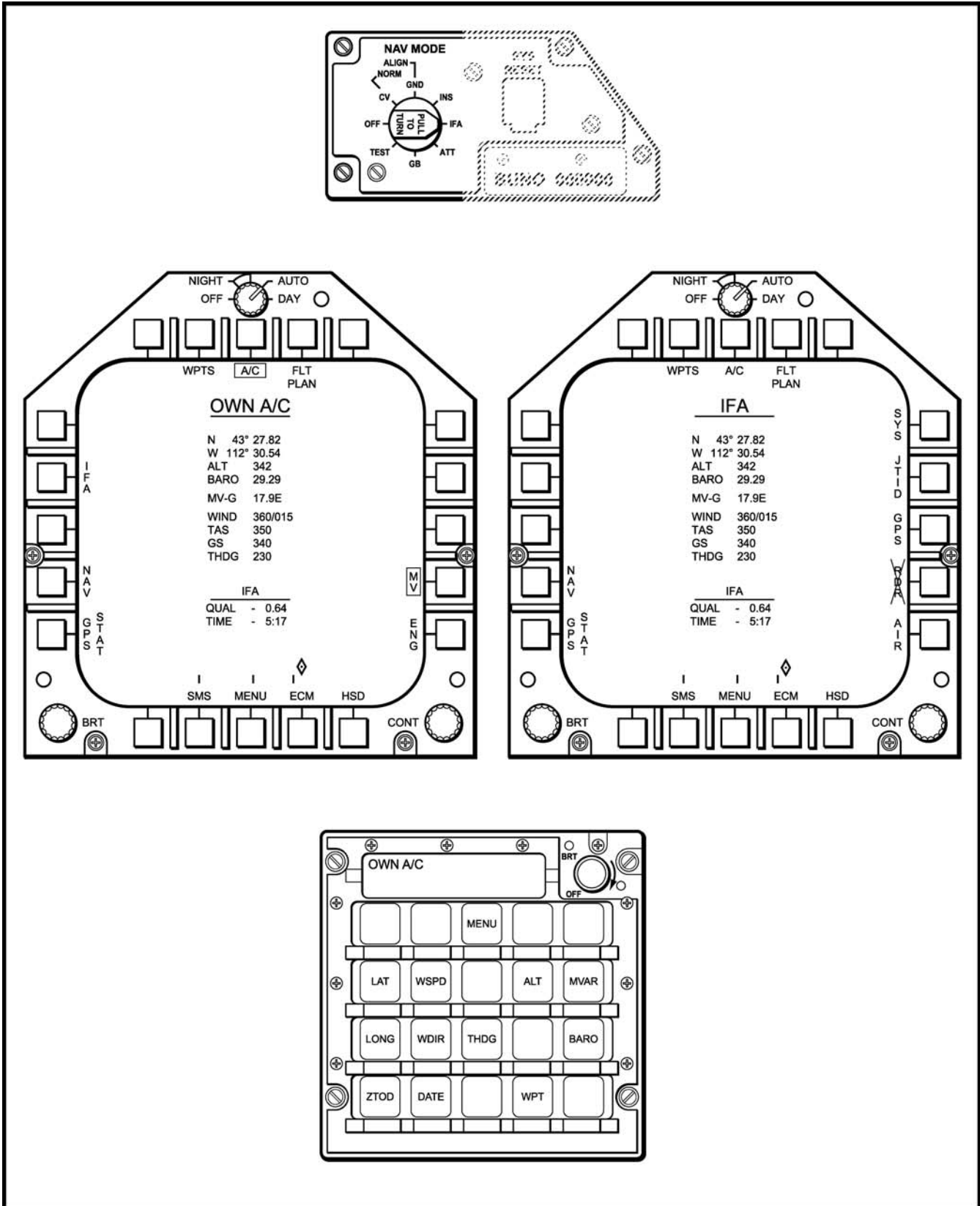
20.3.2.3.1 GPS/SAHRS Mode

The GPS/SAHRS mode provides reasonable navigation in non-maneuvering flight due primarily to the use of GPS position information. However, it is not as accurate as the primary or secondary navigation modes, and substantial errors may accrue during extended maneuvering flight using SAHRS inputs.

In GPS/SAHRS mode, there is no direct transfer of information between the MAGR and the SAHRS. NSV position is derived directly from GPS information, and NSV velocities, attitude, and heading information are derived from SAHRS.

The GPS/SAHRS mode is entered when GPS and SAHR are selected on the OWN A/C or NAV System Aid format. Selection of this mode is verified with the display of "GPS/SAHRS" on the lower left of the HSD format.

If the MAGR FOM increases, the MCS will continue to use GPS position information. If the MAGR declares its output invalid to the MCS (FOM > 7), then GPS/SAHRS mode will be automatically deselected and the boxed GPS legend on the OWN A/C or NAV System Aid format will appear dashed. The navigation system will then operate in the inertial-only SAHRS mode (see paragraph 20.3.2.3.3). If the MAGR recovers to FOM ≤ 7, GPS/SAHRS mode will be reselected automatically, provided that GPS was not deselected manually.



CSC-F14D-1-20-014A

Figure 20-15. INS In-Flight Align Formats

20.3.2.3.2 GPS/IMU Mode

The GPS/IMU mode provides reasonable navigation in non-maneuvering flight due primarily to the use of GPS position information. However, substantial errors will accrue during extended maneuvering flight.

Navigation State Vector position is derived directly from GPS information. If SAHRS velocity is valid, it is used. If not, NSV velocity is derived by mixing GPS and other available system velocities, which could include JTIDS and Air Data. Attitude and heading are derived from inertial angles provided by the IMU.

The GPS/IMU mode is entered when INS and GPS are selected on the OWN A/C and NAV System Aid format, the SAHRS is unavailable, and the NAV MODE switch is placed to ATT, or to INS with only the IMU sub-mode available. Availability of the IMU sub-mode of the INS is verified by the display of "IMU" in the center legend of the NAV System Aid format, which depicts available sensors. Selection of this mode is verified with the display of "GPS/IMU" on the lower left of the HSD format.

Note

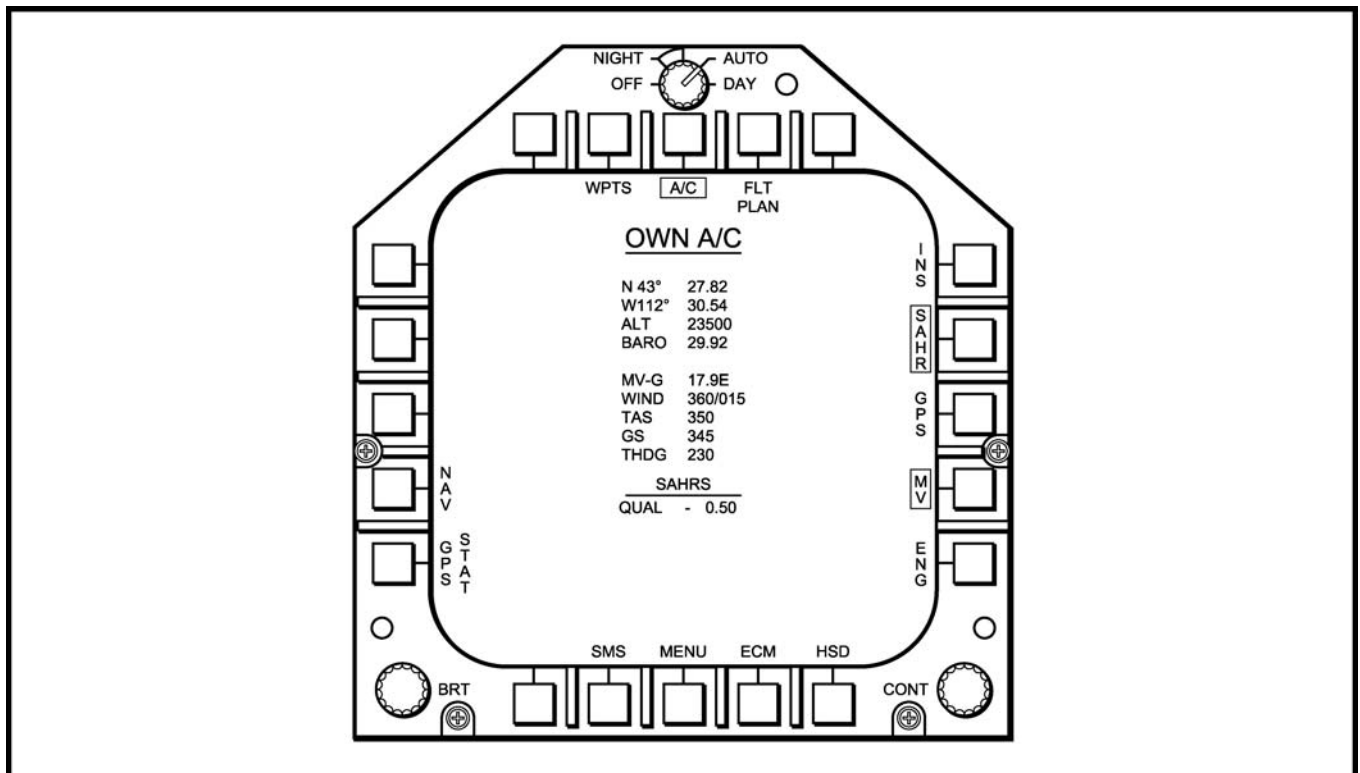
If the INS degrades to the IMU sub-mode, the SAHRS will be selected automatically for navigation reference, if it is available. The IMU will be selected if the SAHRS is not available.

If the MAGR FOM increases, the MCS will continue to use GPS position information. If the MAGR declares its output invalid to the MCS (FOM > 7), GPS/IMU mode will be automatically deselected and the boxed GPS legend (PB 13) on the OWN AC or NAV System Aid format will appear dashed. The navigation system will then operate in the attitude-only IMU mode (see paragraph 20.3.2.4.2). If the MAGR recovers to FOM ≤ 7, GPS/IMU mode will be reselected automatically, provided that GPS was not deselected manually.

20.3.2.3.3 SAHRS Normal Mode

The SAHRS Normal mode uses dynamic inputs sensed by the SAHRS in its normal mode, with the same functionality as INS mode. The Normal mode provides reasonable short-term inertial navigation. NSV position, velocity, attitude, and heading are updated directly by the SAHRS. However, because of the reduced sensitivity and precision within the SAHRS, performance typically is between 2 and 10 nm per hour, depending upon the quality of the initial SAHRS alignment.

The SAHRS Normal mode is entered when SAHR (PB 12) is selected as the sole navigation aid source on the OWN A/C or NAV System Aid format (Figure 20-16). An "M" will be displayed adjacent to the SAHR legend if the selection is manual, indicating that automatic sensor selection is not available. Selection of this mode is verified with the display of "SAHRS" on the HSD format.



CSC-F14D-1-20-028A

Figure 20-16. Secondary Navigation Mode Manually Selected

20.3.2.4 Backup Navigation

20.3.2.4.1 GPS Mode

GPS mode provides minimal navigation information to the aircrew, all of which is derived directly from MAGR outputs and available external velocity reference sources. True airspeed and altitude, as computed by the SCADC, are sent continually to the MAGR to improve its dynamic response. Due to the absence of aircraft-sensed inertial data to stabilize the MAGR, increased errors may be expected in maneuvering flight or if L-band jamming is encountered.

In GPS mode, NSV position is derived directly from GPS information. The NSV velocities are derived by mixing GPS and other valid velocities. Attitude data is not available (except from the standby attitude indicators) and will not be displayed on the HUD or the VDI. Heading is computed by the MCS using GPS north and east velocities, and will be in error due to the drift caused by wind. Wind speed and direction may be entered manually via the DEU OWN A/C format.

GPS mode is entered when GPS is selected as the sole navigation aid source on the OWN A/C or NAV System Aid format. Selection of this mode is verified with the display of "GPS" on the HSD format.

If SCADC air data is lost and the radar altimeter is invalid or turned off, GPS altitude will be displayed on the HUD and VDI. This will be indicated by a "G" acronym

adjacent to the altitude display to alert the pilot that a backup altitude source is selected.

If the MAGR FOM increases, the MCS will continue to use GPS position information. If the MAGR declares its output invalid to the MCS (FOM >7), GPS mode will be automatically selected and the boxed GPS legend (PB 13) on the OWN AC or NAV System Aid format will dash. All navigation information except available air data will be lost. If the MAGR recovers to an FOM ≤ 7, GPS mode will be reselected automatically, provided that GPS was not deselected manually.

20.3.2.4.2 IMU Backup Mode

Inertial Measurement Unit mode provides minimal safety-of-flight information to the aircrew but no inertial navigation capability. All navigation information is derived directly from the IMU outputs of the INS and from available external velocity references.

In the IMU mode, aircraft attitude is derived directly from IMU inertial angles. Initial true heading is also calculated, but may not be accurate. Heading also will be in error by drifts caused by winds. True heading, wind speed and wind direction may be entered manually via the DEU OWN A/C format.

The IMU mode is selected when INS is selected as the sole navigation aid source on the OWN A/C and NAV System Aid format (Figure 20-17), the SAHRS and MAGR are

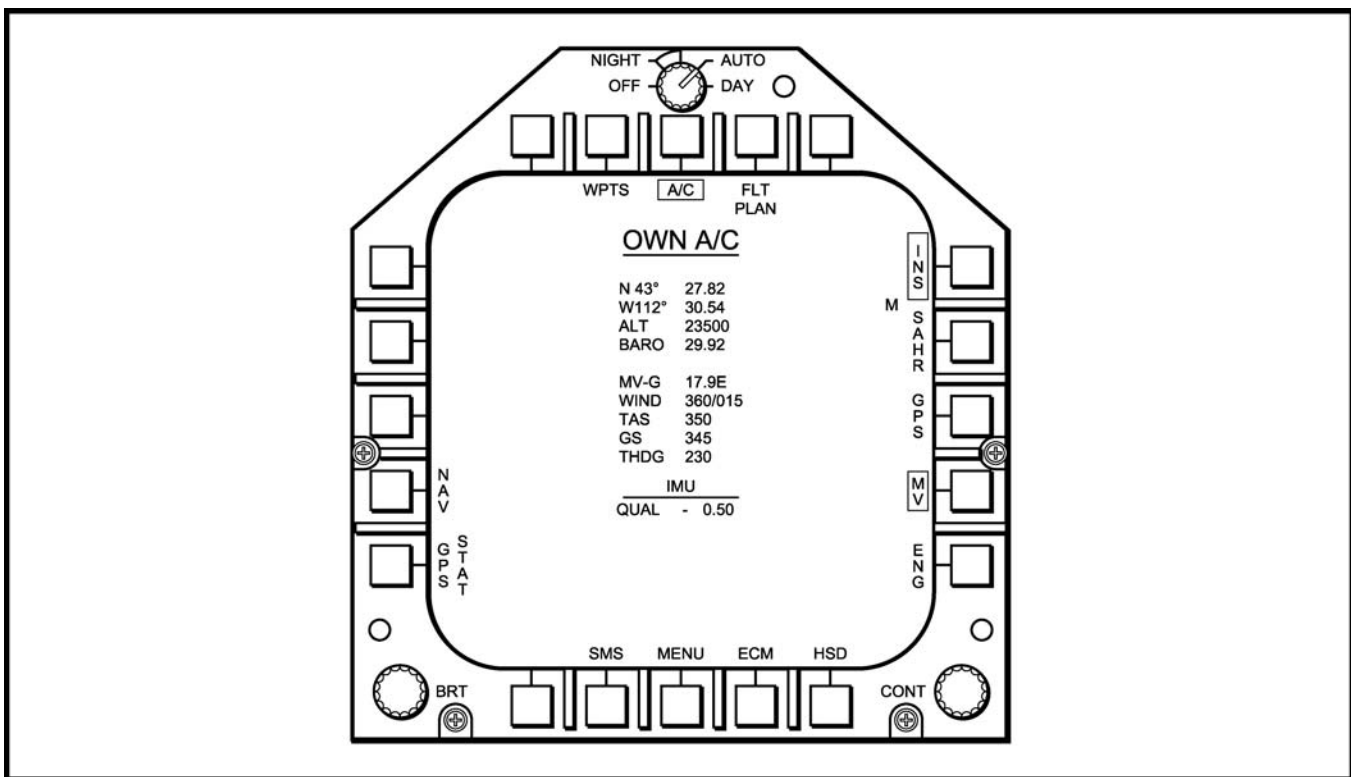


Figure 20-17. IMU Backup Navigation Mode Selection

CSC-F14D-1-20-016A

unavailable or deselected, and either the NAV MODE switch is placed to ATT or to INS with only the IMU sub-mode of the INS available. Availability of the IMU sub-mode of the INS is verified by the display of “IMU” in the center legend of the NAV System Aid format, which depicts available sensors.

If the INS degrades to the IMU sub-mode, SAHRS will be selected automatically (if it is available). If SAHRS is not available, IMU will be selected. If the INS was selected manually (i.e., an M adjacent to the INS legend), then automatic sensor selection will not be available and IMU will be selected even if SAHRS is available.

Selection of this mode is verified with the display of “IMU” on the lower left of the HSD format.



If ATT has been selected manually, the INS will degrade from an inertial mode to an attitude reference mode, and reversion to viable INS function may be difficult or impossible unless GPS is available. A GPS-aided IFA (via prime INS/GPS mode) will produce results similar to alignments attainable on the ground. An IFA using other velocity sources will perform less predictably.

20.3.2.4.3 SAHRS Backup Mode

The SAHRS Backup mode provides minimal safety-of-flight information to the aircrew, but no inertial navigation capability. All information is derived directly from angles provided by the SAHRS and available external velocity reference sources.

The SAHRS Backup mode operates in one of three sub-modes, based on the heading reference source. These sub-modes are selected via SAHR MODE on the NAV System Aid format. In order of desirability, they are:

SAHRS BACKUP SUB-MODES	
SLV	(Slaved) Magnetic heading is sensed by the magnetic azimuth detector (flux valve) and converted to true heading using computed or manually entered magnetic variation. Attitude is derived directly from SAHRS angles.
DG	(Directional Gyro) Magnetic heading is entered manually via the DG HDG selection on the DEU NAV Aid format. Attitude is derived directly from SAHRS angles.
EC	(Emergency Compass) Magnetic heading is sensed directly by the flux valve, without compensation. Attitude is not available.

In addition to automatic selection, SAHRS submode operation may be manually selected via the NAV SYSTEM AID MFD format shown in Figure 20-18. 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 pushbutton on the lower left of the same MFD format until the desired submode is boxed.



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

Note

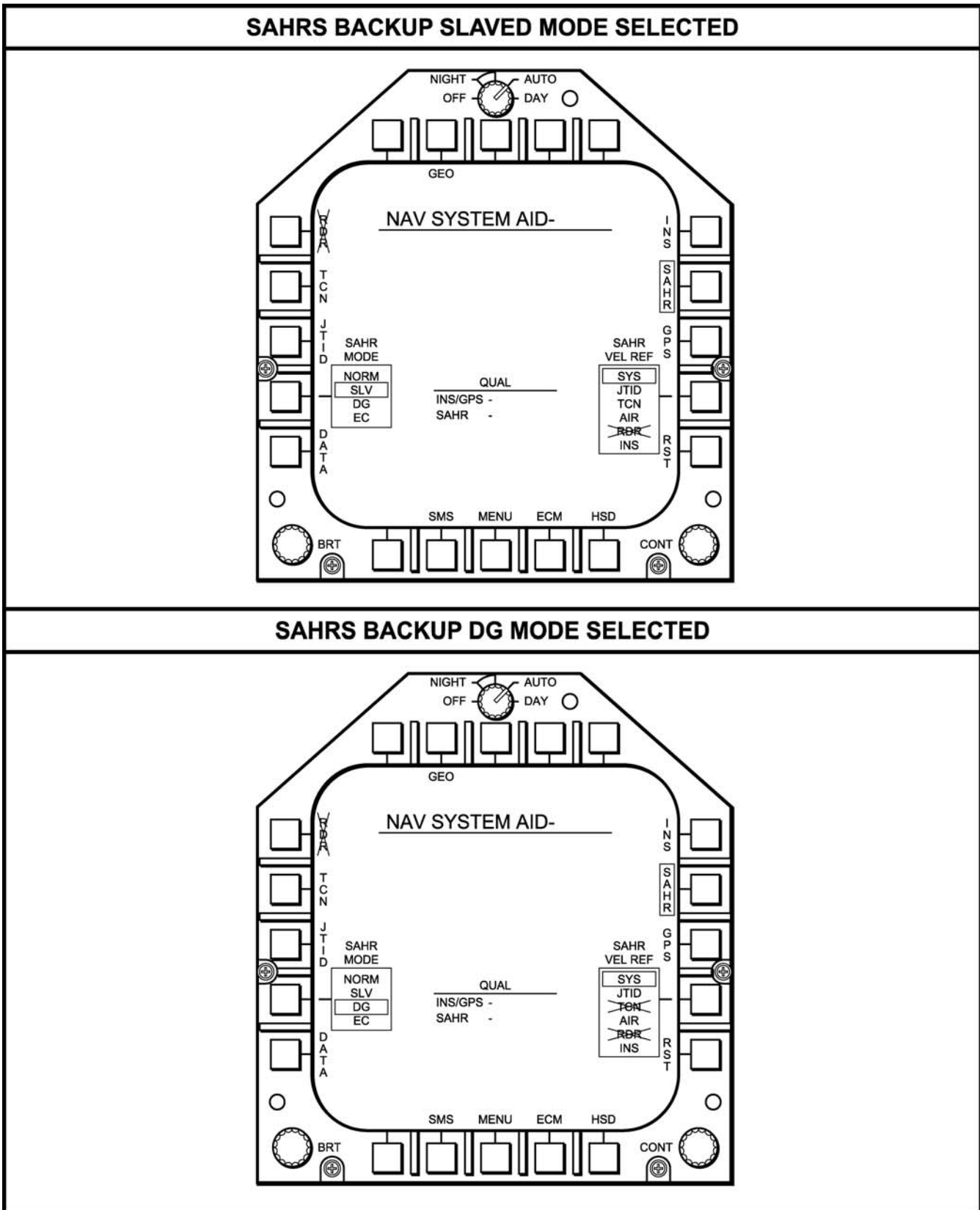
Although it is possible to cycle through the SLV, DG, EC submodes, reversion to NORM requires an in-flight restart. In-flight restart will automatically be initiated when the selection pushbutton is depressed to roll from EC to NORM or can be accomplished by depressing the in-flight RST pushbutton.

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.

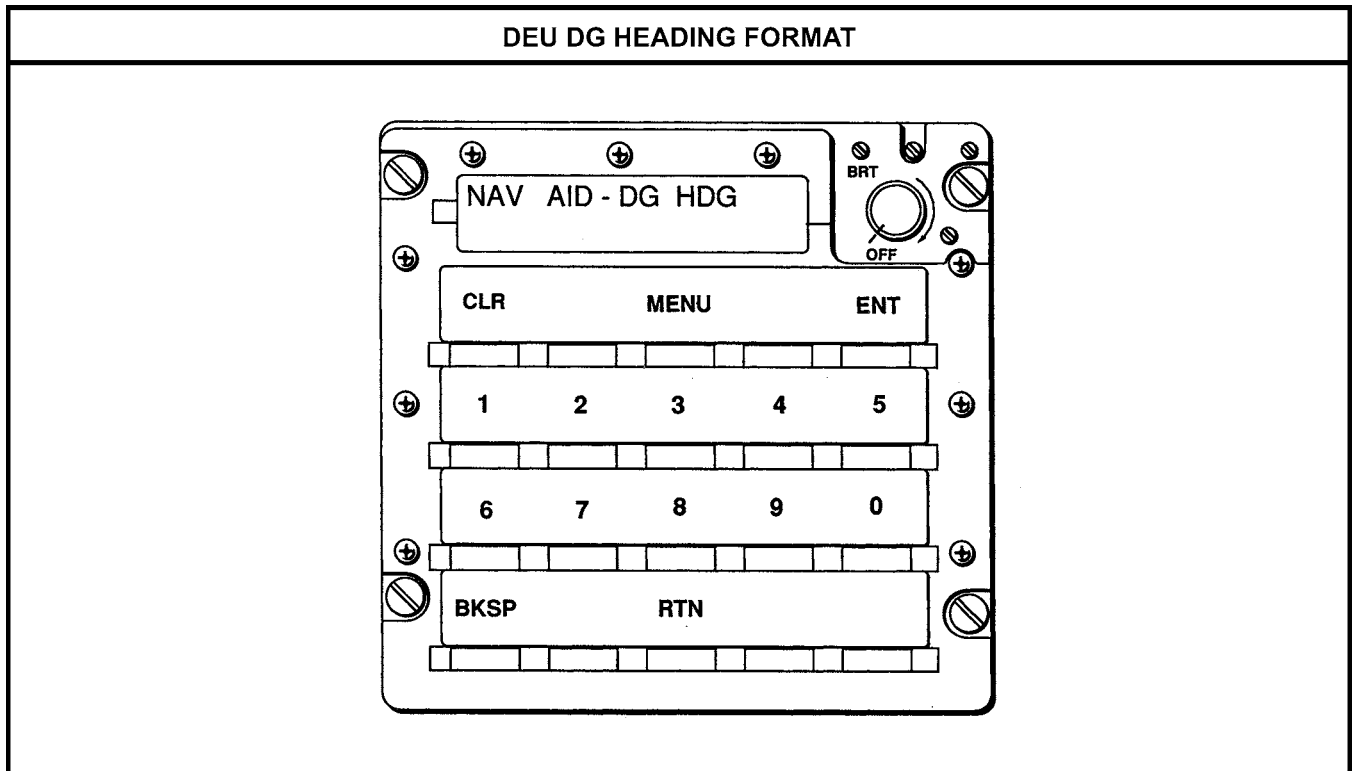
Selection of the DG submode will allow entry of a desired grid heading via the DEU, using the DEU NAV AID-DG HDG format (Figure 20-18). This entered parameter will be the initial heading reference until a new DG heading entry is made. In the system, it is treated as a magnetic-referenced parameter. Attitude information is derived from the SAHRS using first-order leveling and, like the SLV mode, is subject to dynamic errors.

The SAHRS EC sub-mode 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.



CSC-F14D-1-20-017

Figure 20-18. SAHRS Backup SLV and DG Modes (Sheet 1 of 2)



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Figure 20-18. SAHRS Backup SLV and DG Modes (Sheet 2 of 2)

The SAHRS Backup mode is entered when SAHR is selected as the sole navigation aid source on the OWN A/C or NAV System Aid format, with only the SAHRS backup sub-modes available. A degraded SAHRS is verified by the selection of a SAHRS heading source other than NORM on the NAV System Aid format. (Figure 20-18). Selection of this mode is verified with the display of “SAHRS” on the lower left of the HSD format.

20.3.2.4.4 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 20-18). 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.

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.

20.3.3 MAGR Initialization

Before the MAGR can be used for navigation, it must acquire signals from at least four satellites. To accelerate the signal acquisition, the MAGR uses stored almanac data. The data is stored in non-volatile memory supported by the receiver’s internal batteries. If these batteries are removed or are low, the MAGR requests almanac data from the MCS. The MCS loads the almanac data from the MDL if it is available on the cartridge.

Note

If a valid almanac is not available; the MAGR will initiate a cold start, wherein the receiver does a sky search for visible satellites. Search and acquisition can take over 20 minutes.

Note

GPS satellite acquisition time can be affected by a number of conditions, particularly L-band RF interference and line of sight obstructions, as well as the currency of the almanac data. On the ground, aircraft proximity to large structures such as a hangar or an aircraft carrier island may delay or prevent satisfactory satellite acquisition until the aircraft is moved.

Besides almanac data, the MAGR requires an estimate of current position, date, and time to speed acquisition. If any of these quantities are in error, the speed of acquisition will decrease. Generally, a position error of a few miles and a time error of a few minutes will not degrade acquisition perceptibly. The aircrew should verify that the correct data is available from the MCS by checking the OWN A/C MFD format (for position) and GPS Status MFD format (for date and time) during the GPS startup, and correct any significant errors.

20.3.4 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.

20.3.4.1 Normal Concurrent Ground Alignment

1. Select own-aircraft MFD format, (Figure 20-8) by depressing "DATA" pushtile on the MFD MENU1 page (Figure 20-19).
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 20-20). 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 20-21). 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

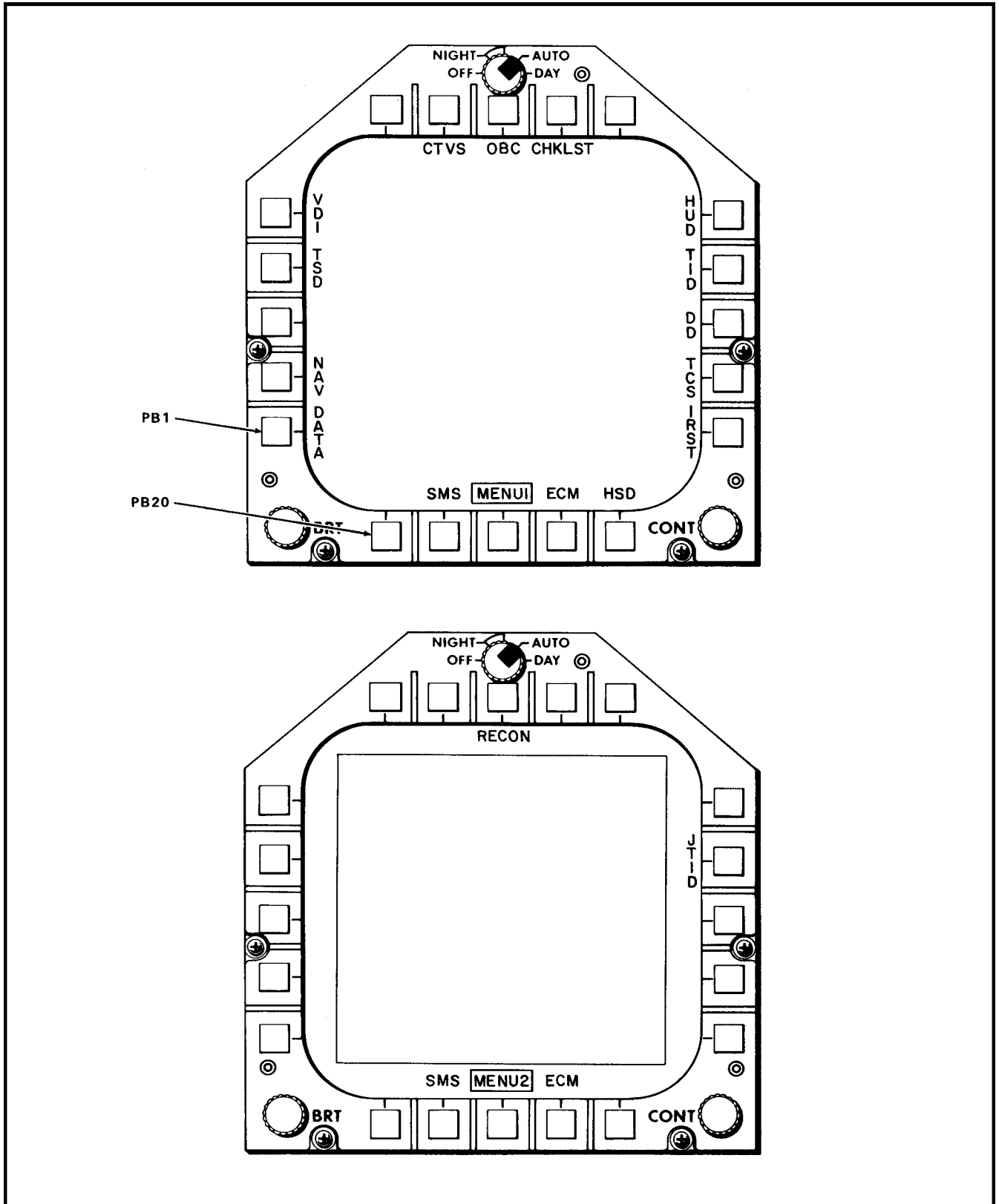
nearest 0.1 arc minute. Longitude entries on the DD below 100° do not require a 0 prior to entering the numerals.

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 20-22).
5. Verify that SHDG is not boxed. If it is, press the SHDG pushbutton to unbox SHDG.

Note

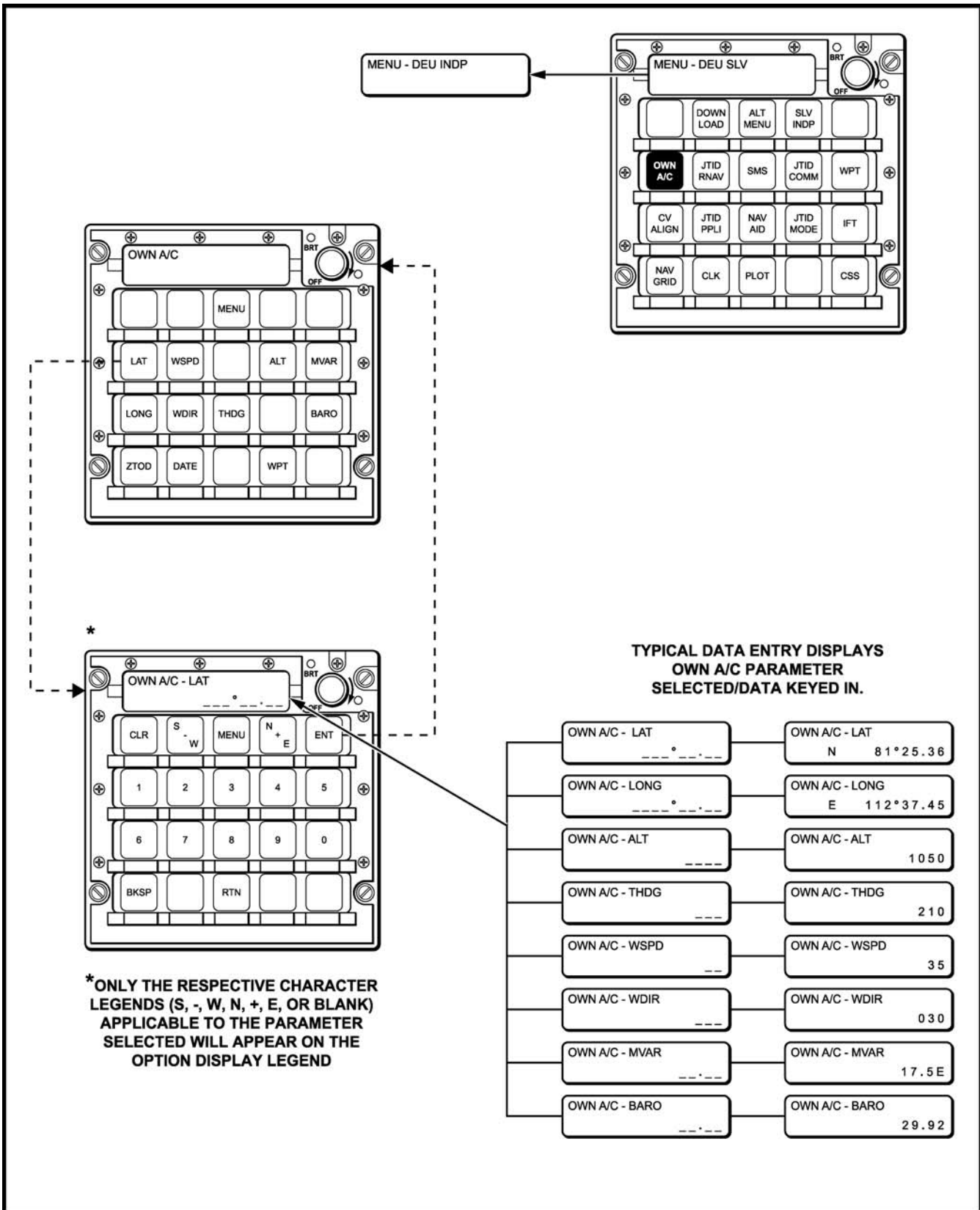
Unboxing of SHDG must be performed within 17 seconds of selecting GND ALIGN on the NAV MODE switch or the boxed SHDG will be selected and unboxed by the system and deselection will not be available.

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.



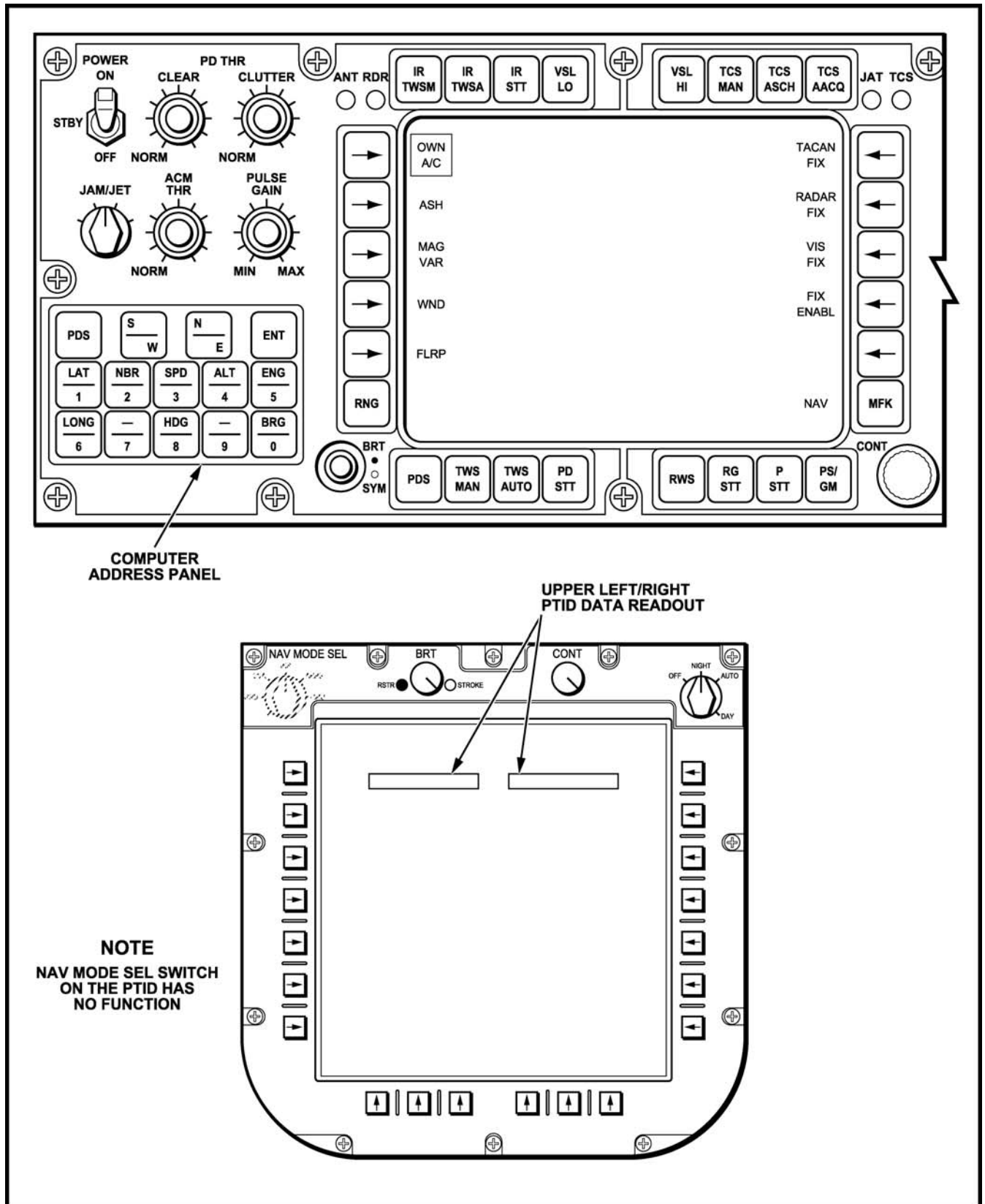
0-F50D-339-0

Figure 20-19. MFD MENU1 and MENU2 Displays



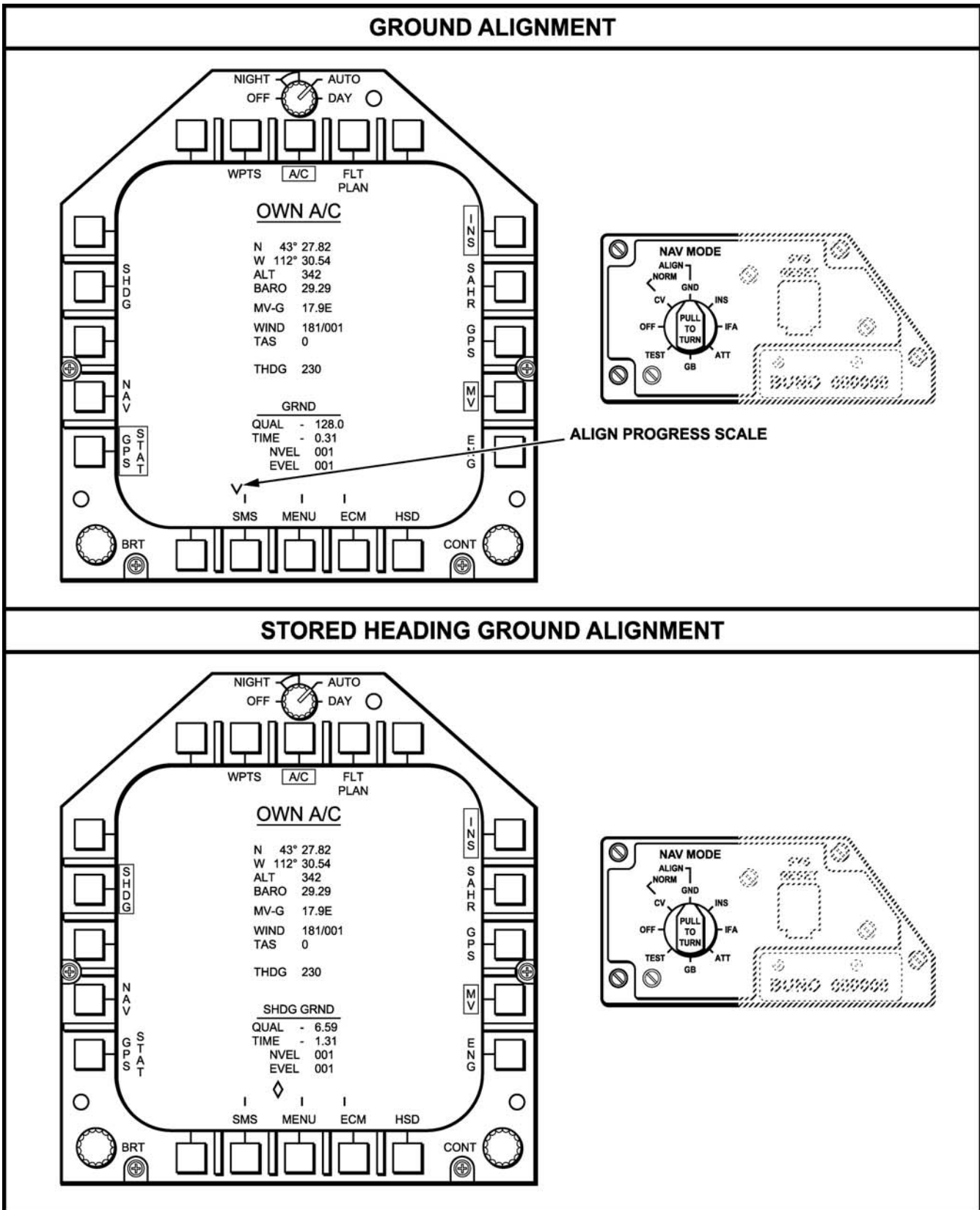
CSC-F14D-1-20-008A

Figure 20-20. DEU Own-Aircraft Data Entry (Typical)



CSC-F14D-1-20-009A

Figure 20-21. DD/PTID Own-Aircraft Data Entry



CSC-F14D-1-20-053B

Figure 20-22. MFD Ground Alignment Formats

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. The RIO may take the alignment anytime the QUAL reaches 1.0 nm per hour. The NAV MODE switch should be rotated to the IFA position once "IFA AVAILABLE" is displayed. This places the navigation system in the INS/GPS mode of operation. If GPS is available when the switch is in the INS position, the "GPS INTLK-SEL IFA" message will post to remind the aircrew that a better navigation mode exists.
11. If GPS is not available, INS performance may be improved 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 of waypoint 1 will be updated to current aircraft position when the NAV MODE switch is placed to INS.

20.3.4.2 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 20.3.4.1. 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.

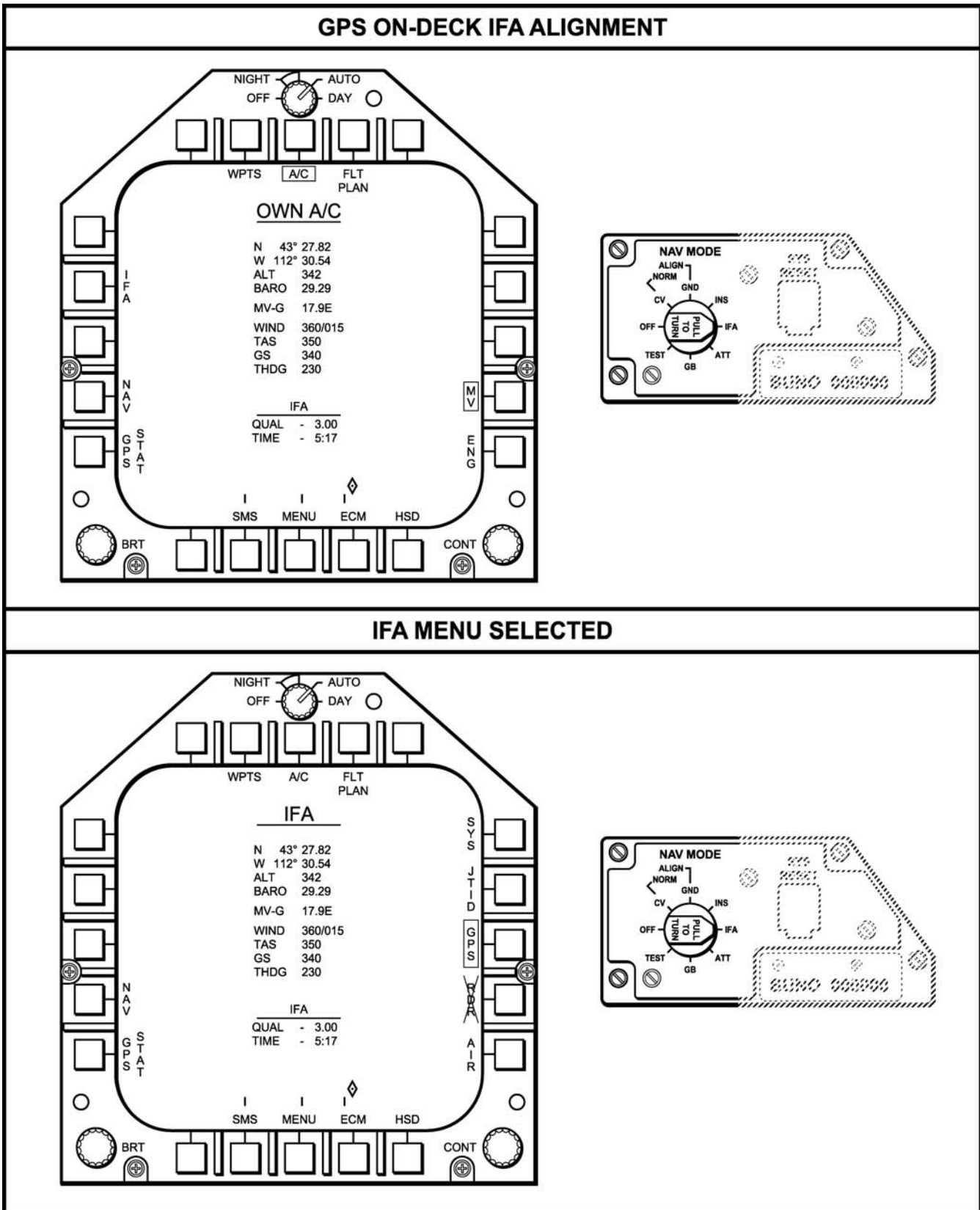
1. Repeat steps 1 through 4 for normal ground alignment.
2. Verify that SHDG is boxed on the OWN A/C MFD format (Figure 20-22). Do not depress the SHDG pushbutton.
3. Repeat steps 6 through 9 as in normal ground align procedure.

20.3.4.3 GPS On-Deck IFA

This method of alignment normally takes 3 to 4 minutes longer than a normal ground alignment, but requires only that the NAV MODE switch be placed in IFA and a GPS solution be available. It can be used ashore or aboard a CV. The aircraft can be moved during a GPS IFA alignment, so taxi and take-off may take place while the alignment is underway. GPS satellite acquisition normally takes from 30 seconds to 3 minutes, depending on the initial estimates of position, date, and time; satellite position; and LOS (line-of-sight) blockage by hangars, carrier island, etc.

To get an IFA Alignment on the ground, perform the following steps:

1. Place the NAV MODE switch in IFA at application of aircraft power (see Figure 20-23).
2. Verify correct date and time on the GPS Status page. If satellites have been acquired, the OWN A/C data page will show own aircraft position based on GPS, if GPS is boxed.
3. Monitor the GPS Status page to ensure satellites are acquired within a few minutes of moving the NAV MODE switch out of the OFF position to IFA. IFA alignment will not commence until satellites are acquired. If satellites are not acquired after a few minutes, transition to a normal ground alignment (on the NAV Mode Switch, select OFF then GND).
4. When the QUAL gets to 1.0, the system will automatically take the alignment and display the INS ALIGN COMPLETE message.



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Figure 20-23. GPS On-Deck IFA Alignment

Note

- The pilot will not have a FPM (Flight Path Marker) until a dot appears in the diamond.
- If GPS data is lost during alignment, the navigation system will align to waypoint 1. Therefore, aircrew should always ensure waypoint 1 coincides with actual aircraft location.
- The NAV MODE switch must remain in the IFA position to remain in the primary navigation mode, INS/GPS. This mode can also be obtained by conducting a normal ground alignment, followed by moving the NAV MODE switch from INS to IFA. GPS FOM ≤ 4 to be effective.
- INS alignment to GPS data via the INS/GPS mode is not always optimum from a cold start. It may require up to 10 minutes (plus up to 2 minutes for MAGR initialization), compared to only 4 or 5 minutes for a normal alignment. If movement of the aircraft during alignment is not anticipated, a normal concurrent ground or CV alignment followed by placing the NAV MODE switch to INS momentarily, then selecting IFA (In-Flight Alignment) may be more expeditious and will yield the same system accuracy.

20.3.5 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.

20.3.5.1 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 A, B, C, and DC circuit breakers (1I3, 1I5, 1I6, 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 20-24).
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.

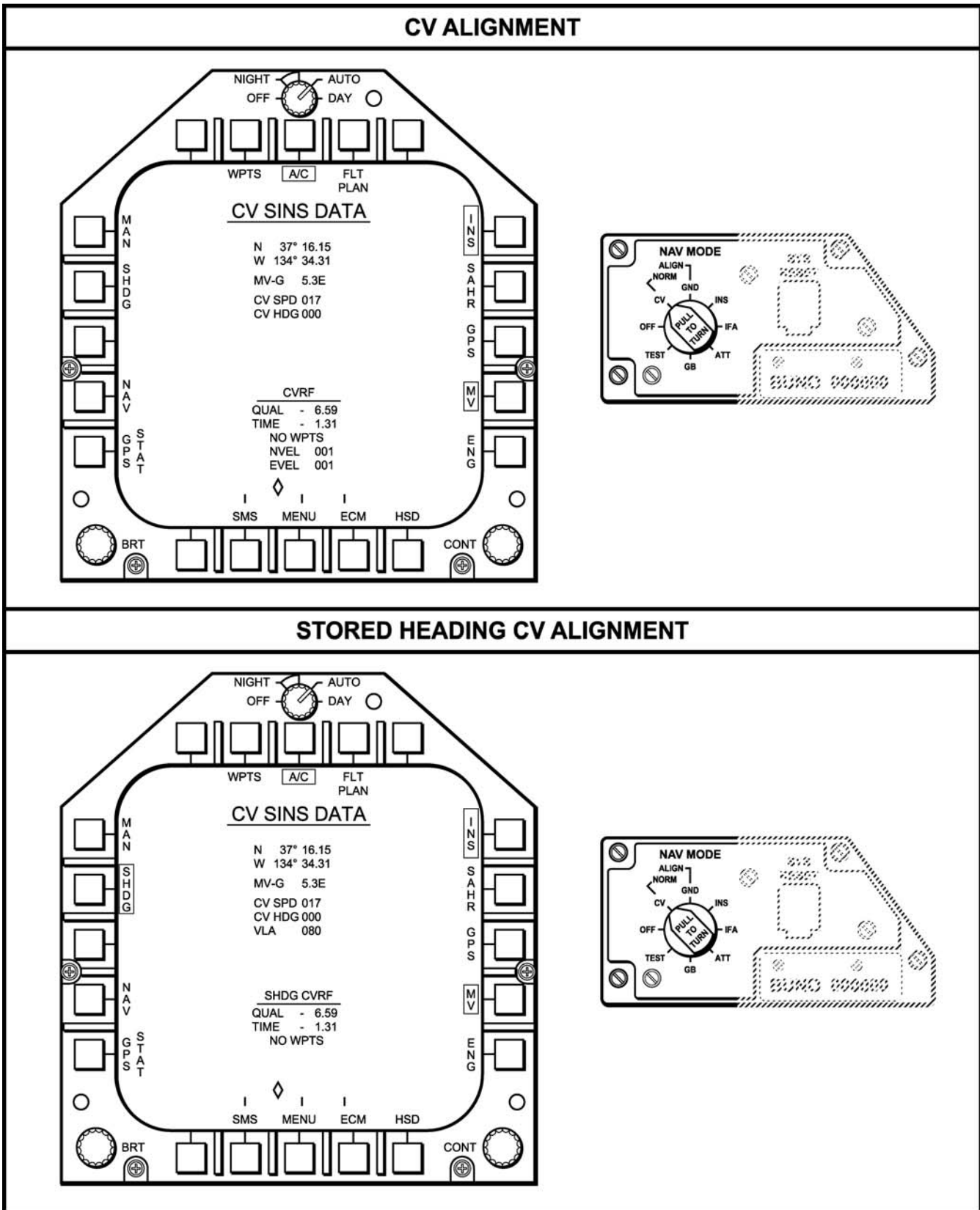
Note

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.



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Figure 20-24. CV Alignment Formats — SINS

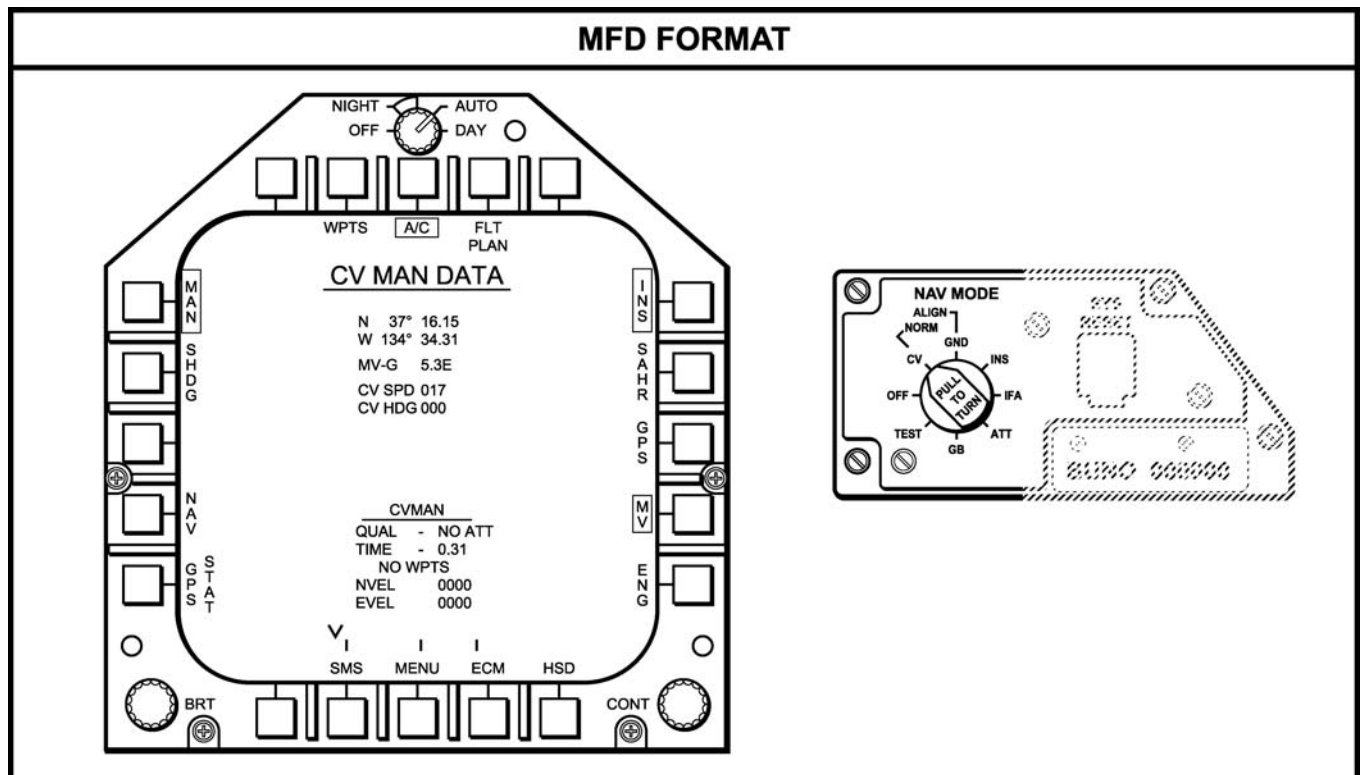


Figure 20-25. CV Alignment Formats — Manual (Sheet 1 of 2)

- 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. The RIO may take the alignment anytime the QUAL reaches 1.0 nm per hour. The NAV MODE switch should be rotated to the IFA position once the “IFA AVAILABLE” message appears. This places the navigation system in the INS/GPS mode of operation.

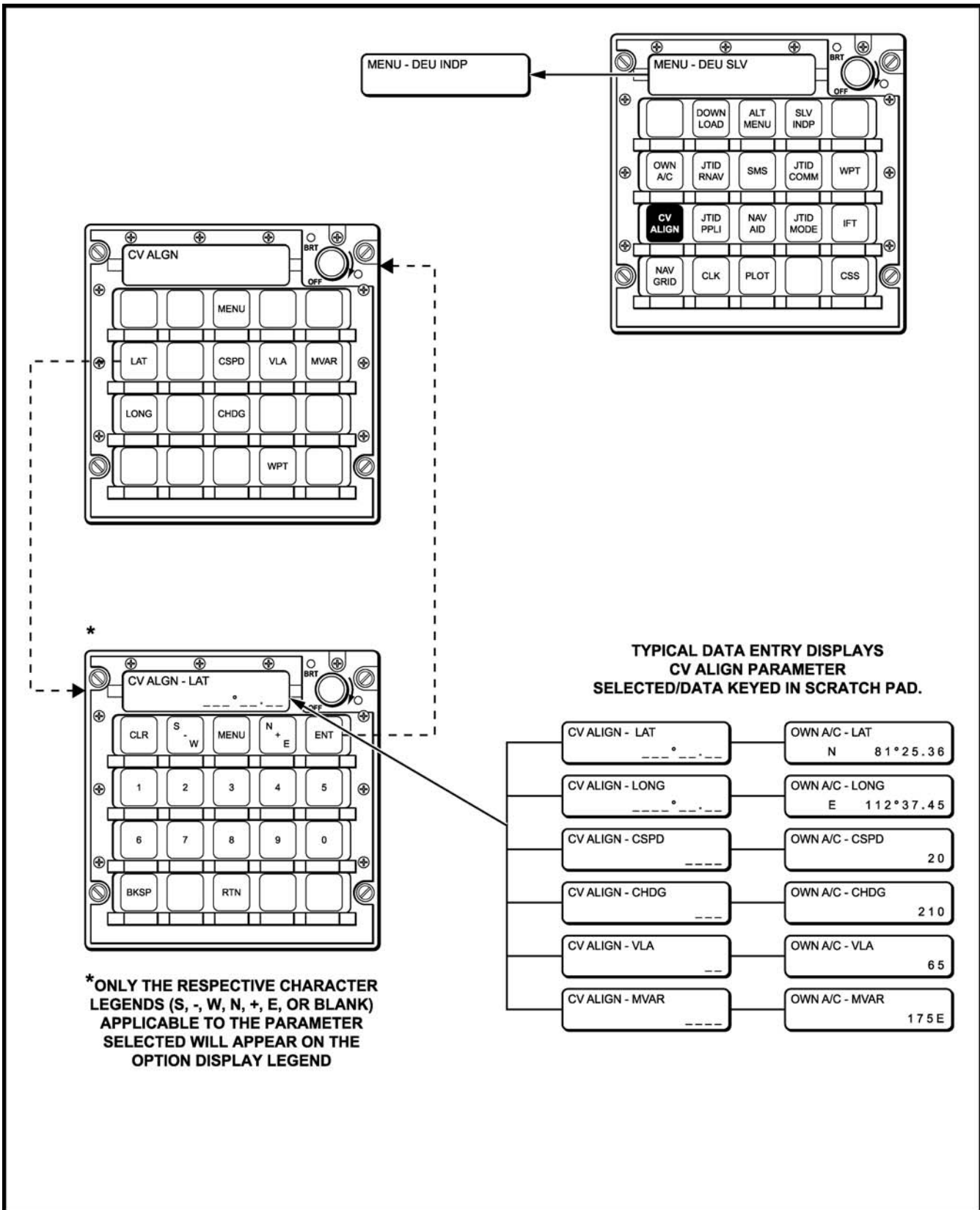
Note

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 20-25](#).

20.3.5.2 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 20.3.5.1. When the INS ALIGN COMPLETE message appears on the HUD/VDI formats, return the NAV MODE switch to OFF.



CSC-F14D-1-20-029

Figure 20-25. CV Alignment Formats — Manual (Sheet 2 of 2)

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 20-24).
 3. Repeat steps 9 and 10 of concurrent SINS carrier align.

20.3.5.3 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 20-25 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 20-25.
- 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 20-26. This is done in a similar manner as described in paragraph 20.3.4.1 and shown in Figure 20-21. 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 20-26.

3. Repeat steps 9 through 11 for concurrent SINS carrier align (paragraph 20.3.5.1).

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.

20.3.5.4 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 20.3.4. 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.

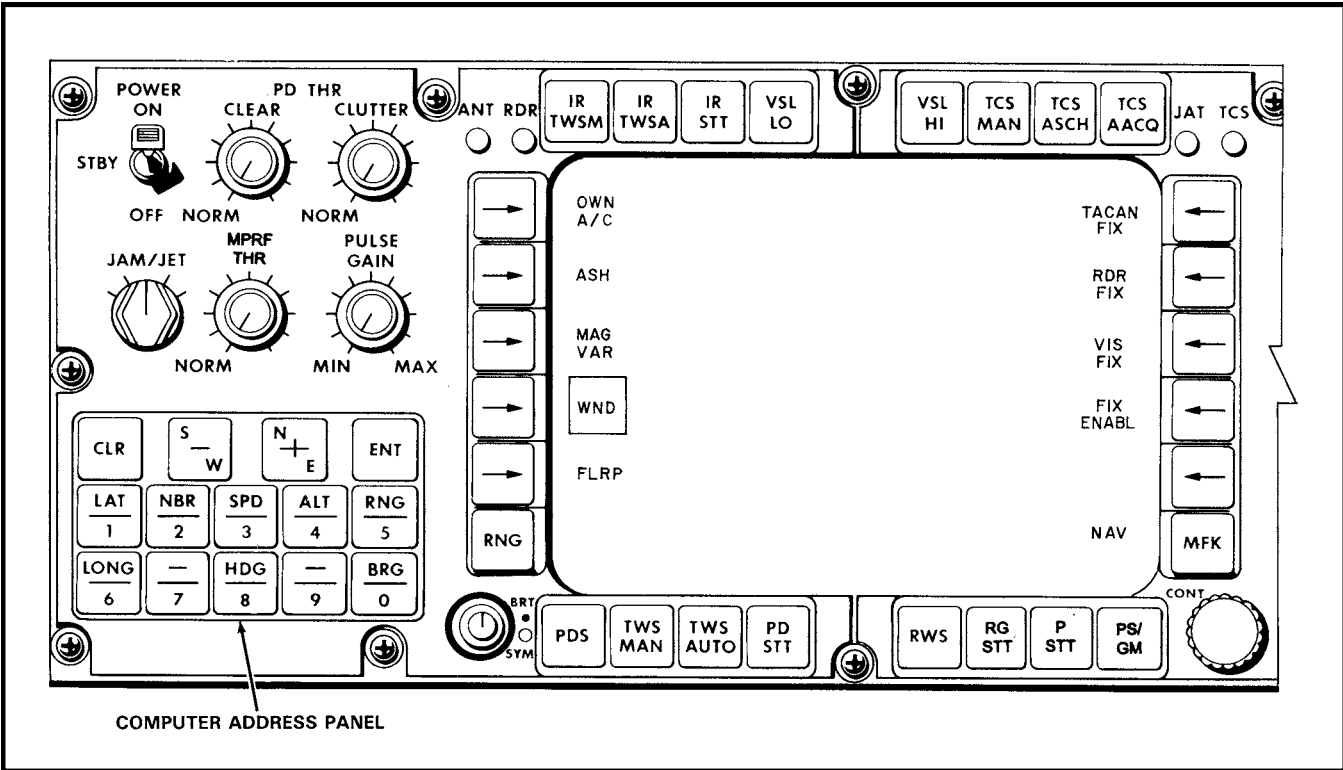
20.3.5.5 SAHRS Standalone Alignment

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 20-27). 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 20-27, 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.

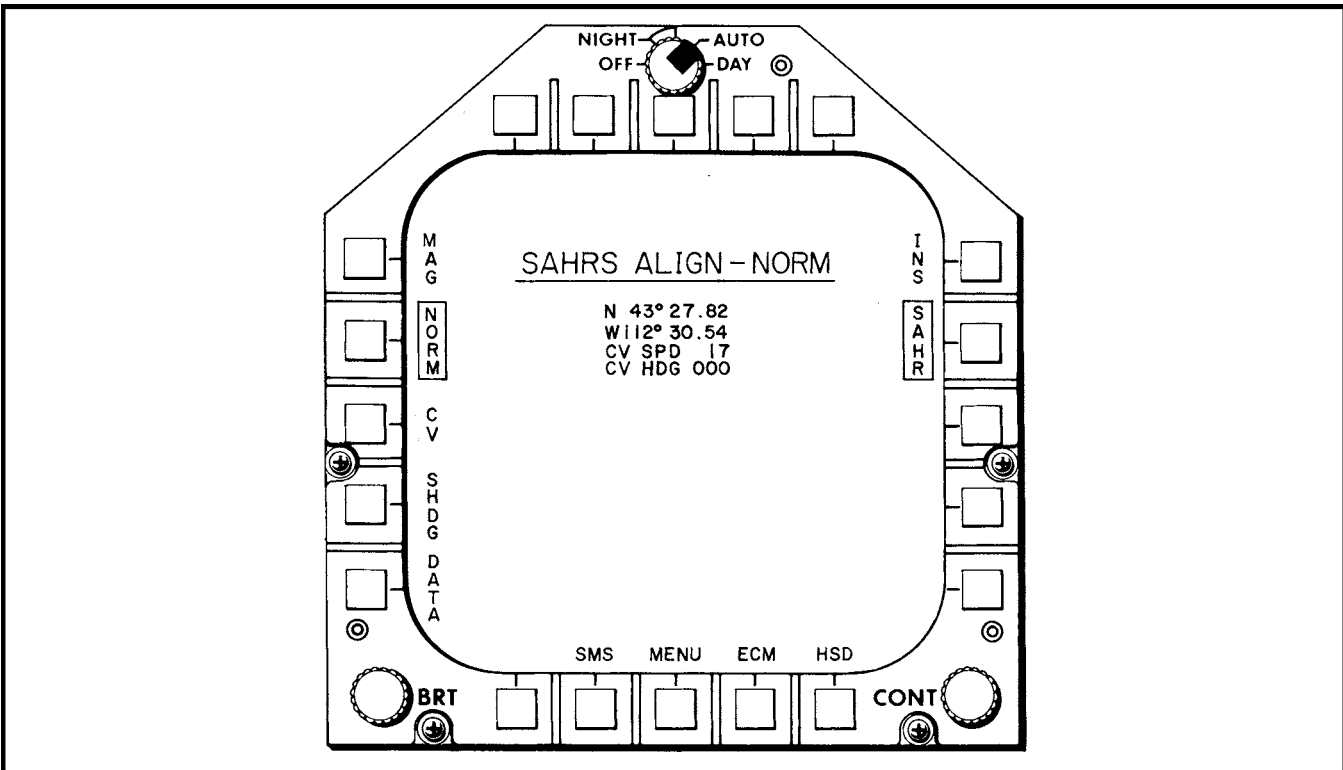
20.3.5.5.1 SAHRS Standalone Normal Ground Alignment

SAHRS normal ground alignment is the recommended mode for SAHRS standalone alignment and it will be



0-F50D-421-0

Figure 20-26. DD Align Data Entry



0-F50D-426-0

Figure 20-27. SAHRS Standalone Align MFD Format

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 20.3.4.1. The SAHRS ALIGN COMPLETE message will usually appear in less than 3 minutes, with an align quality of less than 10 nm per hour.

20.3.5.5.2 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 20-27). 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.

20.3.5.5.3 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 20-27. 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 20.3.5.5.1. 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.

20.3.5.5.4 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 20-27. 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 20.3.2.4.3.

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.

20.3.5.5.5 NGS In-Flight MAD Align AN/USN-180(V)

Whenever the Fluxgate Magnetometer is replaced, an in-flight alignment must be performed. The procedure for an in-flight alignment is as follows:

1. Prestart:
 - a. Have Ground Crew in Preflight Verify: NORM — INIT BIT/ALIGN SWITCH — S1 ON NGS (SSA) PLACED IN UP POSITION (INIT BIT/ALIGN))
 - b. Pull SAHRS (NGS) C.B.'s (PHA, PHB, PHC, DC)
 - c. NMS: OFF
 - d. Parking Brake: SET
2. Post Start (After one or both engines are on line)
 - a. Reset SAHRS (NGS) C.B.s
 - b. NMS GND
 - (1) INS ALGN CMPLT
 - (2) SAHR ALGN CMPLT
 - c. NMS: INS
 - d. PB RELEASED
 - (1) MFD: NAV AID PAGE
 - (2) SAHR MODE: NORM BOXED
 - (3) SAHR VEL REF: SYS BOXED
 - e. Take off Straight and Level Flight
 - f. Airspeed — CHECK (400 Knots)
 - g. Altimeter — CHECK 10,000 ± 5,000 Feet
 - h. NAV SYSTEM AID PAGE
 - (1) VERIFY: SAHR MODE: NORM BOXED
 - (2) SAHR VEL REF: SYS BOXED
 - i. SAHRS MODE — BOX EC
 - (1) Verify SAHRS caution light flashes at a 2 second rate — 1 sec on/1 sec off.

Note

SOLID SAHRS LIGHT — OCCURS, NGS TEST CANNOT BE RUN

- (2) (MUST START WITHIN 15 SECONDS OF BOXING EC)
 - a. Perform ONE FIGURE EIGHT Maneuver
 - b. 70 Degree Bank

- c. 400 Knots
- d. Maintain Constant Speed
- e. TWO FULL 360 degree turns
- f. Maneuver complete in 2 minutes
- j. Maneuver Complete, Check SAHRS Light:
 - (1) Flashes 3 seconds ON/3 seconds OFF. Calibration Successful
 - (2) SAHRS Light Solid ON. Calibration NOT Successful

Note

Another attempt can be made by cycling the SAHRS mode out of EC TO NORM WITH SAHRS VEL REF: SYS BOXED. Repeat Steps h-j.

- k. MFD: NAV AID: SAHR MODE BOX NORM
 - (1) VERIFY: SAHR VEL REF: SYS BOXED
 - (2) SAHRS CAUTION LIGHT OUT

3. Post Flight

- a. Have ground crew set NORM — INIT BIT/Align switch S1 on NGS SSA in the down position NORM.

20.3.6 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. Barometric setting
2. Waypoint data
3. Wind speed and direction
4. Magnetic variation.

20.3.6.1 Barometric Setting

The barometric setting is normally made by the pilot using his 2-inch barometric altimeter setting knob. The setting range is from 28.10 to 30.99 inches of Hg. This will provide system altitude corrections to within a maximum error of 16 feet. When the setting is changed, the new setting will be displayed momentarily in the HUD beneath the

barometer (Figure 20-6). 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 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 pushbutton and the proper numeric values.

20.3.6.2 Waypoint Data Entry

Up to 100 tactical waypoints can be stored in the MCS waypoint file at any time. These can be entered manually, or downloaded from the MDL in accordance with procedures listed in paragraph 20.3.7, Navigation Database. The primary parameters that may be entered for each tactical waypoint are latitude, longitude, altitude and flight plan. These may be entered manually via the DEU by selecting the DEU WPT page (Figure 20-28) 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 20-29.

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 pushbutton and then box the desired waypoint. The coordinates are entered using the quadrant and numeric pushbuttons on the lower left portion of the DD control panel, as indicated on Figure 20-30.

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
Type	TGT, TCN, SAM, GEN

The waypoint type is selectable from the DEU WPT menu, TYPE pushbutton. The waypoint number for which the type is being set is displayed in the DEU input window at the top. When a selection is made, it appears in the input window as a selection in progress until the ENT button is pressed to accept the change. If TGT is selected for a flight plan waypoint, any previously designated target waypoint within the same flight plan will be changed back to type GEN. To remove a selection and enter another one, press CLR. RTN will abort the change and return to the WPT menu, and MENU will abort changes and return to the main menu.

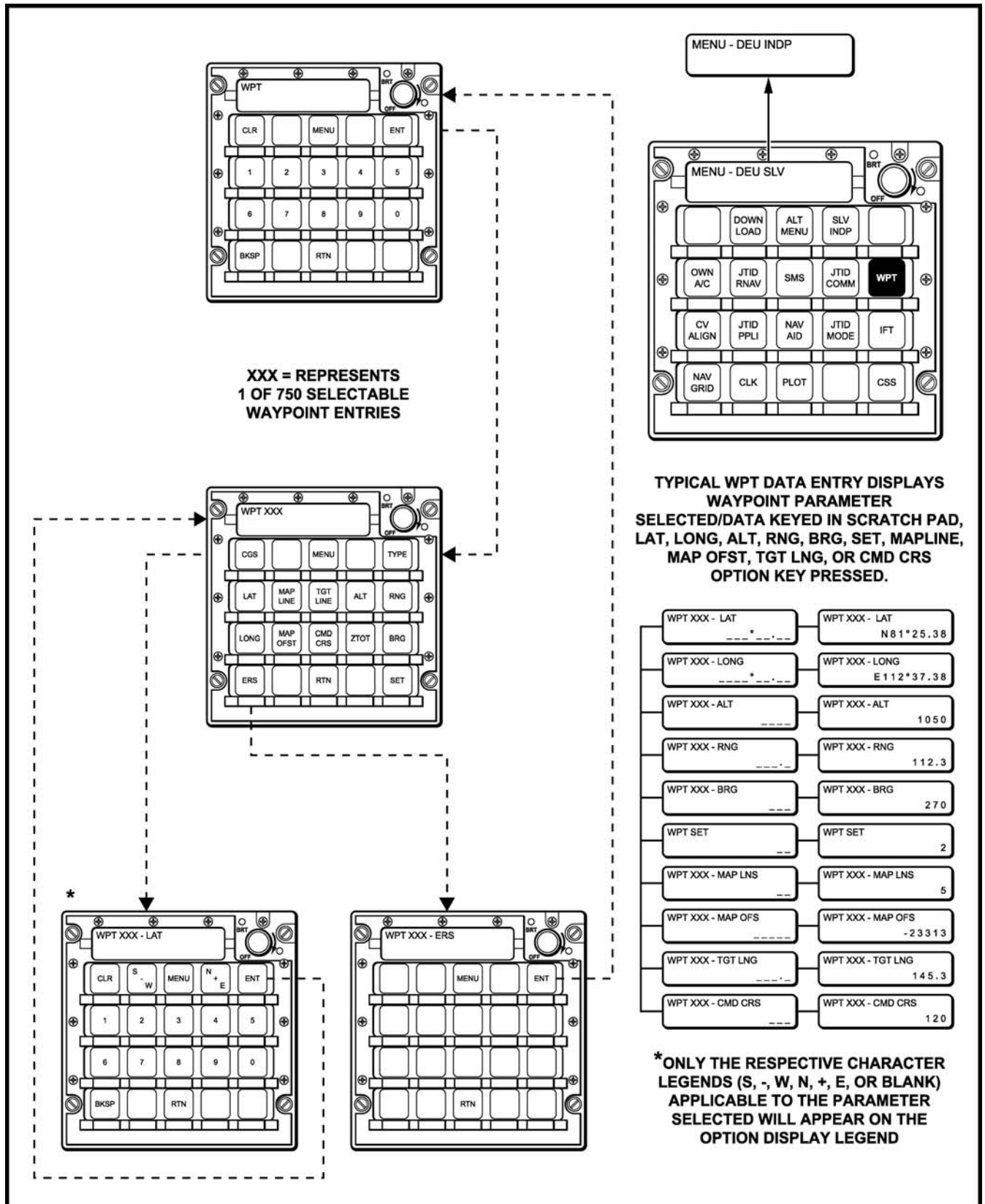
In addition to the above primary waypoint parameters, four other parameters relating to the reconnaissance steering function may also be entered when the specified waypoint is to be used as a reconnaissance target point. These parameters, however, can only be entered via the DEU using the DEU WPT page. 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.

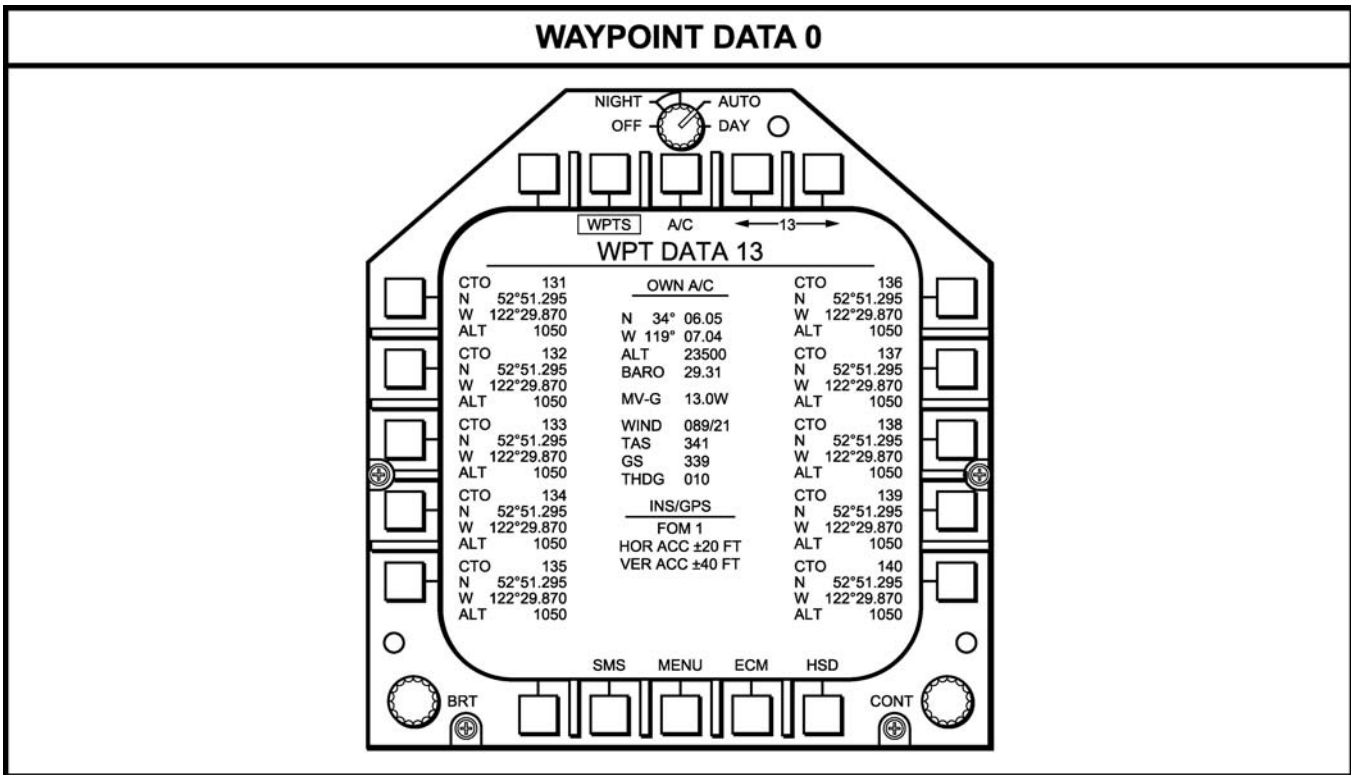
20.3.6.2.1 Zulu Time On Target

Zulu time on target (ZTOT) can be entered for the active TGT waypoint within flight plan. Selecting ZTOT switches to a numeric entry format which allows 6-digit ZTOT. Entering ZTOT within a flight plan maintains that ZTOT for the route even if the target waypoint is changed.



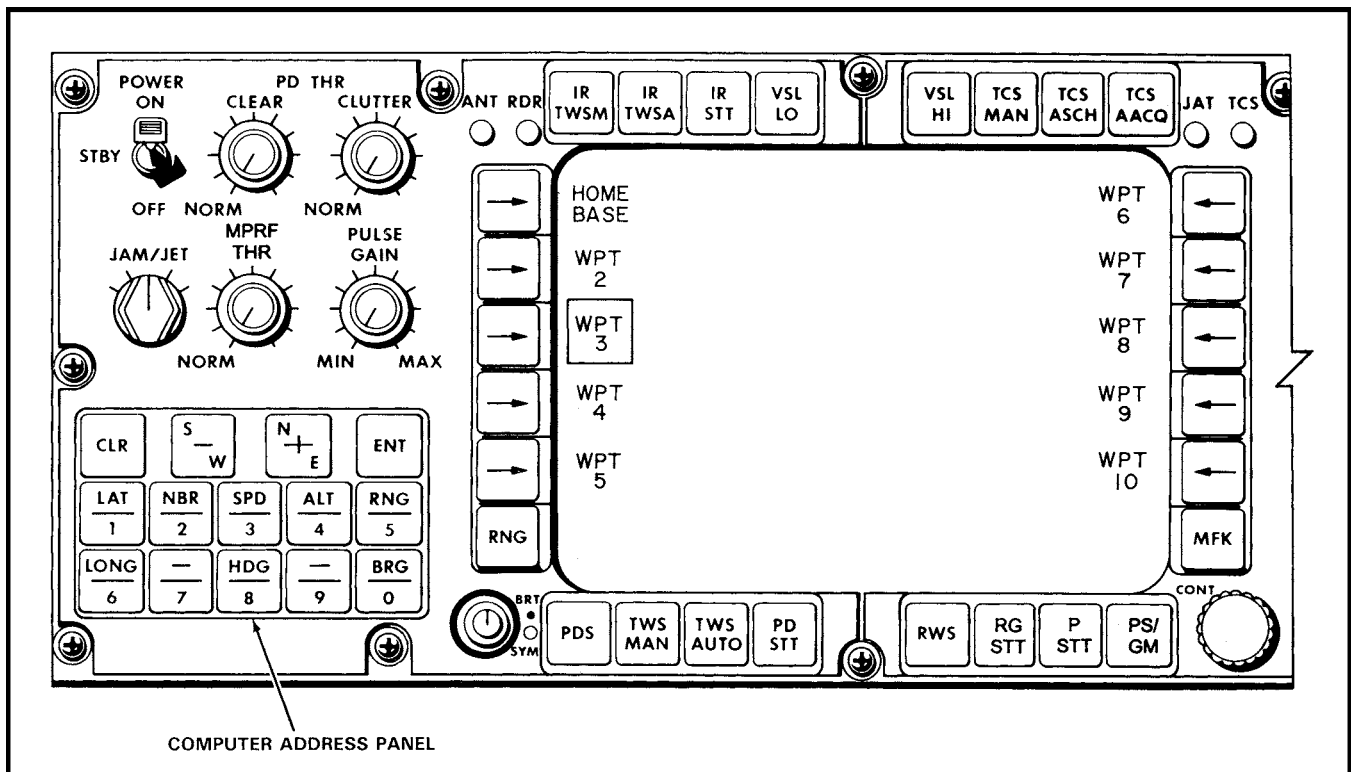
CSC-F14D-1-20-011A

Figure 20-28. Data Entry Unit Waypoint Pages (Typical)



CSC-F14D-1-20-012B

Figure 20-29. MFD Waypoint Data Format



0-F50D-440-0

Figure 20-30. DD Waypoint Data Entry

20.3.6.3 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 SCADC true airspeed is not set valid until it reaches approximately 60 knots.

Wind is entered with the DEU (Figure 20-20) 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 20-26) 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.

20.3.6.4 Magnetic Variation

MAG VAR is available from the navigation system from a prestored table in the MAGR using aircraft coordinates. This value, when displayed on the MFD OWN A/C format, is labeled MV-G. 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). If only SAHRS is available, an MV-S will be displayed.

Magnetic variation from the MAGR table is the default value and will be automatically selected and displayed to the nearest tenth 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 or the DD (Figure 20-31). When this is done the MV-G legend in the center of the format will cycle to MV-C, to MV-E, and back to MV-G, indicating the source and value of magnetic variation used by the navigation system. If GPS is not available and SAHRS is available, MV-S will be the default.

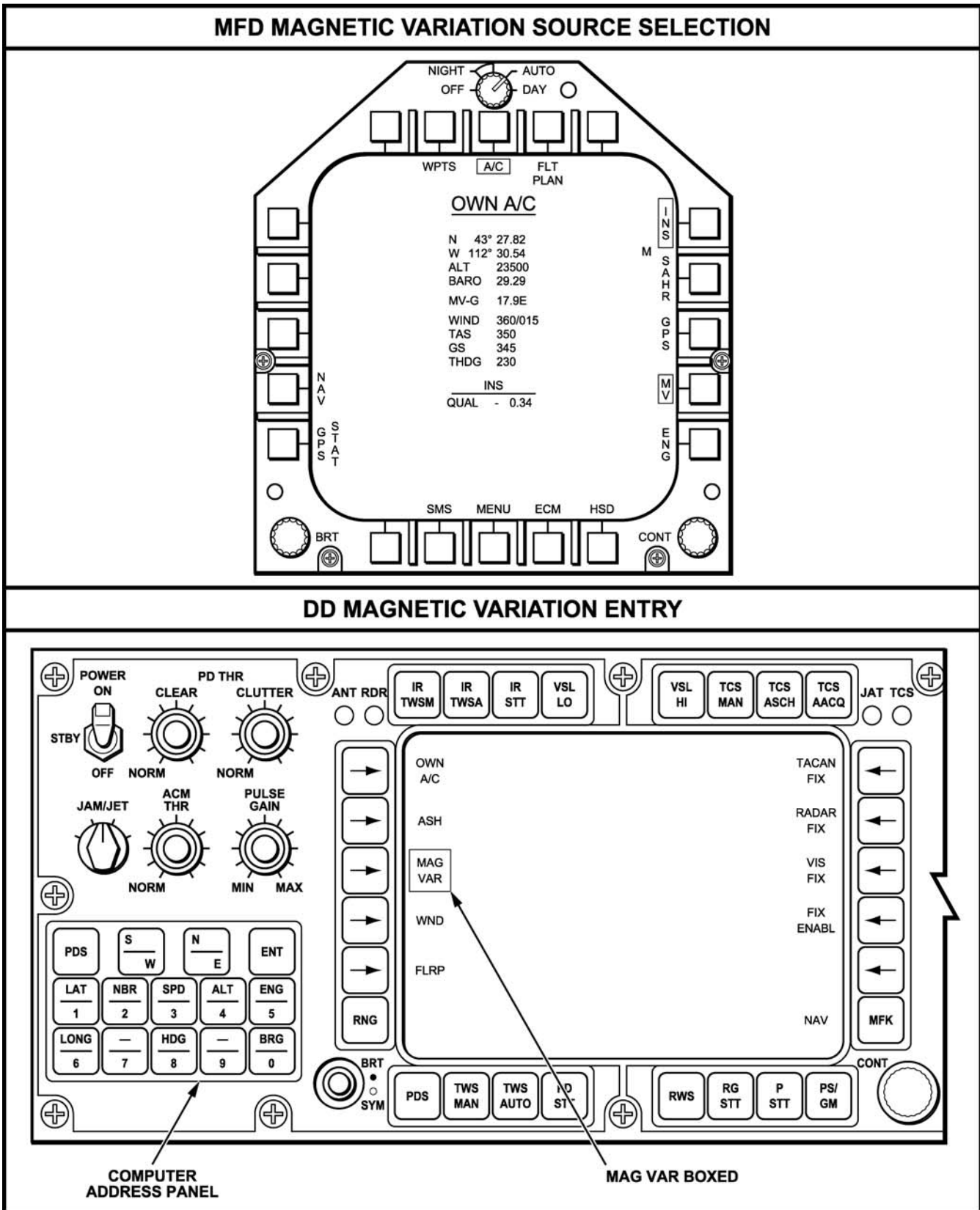
Entered values of magnetic variation can be made using either the DEU or the DD control panel. When the DEU is used (Figure 20-20), the MVAR pushtile on the OWN A/C or CV ALGN format is selected and the value is entered to the nearest tenth degree, preceded by an E or W for east or west, respectively. When the DD control panel is used (Figure 20-31), 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 the value to the nearest tenth degree.

20.3.7 Navigation Database

The navigation database consists of MDL tactical waypoints, MDL flight plan waypoints, MDL reversionary waypoints, flight plan routes, and target steering data. This data is stored on the MDL cartridge using a TAMPS station (TAMPS version 6.1 or later) and is selectively loaded into the MCS. Controls are provided to the aircrew to display, edit and assign steering functions to information in the navigation database.

All Waypoint Data is displayed by selecting the WPT (Waypoint) Data format from the WPT (PB7) on the Own Aircraft format. Multiple pages are available on this format, each page containing ten waypoints. Pages 0 through 9 display tactical waypoints 1 to 100. Pages 10 through 19 show data for Flight Plan 1 (FP1), etc. From page 10 through 74, the pages that would display waypoints reserved for MCS use (Figure 20-32) between flight plans are omitted. For example, the page jumps from 14 to 20, 24 to 30, and so on, up to 74, jumps to 80. Then from 80 to 99 pages continuously, providing access to MDL Waypoints 801 through 999. The page numbers scroll rapidly if the pushbutton is held depressed over the left or right arrows.

In other words, to find the waypoint you want, go to the page equal to the waypoint number with only the hundreds and tens place displayed (i.e., waypoint 9 = 009 = page 0; waypoint 126 = page 12; waypoint 889 = page 88, etc). Figure 20-32 depicts the waypoint numbering scheme.



CSC-F14D-1-20-013A

Figure 20-31. Magnetic Variation Source Selection and DD Entry

20.3.7.1 MDL Tactical Waypoints

The MDL can store up to 100 tactical waypoints, numbered 1 through 100. MDL tactical waypoints are available for GPS and destination steering, and navigation waypoints may be displayed in the data buffers on the HSD format. Each consists of a latitude, longitude, altitude, number, and type.

Tactical waypoints are listed on the WPT Data format in blocks of 10, on pages 0 through 9. Tactical waypoint data may be changed manually via the Waypoint format of the DEU or via hooking and then depressing SET (PB 12) or UPDT (PB 13) on the HSD format, and by transferring waypoints from the flight plan or MDL waypoints formats. Waypoint type may be modified manually via the Waypoint Type format of the DEU (Figure 20-33). Available types on the DEU for tactical waypoints are GEN (General), TAC (TACAN), and SAM (Surface-to-Air Missile). Changes to tactical waypoints in the MCS are recorded onto the MDL cartridge immediately, so depressing RLD (PB 2) on the Flight Plan format has no effect on tactical waypoints. Waypoint types and associated symbols are shown in Figure 20-34.

20.3.7.1.1 Waypoint Data File Use

In general the 100 tactical waypoints can be used in any manner described in paragraph 20.3.9, 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.

20.3.7.2 MDL Flight Plan Waypoints

The MDL can store seven flight plans of up to 50 waypoints each, numbered as 101 through 150 up to 701 through 750 in blocks of 50. The waypoint numbers in between (151 to 200, 251 to 300, etc.) are used internally by the MCS and MDL for preflight planned flight plan storage and cannot be addressed directly.



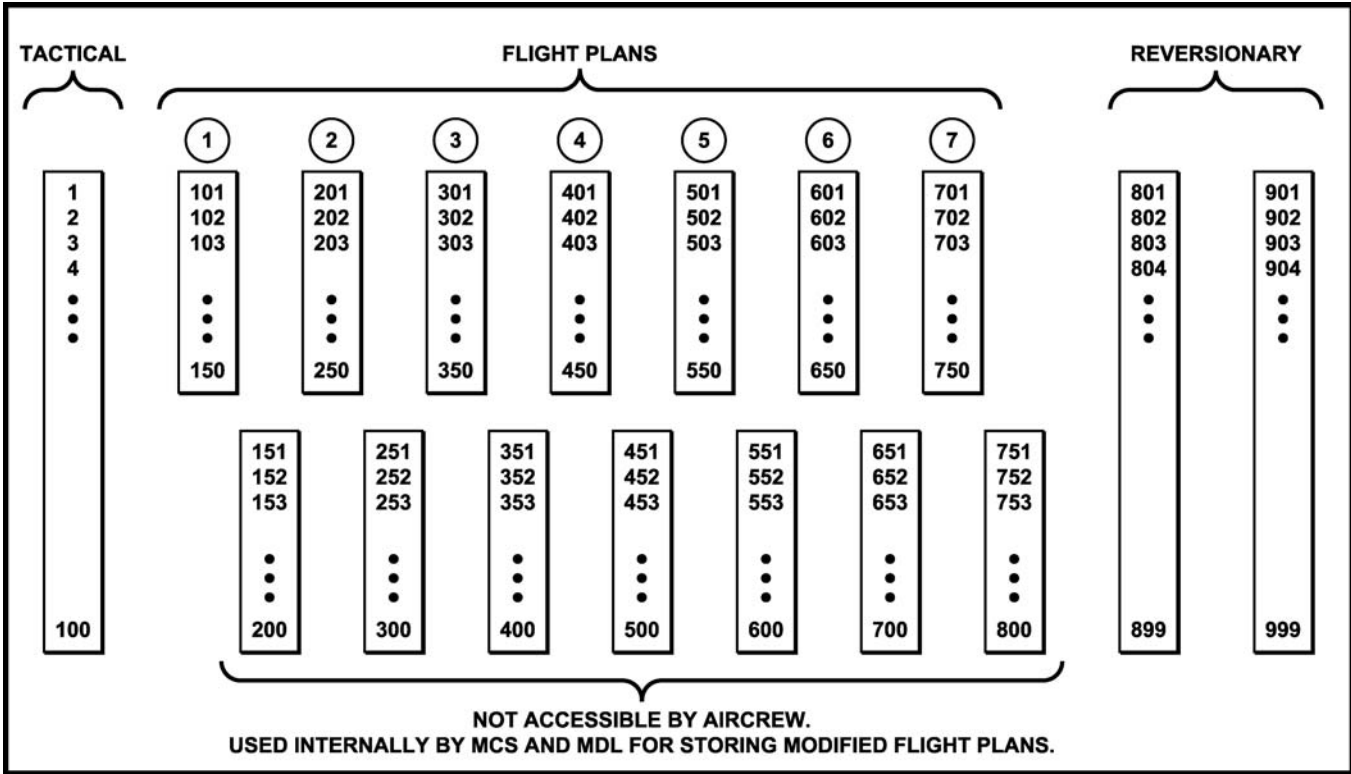
- All seven flight plans must be loaded via TAMPS with at least one waypoint. System instabilities will result when trying to access a blank flight plan for the first time.
- When loading any MDL waypoints via TAMPS, only uppercase alphanumeric should be used for waypoint descriptions.
- Potential exists for an MC crash if Flight Plan Data or Waypoint Data formats are displayed while updating waypoints via the DEU.

Flight plan waypoints are treated as a sequence in order from the first waypoint in the flight plan to the last waypoint defined, without any blank waypoints in between, up to a maximum of 50 waypoints per flight plan.

Note

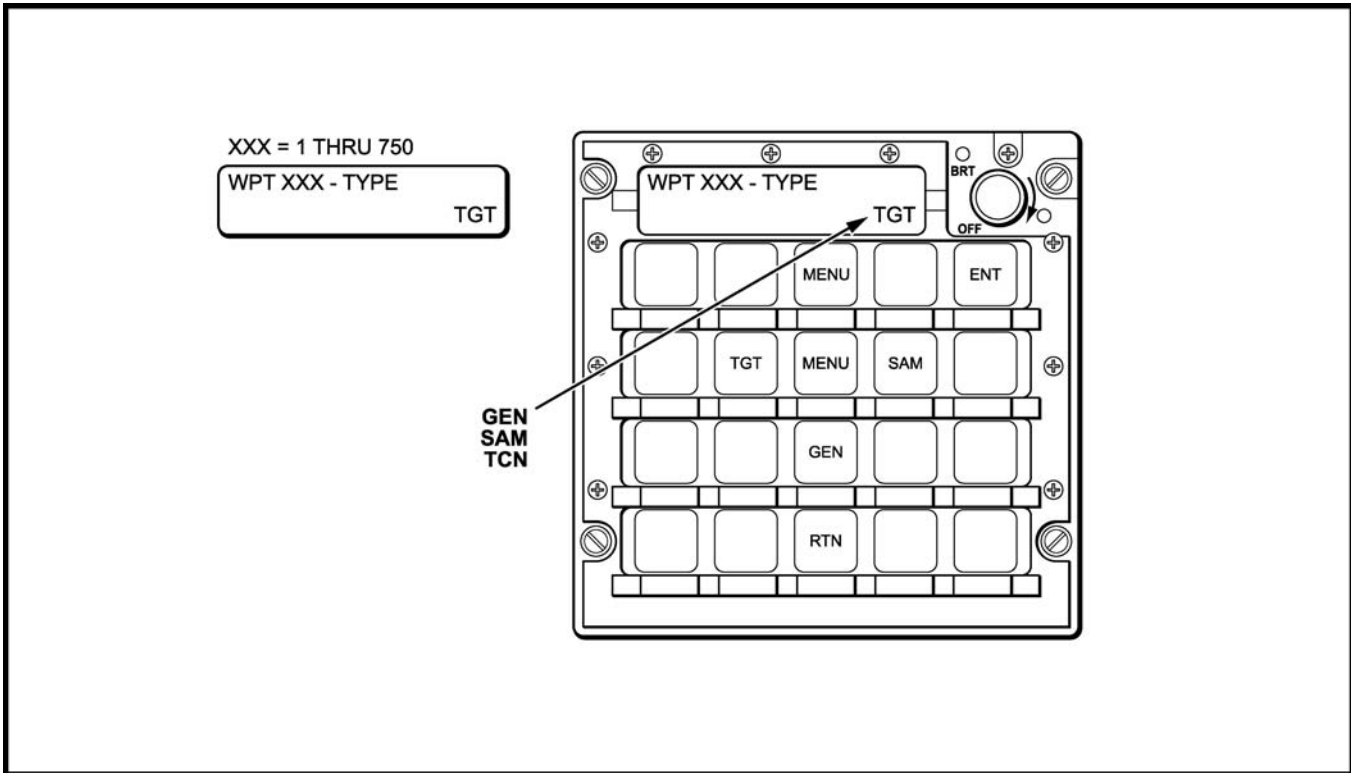
- Trying to add flight plan waypoints more than one waypoint number beyond the last flight plan waypoint using the DEU will put the waypoint in the next consecutive flight plan location in consecutive order.
- Attempting to access a waypoint number that is inaccessible (i.e., 151 to 200, 251 to 300, etc.) for flight plan modification results display of a WAYPOINT INVALID message.

Each MDL flight plan waypoint, consisting of an alphanumeric label, latitude, longitude, altitude, number, and type, can be displayed on the waypoint data format. The waypoint type is assigned by default or from the preflight planned type, but may be modified manually via the WPT TYPE format of the DEU. Only one flight plan waypoint per flight plan may be designated a TGT type for the purposes of target steering and navigation.








CSC-F14D-1-20-030

Figure 20-32. Waypoint Numbering Scheme.



CSC-F14D-1-20-031

Figure 20-33. DEU Waypoint Type Format.

WAYPOINT	SYMBOL
GENERAL	
TACAN	
SAM	
TARGET	
HOMEBASE	

CSC-F14D-1-20-032

Figure 20-34. Waypoint Types and Associated Symbols.

20.3.7.3 MDL Reversionary Waypoints

The MDL can store up to 199 reversionary waypoints, numbered 801 through 999. Mission Data Loader reversionary waypoints are not available directly for display, steering, or modification; but their data may be transferred into flight plan or tactical waypoints and thereafter manipulated. Since their data is not stored in the MCS and cannot be modified directly, depressing RLD (PB 2) on the Flight Plan format has no effect on reversionary waypoints. However, reversionary waypoint data may be transferred into flight plan waypoints through the ADD (PB 12) or RPLA (PB 13) functions on the flight plan format, or tactical waypoints through the XFER (PB 14) function and thereafter manipulated.

Each MDL reversionary waypoint consists of an alphanumeric label, latitude, longitude, attitude, and number and can be displayed from the waypoint data format or by selecting MDL WPT from the flight plan menu. The waypoint type is assigned by default but may be modified via the Waypoint Type format of the DEU after the waypoint is transferred into the tactical or flight plan databases in the MCS.

20.3.8 Flight Plan Management

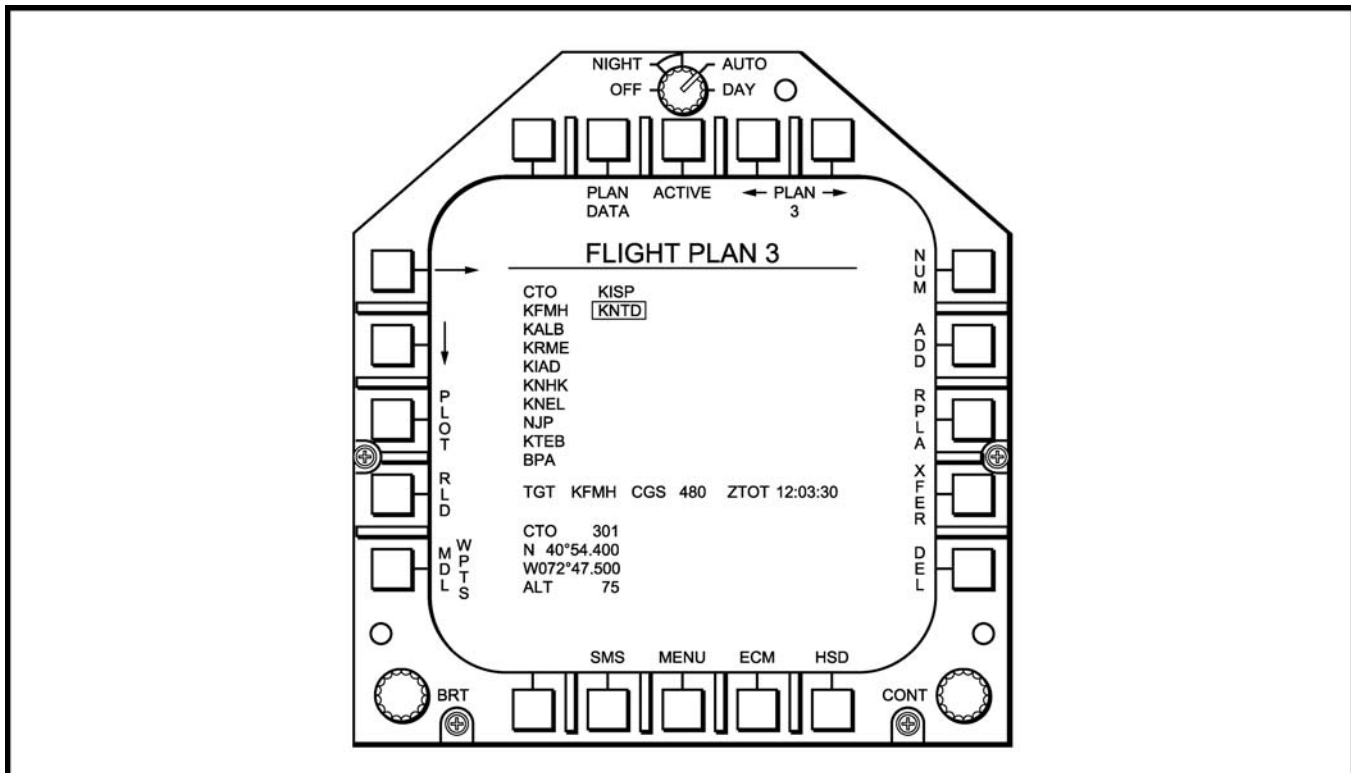
Preplanned flight plan information is available for display and navigation when an MDL cartridge is present. Only one flight plan may be active in the MCS at any given time. Active flight plan waypoints are available for destination, GPS, or auto-waypoint sequence steering. Navigation information for flight plan waypoints may be displayed in the data buffers on the HSD format. Flight plan management consists of:

1. Accessing flight plan data on the MDL
2. Viewing flight plan contents
3. Activating a specific flight plan for use by the navigation system
4. Editing the contents of any flight plan
5. Plotting waypoints in a flight plan as a flight plan route
6. Specifying various parameters for the purpose of flight plan route target steering

20.3.8.1 Flight Plan Data

Flight plan waypoints are numbered starting with the flight plan number in the hundreds position and the position in the flight plan as the next two numbers (i.e. 101 to 150, 201 to 250, 301 to 350, ... 710 to 750). Flight plans are treated as a continuous block of waypoints, so no blank (or erased) waypoints are allowed in the middle of a flight plan. Blanks will be closed up automatically.

Up to seven flight plans of 50 waypoints each are stored on the MDL and can be preflight planned (using TAMPS 6.1 or later). Both an original and a modified copy are stored on the MDL. The original flight plan can never be used directly. It is only used if RLD (PB 2) on the flight plan format is selected to overwrite changes to the modified flight plan. When a flight plan is viewed or made active, it is the modified copy that is used. Any manual changes are recorded onto the modified copy on the MDL, which are retained for future use. The modified copies are retained across system resets, between flights or with the removal of the MDL cartridge. However, depressing RLD (PB 2) on the Flight Plan format reloads the original MDL flight plan into the modified copy and into the MCS (if it is active), overwriting all manual changes permanently. The data in the original MDL flight plan may only be altered via a TAMPS station, which will automatically update the modified copy in the loading process.



CSC-F14D-1-20-034A

Figure 20-35. MFD Flight Plan Format

20.3.8.2 Flight Plan Menu

The Flight Plan Format is illustrated in [Figure 20-35](#). The menu buttons and their functions are described in the legend. The flight plan menu is selected via FLT PLAN (PB 2), on the HSD format or PB 9 on the Own Aircraft format. This is the primary display of flight plan data, listing waypoints in an individual flight plan by name or number. NUM (PB 11) toggles the list between numeric and alphanumeric labels. The default format is alphanumeric (NUM legend not boxed). This is the only MFD format that displays flight plan route and target steering selections, and provides flight plan editing controls. Detailed waypoint data is also displayed for selected waypoints during editing operations. Only those waypoints in a flight plan that have been defined will be displayed.

20.3.8.2.1 MDL Reversionary Waypoint Menu

The MDL Waypoint format is very similar to the Flight Plan format, and can only be reached from the Flight Plan format by selected MDL WPTS (PB 1) ([Figure 20-36](#)). Instead of displaying one of the seven flight plans, the MDL Waypoints format displays one of four pages of reversionary waypoints from 801-999.

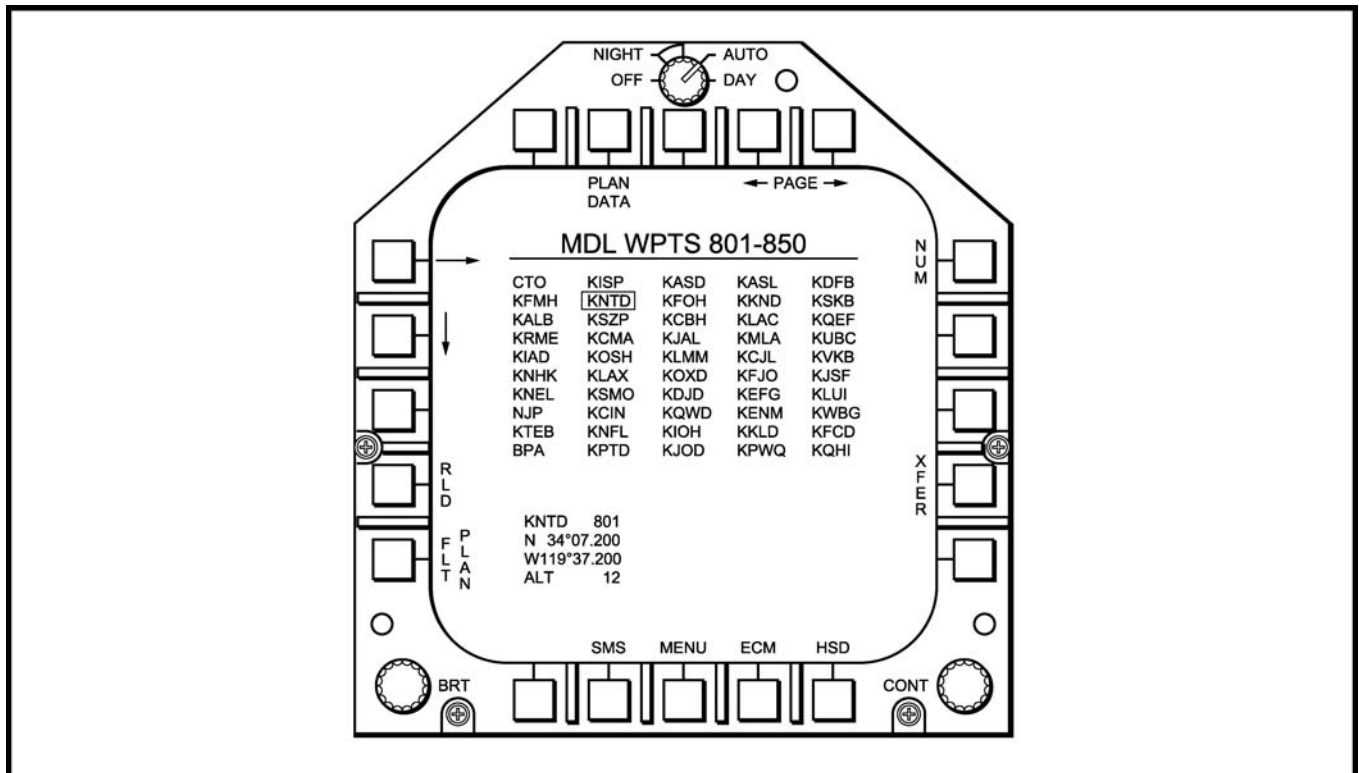
These waypoints are stored on the MDL and cannot be edited or deleted. They are stored with waypoint names, like the flight plans, and represent a navigation aid database that

can be used in flight. The waypoints in the database are selected using a TAMPS station during preflight planning, and can be either added to a flight plan or used to replace an existing flight plan waypoint. They can also be transferred to a tactical waypoint.

Movement through the four pages of MDL waypoints is done with the page left and right buttons on PB 9 and PB 10. The current page is shown by the range of waypoint numbers displayed in the title bar on the page (i.e. MDL WPTS 801-850).

The aircrew can preview information in a given waypoint in the bottom left buffer on the page using the cursor box in a manner similar to that used to view flight plan waypoints. Or, the cursor can be positioned over a waypoint to transfer it to a tactical waypoint, in exactly the same way used for a flight plan transfer.

Two menu items on the MDL Waypoints format were carried over from the Flight Plan format, and do not function in an intuitive manner. The RLD (PB 2) legend has no function on MDL waypoints since there is only one copy of MDL waypoints on the MDL, and these cannot be modified. The second item is the PLAN DATA pushtile (PB 7). Selecting PLAN DATA will call up the PLAN DATA format, but unboxing the legend while on that format always returns you to the Flight Plan format. It does not return you to the MDL WPTS format.



CSC-F14D-1-20-035

Figure 20-36. MDL Reversionary Waypoint Format

20.3.8.2.2 Flight Plan Data Format

Selecting PLAN DATA from the flight plan format (or the MDL WPT format) takes you to the plan data format (Figure 20-37), which displays detailed information on 10 waypoints. The Own Aircraft Data format is displayed between two columns of waypoint data, just like the WPT DATA format. The difference is that it starts on the pages corresponding to the flight plan that was displayed on the flight plan format when PLAN DATA was boxed (even if it was boxed on the MDL WPTS format).

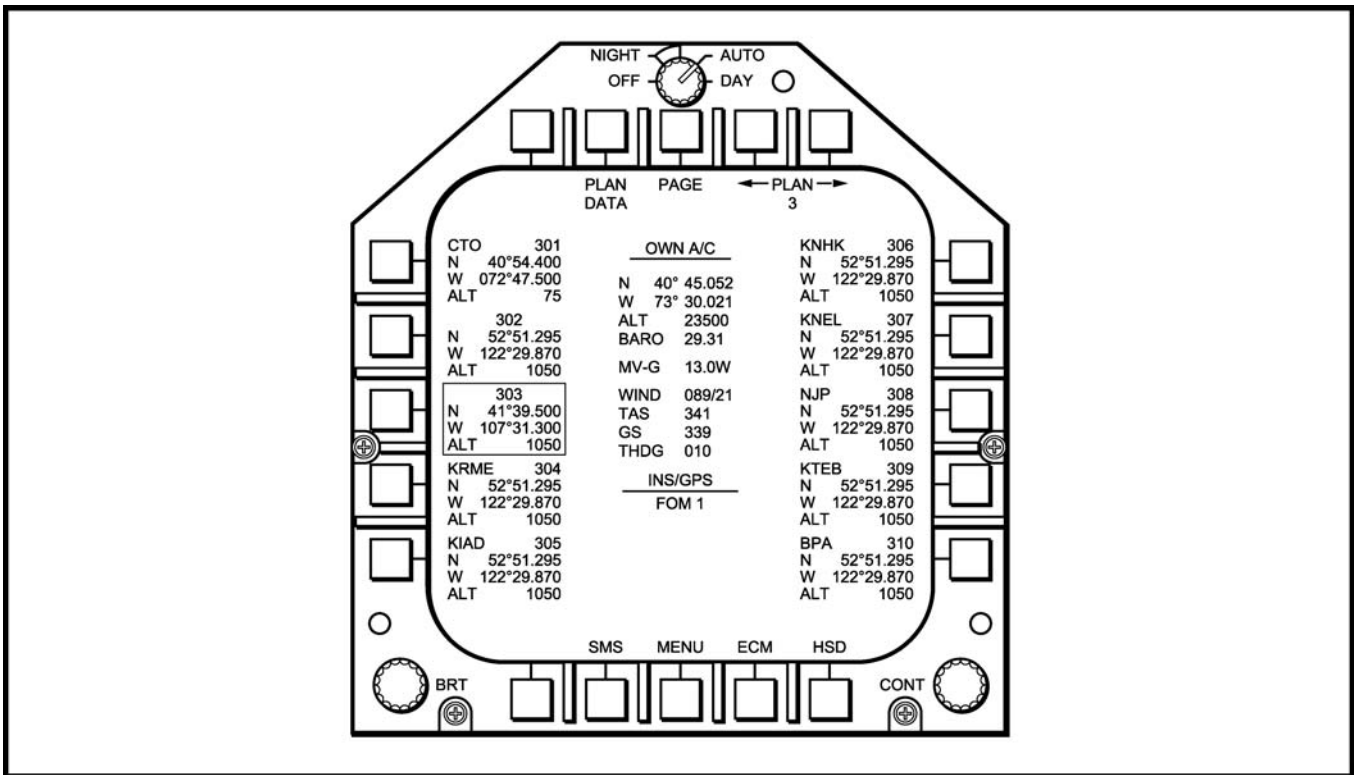
Each flight plan has five pages corresponding to its fifty waypoints, whether they are defined or not. There is no direct indication of which page within a flight plan you are on, other than the waypoint numbers of displayed waypoints, if there are any defined in the number range for the page you are on. There may be blank pages.

A particular flight plan is selected with the left and right arrows on PB 9 and PB 10, similar to the flight plan format. The PAGE button (PB 8) pages between the 5 pages

of waypoints per flight plan. If there are no waypoints defined in the number range for the page you are on for the selected flight plan (e.g., FP 6, 641-650 undefined) the page will have no waypoint information deployed. Successive selections of the PAGE button will toggle through the 5 pages, eventually bringing you to the desired page.

20.3.8.3 Flight Plan Activation

Flight plans are activated on the Flight Plan format. A flight plan is selected for activation via the increment-decrement arrows adjacent to the PLAN legend (PB 9 and PB 10). Depressing ACTIVE (PB 8) causes the selected flight plan to be loaded into the MCS and made available to the navigation system. Activation of a flight plan is verified by a box around the ACTIVE legend when that flight plan number is displayed under the PLAN legend. A flight plan is deactivated by activating a different flight plan, or by unboxing ACTIVE. The latter will result in no flight plan being active in the MCS. An active flight plan is retained in the MCS across a system reset. The default at system power up is no active flight plan.



CSC-F14D-1-20-036A

Figure 20-37. Flight Plan Data Format

Upon selection of an MDL flight plan for activation, the MCS checks the number of waypoints listed in the flight plan. If the number exceeds 50, or the number is negative, the MCS commands an MFD1 and MFD3 computer message “INVALID MDL FORMAT” and returns without further processing of the discrepant flight plan or flight plan waypoints.

The format consists of a list of the waypoints defined in the flight plan, in columns of 10, starting in the upper left of the list display with the first waypoint in the flight plan. The 11th waypoint in the flight plan will be displayed in the first position in the next column and so on. The flight plan waypoints are displayed by default by their name (if no name is defined, the waypoint number is displayed instead). A NUM button is available to toggle between waypoint names and numbers.

Flight plans are displayed one at a time as separate pages. Depression of left or page right buttons (PB 9 and 10) allow switching between pages. The current flight plan page is displayed between the left and right arrows, as well as on the title bar above the waypoint list.

At the bottom of the display are two waypoint transfer buffers that display the currently selected waypoint on the left at all times, and the on the right when in edit modes. The

transfer buffers display the waypoint name, number, latitude, longitude, and altitude.

A rectangular box is displayed over the currently selected waypoint on each flight plan page. This box is called the flight plan cursor, and can be controlled through either the cursor right (→) and cursor down (↓) arrows on PB 5 and PB 4, respectively, or with the SHC (Sensor Hand Control) cursor or TDC (Throttle Designator Controller).

The flight plan menu provides the means to change flight plan pages, reload the original flight plan over the modified version, or go to the MDL Waypoints format. It also provides a way to move the flight plan cursor box, display flight plan waypoint data, activate a flight plan, page through the 7 flight plan pages, and add, replace, transfer, or delete waypoints from a flight plan.

20.3.8.4 Flight Plan Editing

Waypoints may be added, replaced, transferred or deleted within a flight plan via the Flight Plan format and its various sub-formats. The Flight Plan format may be selected on more than one MFD, and up to three separate flight plans (one per MFD) may be edited at any time. If the same flight plan is selected simultaneously on more than one MFD, then any edit operation on one MFD will lock out all edit

commands on the remaining MFDs until the edit operation is completed or canceled. Once an edit operation is completed or canceled, the MFD automatically returns to the Flight Plan format. Exiting an edit operation by any other means, such as selecting HSD (PB 15), will suspend that edit operation and that flight plan will be locked out for editing on any other MFD.

Notes

- Editing Flight Plan Waypoints via the DEU will not be possible if the Waypoint Data page format (Figure 20-29) or Flight Plan Data format (Figure 20-35) is displayed on any MFD.
- Manually-entered waypoints are specified with 3 digits. Specification of waypoints 1 through 99 require leading zeroes (e.g., 0-0- 4, vice 4).
- The cursor box may be positioned over any waypoint of interest or the first empty waypoint on the Flight Plan format either sequentially via the down (↓) and right (→) cursor arrows (PB 4 and PB 5) or non-sequentially via the manual cursor (TDC or SHC).

20.3.8.4.1 Waypoint Addition (Flight Plan Add Mode)

A tactical, flight plan, or reversionary waypoint may be inserted anywhere in a flight plan except past the end of a flight plan. There are no embedded blanks. The cursor box is placed over the desired entry point. When ADD (PB 12) is depressed, the Add Waypoint format is selected (Figure 20-38). All waypoints in the flight plan are shifted down one location in order, and a blank waypoint is added at the cursor. The waypoint to be added is specified by a 3-digit numeric label. A numeric entry format is displayed and BKSP (PB 7) is provided to erase individual keystrokes.

The insertion waypoint number is displayed in the left buffer at the bottom of the Add Waypoint format. Once a valid waypoint number has been entered, data associated with the waypoint to be added is also displayed in the right buffer. Depress ENTER (PB 8) to insert the specified waypoint into the flight plan. If all 50 waypoints in the flight plan were previously defined, the last waypoint will be lost once ENTER is depressed. Depressing CANC (PB 9) cancels the addition operation, and no waypoint data will be lost.

To add a waypoint to a flight plan, perform the following steps:

1. Select FLT PLAN format (PB 2 on HSD).
2. Position the flight plan cursor box where you are inserting a waypoint (following waypoints will be scrolled down) using either the MFD bullseye cursor, or the right/down arrows (PB 4/5).
3. Press ADD (PB12).
4. Enter the waypoint you wish to insert (leading zeros are required, e.g., 004, 021, 053, etc.).
5. Check the waypoint information that appears in bottom right buffer to ensure that this is the desired waypoint. If you entered a waypoint number that is undefined, a WPT INVALID message is displayed.

Select ENTER (PB 8) to accept, CANC (PB 9) to abort the addition operation, or BKSP (PB 7) to modify the entered waypoint number.

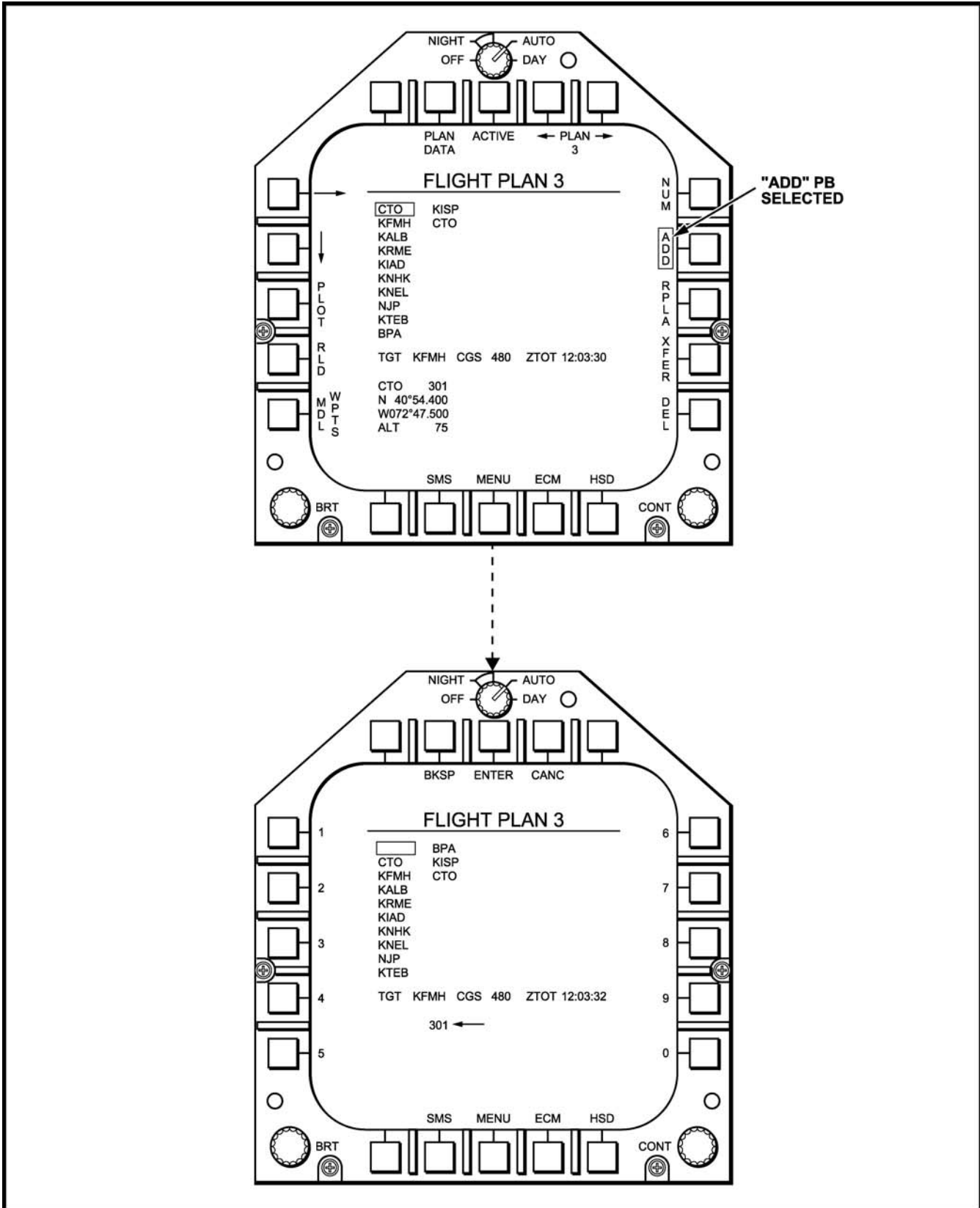
The process for waypoint addition is demonstrated in Figure 20-38.

20.3.8.4.2 Waypoint Replacement (Flight Plan Replace Mode)

A tactical, flight plan, or reversionary waypoint may be substituted anywhere in a flight plan. The technique is identical to that of adding a waypoint, except RPLA (PB 13) is depressed (see paragraph 20.3.8.4.1). The only distinction of the Replace Waypoint format is that the flight plan waypoints are not shifted down from the selected entry point, and the left buffer will display the waypoint information for the waypoint that will be overwritten. The original data in the selected entry waypoint is lost when replacement is completed.

To replace a waypoint in a flight plan with another waypoint, perform the following steps:

1. Select the FLT PLAN format (PB 2 on HSD).
2. Position the flight plan cursor box over the waypoint you are replacing, using either the MFD bullseye cursor or the right/down arrows (PB 4/5).
3. Press RPLA (PB 13).
4. Enter the waypoint that will replace the highlighted waypoint (leading zeros are required, e.g., 004, 021, 053, etc.).



CSC-F14D-1-20-037

Figure 20-38. Flight Plan Format – Waypoint Add Page (Sheet 1 of 2)

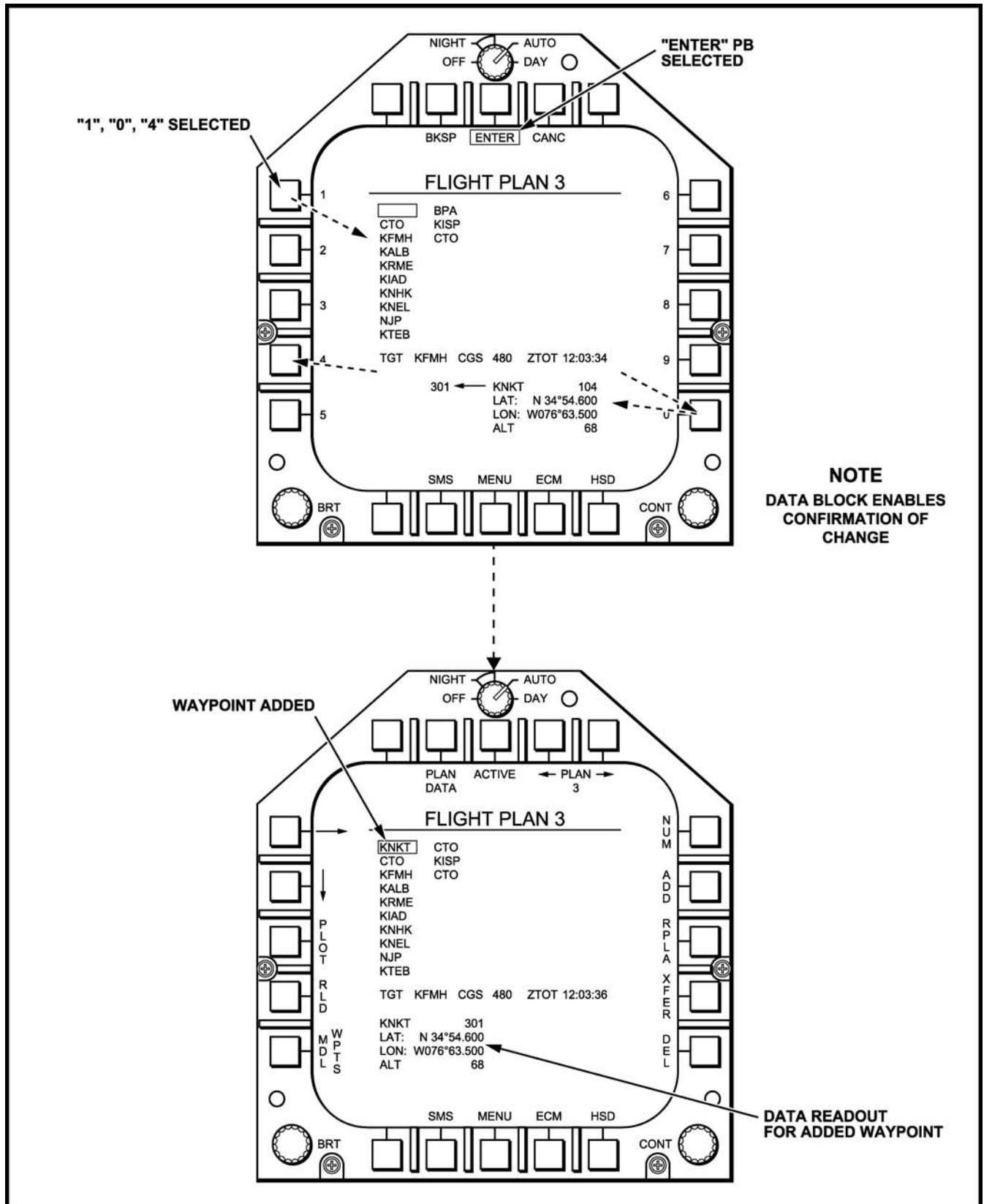


Figure 20-38. Flight Plan Format – Waypoint Add Page (Sheet 2 of 2)

CSC-F14D-1-20-038A

5. Check the waypoint information that appears in bottom right buffer to ensure that this is the waypoint desired. If you entered a waypoint number that is undefined, a WPT INVALID message is displayed.
6. Select ENTER (PB 8) to accept, CANC (PB 9) to abort the addition operation, or BKSP (PB 7) to modify the entered waypoint number.

The process for waypoint replacement is demonstrated in [Figure 20-38](#).

20.3.8.4.3 Waypoint Transfer (Flight Plan Transfer Mode)

A flight plan or reversionary waypoint may be transferred into a tactical waypoint. The cursor box is positioned over the flight plan or reversionary waypoint to be transferred. When XFER (PB 14) is depressed, the Transfer Waypoint format is selected. Increment (PB 12) and Decrement (PB 13) controls are provided to select a tactical waypoint destination, which is displayed adjacent to these controls. At the bottom of the Transfer Waypoint format, the selected transfer waypoint is displayed by number with its data in the left transfer buffer. The destination tactical waypoint data is also displayed in the right transfer buffer, and updated as the tactical waypoint number is scrolled using the increment and decrement pushbuttons. Depressing ENTER (PB 8) completes the transfer. The existing tactical waypoint is overwritten with the waypoint information of the selected flight plan. Depressing CANC (PB 9) cancels the transfer operation. Flight plan and reversionary waypoints are never affected by the transfer operation.

To transfer a flight plan or reversionary waypoint into a tactical waypoint, perform the following steps:

1. Select the FLT PLAN or reversionary format (PB 2 on HSD).
2. Position the flight plan cursor box over the waypoint you are transferring using either the MFD bullseye cursor, or the right/down arrows (PB 4/5). You can change the cursor position at any time during the transfer operation.
3. Press XFER (PB 14).
4. Scroll the waypoint number to the tactical waypoint number you would like to transfer into on the increment/decrement arrows on PB 12/13. The existing content of the selected waypoint will be shown in the bottom right buffer.
5. Check the waypoint information that appears in bottom right buffer to ensure that this is the

waypoint you want to overwrite with the waypoint information in the left buffer. If you entered a waypoint number that is undefined, a WPT INVALID message will be displayed.

6. Select ENTER (PB 8) to accept, or CANC (PB 9) to abort the addition operation.

The process for transferring tactical waypoints is demonstrated in [Figure 20-40](#) and [Figure 20-41](#).

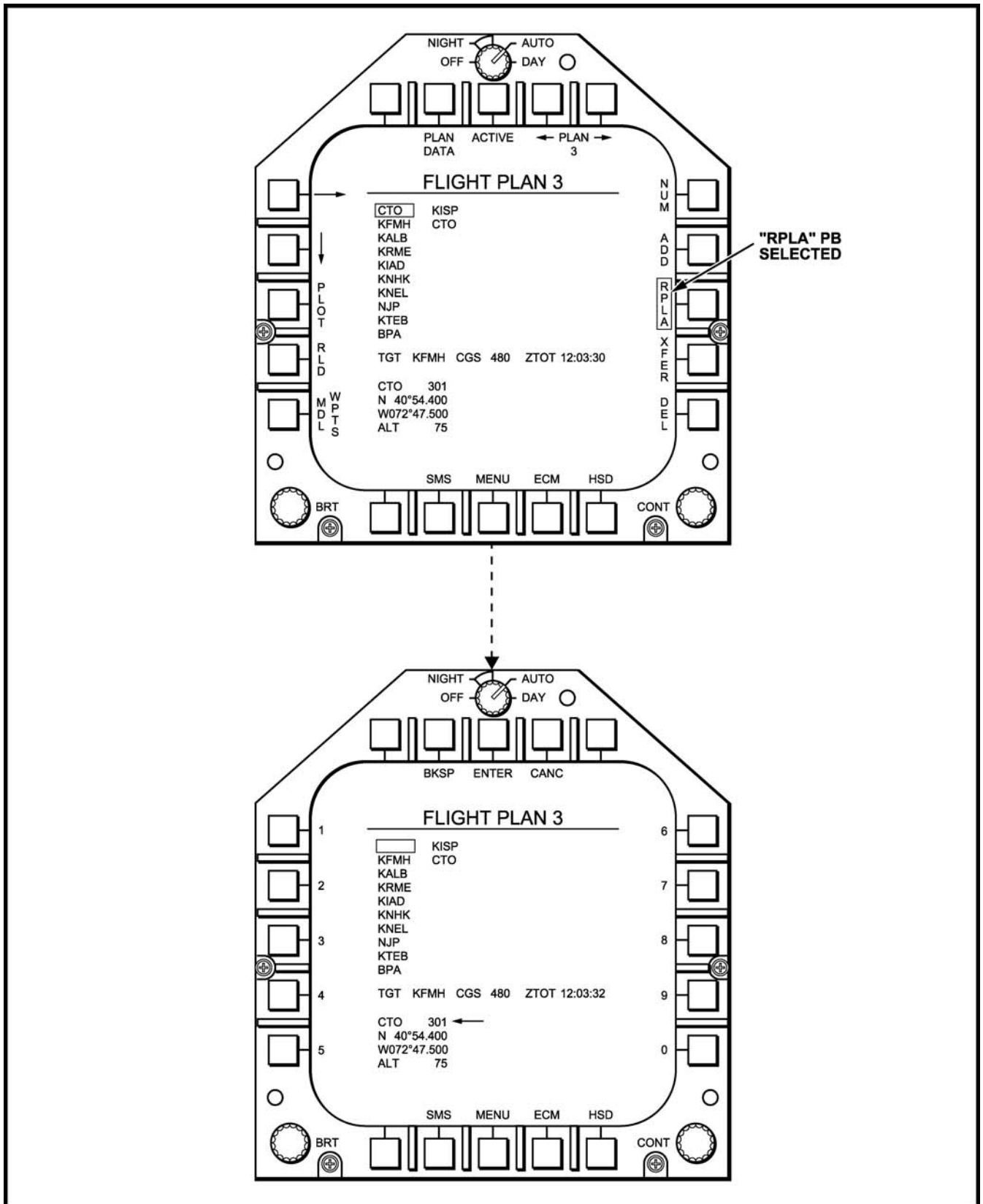
To transfer an MDL waypoint to a tactical waypoint, perform the following steps:

1. Select the MDL Waypoints format (PB 1 on FLT PLAN format).
2. Position the MDL WPT cursor box over the waypoint to be transferred using either the MFD bull's eye cursor, or the right/down arrows (PB 4/5). The cursor position can be changed anytime during the transfer operation.
3. Press XFER (PB 14)
4. Scroll the waypoint number to the tactical waypoint number into which the MDL waypoint will be transferred using the increment/decrement arrows (PB 13/14). The existing content of the selected waypoint will be shown in the bottom right buffer.
5. Check the waypoint information that appears in the bottom right buffer to ensure that this is the waypoint that will be overwritten. If an undefined waypoint is entered, a WPT INVALID message will appear.
6. Select ENTER (PB 8) to accept, or CANC (PB 9) to abort the transfer operation.

The process for transferring an MDL waypoint is illustrated in [Figure 20-41](#).

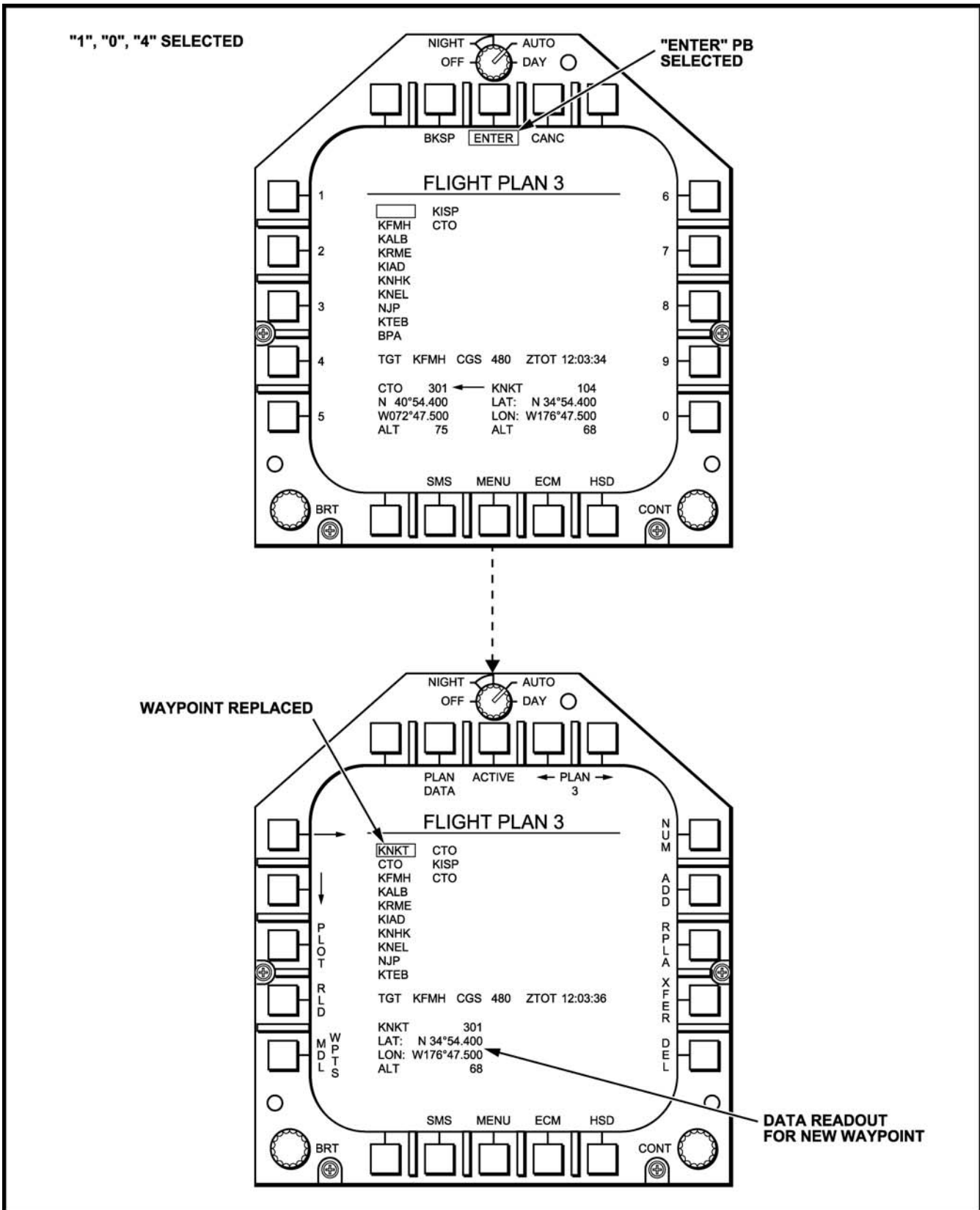
20.3.8.4.4 Waypoint Deletion (Flight Plan Delete Mode)

To delete a flight plan waypoint, the cursor box is positioned over the flight plan waypoint to be deleted. Depressing DEL (PB 15) selects the Delete Waypoint format, which blanks the selected waypoint. All subsequent waypoints selected using the cursor are also blanked. At the bottom of the Delete Waypoint format, data is displayed for both blank and non-blank waypoints selected via the cursor box. Depressing ALL (PB 1) will blank all waypoints in the flight plan.



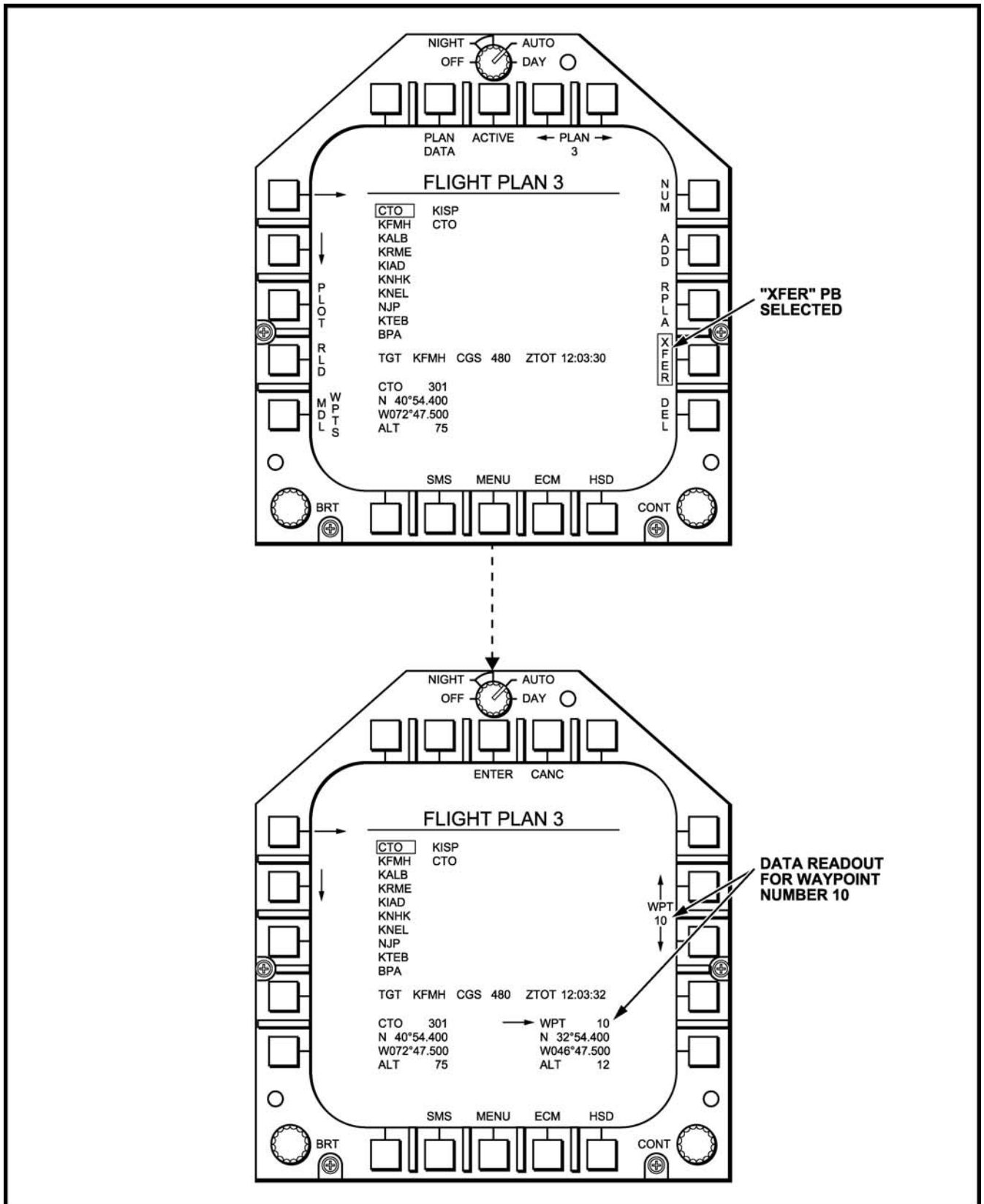
CSC-F14D-1-20-039

Figure 20-39. Flight Plan Format – Waypoint Replacement Page (Sheet 1 of 2)



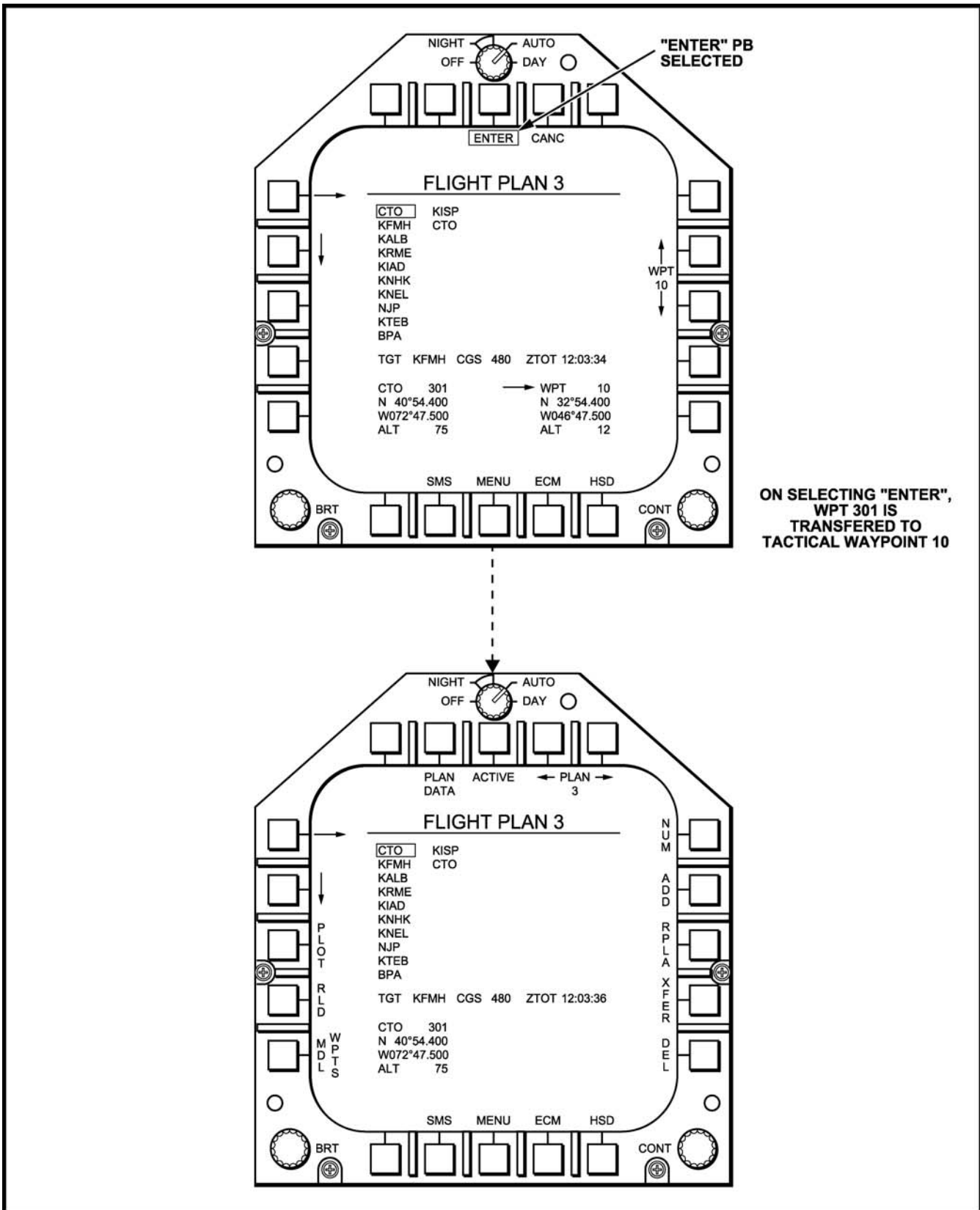
CSC-F14D-1-20-040

Figure 20-39. Flight Plan Format – Waypoint Replacement Page (Sheet 2 of 2)



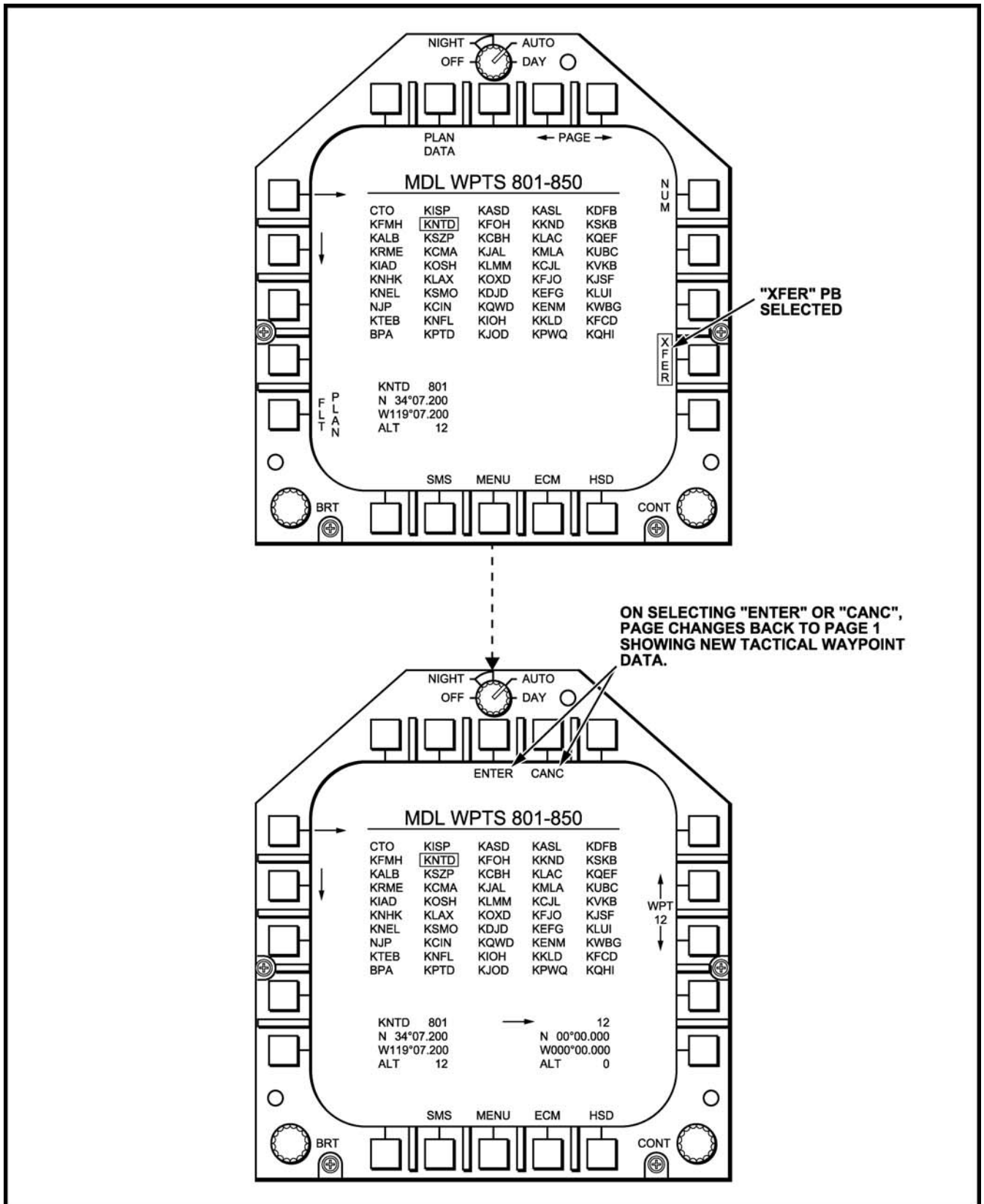
CSC-F14D-1-20-041

Figure 20-40. Flight Plan Format – Waypoint Transfer Page (Sheet 1 of 2)



CSC-F14D-1-20-042

Figure 20-40. Flight Plan Format – Waypoint Transfer Page (Sheet 2 of 2)



CSC-F14D-1-20-043

Figure 20-41. MDL Reversionary Waypoint Format – MDL Waypoint Transfer

Depressing ENTER (PB 8) deletes all blanked waypoints. Depressing CANC (PB 9) cancels the delete operation and no waypoint data is lost.

To delete a waypoint, or several waypoints from a flight plan, perform the following steps:

1. Select the FLT PLAN format (PB 2 on HSD).
2. Position the flight plan cursor box over a waypoint to be deleted using either the MFD bull's eye cursor, or the right/down arrows (PB 4/5).
3. Press DEL (PB 15).
4. The waypoint under the cursor will blank. The cursor can be moved with either the HSD bull's eye cursor or the right/down arrows (PB 4/5), and every waypoint over which the cursor moves will blank.

Note

The waypoints are not actually deleted until ENTER is selected.

5. Press DEL ALL if the entire flight plan is to be emptied.
6. Select ENTER (PB 8) to accept, or CANC (PB 9) to abort the operation.

The process for deleting a waypoint is illustrated in [Figure 20-42](#).

20.3.8.5 Flight Plan Routes

Any or all waypoints in a flight plan may be linked together into a flight plan route. Only one route may be specified in each flight plan. Flight plan routes are presented on the HSD format as a series of flight plan waypoints linked by plotlines if PLOT (PB 14) is selected on the HSD format (see paragraph 20.3.9, Tactical Navigation).

Routes are specified on the Flight Plan format. The cursor box is positioned over a flight plan waypoint. Depressing PLOT (PB 3) brightens the selected waypoint, indicating that it has been included in the flight plan route. The PLOT legend is also boxed, indicating that any other waypoint that is subsequently selected using the cursor will also be included in the route, until PLOT is unboxed. Waypoints selected as part of the flight plan route are displayed brightened on the Flight Plan format. If the cursor box is placed over a flight plan waypoint that is part of the route, PLOT will not box. In order to deselect that waypoint as part of the route, PLOT must be depressed twice, once to box the menu item, and a second time to deselect the point as part of the route.

Routes are saved with the flight plan modified copies on the MDL cartridge, so that they are retained across system resets, between flights, and with the removal of the MDL cartridge.

20.3.9 Tactical Navigation

The following paragraphs describe the procedures to be used for tactical navigation. This includes a description of various navigation information, display steering modes, autopilot steering, all-weather landing, position updating, continuous position updating, and surface waypoint determination position.

20.3.9.1 Range, Bearing, and Time To Go to Waypoints and TACAN Stations

Range and bearing, and various time remaining readouts available to any valid waypoint or TACAN station. Paragraph 20.2.1 describes most of this information. In addition, a number of specialized readouts and displays are provided, and are described below.

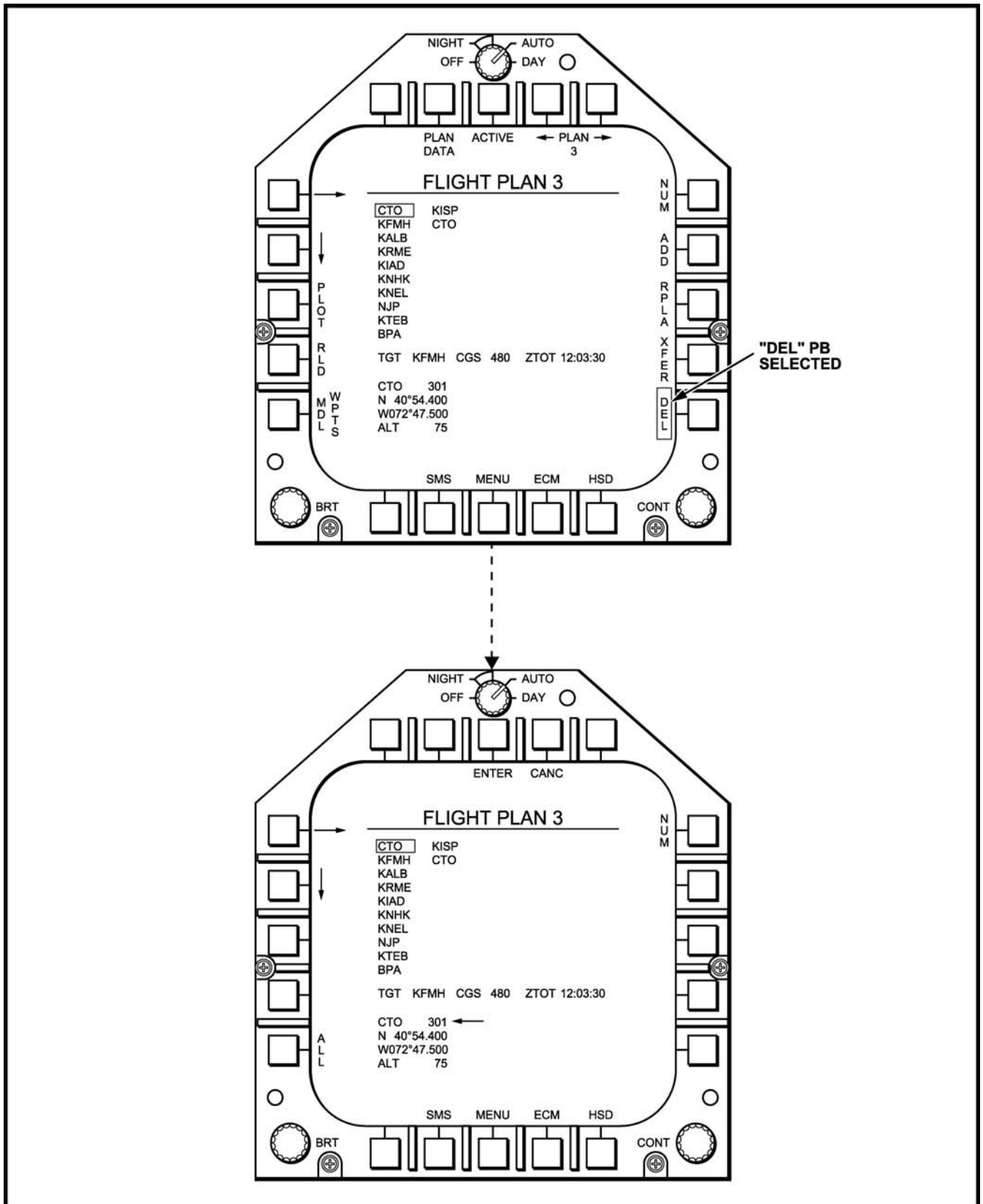
20.3.9.1.1 HSD Commanded Ground Speed

At times Commanded Ground Speed (CGS) replaces TAS at the top of the HSD ([Figure 20-9](#)). This occurs if the steer point is a route waypoint, the steering mode is DEST or AUTO, a target has been entered for the active flight plan, and a ZTOT has been entered for that target on the DEU. The value is computed by the mission computer and represents the ground speed required to achieve the ZTOT (Zulu Time On Target) by following the route.

If a CGS has been entered for the target using the DEU, the computed CGS is based on flying at the entered CGS from the route waypoint prior to the target. For example, assume that a CGS of 500 was entered for the target, waypoint 105. If waypoints 101 to 104 are all route waypoints, then the computed CGS enroute between waypoints 101 and 104 would be the ground speed required to fly from 104 to 105 at 500, and achieve the entered ZTOT. If ground speed matches CGS on the HSD, then the ETA on the HSD should match the ZTOT for the TGT.

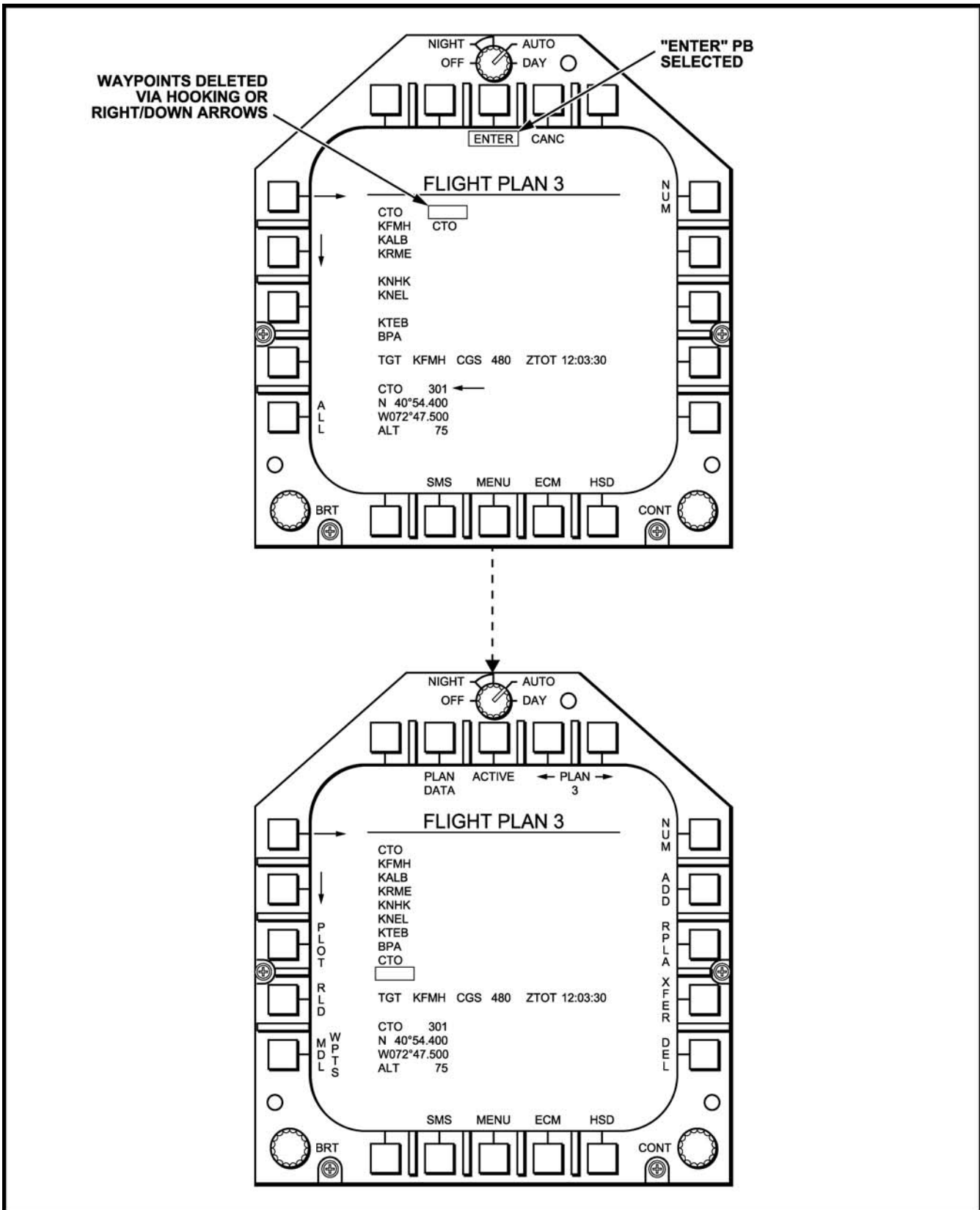
20.3.9.1.2 HSD Steering Aids

The following paragraphs define some of the HSD format steering aids: Course Line Functionality, TACAN Needle Display, Waypoints and Plotlines, CDI (Course Deviation Indicator) Functionality, and Cross Track Error Indication. [Figure 20-9](#) lists some of the display items relevant to these steering aids.



CSC-F14D-1-20-044

Figure 20-42. Flight Plan Format – Waypoint Delete Page (Sheet 1 of 2)



CSC-F14D-1-20-045

Figure 20-42. Flight Plan Format – Waypoint Delete Page (Sheet 2 of 2)

20.3.9.1.2.1 HSD Course Line Functionality

The course line on the HSD is drawn through the current steer point or TACAN station and rotates with the selected course (CRS knob) while in GPS or TCN steering (Figure 20-45).

20.3.9.1.2.2 HSD TACAN Needle Display

The HSD TACAN needle is displayed as a cross-hatched head and tail pointer on the inside of the compass rose. In all steering modes, except GPS, it is displayed if valid TACAN bearing is available and the head of the needle always points to the station. In GPS steering modes, the TACAN needle points to the selected steer point as if it were a TACAN station.

20.3.9.1.2.3 HSD Waypoints and Plotlines

Waypoints and plotlines are displayed on the HSD. Plotlines connect waypoints that are defined as route waypoints (assuming more than one) within a flight plan.

There is a display limit of 32 plotlines and 30 waypoints on the HSD. The current steer point will always be displayed, along with the next closest 29 waypoints in range to the aircraft. Plotlines are displayed independent of waypoints. If a plotline does not appear to go to a waypoint, it may be that the waypoint is not one of the closest 30.

There is a capability in TAMPS to create a tactical waypoint on the MDL with a “blank” type associated with it. This allows the use of plotlines to box out operating areas without having displayed waypoints at every point defining that area cluttering the display. However, these blank waypoints count as part of the “displayed” 30.

A route waypoint is one which is part of an active flight plan, and which has been brightened on the flight plan format with the “PLOT” button. It will be displayed with a plotline through it on the HSD if PLOT is boxed on the HSD.

The steer point is the waypoint that is currently selected for waypoint steering in DEST, AUTO, or GPS steering modes. Its number is displayed next to the steering mode in the lower right of the HSD.

20.3.9.1.2.4 HSD CDI Functionality

When the steering mode is GPS and CDI (PB 14) is boxed, the Course Deviation Indicator (CDI) is displayed in place of the course line. The differences between this and the TACAN CDI are that the reference point is the selected steer point and the scaling is based on a horizontal distance from the centerline of the selected course to that waypoint.

As with TACAN CDI, the scaling of the CDI offset dots is based on gear up/gear down status. With the gear up, the two dots on each side represent 2 and 4 nm offsets from the selected course. With the gear down, they represent 0.5 and 1 nm offsets.

Note

GPS CDI is a fixed horizontal deviation where the TACAN CDI deviation is an angular offset that corresponds to greater horizontal deviation at greater range. The TACAN CDI actually gives finer resolution steering cues than the GPS CDI; and the GPS CDI gives better accuracy at range. At very short ranges from the waypoint or station (i.e., less than 0.5 miles), the TACAN gives you more accurate cues and is more sensitive to small deviations. The GPS is much more stable and is not subject to “swings” due to poor reception.

20.3.9.1.2.5 HSD Cross Track Error Indication

Cross Track Error is the perpendicular horizontal deviation from a selected course to a waypoint (in GPS steering) or from the route centerline (in DEST or AUTO steering). Cross Track Error is displayed with accuracy to tenths of a nm. If the following conditions are met, Cross Track Error is displayed on the HSD just above the compass rose to the right:

- GPS, DEST, or AUTO steering
- Current steer point is part of route beyond first route waypoint for DEST and AUTO.

20.3.9.2 Display Steering Modes

Several steering modes, optimized for specific missions and phases of flight, are available to the aircrew. These steering modes, with their associated controls and displays, are summarized in Figure 20-43. Steering modes may be selected by cycling through modes using STR (PB 9) on the HSD format, or by making individual selections from the menu presented on the VDI format. Although partial steering cues may be presented on the HUD A/A and A/G formats, complete steering cues are always presented on the TLN format.

In most modes, the aircrew selects the navigation steering waypoint manually via the HSD format, by the following method:

1. Depress the decrement (PB 4) or increment (PB 5) arrows until the desired waypoint is displayed between them. Navigation data for each waypoint is displayed in the boxed (left or right) data buffer as it is selected.

STEERING MODE (LABEL)	SELECTION SOURCE		HSD RIGHT BUFFER DISPLAY		AVAILABLE STEERING CUES AND CLOCKS (HUD/VDI/HSD)
	HSD	VDI	WPT	TCN	
Destination (DEST)	X	X	X		Command heading markers
					Destination bearing pointer (Course Line)
					Destination bearing marker ¹
					WPT range readout
					Time-to-go to waypoint readout
					Cross-track error if route waypoint selected
					TACAN station bearing pointer (To and From) ²
TACAN (TACAN)	X			X	Course deviation markers
					Course deviation indicator
					TACAN station bearing pointer (To and From) ²
					Selected course line (through station)
					TACAN range readout
					Time-to-go to station readout
GPS Pseudo-TACAN (GPS)	X		X		Command heading markers
					Course deviation markers
					Destination bearing marker ¹
					Selected course line (through steer point)
					GPS range readout
					Time-to-go to waypoint readout
					Cross-track error from course line readout
Auto-Waypoint Sequencing ³ (AUTO)	X		X		Command heading markers
					Destination bearing pointer (Course Line)
					Destination bearing marker ¹
					WPT range readout
					Time-to-go to waypoint readout
					Cross-track error from route line readout
					TACAN station bearing pointer (To and From) ²
Commanded Ground Speed ³ (AUTO)	X		X		Command heading markers
					Destination bearing pointer (Course Line)
					Destination bearing marker ¹
					WPT range readout
					Time-to-target readout
					Commanded ground speed readout
					Ground speed error caret
					Cross-track error from route line readout
TACAN station bearing pointer (To and From) ²					
NOTES:					
1. Displayed in all steering modes if a valid destination steer point is entered in the MCS					
2. Displayed in all steering modes if a valid TACAN signal is being received.					
3. Automatically changes to DEST steering inbound to the target waypoint or once the last waypoint on the flight plan route is overflown.					

Figure 20-43. Steering Mode Summary

2. Select ENT (PB 15) to make the displayed waypoint the navigation steer-point. The waypoint number will be displayed in the lower right corner of the HSD format along with the current steering mode.

In other modes, the navigation steer-point may be selected automatically by the MCS or is calculated from encoded digital data link or analog RF signals, such as data link or TACAN.

Internal navigation calculations are computed using the NAV State Vector, which is updated with INS, SAHRS and/or GPS information, and is updated if any one of these constituent sources is valid.

20.3.9.2.1 Destination 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 push-button. This results in the HSD format in [Figure 20-44](#). 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 selecting DEST from the STR pushbutton on the 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.

DEST steering provides bearing, range and time information for navigation direct to or from a waypoint. All navigation parameters are computed internally from inertial coordinates (see [Figure 20-44](#)).

The command heading markers in the HUD heading scale and along the HSD format compass rose provide a wind-corrected heading cue direct to the destination waypoint via Great Circle route. The HSD course line and destination bearing marker provide non-wind-corrected bearing to the destination waypoint. The selected heading and course functions (HSEL [Heading Selected] and CSEL [Course Selected]) are not operable. The HSD left and right hand data buffers display waypoint information.

Note

The destination bearing marker on the HSD format is displayed in all steering modes, including steering off, if a valid destination waypoint is entered as the destination steer point.

20.3.9.2.2 TACAN Steering

In the TACAN steering mode ([Figure 20-45](#)), 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 selects TACAN by the STR pushbutton. 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 arrowhead 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 20-45](#) 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.

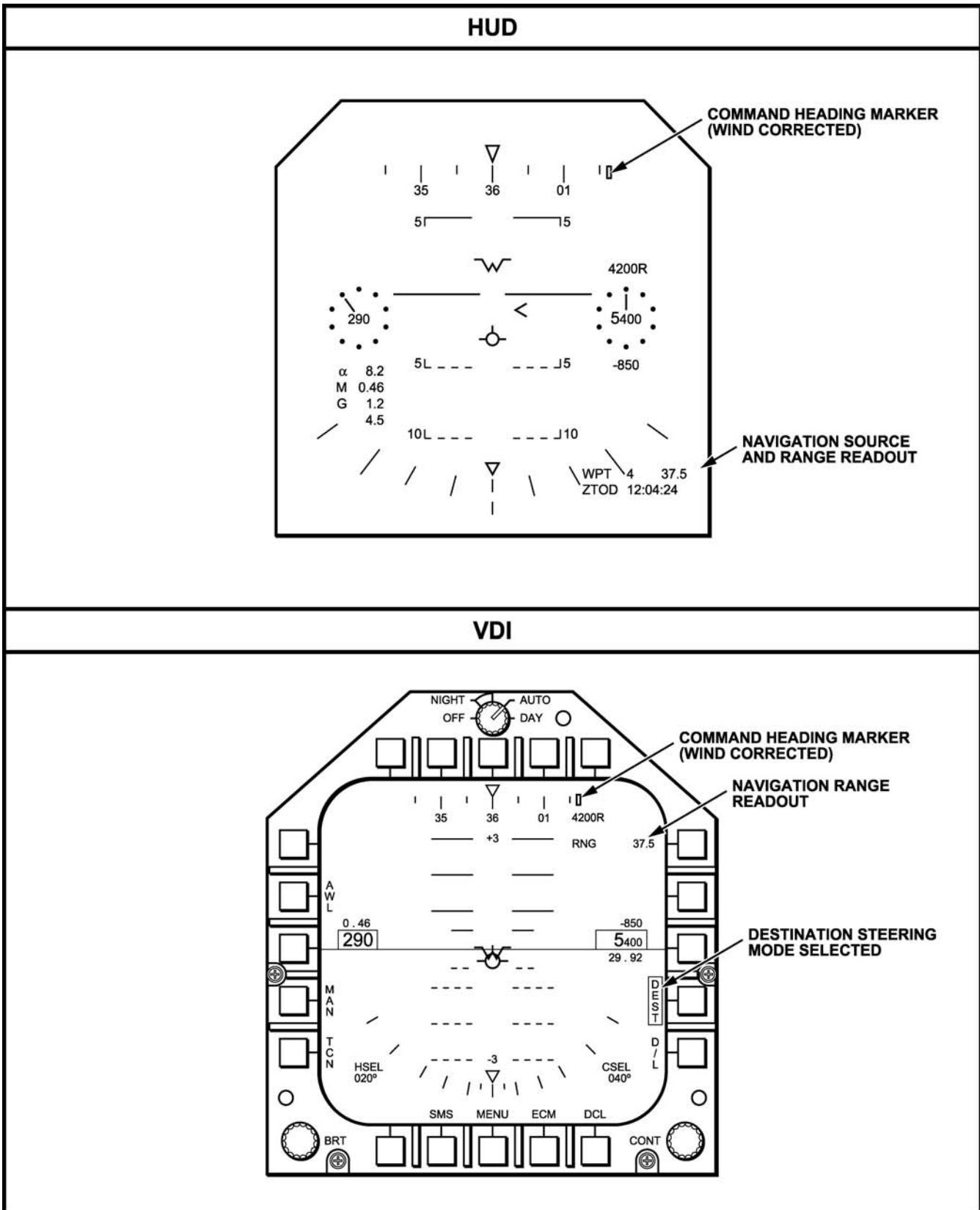
TACAN steering provides course, bearing, range and time information for navigation to a TACAN station either direct or along a specified course. Bearing and range to station are decoded from external analog RF TACAN signals. TACAN steering requires an operative JTIDS receiver with TACAN.

Note

Digital TACAN information is only available in the upper right HSD buffer while steering mode is TACAN or BLANK. The TACAN station bearing pointer and symbol are available in all steering modes except GPS pseudo-TACAN.

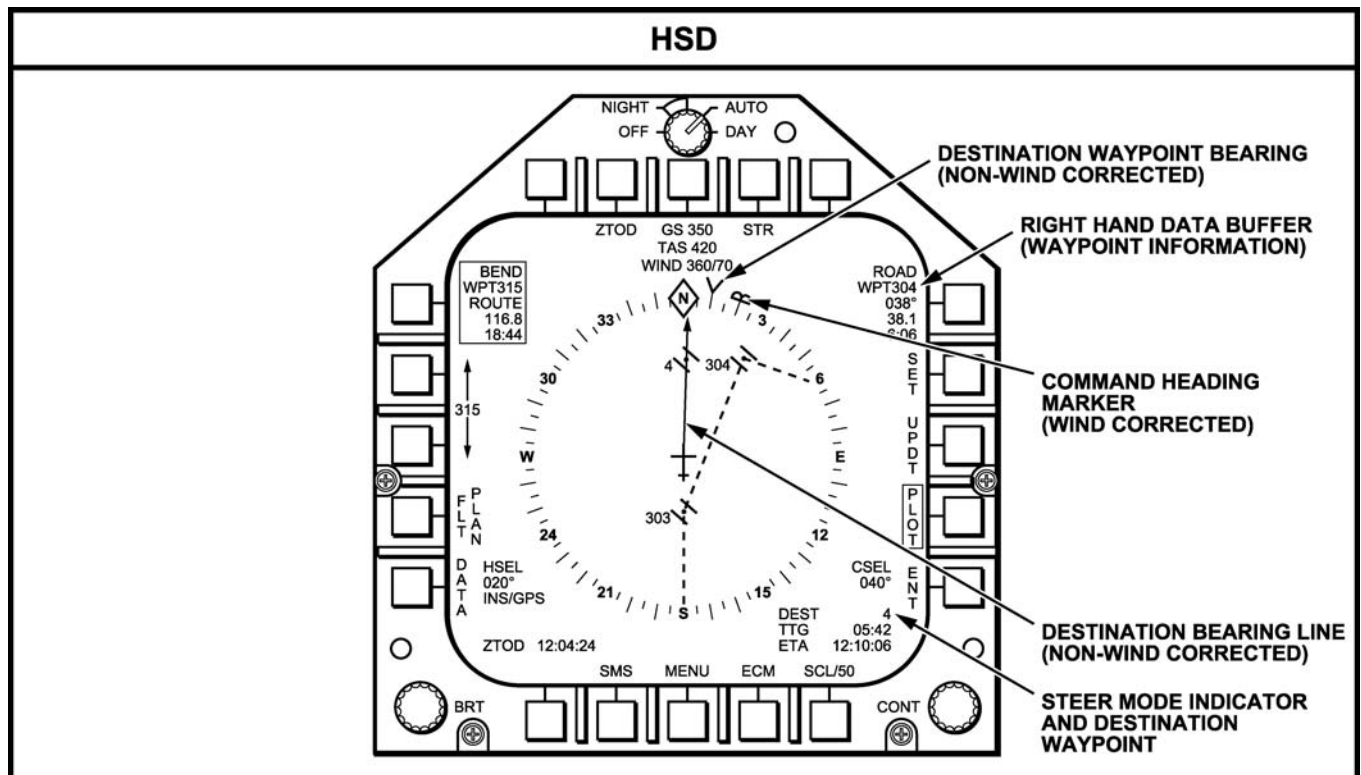
20.3.9.2.3 GPS Steering (Pseudo-TACAN)

GPS steering provides “pseudo-TACAN” course, bearing, range and time information for navigation to a waypoint either direct or along a specified course. The GPS steering emulates TACAN steering using precise GPS position information and requires an operative MAGR .



CSC-F14D-1-20-020A

Figure 20-44. Destination Steering Displays (Sheet 1 of 2)



CSC-F14D-1-20-021

Figure 20-44. Destination Steering Displays (Sheet 2 of 2)

Steering cues are similar to those in TACAN steering. However, on the HUD and the VDI format the course deviation marker scale is such that each dot represents a 2 nm deviation for a maximum deflection of 4 nm with the landing gear handle up, and 0.5 nm deviation for a maximum deflection of 1 nm with the landing gear handle down. Additionally, a cross-track error digital readout is displayed on the HSD format, which provides actual lateral deviation from the selected course line. The HSD left and right hand data buffers display waypoint information. Typical GPS steering formats are illustrated in [Figure 20-46](#).

20.3.9.2.4 Automatic Waypoint Sequence Steering

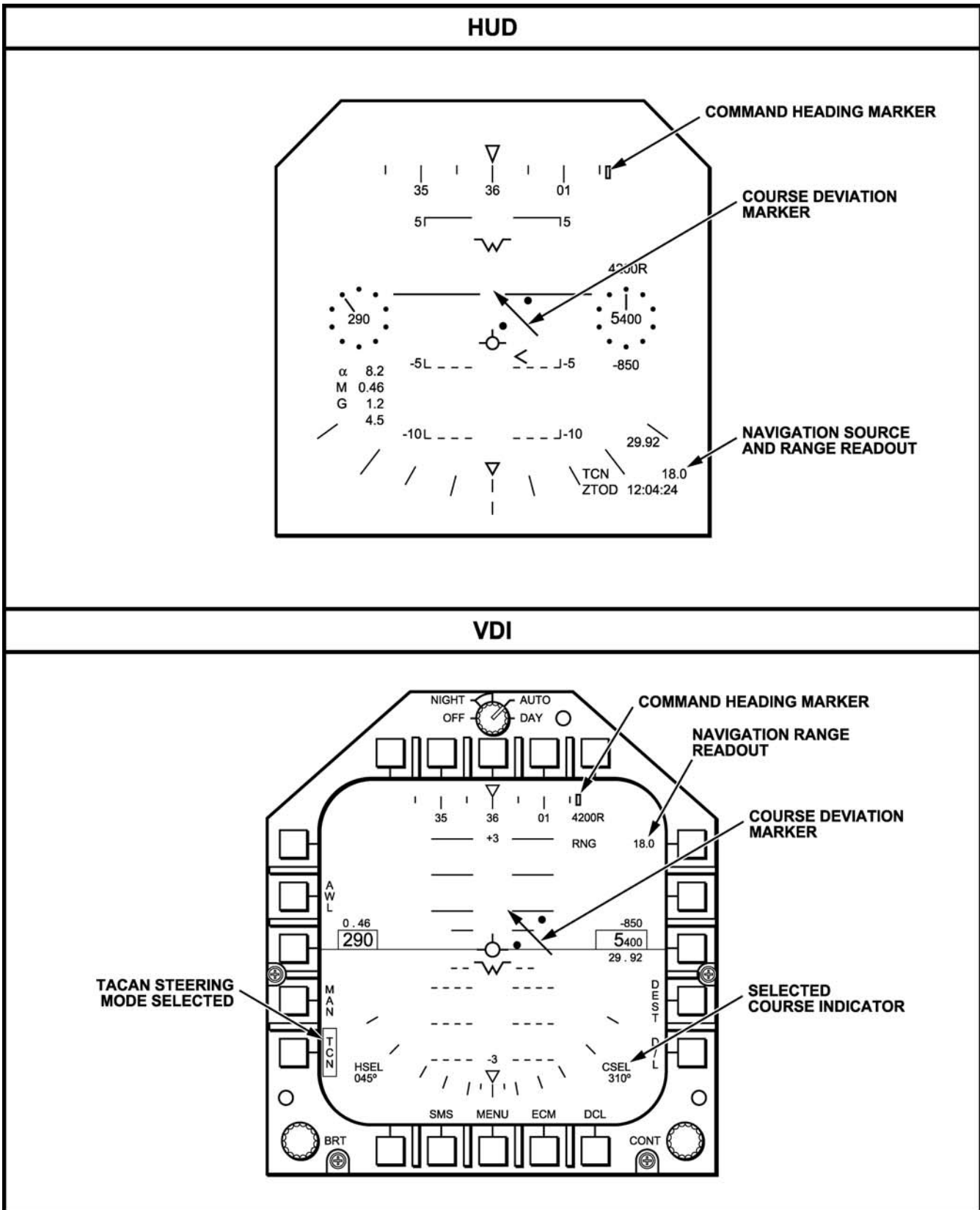
AUTO steering provides the functionality of DEST steering, with the additional MCS feature of automatic stepping to successive waypoints along a flight plan route. AUTO steering is only available with an active flight plan route, and may be selected only if the current destination waypoint is included on that route but is not the designated Target waypoint or the last waypoint in the selected sequence. All navigation parameters are computed internally from inertial coordinates.

AUTO steering is replaced with DEST steering automatically when any of the following conditions occur:

1. The navigation steerpoint steps to the Target waypoint
2. A waypoint not on the flight plan route is selected as the navigation steerpoint
3. The final waypoint on the flight plan route is reached
4. The flight plan is deactivated or changed

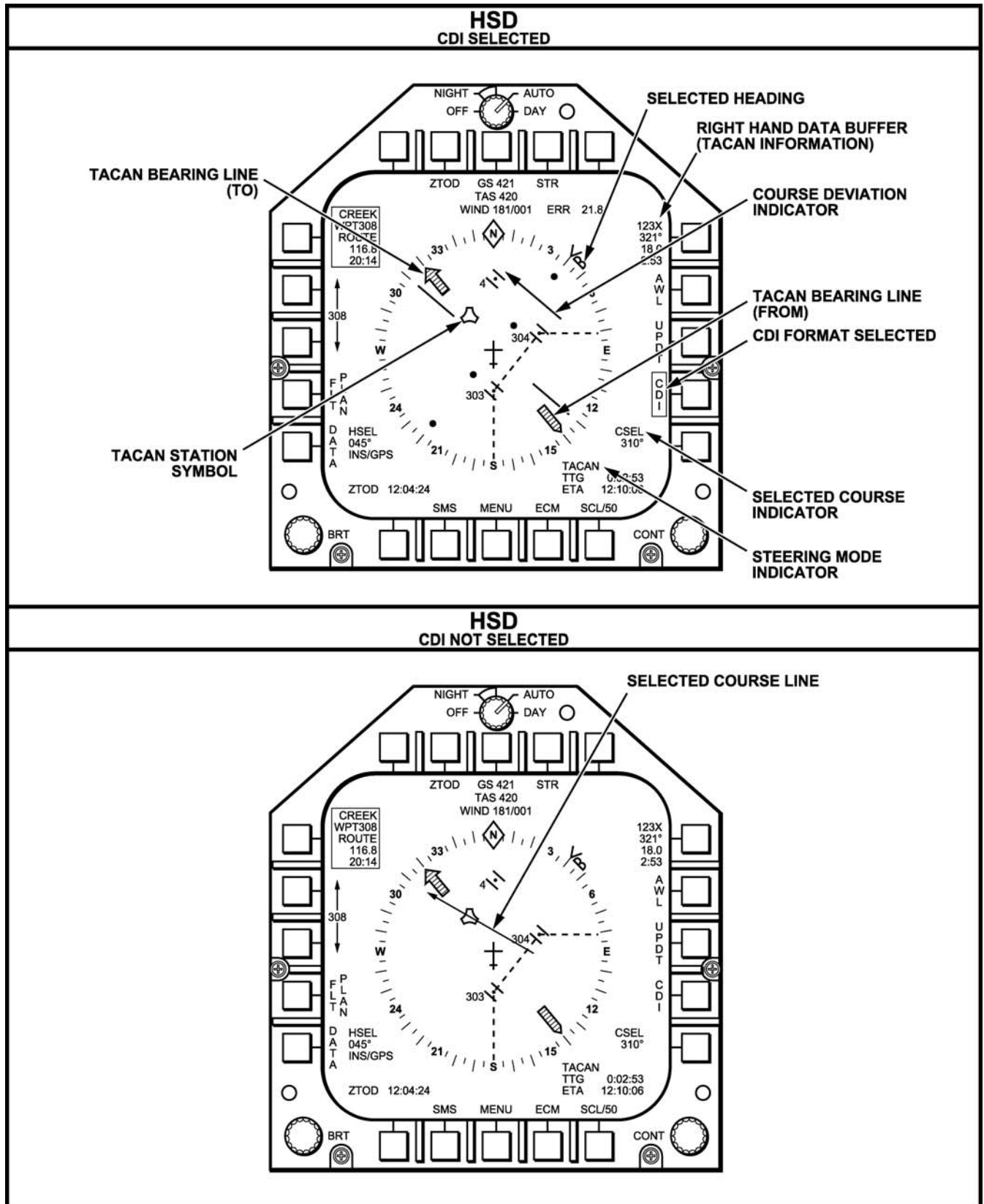
AUTO steering may be reselected once any other waypoint on the route is selected as the steerpoint. Cues for AUTO steering are similar to those for DEST steering (see paragraph 2). Additionally, a cross-track error digital readout on the HSD format provides actual lateral deviation from the centerline of the current route leg. The HSD left and right hand data buffers display waypoint information. The changeover point for automatic waypoint sequencing and typical AUTO steering displays are illustrated in [Figure 20-47](#).

Automatic sequencing occurs when the current AUTO steering point is passed (90° or greater off the nose) within 5 nm.



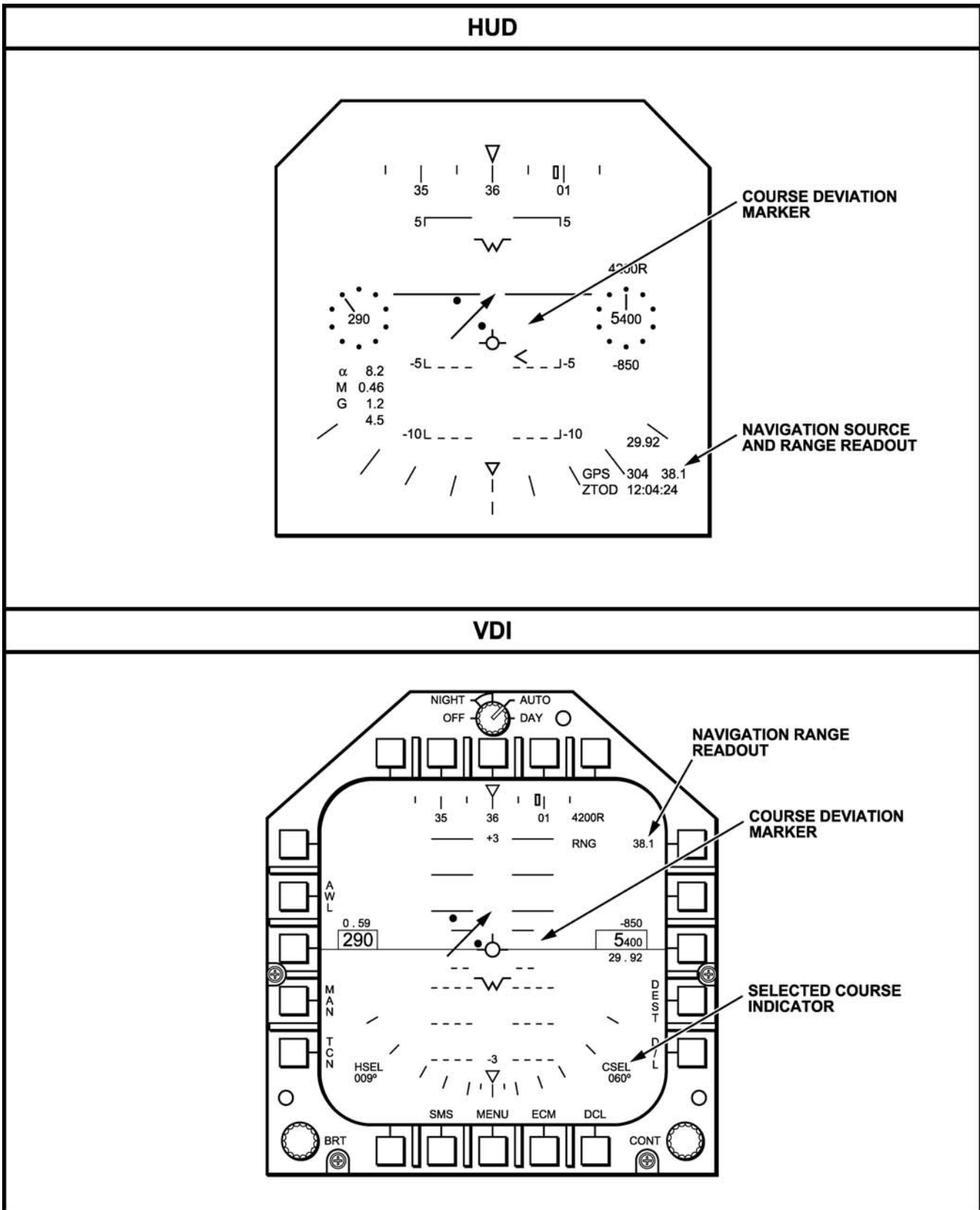
CSC-F14D-1-20-022A

Figure 20-45. TACAN Steering Mode Formats (Sheet 1 of 2)



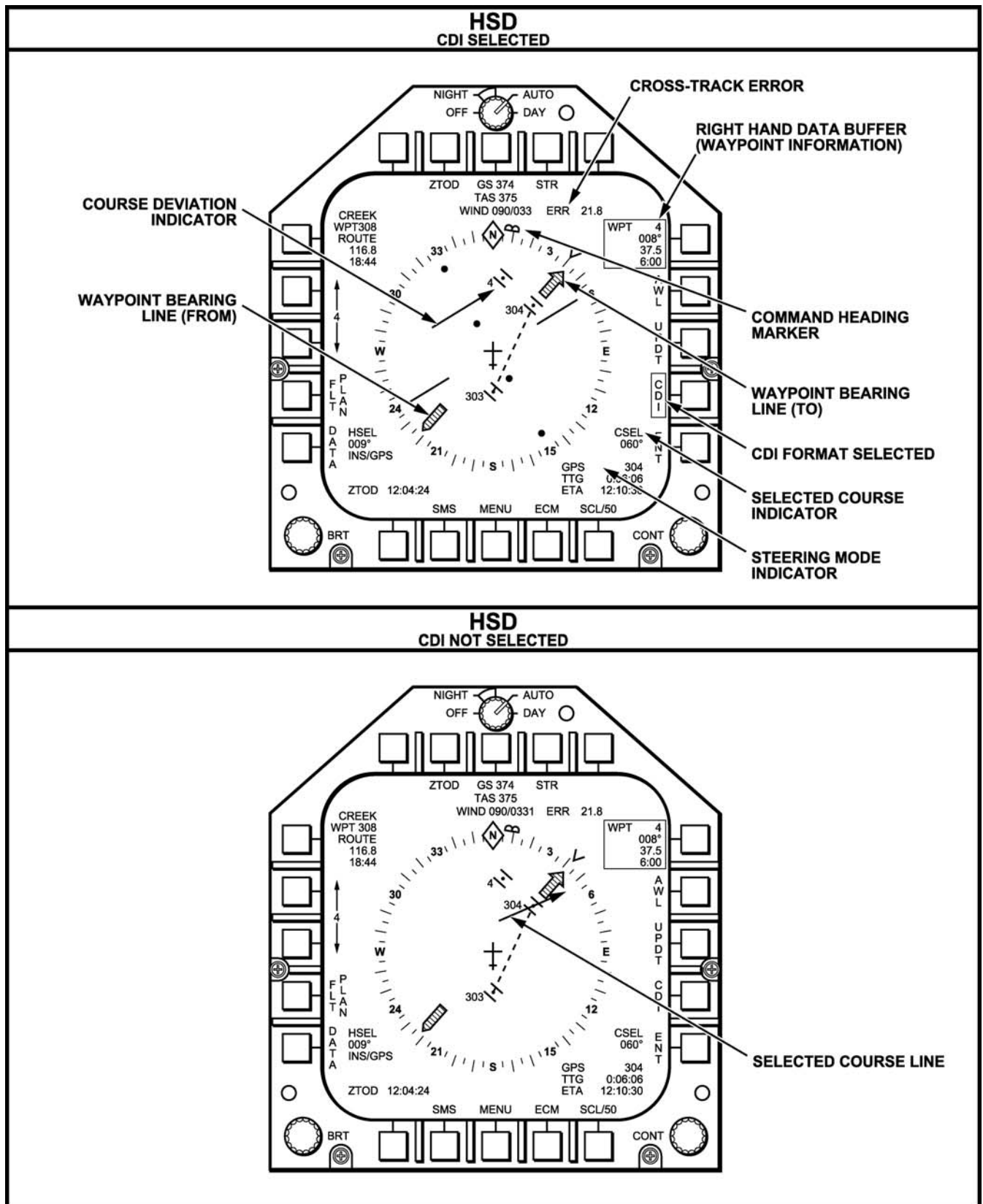
CSC-F14D-1-20-023

Figure 20-45. TACAN Steering Mode Formats (Sheet 2 of 2)



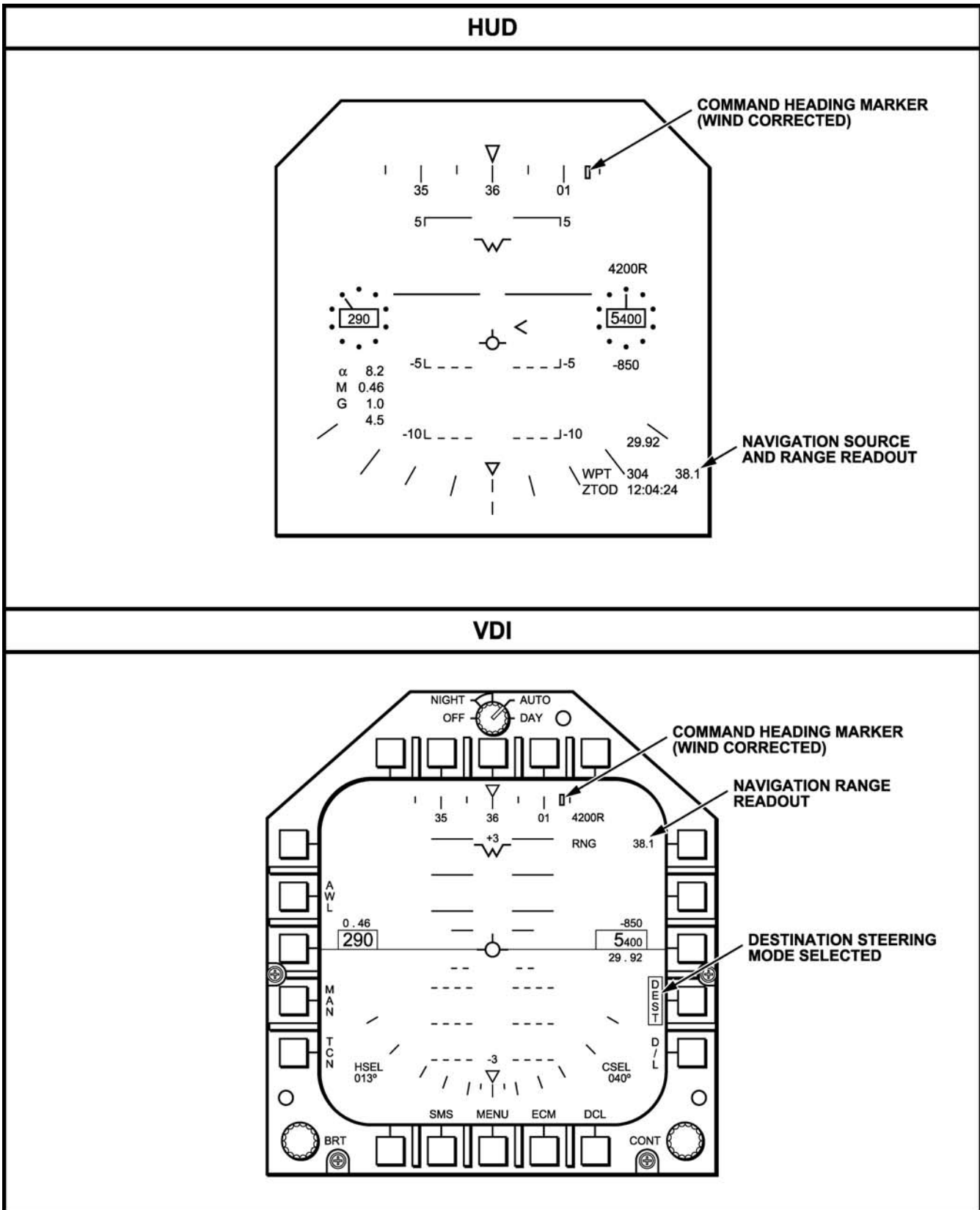
CSC-F14D-1-20-024A

Figure 20-46. Typical GPS Steering Formats (Sheet 1 of 2)



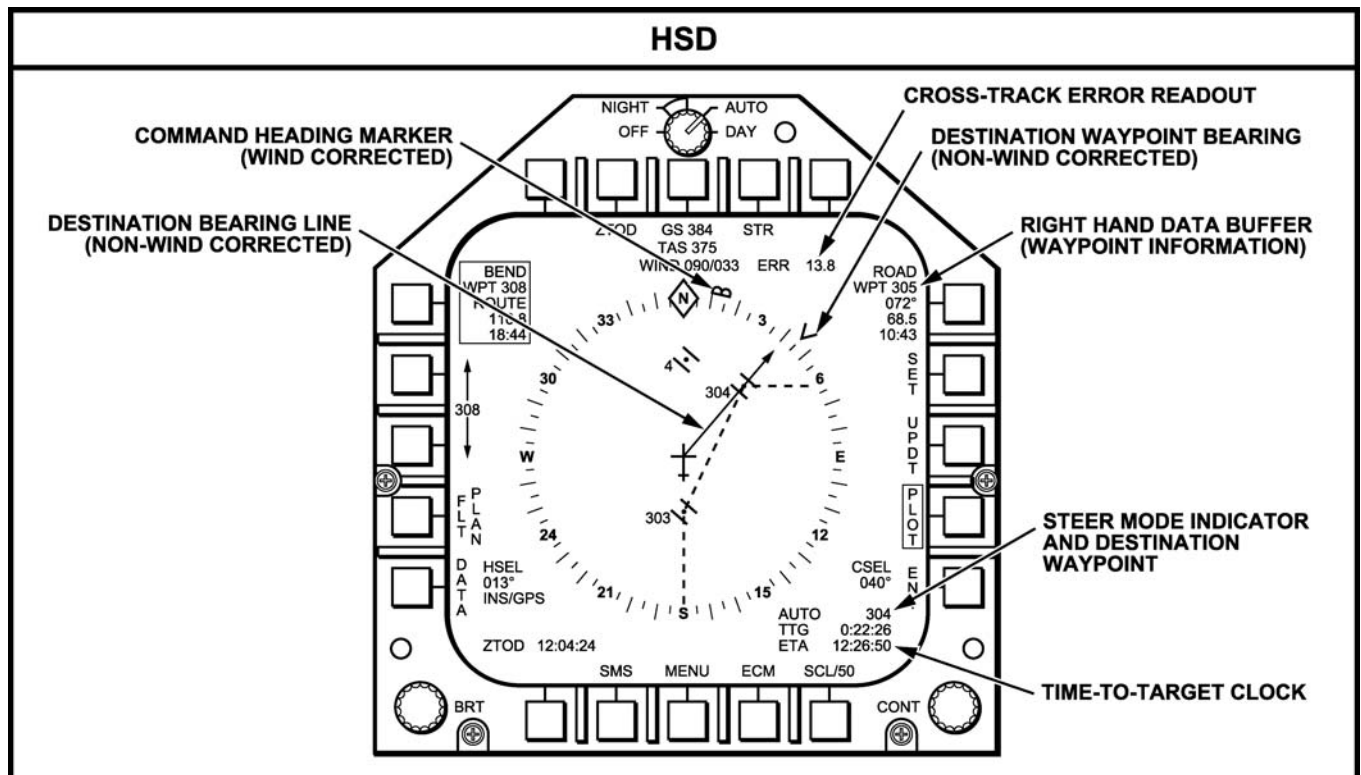
CSC-F14D-1-20-025

Figure 20-46. Typical GPS Steering Formats (Sheet 2 of 2)



CSC-F14D-1-20-026B

Figure 20-47. Auto Waypoint Steering Displays (Sheet 1 of 2)



CSC-F14D-1-20-046

Figure 20-47. Auto Waypoint Steering Displays (Sheet 2 of 2)

20.3.9.2.5 Commanded Ground Speed Steering

Commanded Ground Speed steering is a special sub-mode of AUTO steering which provides additional airspeed cues for precise timing of arrival over a defined flight plan Target waypoint. Existing AUTO steering cues are still available, and the steering mode buffer of the HSD format will display the AUTO legend. (See paragraph 20.3.9.2.4.)

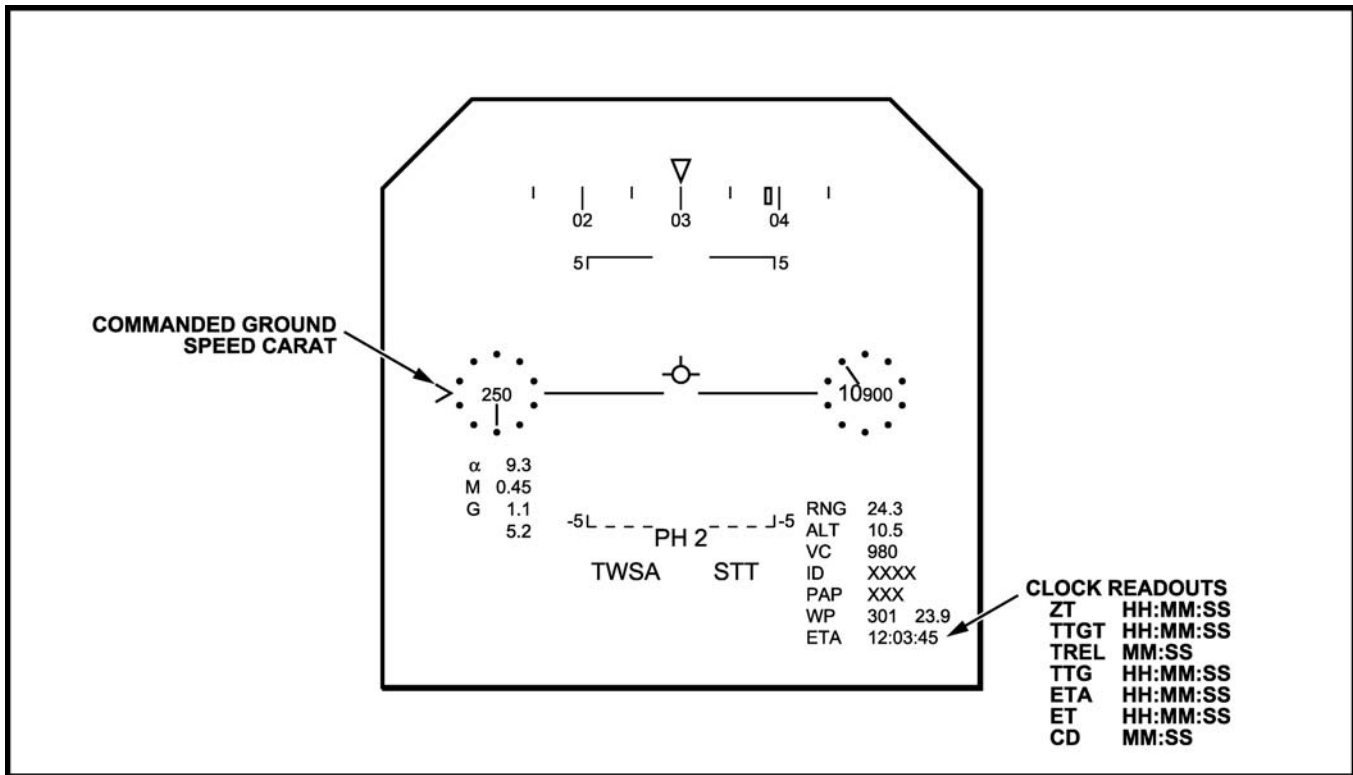
To enable CGS steering, the aircrew must specify the following parameters for a flight plan route: TGT (Target Waypoint), CGS, and ZTOT. The MCS will attempt to calculate and display on the HUD and the HSD format airspeed cues to achieve the specified time and airspeed over the TGT if the following conditions are met:

1. A flight plan with a defined route is active.
2. The current destination waypoint is on the flight plan route.
3. AUTO steering is selected.
4. The TGT and ZTOT have been specified for the flight plan.
5. Valid ZTOD from the MAGR is available.

The TGT, ZTOT and CGS parameters are entered via the DEU as follows:

1. From the main menu, select WPT.
2. Enter the desired TGT waypoint number and select ENTER.
3. Select TYPE, and from this submenu select TGT and ENTER.
4. Select CGS, enter the desired ground speed in knots for the terminal inbound leg to the TGT and ENTER.
5. Select ZTOT, enter the desired Zulu time on target and ENTER.

In CGS steering, the MCS continually calculates the ground speed required to cover the distance from the current aircraft location to the TGT along the active flight plan route, and also accounts for the CGS specified for the final leg inbound to the TGT. The difference between the aircraft's ground speed and the CGS is presented graphically on the HUD and digitally on the HSD format. Commanded Ground Speed steering provides the aircrew with cues for airspeed control to meet the timing requirements specified by CGS



CSC-F14D-1-20-055

Figure 20-48. Commanded Ground Speed Indication

and ZTOT. The CGS cues are displayed to the aircrew whenever valid, and are determined by the following criteria:

1. CGS exceeds 133 knots
2. The specified ZTOT can be met.

When valid, CGS steering cues are displayed on all HUD master modes. In addition to normal AUTO steering cues, a caret is presented along the HUD airspeed dial edge that provides a “fly-to” cue for airspeed (see Figure 20-48). When the airspeed tic and the caret are aligned, specified ZTOT and CGS requirements over the TGT will be met. If the current ground speed differs from CGS by more than 30 knots, the caret becomes fixed at a preset angular limit (three dots), and rotates with the airspeed tic until the difference becomes less than 30 knots. CGS also replaces the TAS display under PB 8 on the HSD format.

Note

Whenever CGS steering is valid, the HUD analog airspeed dial and tic will be displayed along with the HUD airspeed caret, regardless of the position of the HUD Format switch (ANLG, BOTH or DGTL).

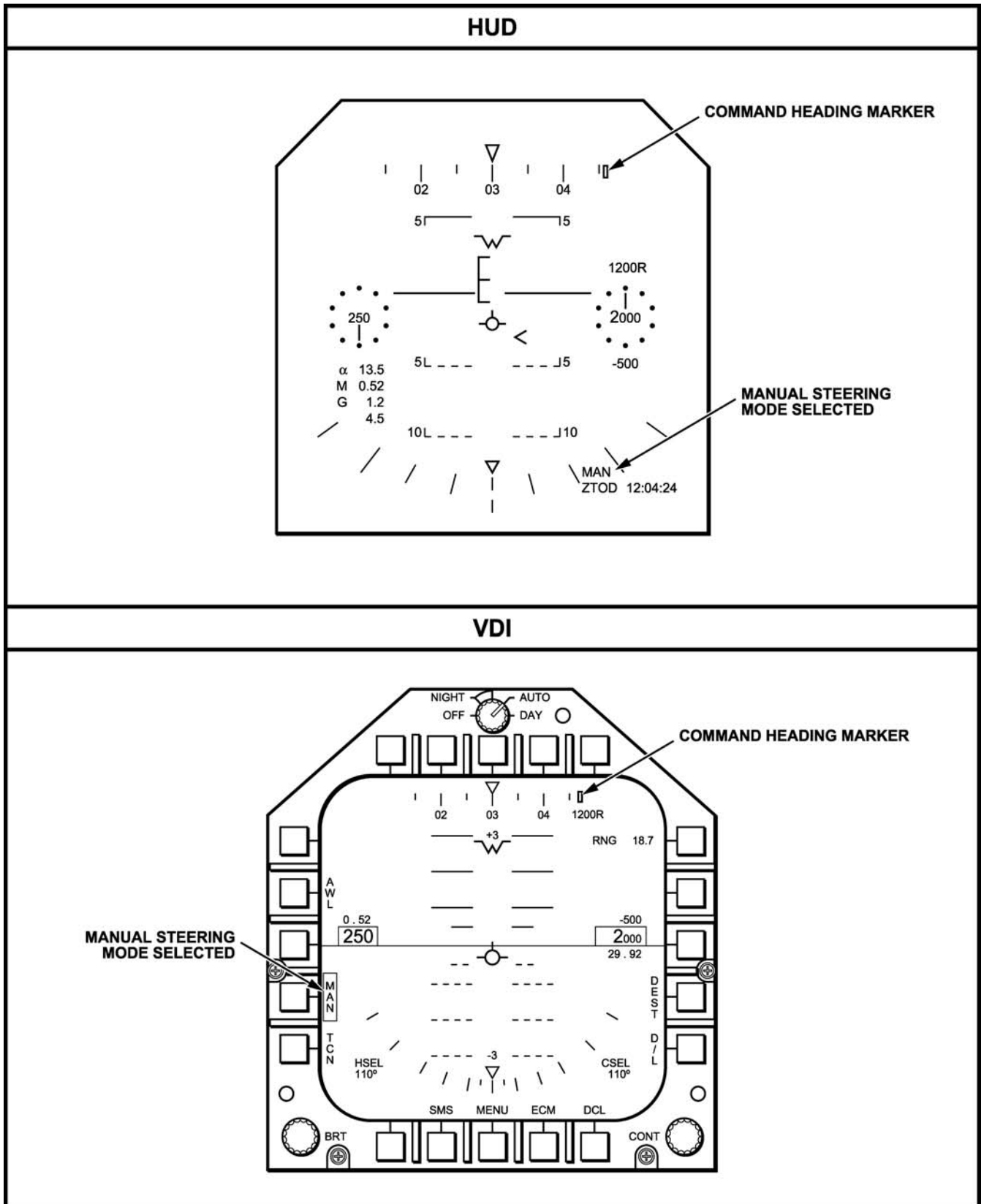
20.3.9.2.6 Manual Steering

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.

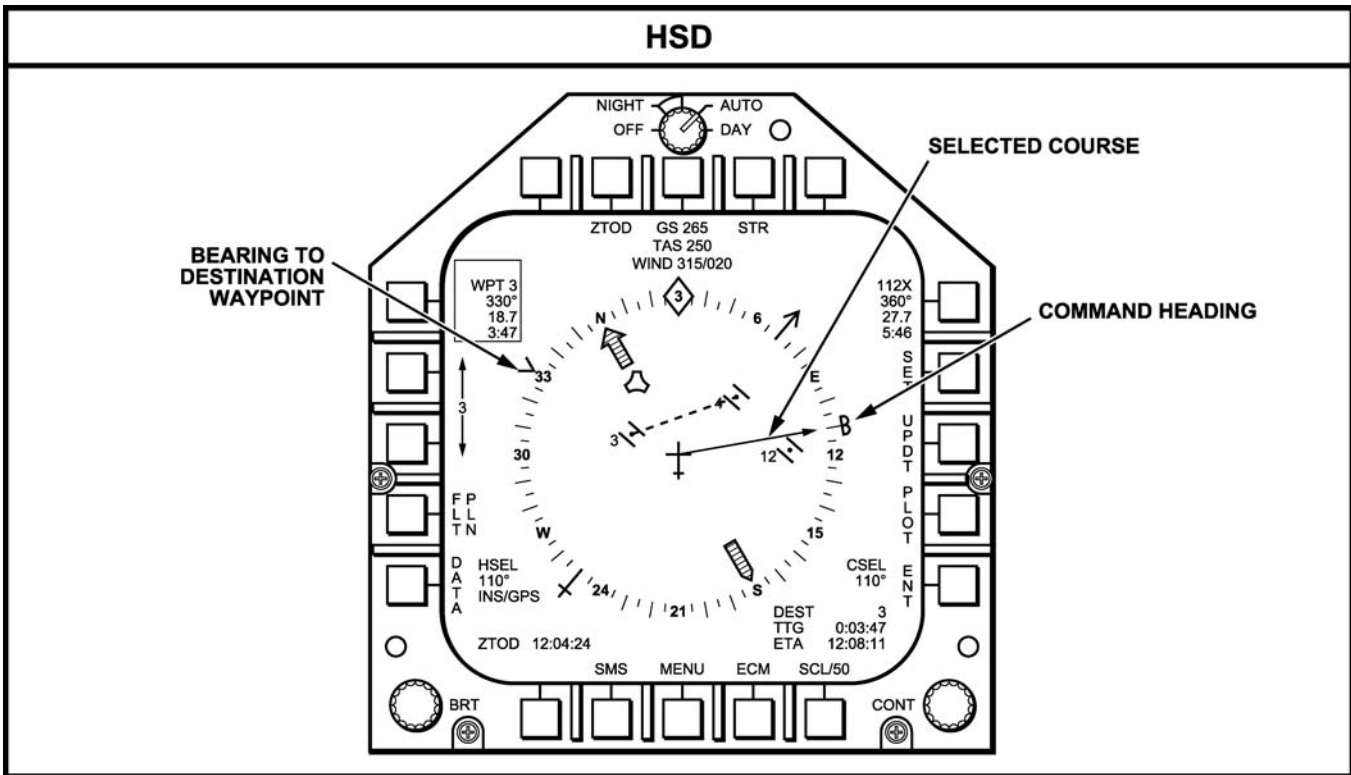
Figure 20-49 shows the display formats used for manual steering. Manual steering mode can be selected as follows:

1. Call the VDI MFD format.
2. Using the pilot’s CRS select knob on the course/heading panel (FO-3), select a course.



CSC-F14D-1-20-047B

Figure 20-49. Manual Steering Mode Formats (Sheet 1 of 2)



CSC-F14D-1-20-048

Figure 20-49. Manual Steering Mode Formats (Sheet 2 of 2)

3. Verify the selected course value under CSEL on the VDI MFD format.
4. Depress the MAN pushbutton on the VDI format.

Steer aircraft to the command heading marker on the HUD or VDI.

20.3.9.2.7 Data Link Steering

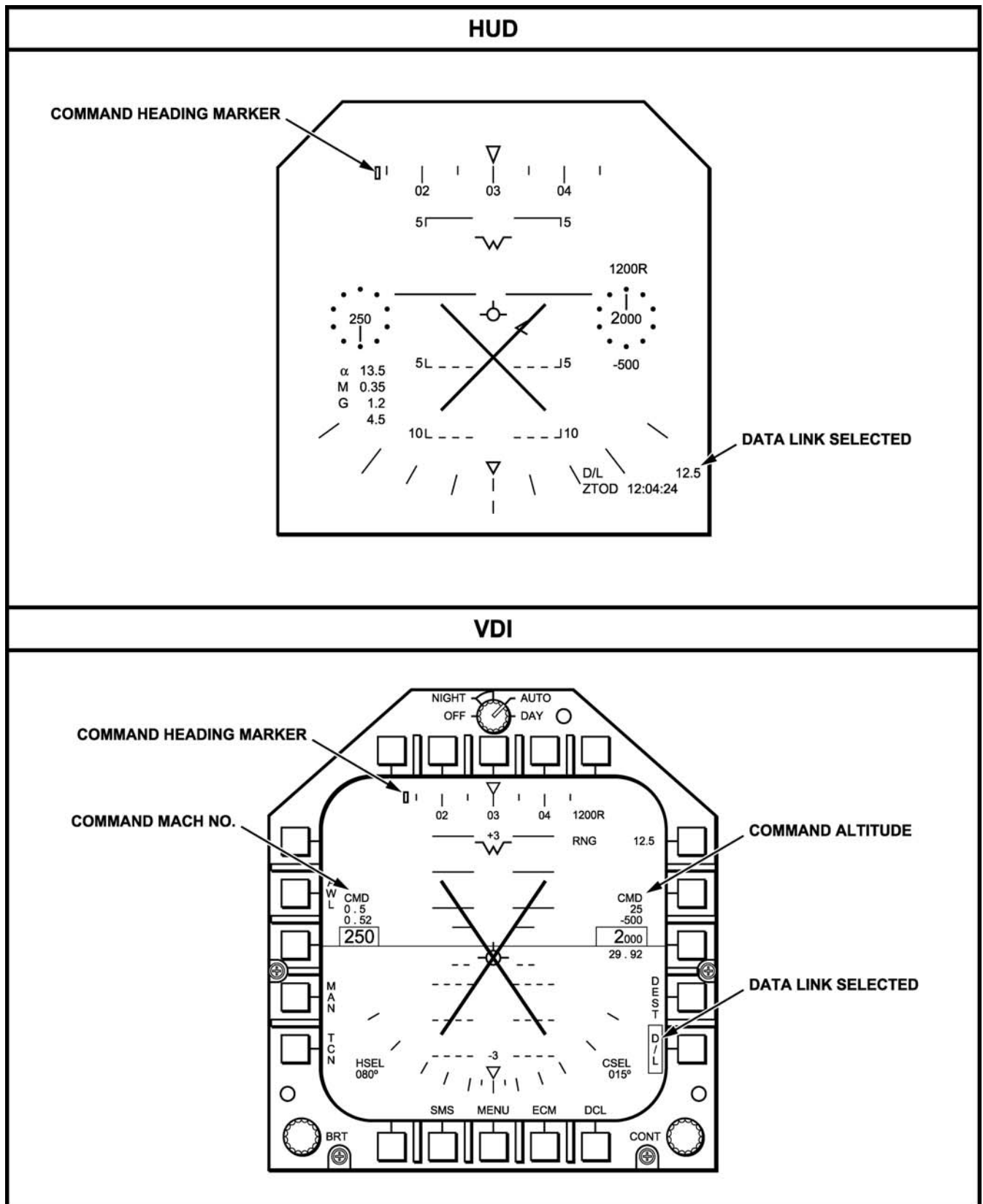
In the data-link display steering mode (Figure 20-50), the pilot maintains a command course, commanded by external inputs from the ASW-27C data link or AN/URC-107 JTIDS data link, by steering the aircraft to the command heading marker on the HUD, VDI, or HSD format. The pilot also adjusts aircraft altitude 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.

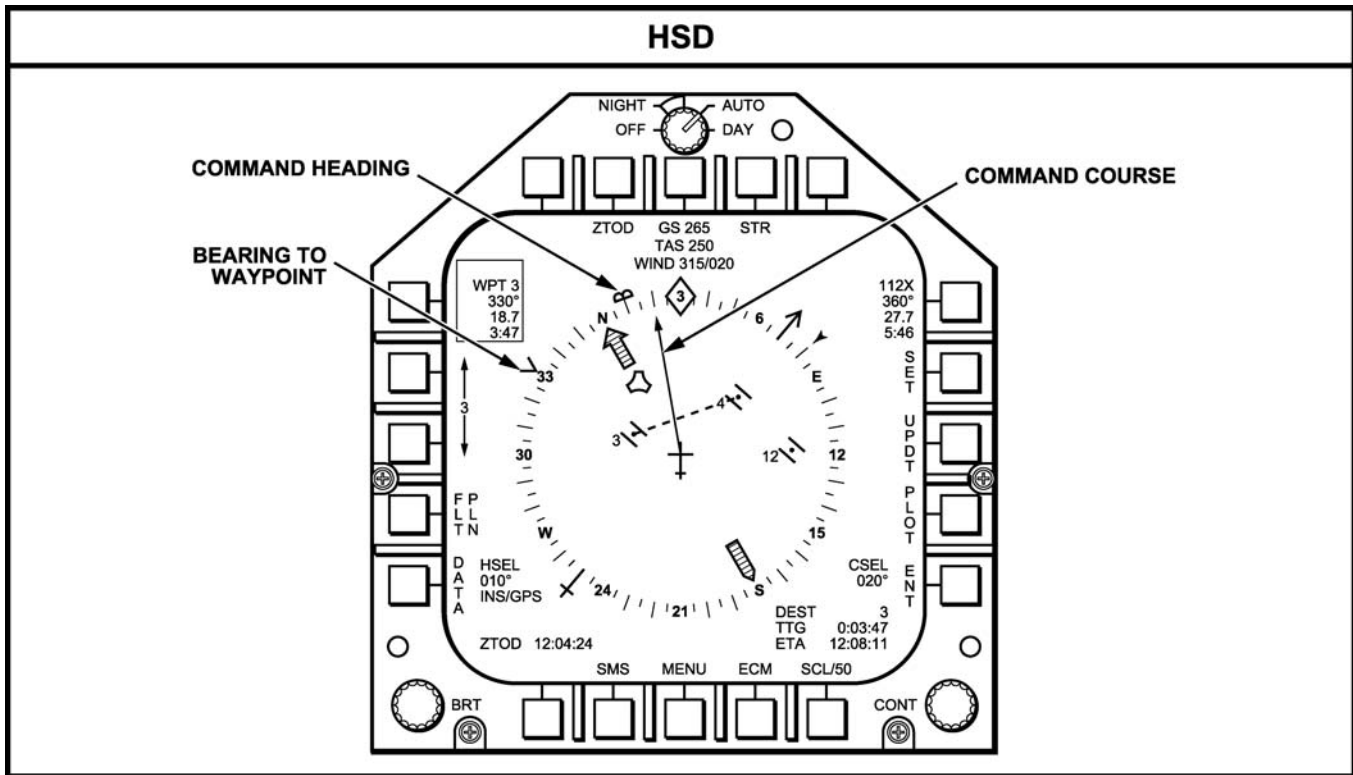
Data-link steering using the ASW-27C or URC-107 JTIDS can be performed as follows:

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.



CSC-F14D-1-20-049B

Figure 20-50. Data-Link Steering Mode Formats (Sheet 1 of 2)



CSC-F14D-1-20-050

Figure 20-50. Data-Link Steering Mode Formats (Sheet 2 of 2)

20.3.9.2.8 All-Weather Landing Steering

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 DFCS ACL function, and Chapter 17 provides ACLS description and procedures.

Note

The AWL function is not supported by the JTIDS.

20.3.9.2.9 Autopilot Steering

The mission computer provides the DFCS autopilot with a set of steering validity discrettes 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 DFCS functions.

Note

The autopilot data-link vector hold steering mode is not supported using JTIDS vector steering data.

20.3.9.2.10 No Steering Selected

Steering is turned off if STR (PB 9) on the HSD format is cycled until the steering mode buffer displays a blank, or if a boxed steering selection (other than AWL) is unboxed on the VDI format. The selected heading and course functions (HSEL and CSEL) are not operable. The HSD right hand data buffer displays TACAN information (“TO” the station). No steering is the default steering mode on aircraft power up.

20.3.9.3 Navigation System Updates

Occasionally, when GPS is unavailable, the small errors in the navigation system build up to a point that requires position updating. The following paragraphs provide a description of the procedures for performing navigation system updates.

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.

Note

Because of the high degree of accuracy available when in INS/GPS mode, one fix position updates are not available while in that mode. GPS must be unboxed to do a navigation update.

A navigation update is performed by calling up the INS UPDATE MFD format shown in [Figure 20-51](#) that will appear when the UPDT pushbutton is depressed on the HSD basic MFD format, shown [Figure 20-9](#). 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 20-51](#). 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 MFD format containing the point as shown in [Figure 20-29](#) that is available from the OWN A/C basic format. The procedures for each of the types of updates are provided below.

20.3.9.3.1 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 20-29](#)). If incorrect, enter the correct coordinates for the point via the DEU or the DD.
2. Call up the INS UPDATE MFD format, [Figure 20-51](#). 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

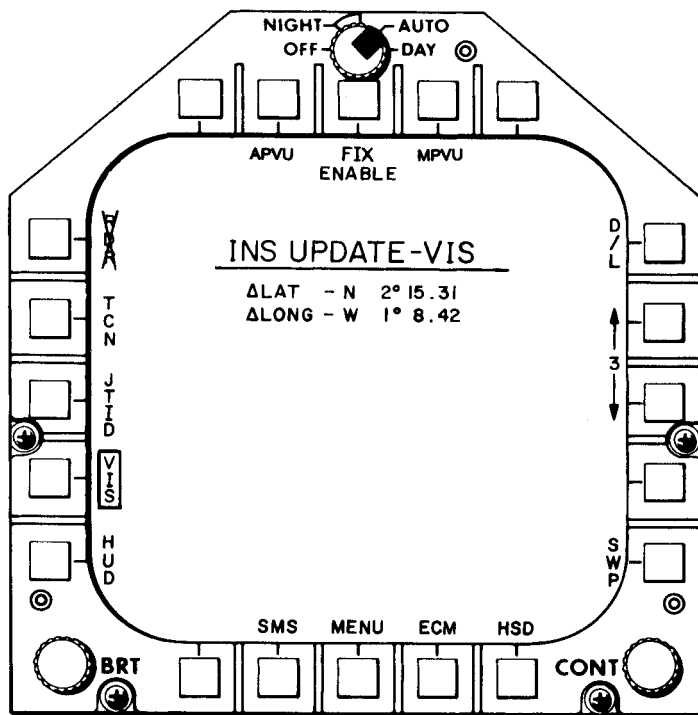
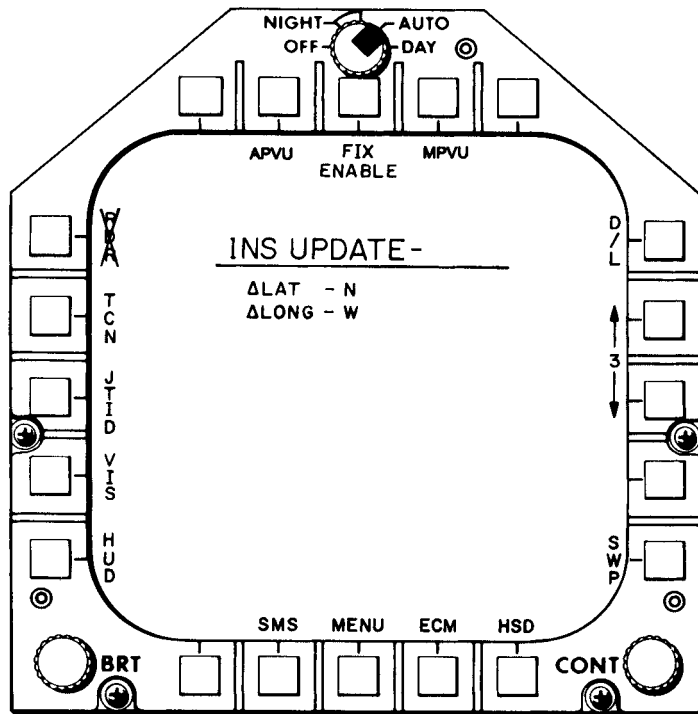
boxed at this time, and delta LAT and delta LONG will appear as shown in [Figure 20-51](#). Optimum results will be obtained with low and slow flight conditions.

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.

20.3.9.3.2 TACAN One-Fix Update

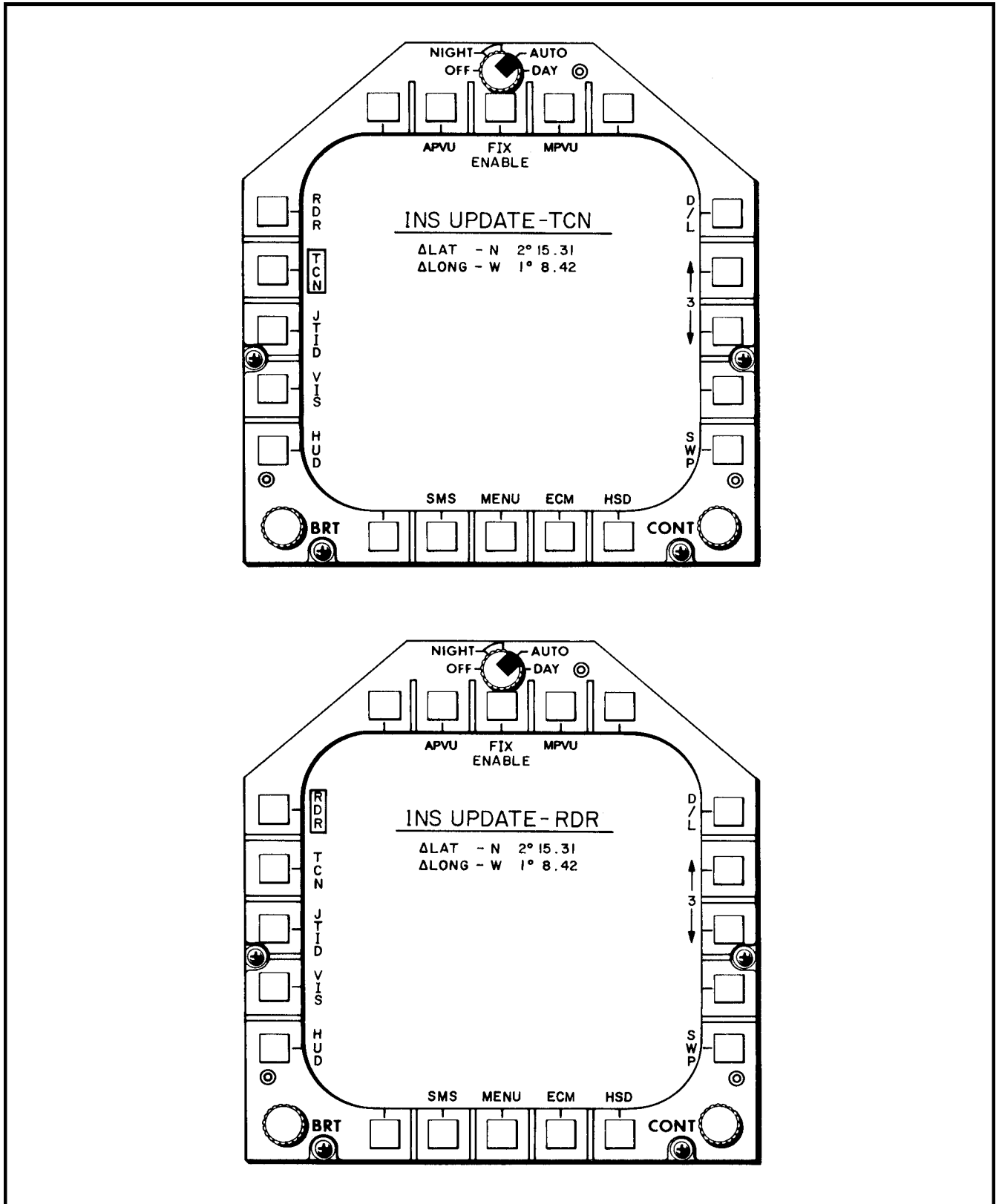
TACAN one-fix update computes aircraft position using TACAN measurements of range and bearing from a TACAN station whose coordinates are known and stored in the waypoint file. The procedure requires that the TACAN be operating and the station selected correspond to the waypoint that will be called up 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 20-29](#). If incorrect, enter the correct values via the DEU or DD.
3. Call up the INS UPDATE format, [Figure 20-51](#). 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 20-51](#).
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.



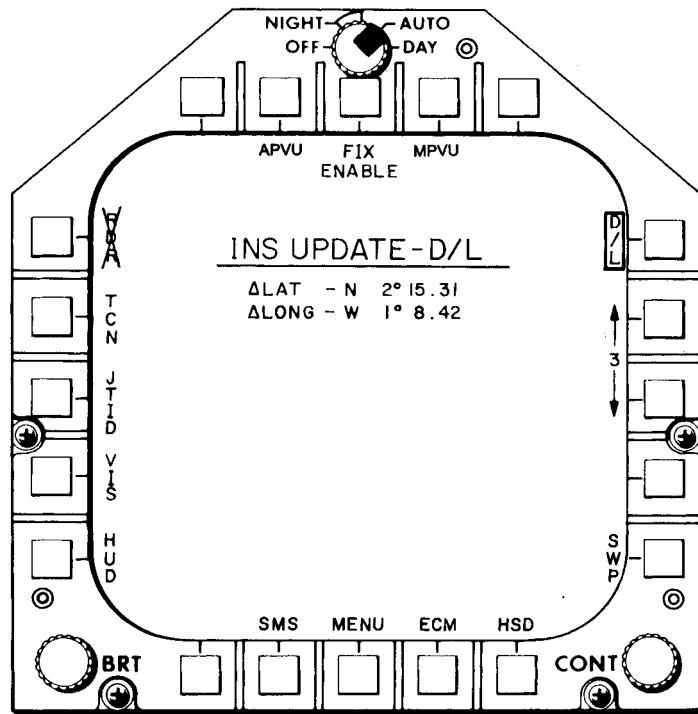
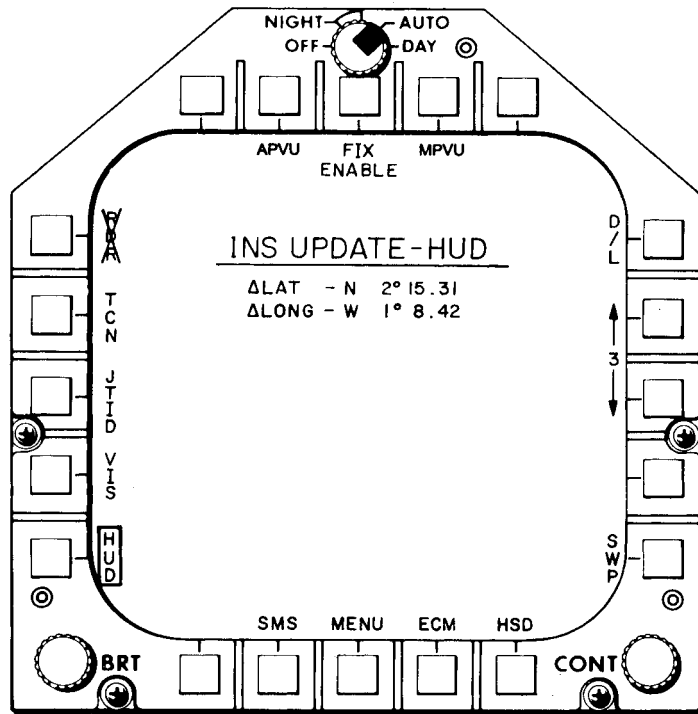
0-F50D-430-1

Figure 20-51. INS UPDATE MFD Formats (Sheet 1 of 4)



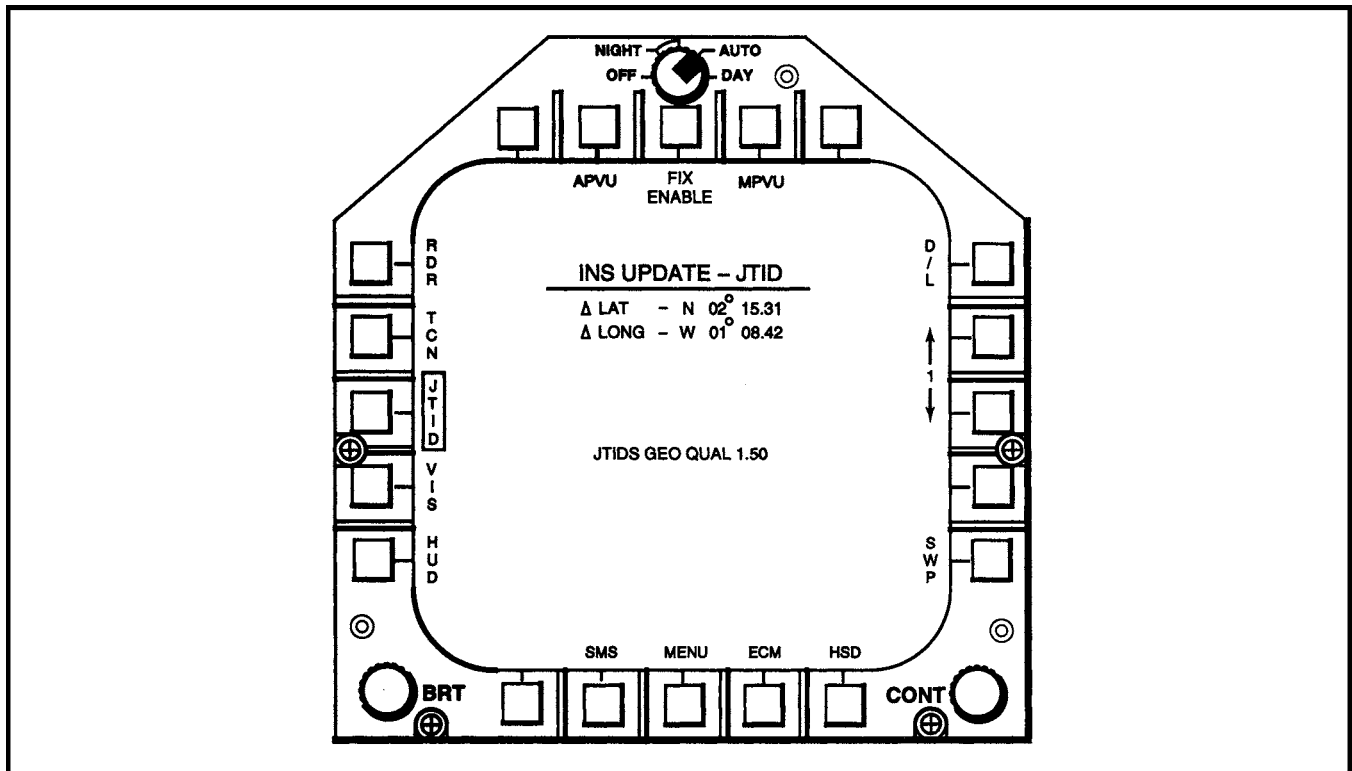
0-F50D-430-2

Figure 20-51. INS UPDATE MFD Formats (Sheet 2 of 4)



0-F50D-430-3

Figure 20-51. INS UPDATE MFD Formats (Sheet 3 of 4)



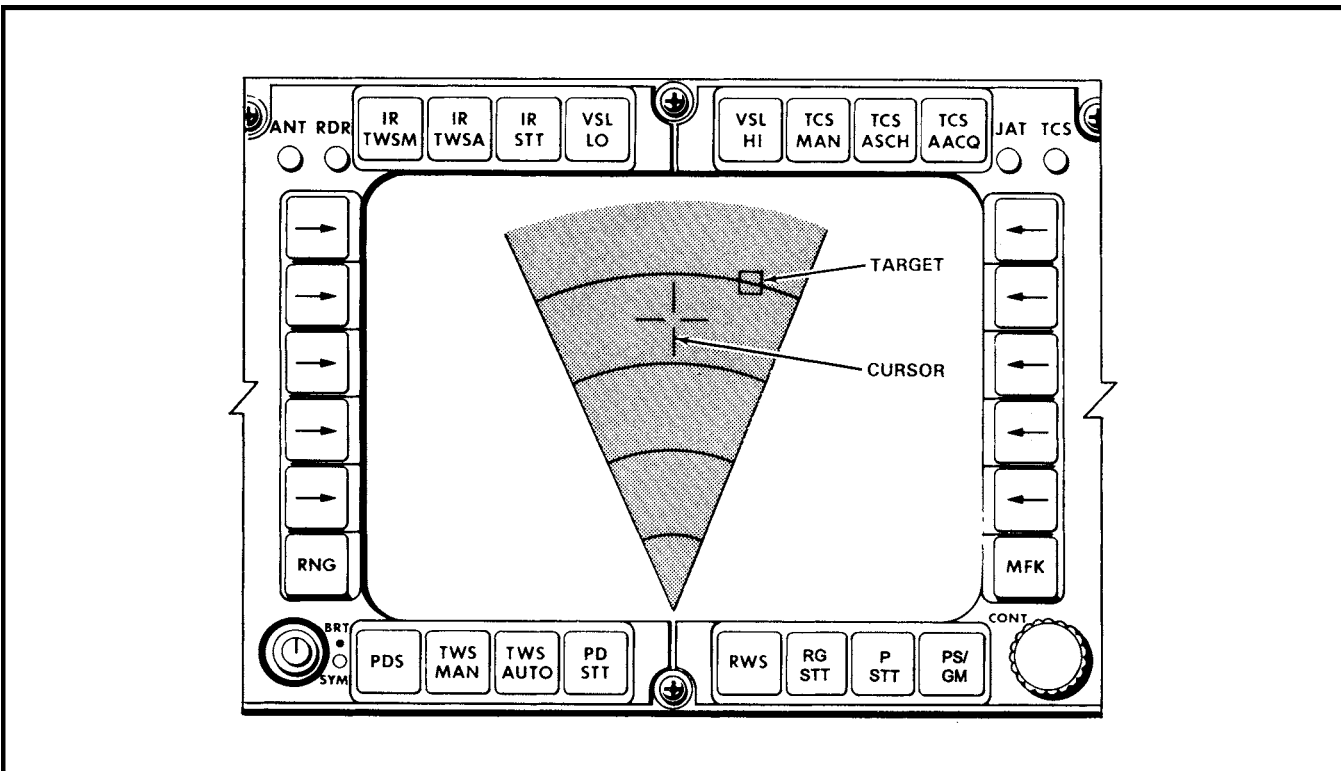
(AT)0-F50D-430-4

Figure 20-51. INS UPDATE MFD Formats (Sheet 4 of 4)

20.3.9.3.3 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 20-52](#).
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 20-29](#). If incorrect, enter the correct values via the DEU or DD.
3. Call up the INS UPDATE format, [Figure 20-51](#). 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 20-52](#)) 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 20-51](#).
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.



0-F50D-443-0

Figure 20-52. DD Control Panel With GND MAP Selected

20.3.9.3.4 Data-Link One-Fix Update

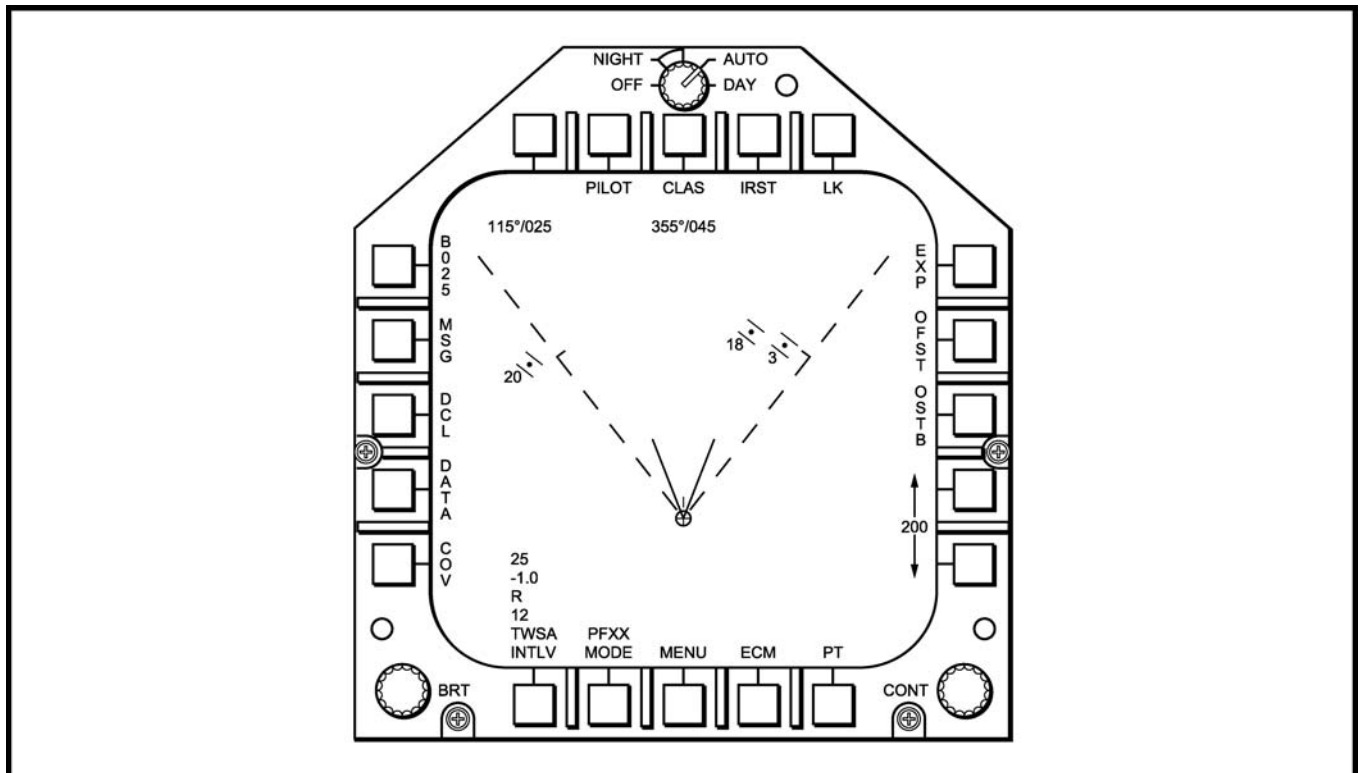
Data-link one-fix update computes aircraft position using inputs from an external platform that measures the aircraft position with respect to an agreed data-link target point whose coordinates are stored in a specific location in the waypoint file. The measured information consist of components of slant 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 20-53). 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 appropriate page of the WPT Data MFD format.
3. Call up the INS Update MFD format (Figure 20-49) and select waypoint 18 via the increase/decrease pushbuttons.
4. Call up the TSD MFD format (Figure 20-53) 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 20-51).



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Figure 20-53. MFD TSD Format

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 sensor 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.

20.3.9.3.5 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.

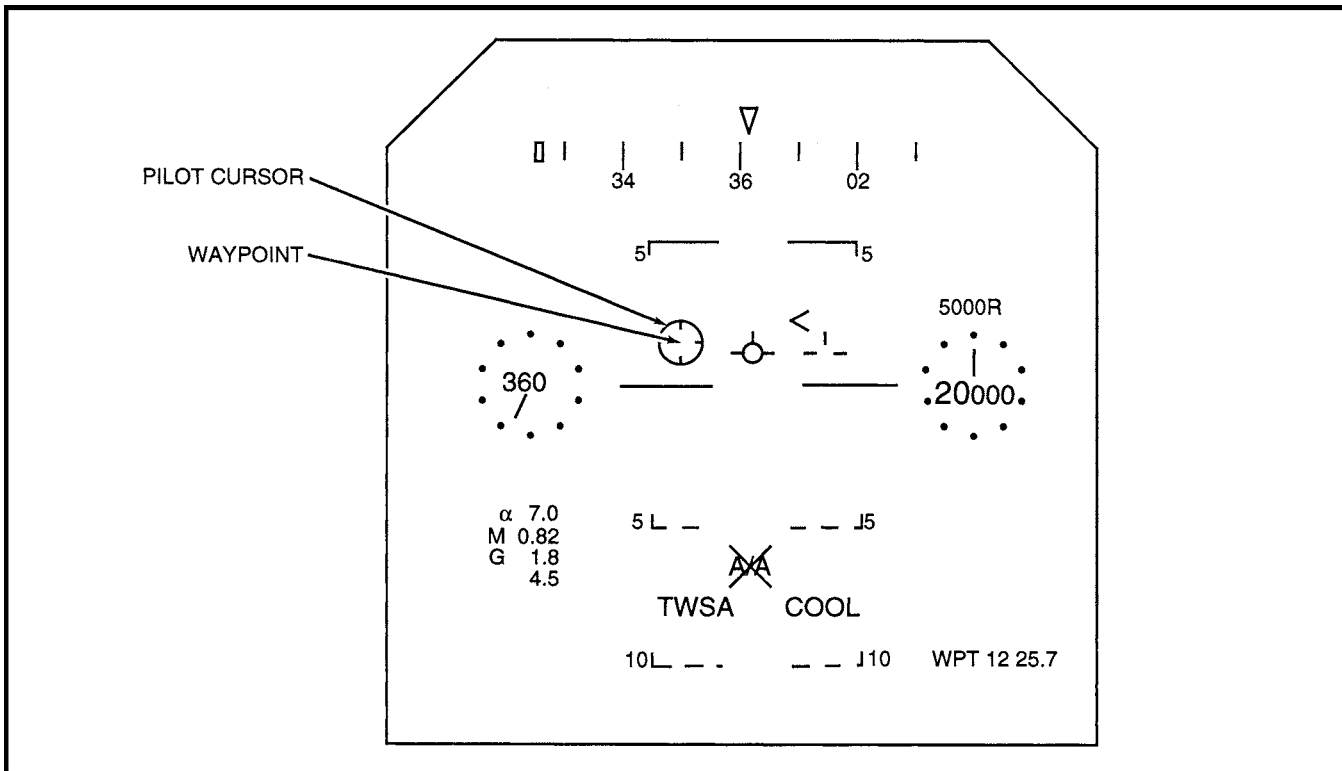
1. Verify that the coordinates of the HUD visual target are the same as those of the waypoint to be selected for updating by calling up the appropriate WPT DATA MFD format (Figure 20-29).
2. Call up the INS UPDATE MFD format (Figure 20-51). Select the waypoint corresponding

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 20-54).
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 20-51.
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.

20.3.9.3.6 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



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Figure 20-54. HUD/Designate Position Update

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 20-51) available from the MENU MFD format.
3. Depress the JTID pushbutton on the INS UP-DATE 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 20-51.

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.

20.3.9.4 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 20-55) 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 20-55](#). Depression of the ENABLE pushbutton on the top center of the 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 20-55](#)) 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 20.3.9.3.2. 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.

20.3.9.5 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 PTID. 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 20-56](#)), 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 20-56](#) displays only the mode legends, the boxed SWP legend, and the SURFACE WPT POS header.

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 pushbutton. When using the PTID method, pressing the sensor hand control trigger enters the coordinates that are displayed on the MFD.

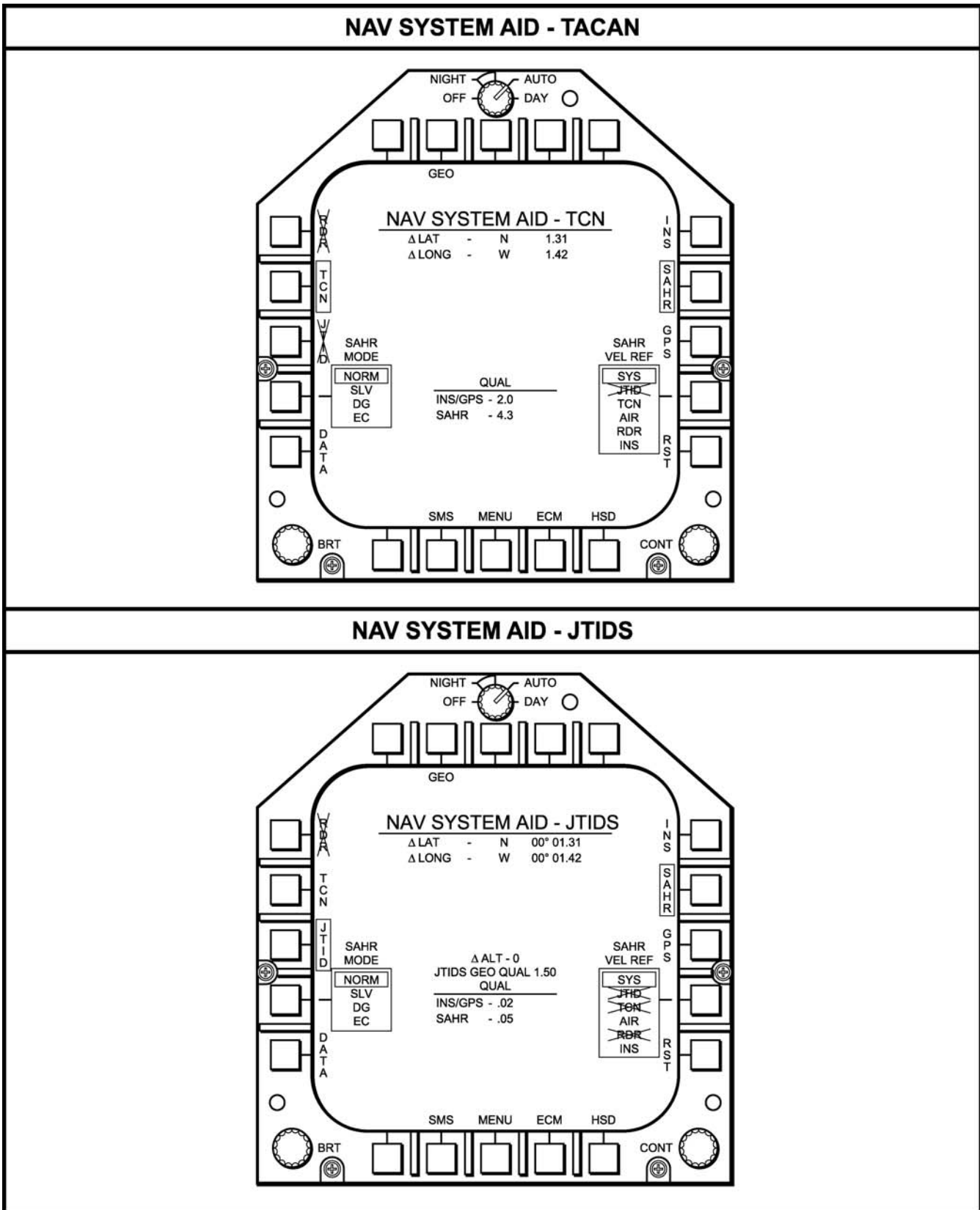
The paragraphs that follow describe the various methods and provide procedures.

20.3.9.5.1 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.

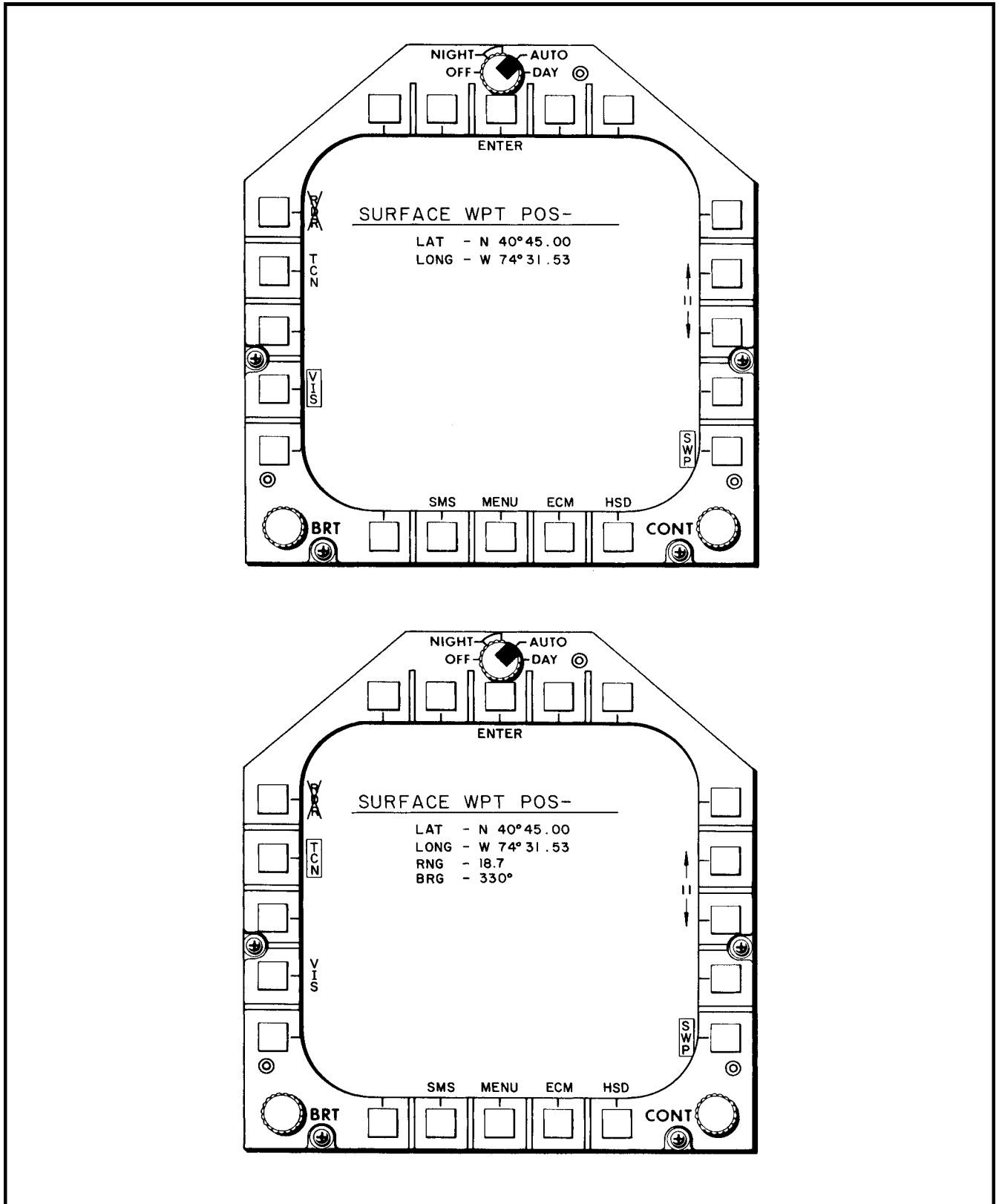
Note

- Visual mode is inoperable with GPS boxed.
 - For best results, the aircraft should be flown low and slow for this procedure.
1. Call up the MFD INS UPDATE format ([Figure 20-51](#)).
 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 push-button, 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 20-29](#)).



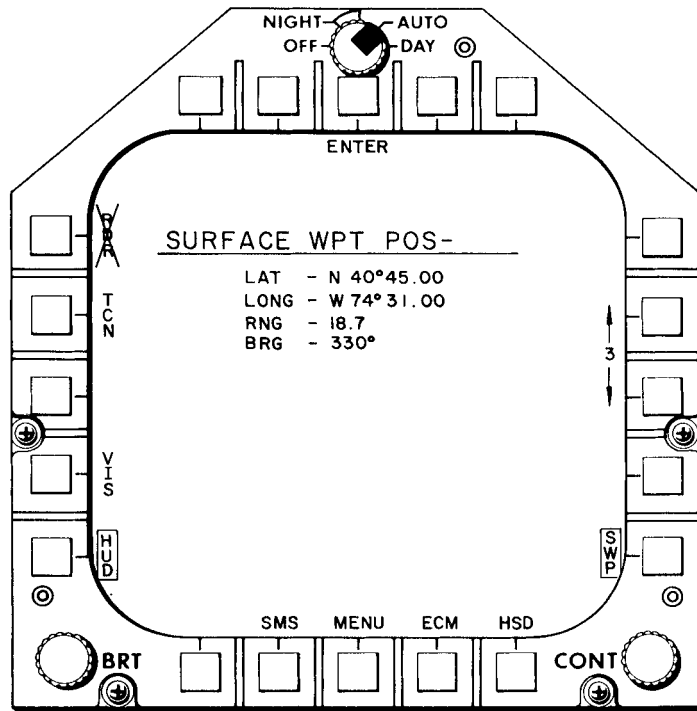
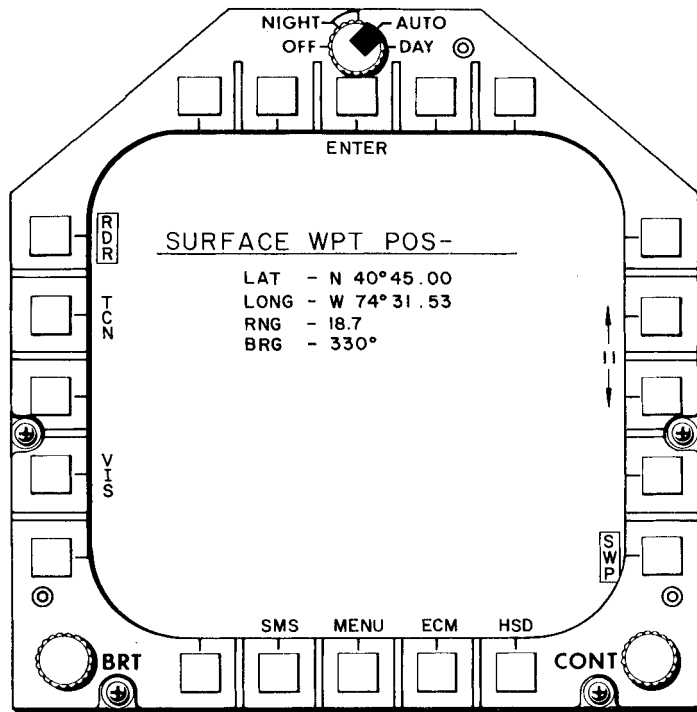
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Figure 20-55. Navigation System Continuous Update MFD Format



0-F50D-432-1

Figure 20-56. Surface Waypoint Position MFD Formats (Sheet 1 of 2)



0-F50D-432-2L

Figure 20-56. Surface Waypoint Position MFD Formats (Sheet 2 of 2)

20.3.9.5.2 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 20-51).
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 20-29).

20.3.9.5.3 Radar Mode

For a radar surface way-point 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 20-51).
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 20-57).

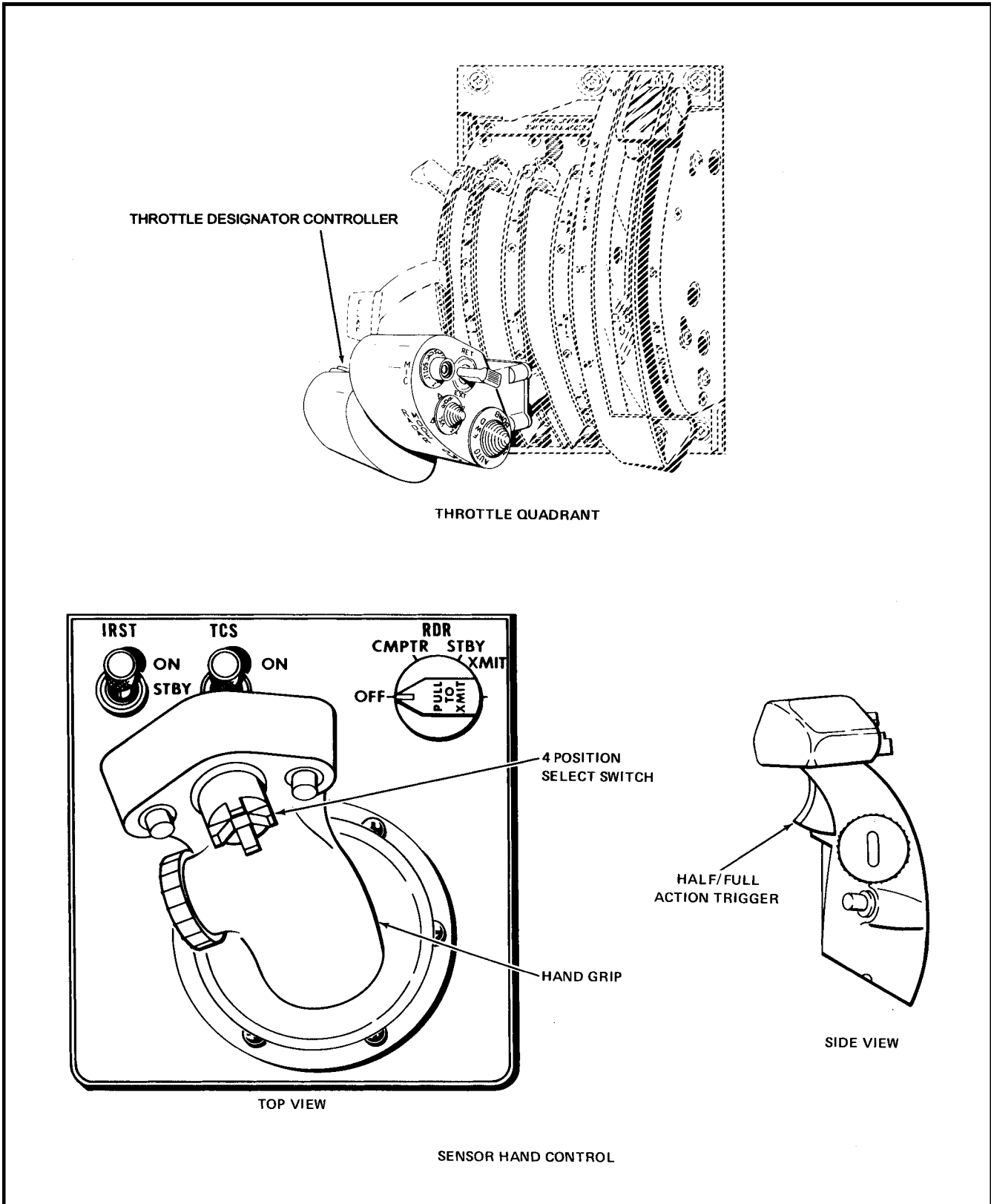
Select the half-action mode by depressing the trigger on the RIO sensor hand control to the first detent position.

6. 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).
7. Depress the RDR pushbutton on the SURFACE WPT POS format to display the waypoint latitude and longitude and box the RDR legend.
8. 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.

20.3.9.5.4 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 20-51).
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 TDC (Figure 20-57), 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.



0-F50D-347-0

Figure 20-57. Cursor Controls

20.3.9.5.5 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 20-28).

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 pushbutton and select a waypoint number for the new waypoint.
4. Press the ENTER pushbutton 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.

20.3.9.5.6 PTID Spot Hook Mode

In the spot hook mode, coordinates are computed for a point designated by the RIO by spot hooking on the PTID based on aircraft present position.

1. Set the sensor hand control cursor select switch to the down (PTID cursor) position.
2. On the PTID control panel (FO-4), depress the NON ATTK and SYM ELEM pushbuttons.
3. Set the azimuth scan to $\pm 20^\circ$ 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 PTID 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 PTID 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.

The coordinates of the hooked position can be verified by calling the WPT DATA format.

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 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.



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

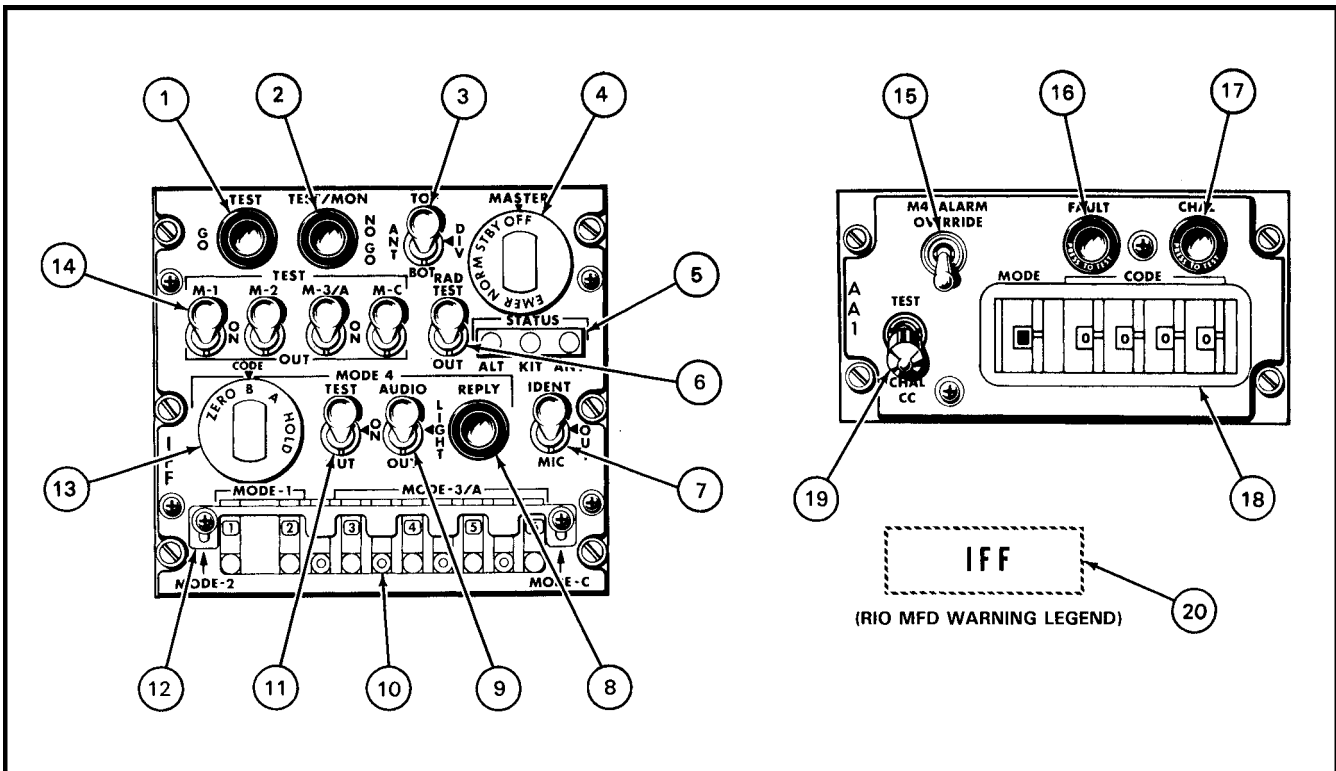
The IDENT-OUT-MIC switch is a three-position toggle switch. The spring-loaded IDENT adds an identification of position pulse to mode 1, 2, and 3/A replies for a period of 15 to 30 seconds. In MIC, the identification of position function is activated for 15 to 30 seconds each time the UHF microphone switch 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.



0-F50D-40-0

NOMENCLATURE	FUNCTION
<p>① TEST light (GO)</p>	<p>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.</p>
<p>② TEST/MON light (NO GO)</p>	<p>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.</p>
<p>③ ANT switch</p>	<p>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.</p>
<p>④ MASTER switch</p>	<p>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.</p>

Figure 21-1. IFF Control Panels (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
<p>5 STATUS lights (red)</p>	<p>ALT — Illumination indicates altitude encoder circuit failure during MODE C test.</p>
	<p>KIT — Illumination indicates KIT/KIR TSEC failure during MODE 4 test.</p>
	<p>ANT — Illumination indicates excessive voltage standard wave ratio (VSWR) to antenna during MODE C or MODE 4 tests.</p>
<p>6 RAD switch</p>	<p>OUT — Deenergized position.</p>
	<p>TEST — When selected, transponder replies to mode 3/A or 4 TEST mode interrogations from a ramp test set during ground maintenance testing.</p>
<p>7 IDENT — OUT — MIC switch</p>	<p>IDENT — Momentary position provides IDENT reply for 15 to 30 seconds after releasing switch; replies to interrogation in modes 1, 2, 3/A.</p>
	<p>OUT — Deenergizes circuit.</p>
	<p>MIC — Transfers IDENT reply activation switch from IDENT to radio microphone switch</p>
<p>8 MODE 4 REPLY light</p>	<p>Illuminates when system has successfully replied to a mode 4 interrogation provided the AUDIO/LIGHT/OUT switch is not in the OUT position.</p>
<p>9 MODE 4 AUDIO/ LIGHT/ OUT switch</p>	<p>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.</p>
	<p>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.</p>
	<p>OUT — Disables all ICS tone and light monitoring of mode 4 interrogations, replies, and nonreplies.</p>
<p>10 CODE selectors (MODE 1 and 3/A)</p>	<p>Code selectors are rotatable drums with imprinted numbers that appear in code selector windows, permitting selection of codes for mode 1 and 3/A.</p>
<p>11 MODE 4 switch</p>	<p>ON — Enables mode 4. See Figure 21-2 for mode 4 caution/reply light logic.</p>
	<p>TEST — Activates KIT mode 4 computer self-test. TEST GO light illuminates if system is 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.</p>

Figure 21-1. IFF Control Panels (Sheet 2 of 3)

NOMENCLATURE	FUNCTION
<p>⑫ MODE 2</p>	<p>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.</p>
<p>⑬ MODE 4 CODE switch</p>	<p>ZERO — Erases code 4 from KIR-1A and KIT-1A computers. IFF ZERO advisory legend appears on upper left of RIO's MFD.</p> <p>B — Selects KIT-1A computer B code.</p> <p>A — Selects KIT-1A computer A code.</p> <p>HOLD — Retains code in KIR-1A computers when landing gear is down or when system is turned off.</p>
<p>⑭ MODE switches (1,2, 3/A, and C)</p>	<p>TEST — GO TEST light illuminates if system is functioning properly; NO GO TEST light illuminates if system failure.</p> <p>ON — Permits selection of interrogating modes to which the transponder will reply.</p> <p>OUT — Deenergized position.</p>
<p>⑮ M4 ALARM OVER-RIDE switch</p>	<p>Disables the mode 4 tone alarm to the RIO's ICS.</p>
<p>⑯ FAULT light</p>	<p>Indicates a malfunction of APX-76 receiver-transmitter, caused by receiver, video, or transmitter signals.</p>
<p>⑰ CHAL light</p>	<p>Remains illuminated for the duration of a challenge period indicating correct operation.</p>
<p>⑱ CODE selectors</p>	<p>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.</p>
<p>⑲ TEST-CHAL CC switch</p>	<p>Momentary two-position center-return switch.</p> <p>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.</p> <p>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).</p>
<p>⑳ IFF warning legend</p>	<p>Indicates mode 4 interrogation was received, but system has not generated a reply; mode 4 KIT/KIR computers have been zeroized; or KIT/KIR has failed self-test.</p>

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 programmable tactical information display (PTID). The IFF transponder is also continuously checked by aircraft self-test. Failure causes the IFX acronym to be shown on the PTID. 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 springloaded 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](#).)

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 Classified NATOPS Supplement.

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 is displayed in a B-scan format without radar video. [Figure 21-3](#) shows IFF display formats.

The synchronizer also sends a mode 4 pretrigger to the interrogator computer.

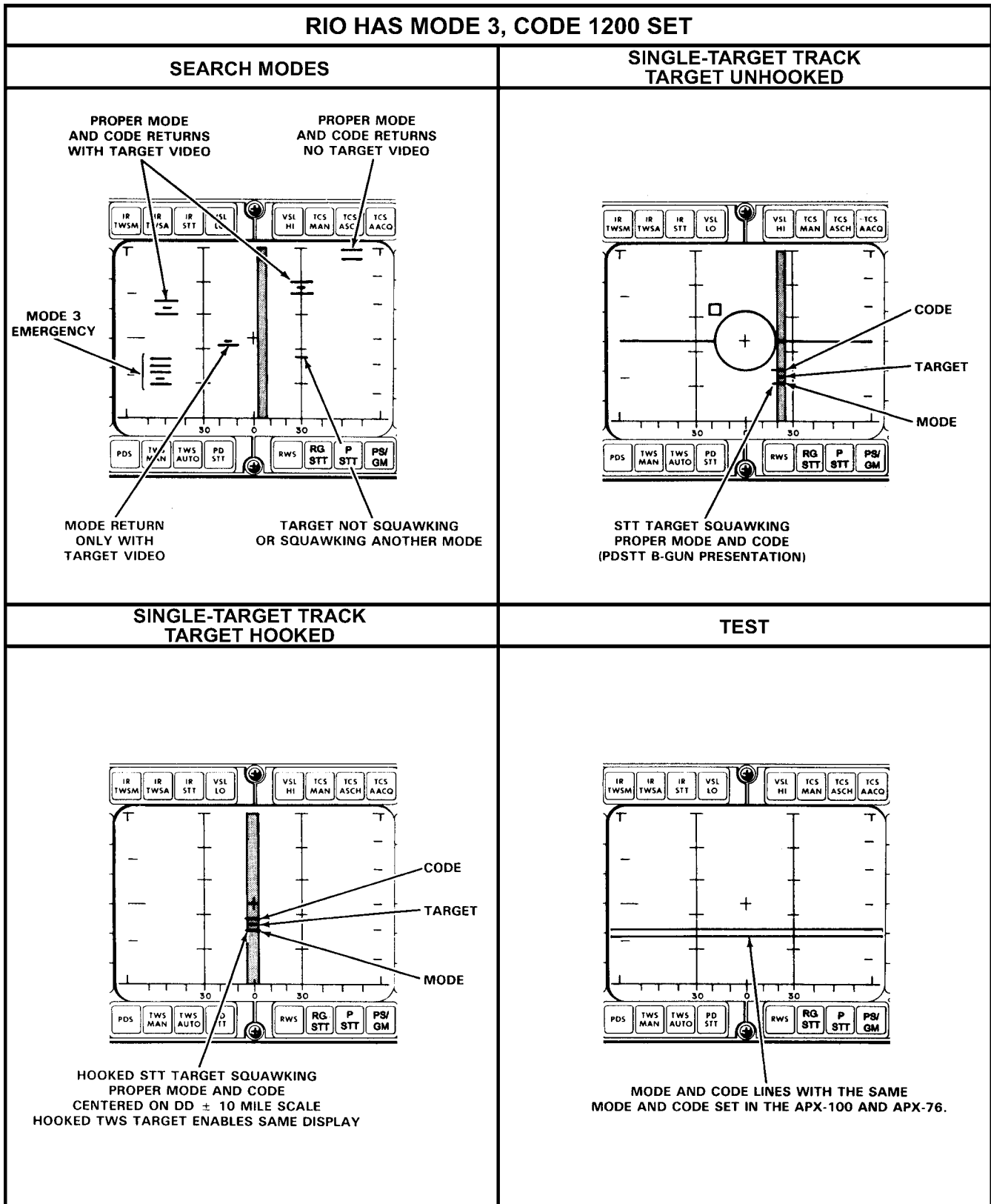
The interrogator computer generates mode 4 interrogations and interpolates mode 4 replies. Display of mode 4 is the same as all other modes. The mode 4 codes are prevented from zeroing when the RDR power switch is cycled.

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. [Figure 21-3](#) shows the correct IFF self-test display format. 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 PTID 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.



0-F50D-250-0

Figure 21-3. IFF Display Formats

PART VIII

Weapon Systems

Chapter 22 — TARPS Subsystem

Chapter 23 — Navigation Command and Control Grid

The following chapters are to be found in NAVAIR 01-F14AAD-1A:

Chapter 24 — F14D Weapon System

Chapter 25 — Weapon System Controls and Displays

Chapter 26 — AN/APG-71 Radar System

Chapter 27 — AN/AAS-42 Infrared Search and Track System

Chapter 28 — AN/AXX-1 Television Camera Set

Chapter 29 — Integrated Sensor Operation

Chapter 30 — Stores Management System

Chapter 31 — Air-to-Air Weapons

Chapter 32 — Air-to-Ground Weapons

Chapter 33 — LANTIRN Targeting System

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); and low- to medium-altitude panoramic camera (KA-99), or long-range standoff frame camera (KS-153A with 24-inch lens).

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 or standoff frame camera

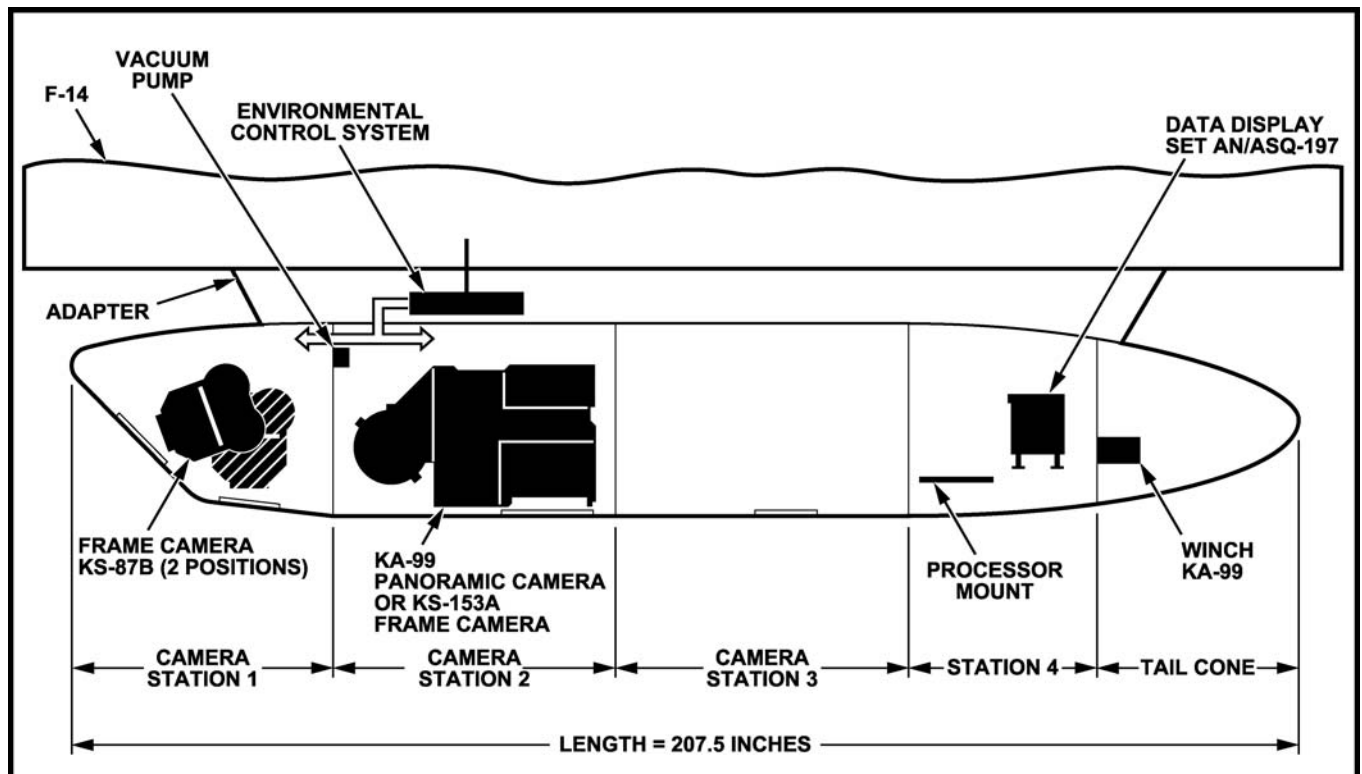


Figure 22-1. Tactical Air Reconnaissance Pod System

4. Data display system
5. TARPS environmental control system
6. 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 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.

22.1.5 TARPS Environmental Control System

The ECS supplies conditioned air for pod cooling and heating and for defogging the camera windows.

22.1.6 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:

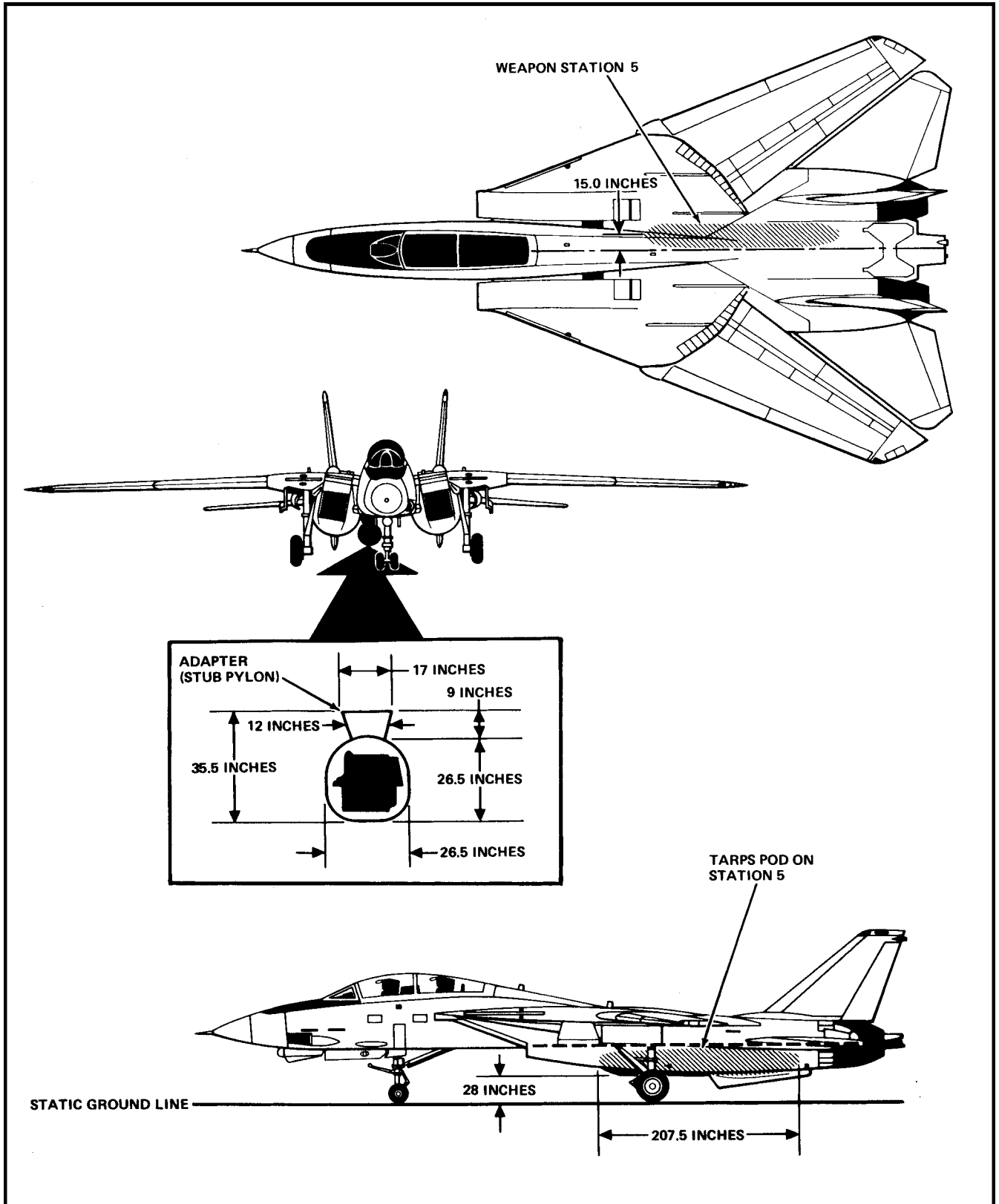
1. Selection of waypoint to be reconnoitered and steering mode (point-to-point, command course, or mapping) to be employed.
2. Display of reconnaissance steering cues and camera status the HUD when valid steering is selected and the aircraft is not in A/A with a weapon selected.
3. Display of reconnaissance 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.
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:

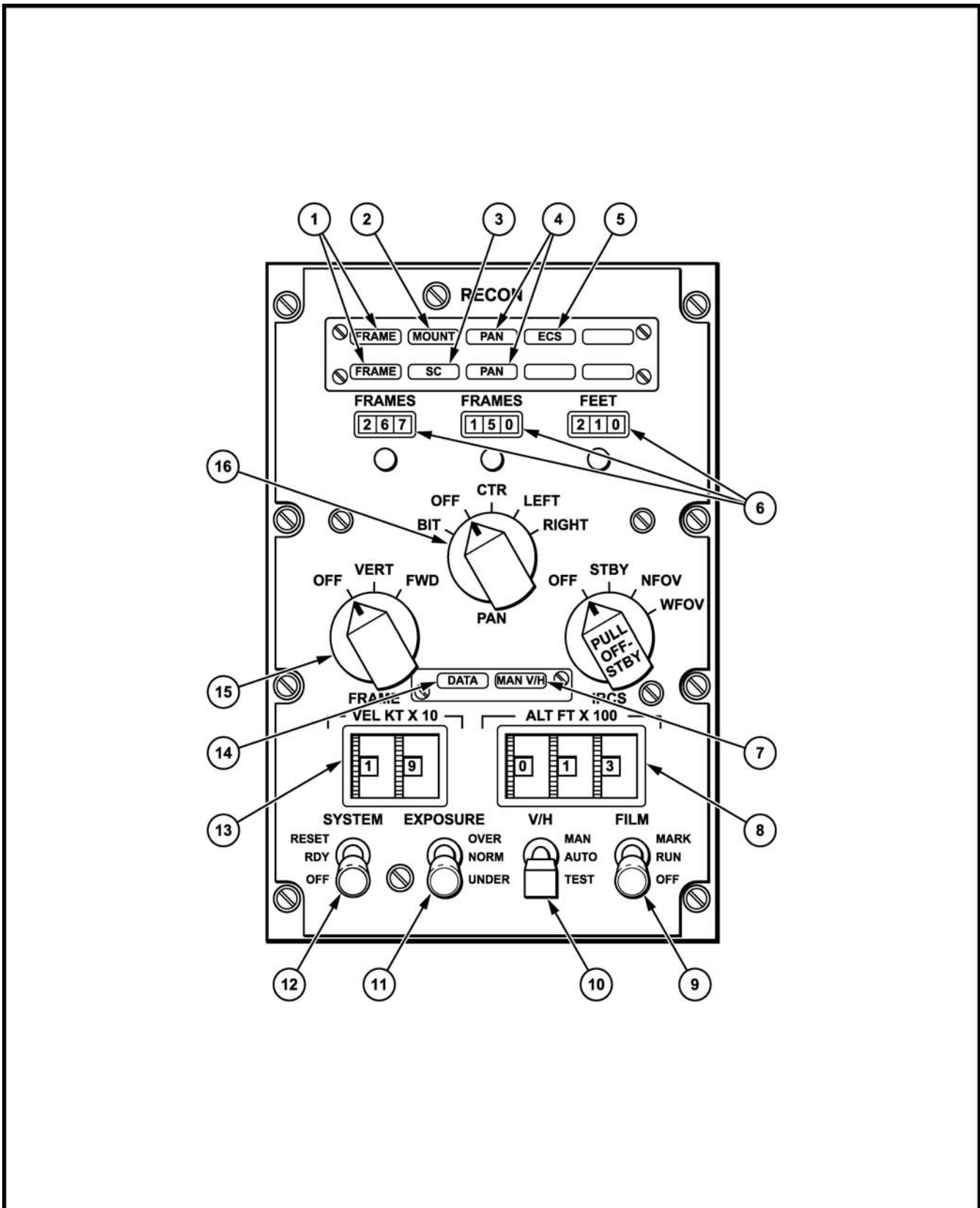
	CARD
RECON POD	1E2
RECON CONTR/LANTIRN POD PWR	9E2
RECON POD DC PWR NO. 1	9E4
RECON POD DC PWR NO. 2	9E3
RECON HTR/LANTIRN PWR 3 PH	2C3
RECON ECS CONT AC	2G4
RECON ECS/LANTRIN POD CONT	9E1

Refer to Chapter 2 for an alphanumeric listing of circuit breakers.



0-F50D-264-0

Figure 22-2. TARPS Component Locations



CSC-F14D-1-22-006

Figure 22-3. Controller Processor Signal Unit (Sheet 1 of 5)

NOMENCLATURE	FUNCTION
<p>① FRAME lights</p> <ul style="list-style-type: none"> • Amber • Green 	<p>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.</p>
<p>② MOUNT light</p> <ul style="list-style-type: none"> • Amber 	<p>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.</p>
<p>③ SC (Sensor Control) light</p> <ul style="list-style-type: none"> • Amber 	<p>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.</p>
<p>④ PAN lights</p> <ul style="list-style-type: none"> • Amber • Green 	<p>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.</p>
<p>⑤ ECS (Environmental Control System) light</p> <ul style="list-style-type: none"> • Amber 	<p>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.</p>
<p>⑥ Frames and feet (indicators)</p>	<p>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.</p>
<p>⑦ MAN V/H light</p> <ul style="list-style-type: none"> • Amber 	<p>OFF – Vg/H from aircraft computer within acceptable limits.</p> <p>ON – Illuminated amber:</p> <p>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.</p> <p>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.</p> <p>If negative AGL or computed Vg/H = 0, MAN Vg/H is being used. Set corrected values of Vg/H in thumbwheels.</p> <p>V/H switch in MAN. Manual V/H intentionally selected. Values set in thumbwheels being used. Set correct values in thumbwheels.</p> <ul style="list-style-type: none"> • A TARPS advisory will appear on the Reconnaissance MFD CAWS window when MAN V/H is selected (Figure 24-7). In addition, a TARP1 is generated on the OBC Basic Display and Maintenance Failure Format (Figure 24-8). • If negative AGL or Vg/H = 0, and the TARPS pod is not on the aircraft, there is no MAN Vg/H advisory.

Figure 22-3. Controller Processor Signal Unit (Sheet 2 of 5)

NOMENCLATURE	FUNCTION
<p>8 ALT FT × 100</p>	<p>Used to set manual altitude inputs to pod. Counter range is from 000 to 999, read in multiples of 100 feet.</p>
<p>9 FILM switch</p>	<p>MARK — (momentary position) Allows RIO to mark special interest frame with * in data block.</p> <p>RUN — Activates selected sensor when SYSTEM switch is set to RDY.</p> <p>OFF — Terminates TARPS sensor operation.</p>
<p>10 V/H selector switch</p>	<p>MAN — Selects manual thumbwheel inputs. (TARPS advisory appears on MFD CAWS Figure 24-7. TARP1 appears on OBC Basic Display and Maintenance Failure Format Figure 24-8).</p> <p>AUTO — Selects aircraft computer value of Motion Compensation Factor (MCF).</p> <p>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.</p>
<p>11 EXPOSURE selector switch</p>	<p>UNDER — -1 f-stop exposure for doubled SC film setting.</p> <p>NORM — Normal exposure for doubled SC film setting.</p> <p>OVER — +1 f-stop for doubled SC film setting.</p>
<p>12 SYSTEM switch</p>	<p>OFF — Aircraft power denied to TARPS. No sensors can be operated.</p> <p>RDY — Aircraft power available at sensor connectors. If respective sensor moved from OFF position, sensor is placed in standby or ready mode.</p> <p>RESET — Clears TARPS failure signal. If failure is other than transient, TARPS advisory remains.</p>

Figure 22-3. Controller Processor Signal Unit (Sheet 3 of 5)

NOMENCLATURE	FUNCTION
<p>13 VEL KT × 10 thumbwheels</p>	<p>Use to set manual ground speed inputs to pod. Counter range is from 00 to 99, read in multiples of 10 knots.</p>
<p>14 DATA light</p>	<p>OFF — Data received from computer ON -Data from aircraft computer failed (via CPS DATA FAIL discrete).</p> <p style="text-align: center;">Note</p> <p>A TARPS advisory will appear on the Reconnaissance MFD CAWS window (Figure 24-7) when MAN V/H is selected. In addition, a TARP1 and TARP2 are generated on the OBC Basic Display and Maintenance Format. (Figure 24-8).</p>
<p>15 FRAME camera switch</p>	<p>OFF — Frame camera is shut off.</p> <p>VERT — SYSTEM switch is RDY. Power applied to frame camera. Mount placed in vertical position. When FILM switch in RUN, camera is cycling.</p> <p>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.</p> <p style="text-align: center;">Note</p> <p>Requires approximately 15 seconds to transition between FWD and VERT (The amber mount light illuminates if transition not completed in 23 seconds.)</p>

Figure 22-3. Controller Processor Signal Unit (Sheet 4 of 5)

NOMENCLATURE	FUNCTION
<p>16 PAN camera switch</p>	<p>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.</p> <div style="text-align: center; border: 2px dashed black; padding: 5px; width: fit-content; margin: 10px auto;"> <p>CAUTION</p> </div> <p>Do not run PAN BIT check. (May cause the film to jam)</p> <p>OFF — Pan camera is shut off.</p> <p>CTR — SYSTEM switch in RDY. Pan camera enabled. Awaiting operate command.</p> <p>FILM switch to RUN; pan camera cycling. Exposure, average of left and right light sensors. Camera set for 55% overlap at NADIR.</p> <p>KS-153A/24 inch: selects 21.4 degree scan centered on NADIR.</p> <p>LEFT — SYSTEM switch in RDY. Pan camera enabled. Awaiting operate command.</p> <p>FILM switch to RUN; pan camera cycling. Exposure controlled by left light sensor. Camera set for 55% overlap at 30° below left horizon.</p> <p>KS-153A/24 inch: selects 21.4 degree scan centered on one of the preset depression angles.</p> <p>To prevent interference in coverage by the external fuel tanks the following preset value is recommended: 27° depression angle.</p> <p>RIGHT — SYSTEM switch in RDY. Pan camera enabled. Awaiting operate command.</p> <p>FILM switch in RUN; pan camera cycling. Exposure controlled by right light sensor. Camera set for 55% overlap at 30° below right horizon.</p> <p>KS-153A/24 inch: selects 21.4 degree scan centered on one of the preset depression angles.</p> <p>To prevent interference in coverage by the external fuel tanks the following preset value is recommended: 31° depression angle.</p> <p style="text-align: center;">Note</p> <p>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.</p>

Figure 22-3. Controller Processor Signal Unit (Sheet 5 of 5)

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 programmable 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 pushbutton 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 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

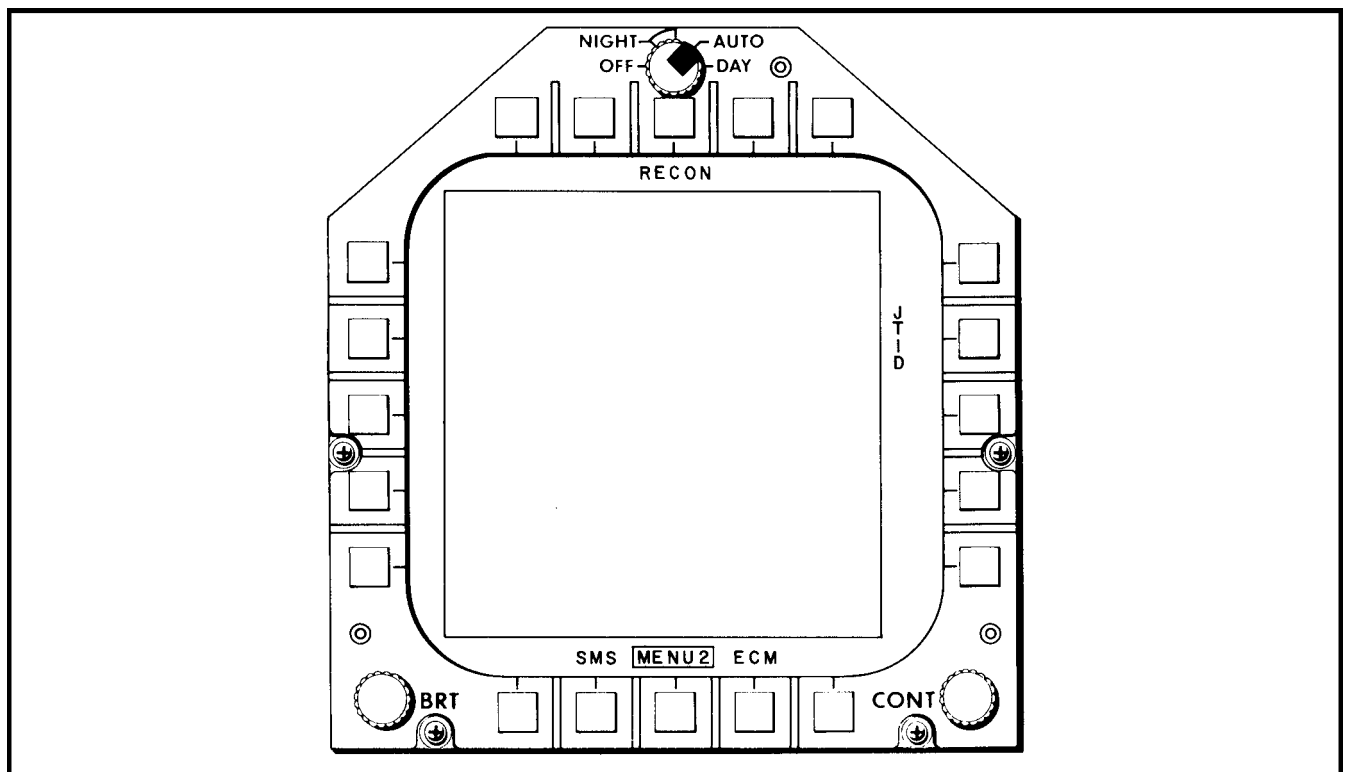
The mission computer will report the following advisories on the MFD (Figure 22-6):

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.

Note

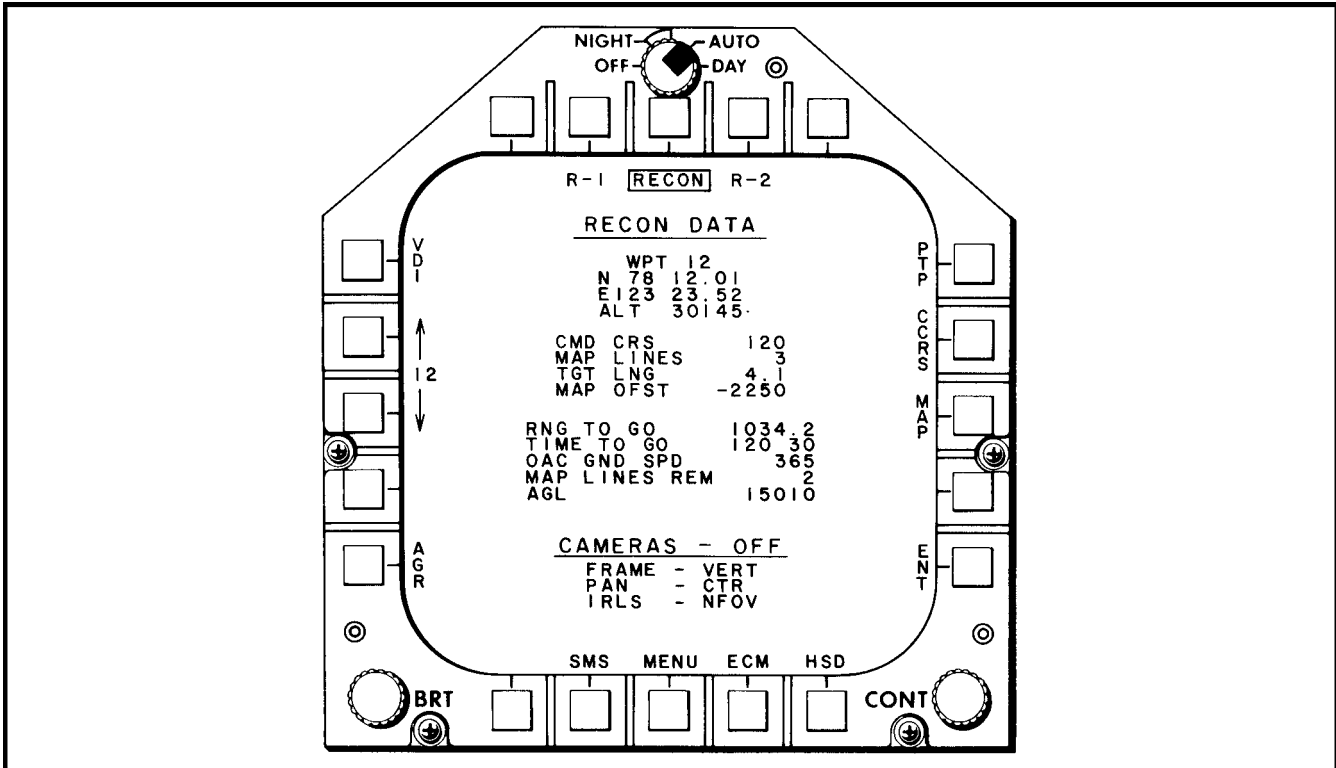
A crew alert is generated from the CPS when any of the following conditions occur:

- a. Sensor failure (includes serial frame camera mount position).
- b. ECS failure.
- c. SC/DDS failure.



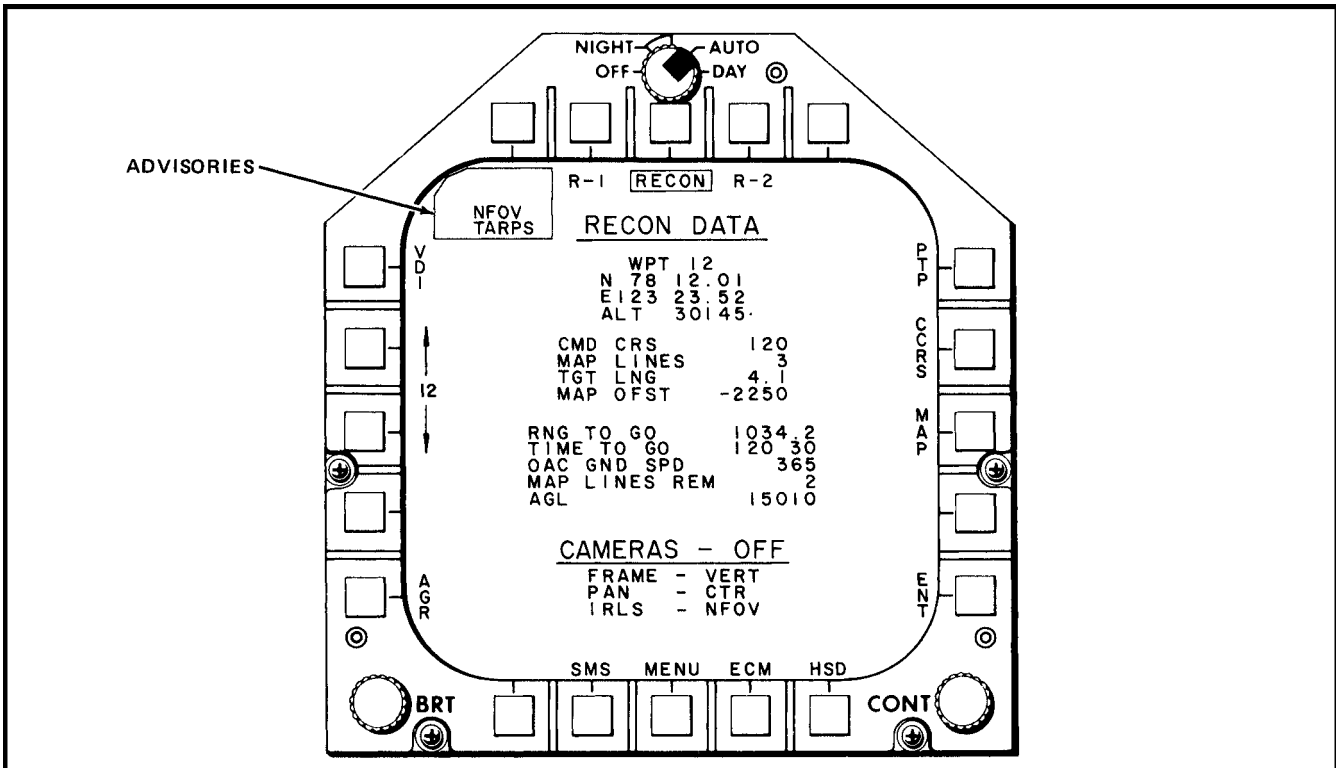
0-F50D-306-0

Figure 22-4. MFD MENU2 Format



0-F50D-307-0

Figure 22-5. MFD RECON DATA Status Format



0-F50D-453-0

Figure 22-6. TARPS Advisories

- 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).

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.

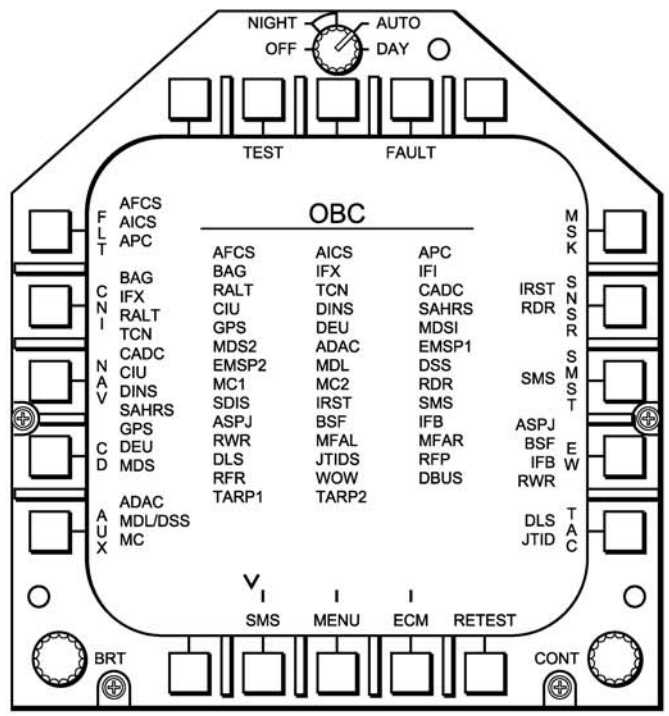
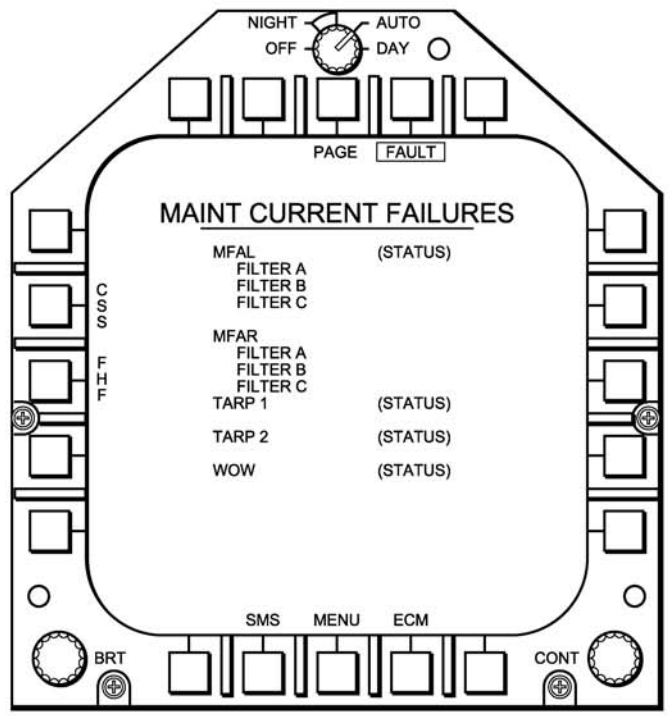


Figure 22-7. MFD OBC/Maintenance Failure Formats

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.
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 (Figure 22-8 and Figure 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 Figure 22-8, Figure 22-9, and Figure 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 (Figure 22-11 and Figure 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.

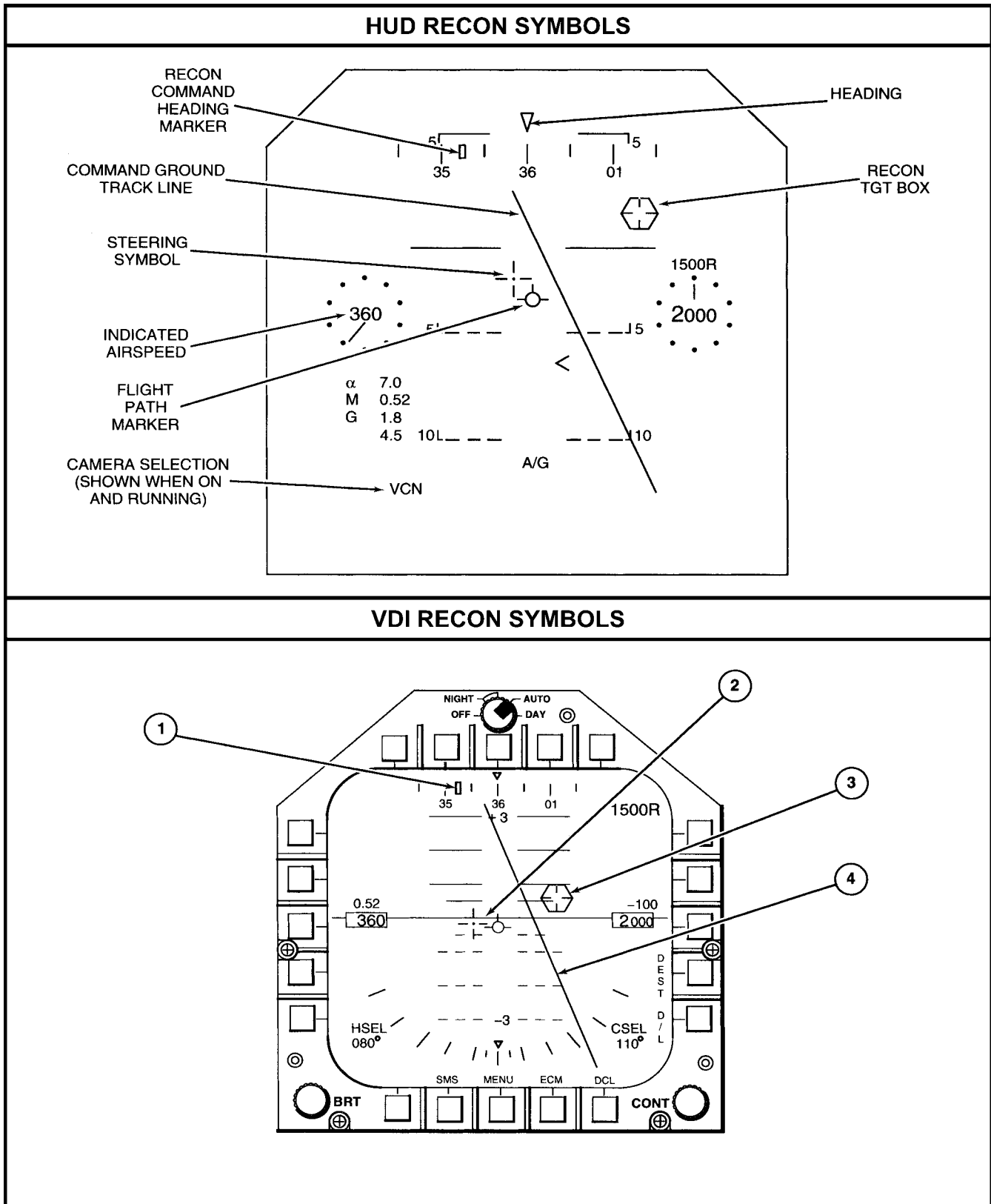
Note

- 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 RE-CON WPT DATA 2 formats (Figure 22-12). MFD RE-CON 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).

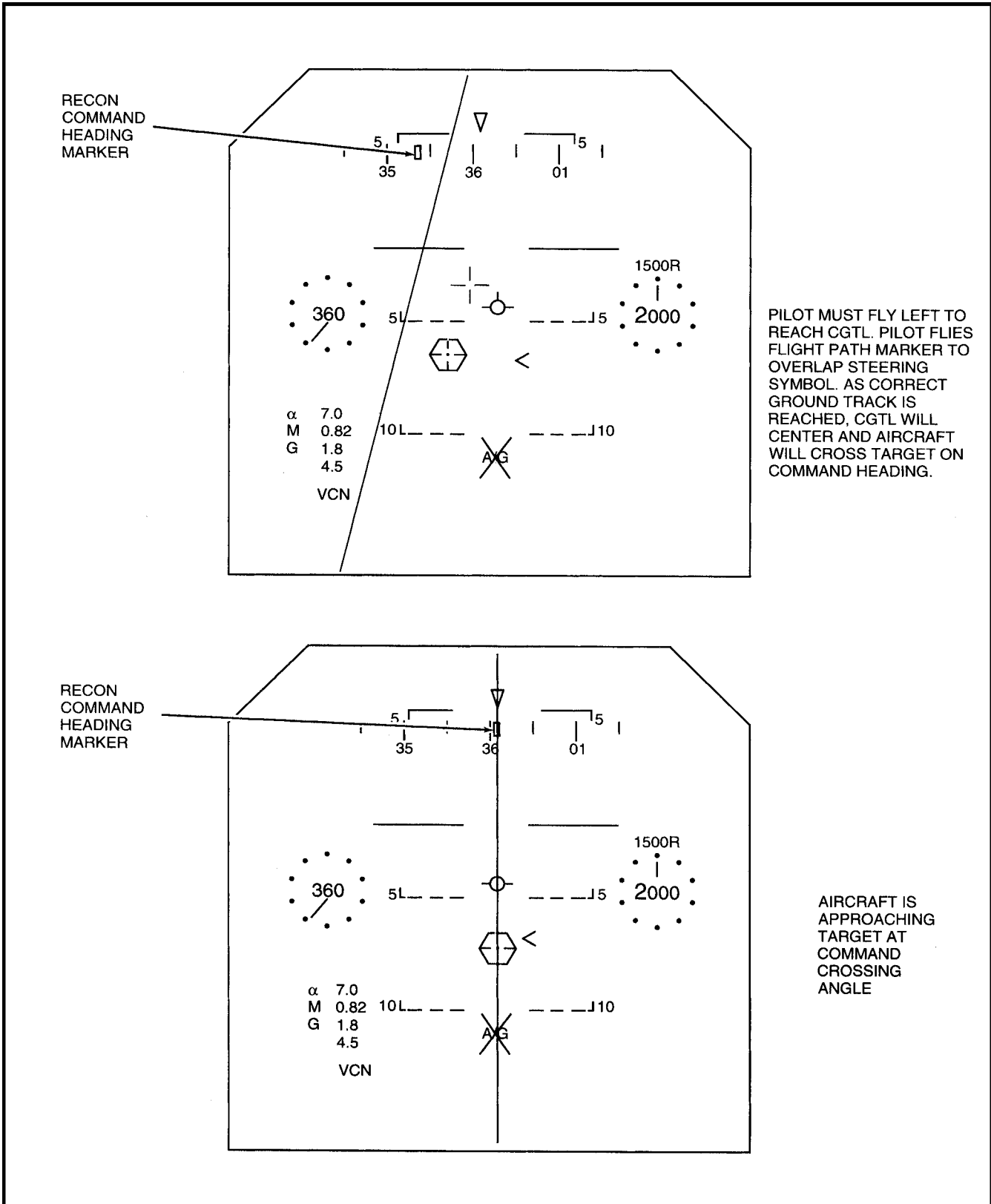


(AT)3-F50D-312-0

Figure 22-8. HUD/VDI Reconnaissance Symbology (Sheet 1 of 2)

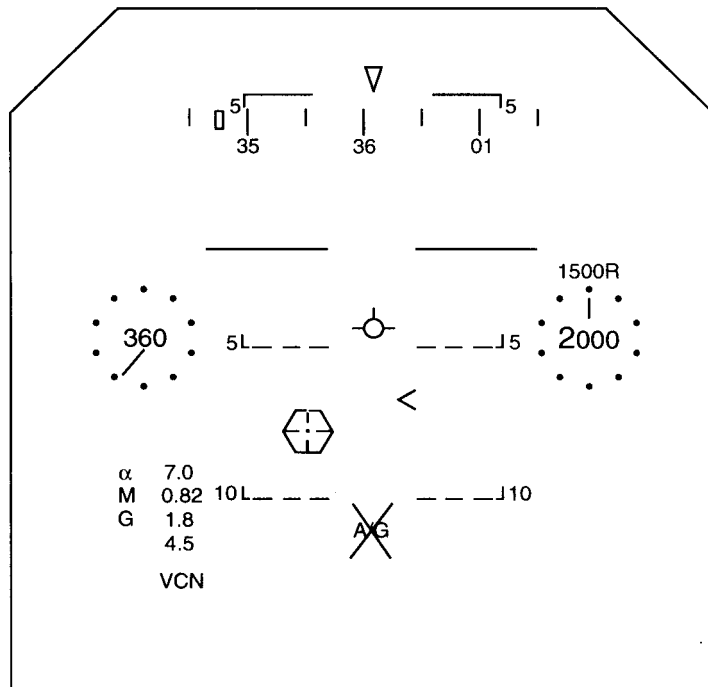
NOMENCLATURE	FUNCTION
<p>① Recon Command Heading Marker</p>	<p>Indicates the magnetic heading for Recon steering.</p> <ul style="list-style-type: none"> – Primary steering cue for initial phase of PTP steering. – Indicates intended magnetic heading to DSPT (as commanded by the Recon Steering Symbol).
<p>② Recon Steering Symbol</p>	<p>Provides command bank information via azimuth displacement from velocity vector.</p>
<p>③ Target Designator, Hexagon</p>	<p>Displays target position referenced to the aircraft navigation system.</p>
<p>④ Command Ground Track Line (CGTL)</p>	<p>Displays the path of the command ground track. Indicates cross track displacement error.</p>
<p>Camera Selection Legend</p>	<p>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)</p>
<p>Note</p> <p>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.</p>	

Figure 22-8. HUD/VDI Reconnaissance Symbology (Sheet 2 of 2)



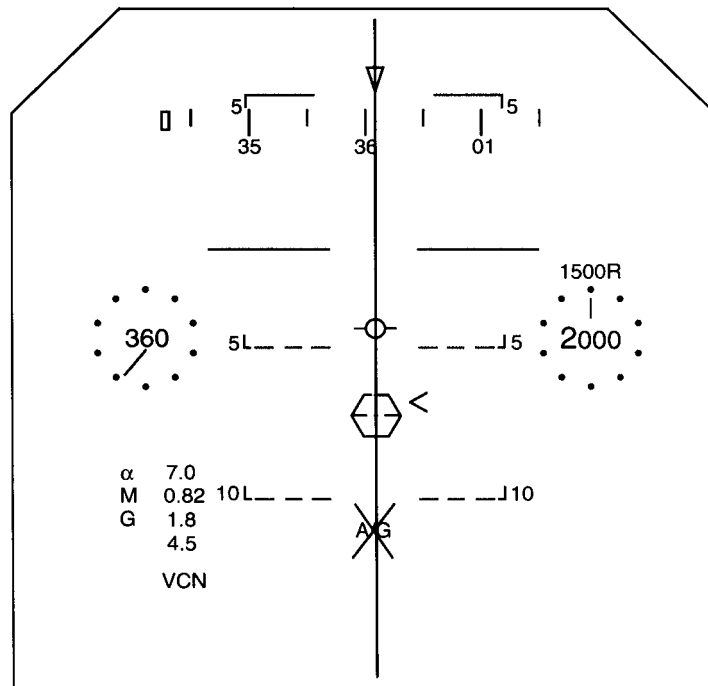
(AT)3-F50D-313-1

Figure 22-9. HUD Reconnaissance Display (Command Course Steering) (Sheet 1 of 2)



PILOT MUST FLY LEFT FOR
RECON COMMAND
HEADING MARKER TO
MATCH AIRCRAFT
HEADING

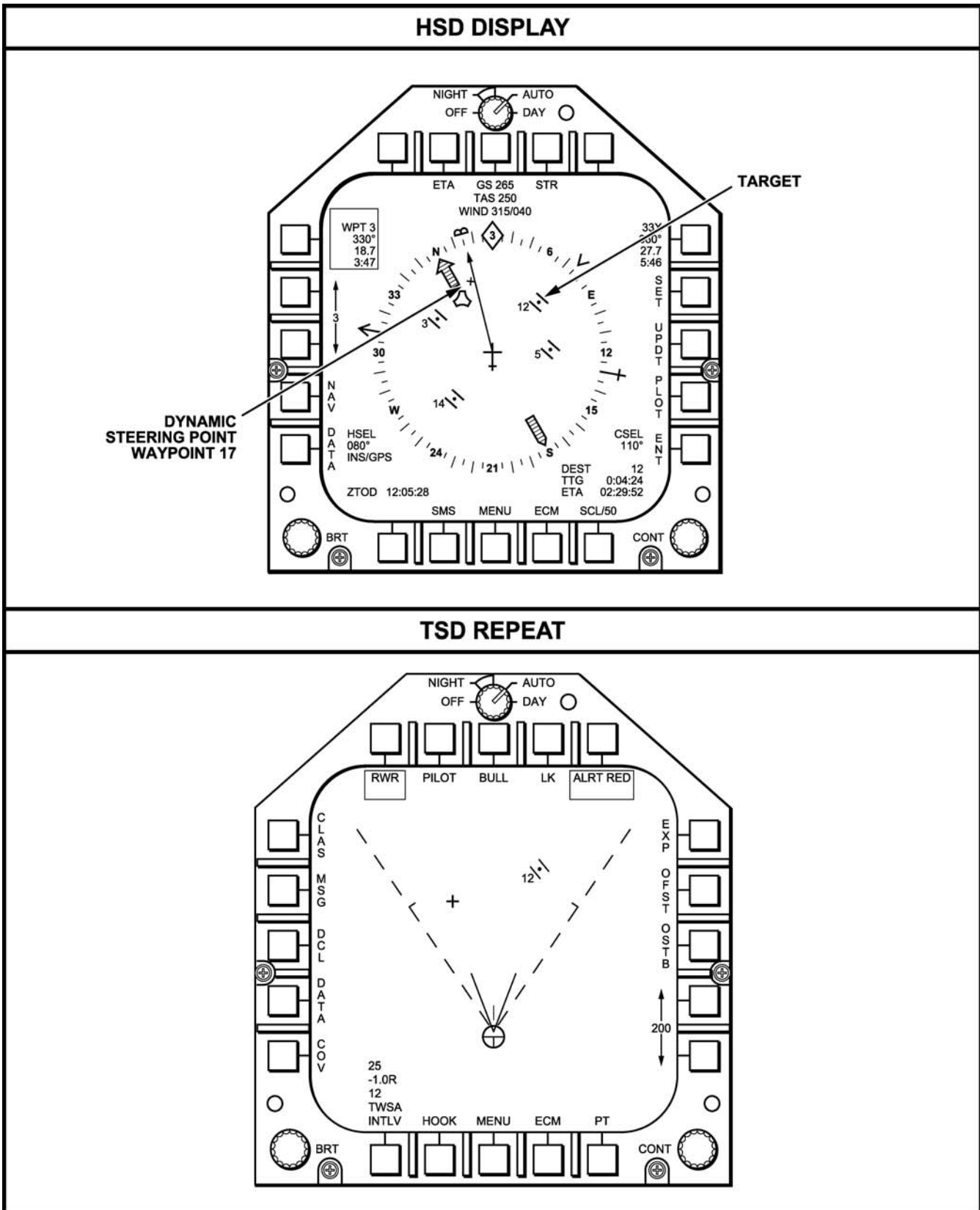
INITIAL APPROACH



FINAL APPROACH

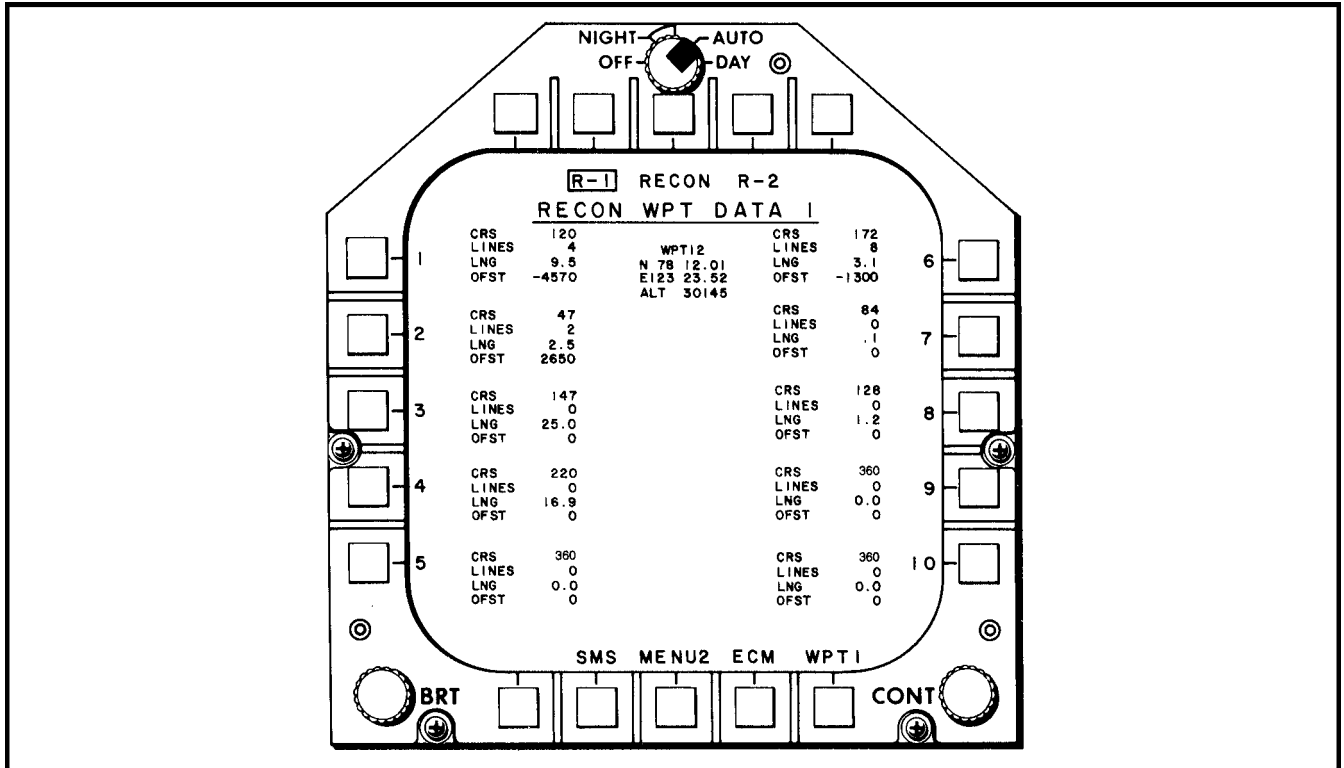
(AT)3-F50D-313-2

Figure 22-9. HUD Reconnaissance Display (Command Course Steering) (Sheet 2 of 2)



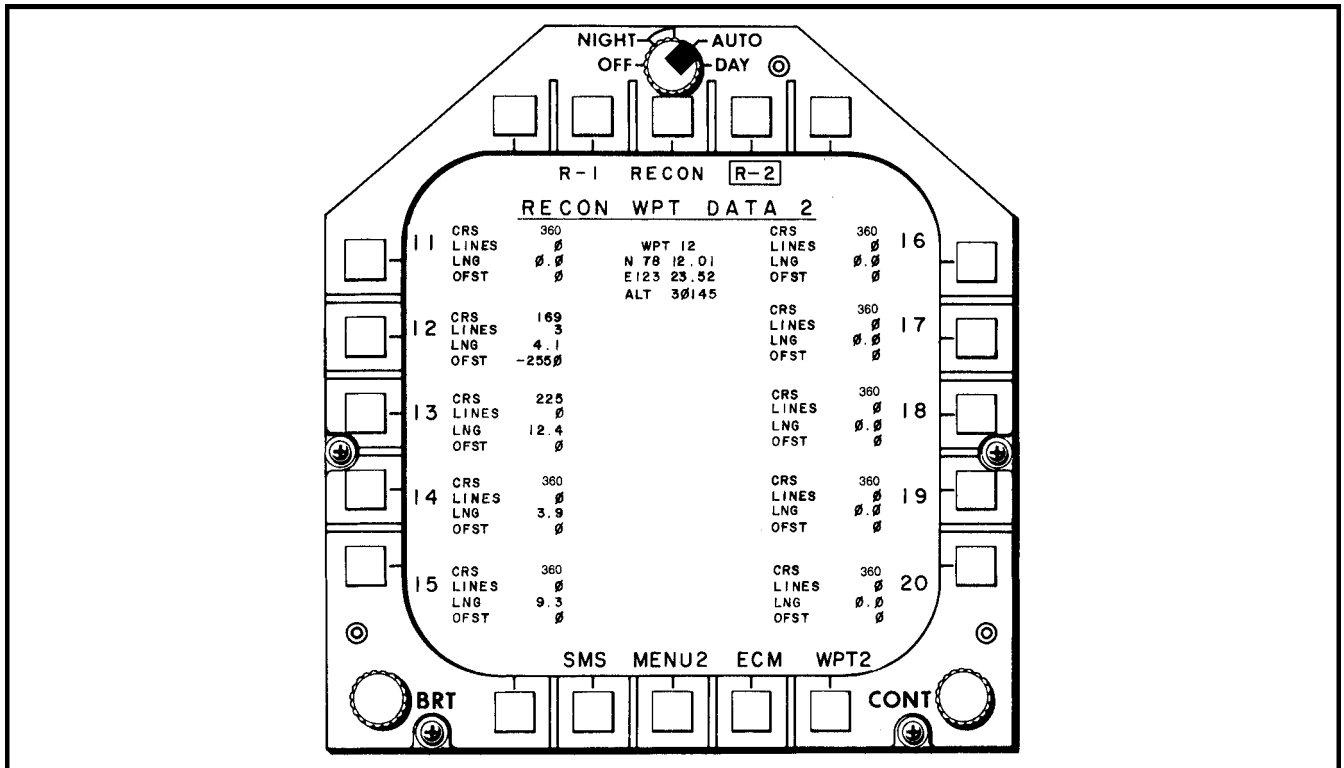
CSC-F14D-1-22-005

Figure 22-10. Dynamic Steering Point Display



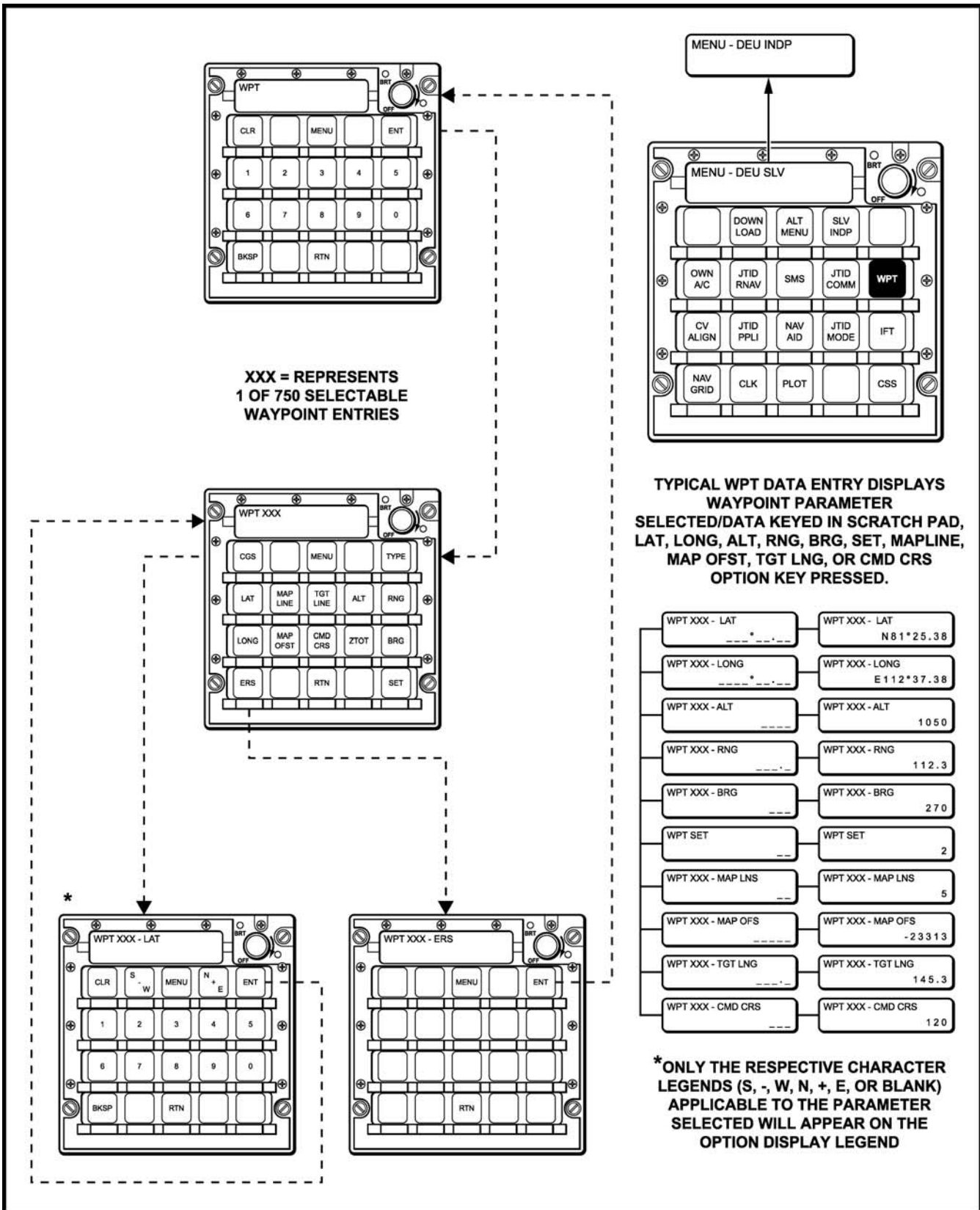
1-F50D-308-0

Figure 22-11. MFD RECON WPT DATA 1 Format



1-F50D-309-0

Figure 22-12. MFD RECON WPT DATA 2 Format



CSC-F14D-1-22-003

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.



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 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 also 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-IT-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 × 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 tuning, 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 × 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

Focal length	6 inches
Diaphragm range	f 2.8 to 6.7
Field of view	41° × 41°
Negative Format	4.5 × 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)
<p>*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.</p> <p>**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.</p> <p>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.</p> <p>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.</p> <p>Optional 3-inch focal length lens available.</p>	

Figure 22-14. KS-87D Serial Frame Camera Characteristics

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 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 flight-crew'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.

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 × 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.

Focal Length	9 inches
Maximum Aperture	f/4.0
Field Of View	28° × 180°
Negative Format	4.5 × 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	
<ul style="list-style-type: none"> • 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

Focal Length	24 inches/610 mm
Angular Field Of View	21.4 across track, 10.7 along track
Film Format	4.5 × 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 nm 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 ½ 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)

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 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, flying below sea level 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 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.

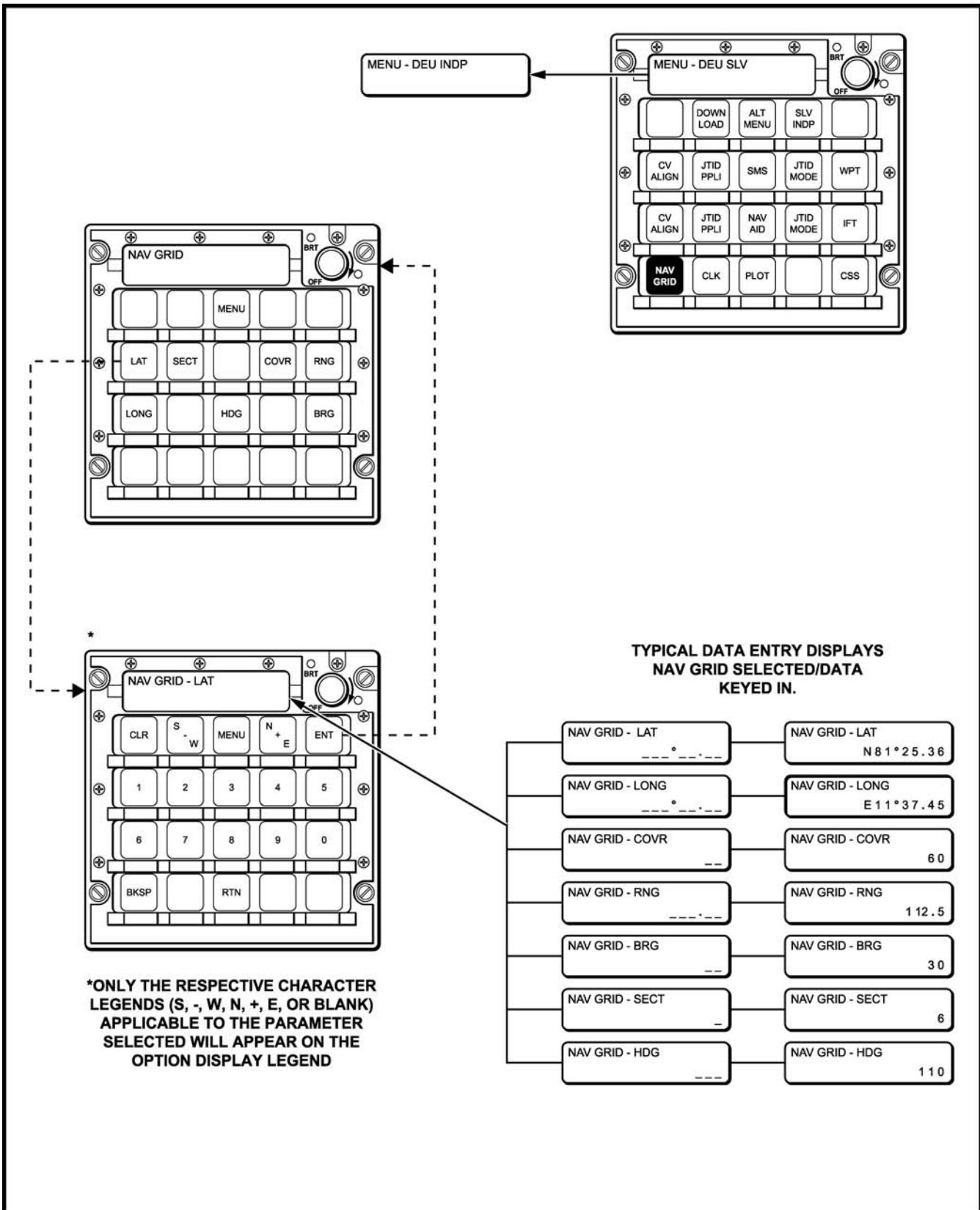
Grid parameters can be entered via the DEU or the DD computer address panel. The DEU NAV GRID parameters are used for NAV GRID entries and are the primary entry device with the DD as the backup.

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).

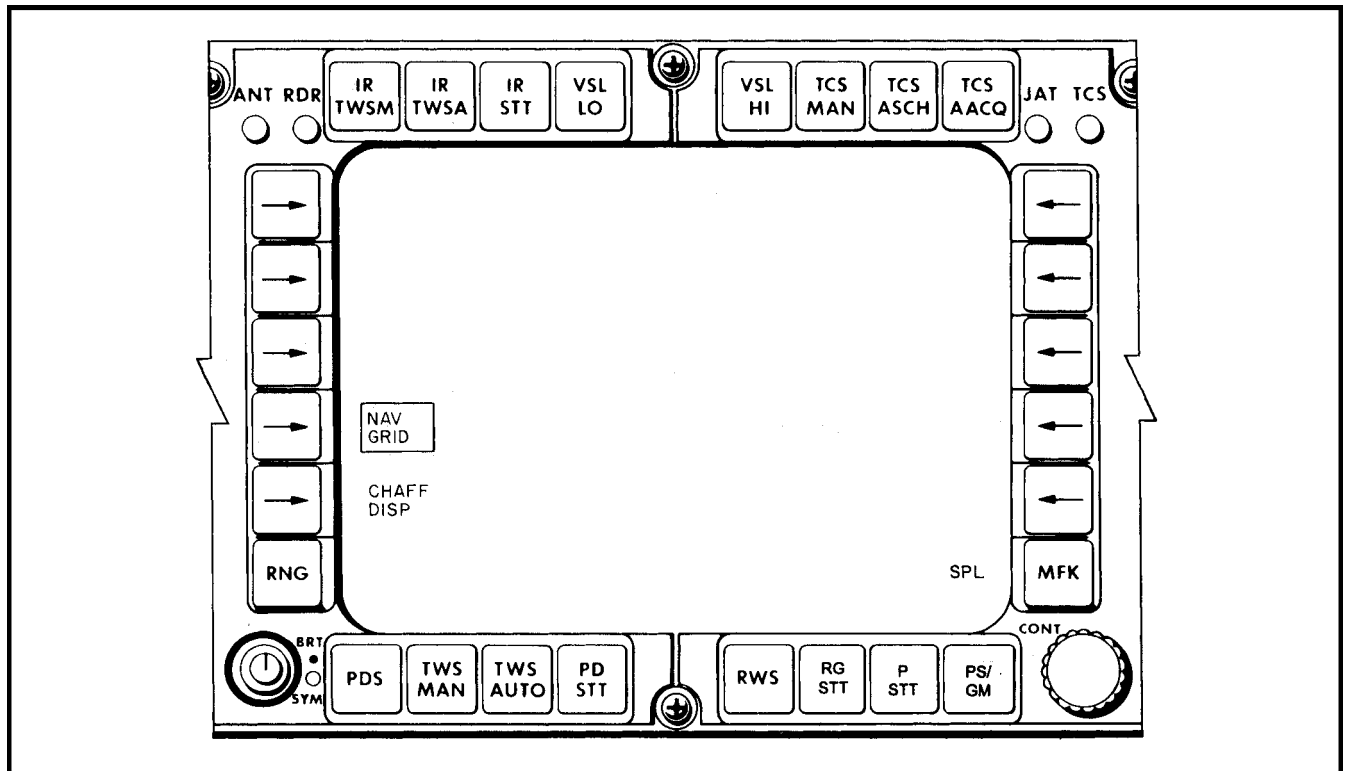
23.1.1.2 DD Data Entry Procedures

1. On the DD, press the MFK pushbutton 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).



CSC-F14D-1-23-002A

Figure 23-1. DEU NAV GRID Data Entry — Typical



1-F50D-406-0

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 PTID in either a ground-stabilized or aircraft-stabilized format.

23.1.2.1 Programmable Tactical Information Display

The PTID NAV GRID display is enabled by selecting the A/C STAB position of the PTID 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 PTID 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 PTID is achieved by moving the PTID MODE switch to GND STAB then to A/C STAB. Own aircraft is initially displayed at the center of the PTID. The top of the PTID 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

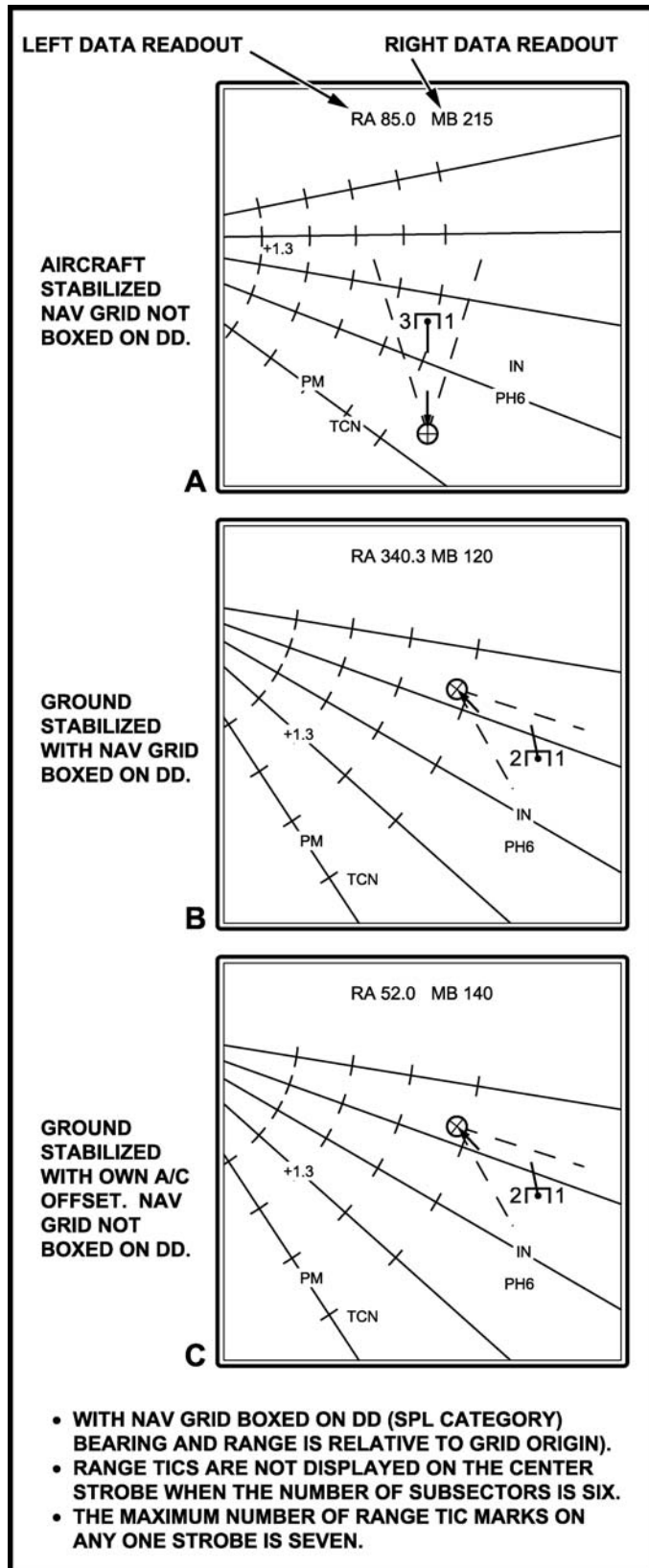
(threat axis) with each sector bounded by two strobes. Short tic marks on the strobes represent 50-mile increments from grid origin; longer tic marks represent 100-mile increments. A maximum of seven range tics (350 miles) is displayed. When the grid contains six sectors, no range tics are displayed on the center strobe.

Selectable range scales are 25, 50, 100, 200, and 400 in either stabilized mode. A PTID 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.

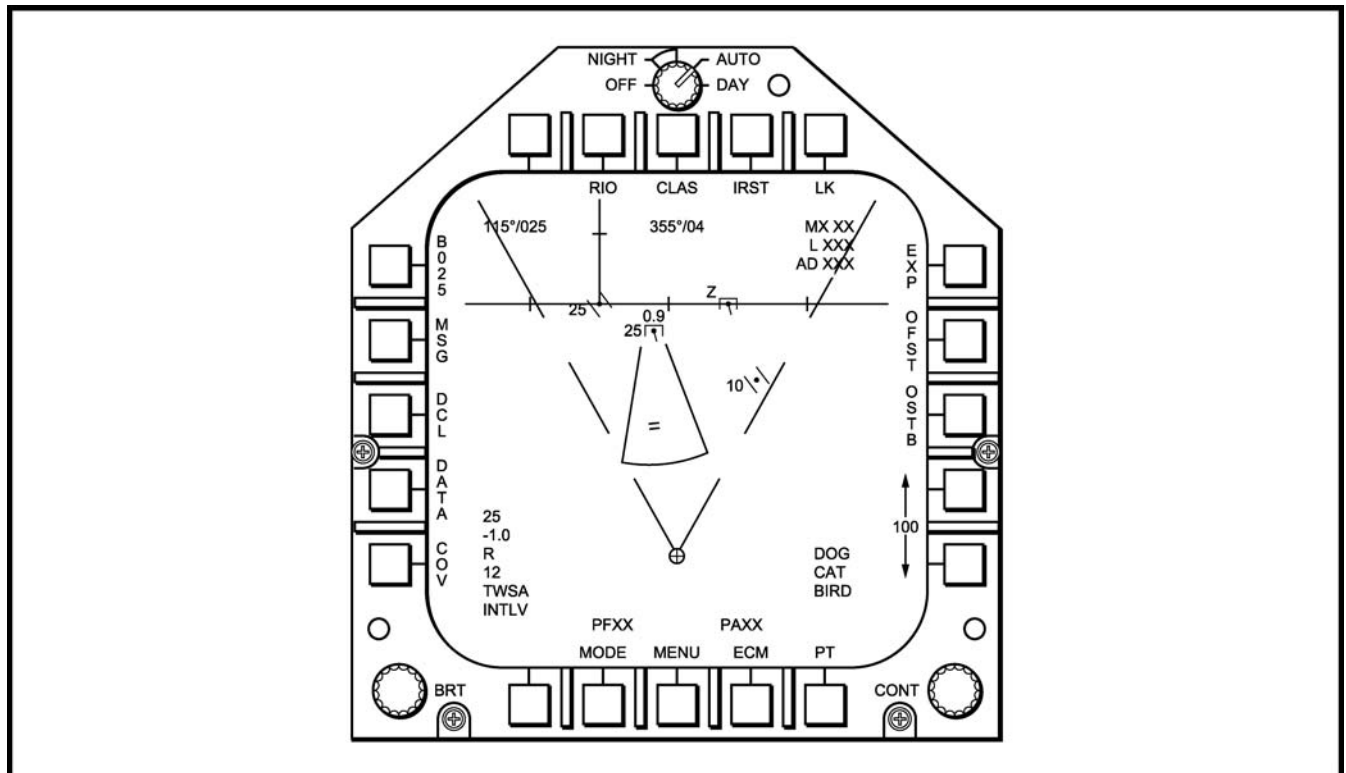
23.1.2.2 Tactical Situation Display

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 PTID, the TSD



CSC-F14D-1-23-003

Figure 23-3. PTID NAV GRID Displays



CSC-F14D-1-23-001A

Figure 23-4. TSD NAV GRID Display

can display the NAV GRID in either ground or aircraft-stabilized formats as selected by the GSTAB or ASTAB pushstiles. 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 PTID 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 OFF-SET and EXPAND capability for all TSD formats. Unlike the PTID, bearing and range data hooked tracks or waypoints cannot be referenced to grid origin.

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 and RIO are necessarily integrated. The performance of one crewmember contributes 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 contributing 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 effective communication, 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 appropriate checklists utilizing a challenge and reply system. The RIO

will normally be responsible for all communications except in tactical situations as designated in squadron SOP.

37.2.4 Mission Commander

The mission commander may be either a pilot or a RIO. The mission commander 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, they 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

The briefing shall include confirmation that those tasks delineated in paragraph 37.2.5.1 have been or will be accomplished.

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, the F14-D NATOPS Pocket Checklist.

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, the F14-D NATOPS Pocket Checklist.

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 and/or navigational information derived from the RIO's 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 receive a "Ready for Shutdown" report from the RIO. 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 goals 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, the Functional Checkflight Checklist.

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, the Functional Checkflight Checklist.

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 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, emergency and post-flight procedures. Improper crew coordination is usually an attributable factor to improperly executed emergency procedures.

37.4.2 Pilot

The pilot should relate to the RIO all indications relevant to an 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 an 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 PTID. 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 PTID. Avionics and radar failure acronyms are displayed on the PTID 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

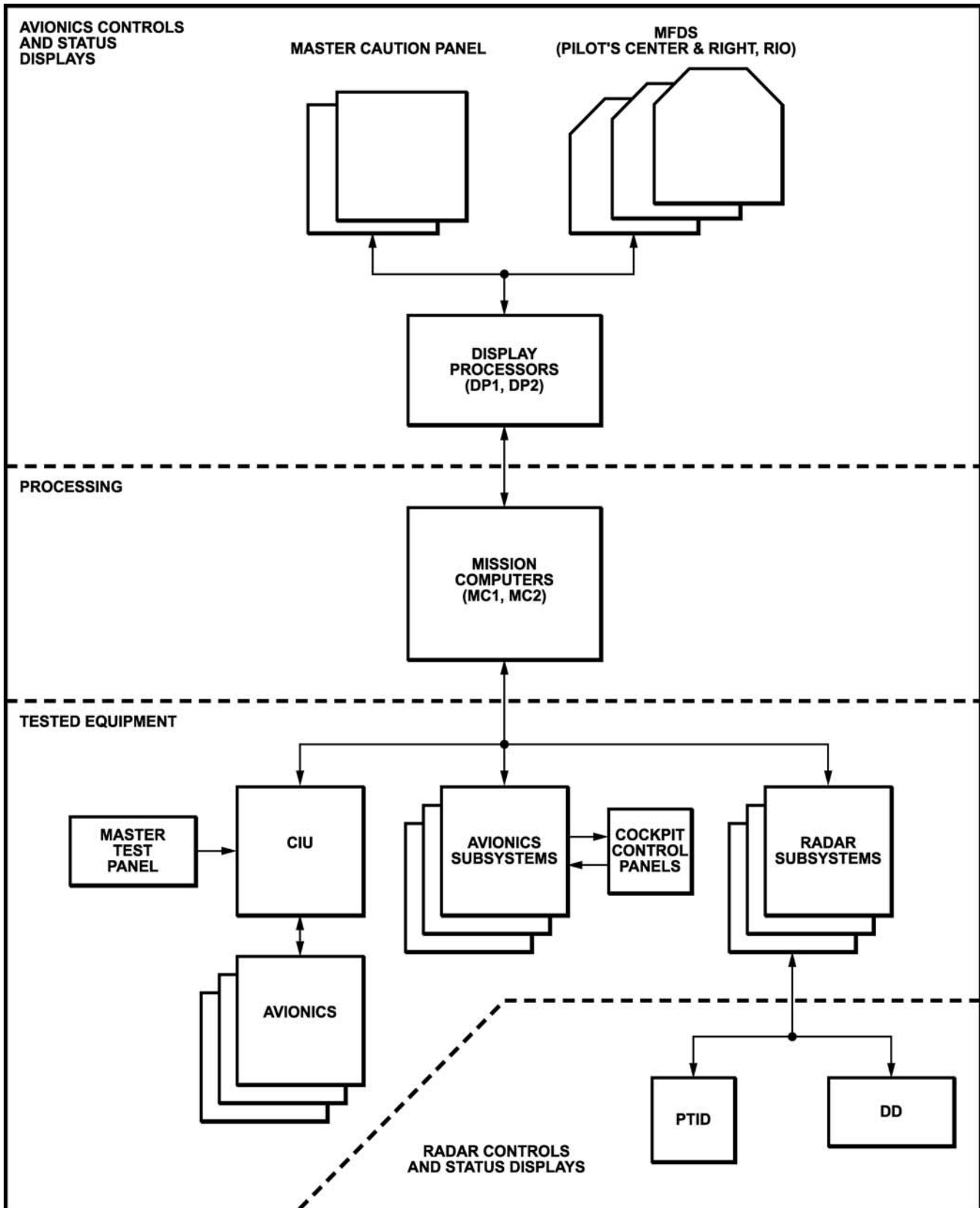
Master test checks are initiated by the pilot through the MASTER TEST panel ([Figure 38-3](#)) on the right outboard console. These tests check the operational status of specific aircraft systems basic to safety of flight and mission success. The OBC, WG SWP, FLT GR UP, and FLT GR DN positions are used 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.



CSC-F14D-1-38-002A

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 subsystem bussed
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.



Cycling the CIU PH A, B, and C circuit breakers (3E7, 4E1, and 4E2) with the MASTER TEST switch in or above the OBC position will cause the DFCS BIT sequence to initiate. DFCS 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 PTID.

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 DFCS BIT switch position allows the independent execution of DFCS IBIT. DFCS IBIT is armed by raising the MASTER TEST switch and rotating it to the DFCS BIT position. Depressing the MASTER TEST switch while DFCS IBIT is armed will initiate DFCS IBIT. Results of this test are displayed through the caution/advisory lights, acronyms on the MFDs, and fault codes on the DCP.

Note

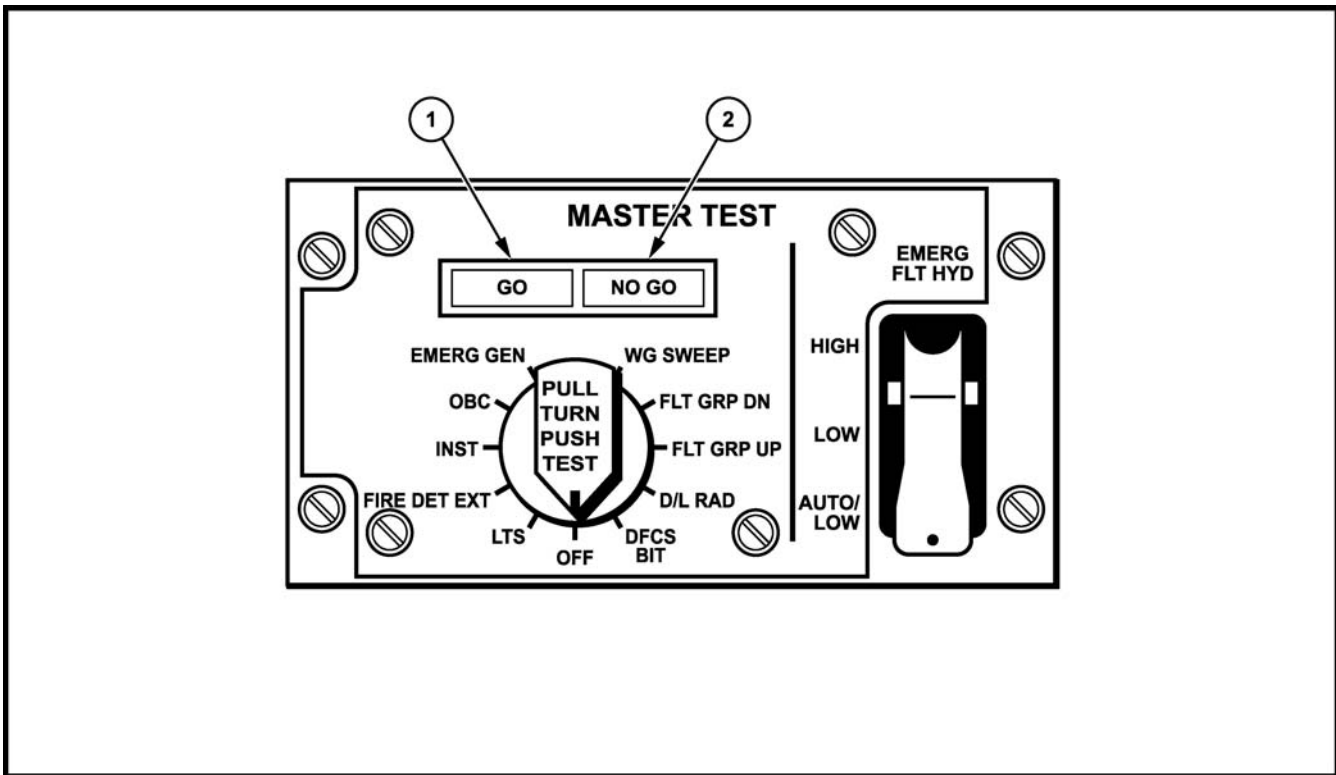
The DCP fault codes cannot be cleared while DFCS IBIT is armed. This condition will occur

if the MASTER TEST switch is not rotated out of the DFCS BIT position following completion of a DFCS IBIT.

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 equipment 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.



CSC-F14D-1-38-001A

NOMENCLATURE	FUNCTION
<p>① MASTER TEST switch</p> <p>Note</p> <ul style="list-style-type: none"> The 10 second audio alarm goes on. If EIG fails self test, the BIT segment to the left of the EGT legend remains illuminated 	<p>OFF — Disables test functions.</p> <p>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.</p> <p>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.</p> <p>INST — 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.</p> <p>RPM 96%</p> <p>EGT 960°C (initiates engine over temperature alarm)</p> <p>FF 10,500 pounds per hour</p> <p>FUEL QTY 2,000 ± 200 pounds(both cockpits)</p> <p>WING SWEEP 45° ± 2.5°</p> <p>AOA 18 ± .5° units</p> <p>BINGO ON (if Bingo set > 2,000)</p> <p>FEED/WING/EXT FUEL QTY 2,000 pounds</p>

Figure 38-3. Master Test Panel (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
	<p>OBC — Enables preflight testing when selected prior to selecting a subsystem for test via the MFDs. Failure acronyms are displayed on the MFDs.</p>
	<p>EMERG GEN — Activates automatic transfer feature of generator and checks tie connectors. GO lights indicate satisfactory check. If the NO GO light remains illuminated, a malfunction is indicated.</p>
	<p>WG SWP — 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.</p>
	<p>FLT GR DN — 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.</p>
	<p>FLT GR UP — 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.</p>
	<p>D/L RAD — 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.</p>
	<p>DFCS BIT — (after engine start) Permits running DFCS IBIT independently of the rest of OBC.</p>
<p>② GO-NO GO lights</p>	<p>GO — Indicates valid test.</p>
	<p>NO GO — Indicates unsatisfactory test.</p>
<p>Note Functional only in LTS, FIRE DET/EXT, INST EMERG GEN, and FLT GR UP.</p>	

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
DFCS AN/ASW-43	N/A	53	2	N/A
AICR C-8684	N/A	63	2	N/A
AICL 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)
EMSP1	N/A	N/A	2	N/A
EMSP2	N/A	N/A	2	N/A
GPS	30	4 Mins	N/A	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
MDL	N/A	(Note 3)	1	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

Figure 38-4. Subsystem BIT Mode Test Times (Sheet 1 of 2)

SUBSYSTEM/DESIGNATION	INITIAL	COMMANDED	CONTINUOUS MONITOR	COCKPIT
TACAN AN/ARN-118 or AN/URC-107	(Note 6)	(Note 6)	(Note 6)	(Note 6)
TARPS	N/A	N/A	2	N/A

Notes:

- All test times are in seconds unless otherwise noted.
- This test is the Data Link PAD (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.
- MDL Commanded BIT times of 5.0 and 65.0 seconds correspond to the Mission Data Loader (MDL) test, and the MDL test including the Bulk Memory Checksum test, respectively.
- This test remains in effect for as long as the PUSH TO TEST knob on the RADAR ALTITUDE indicator is held depressed.
- 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.
- 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 PTID 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 responds with GO or NO GO at the completion of the test.

Data bus test is performed by the MCS in order to detect data bus (mission bus No. 1 and No. 2, and inter-computer 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.

The isolation of DFCS faults to the WRA level requires reference to the fault codes displayed on the DCP (See [Figure 38-11](#)).

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 BIT Status Types



Aircraft shall be considered down with PFCC, RFCC, or YFCC codes in the DCP FAIL group or with an inoperative DCP display. Initiation of OBC/IBIT with this condition will result in invalid IBIT indications.

Note

If a flight control computer fault is detected during DFCS IBIT, a PFCC, RFCC, or YFCC code will be logged on the DCP. However, additional fault codes will be suppressed, possibly masking other actual failures.

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 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 warmup 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
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
DFCS	X(1)	X	
DP1	X	X	X
DP2	X	X	X
DLS	X(1)	X	
EMSP1	X	X	
EMSP2	X	X	
GPS	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
MDL	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. Equipment Subsystem BIT 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 38-12](#).

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 PTID 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

FLIGHT STATUS	TEST SELECTS	EQUIPMENT TESTED
<p>PREFLIGHT</p> <p>Weight-on-wheels, TAS < 76 KTS, Master Test switch set to OBC. Parking brake set</p>	<p>Preflight test</p>	<p>(1) CIU, CADC, APC, DFCS, AICS, RALT, IFB, ADAC, DSS, MDL, SMS, (1) DLS, BSF, (2) SDIS, IRST, JTIDS</p>
	<p>Retest test</p>	<p>(1) CIU, ADAC, DSS, MDL, DEU, SMS, (3) ASPJ, (NON-RADIATE), SDIS, IRST</p>
	<p>Individual/group test</p>	<p>(1) CIU, CADC, APC, DFCS, AICS</p>
<p>Weight-on-wheels, parking brake set</p>	<p>Individual/group test</p>	<p>(3) INS, SAHRS, JTIDS, MDL, GPS</p>
<p>Weight-on-wheels, TAS < 76 KTS</p>	<p>Individual/group test</p>	<p>RALT</p>
	<p>Retest test</p>	<p>ADAC, DSS, MDL, DEU, SMS, (2) ASPJ (NON-RADIATE), SDIS, IRST</p>
<p>INFLIGHT</p> <p>Weight-off-wheels, TAS > = 76 KTS</p>	<p>Inflight test</p>	<p>IFB, DEU, IFX, BAG, SMS, (1) DLS, (2) ASPJ (RADIATE), MFA LEFT/RIGHT SDIS, IRST</p>
	<p>Individual/group test</p>	<p>BAG, IFX, (3) ASPJ (RADIATE)</p>
	<p>Retest test</p>	<p>ADAC, DSS, MDL, DEU, SMS, (2) ASPJ (RADIATE), SDIS, IRST, GPS</p>
<p>Preflight/Inflight</p>	<p>Individual/group test</p>	<p>(4) DP1, (4) DP2, DEU, IFB, (5) MC1, (5) MC2, ADAC, (6) MDL, SMS, (1) DLS, SDIS, IRST, GPS</p>
	<p>Retest test</p>	<p>ADAC, DSS, MDL, DEU, SMS, SDIS, IRST</p>

NOTES:

(1) CIU/DLS:

When the CIU or DLS is selected for test through the MFDs, 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 MFDs, 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. BIT Interlocks 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 MCs must be operationally GO OR Preflight (Weight on wheels)
NONE	In-flight (Weight off wheels), one MC not operationally GO

(6) MDL:

Prior to selecting the MDL/DSS for test through the MFDs, the Mission Data Loader must be inserted into the Mission Data Loader Receptacle (MDLR). MDL BIT will be limited (i.e., less bulk memory checksum test) when the MDL 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, MDL 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. BIT Interlocks Test Restrictions (Sheet 2 of 2)

OBC DISPLAY FORMAT	TEST SELECTION TYPE
BASIC	SEQUENCES: Preflight Inflight Retest
Functional group	Group or individual:
FLT (flight)	DFCS, 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, MDL, 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	
GPS	
MAINTENANCE	
CURRENT FAILURES	
FAILURE HISTORY FILE	

Figure 38-8. OBC Display Format Types

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 PTID OBCCM window will be affected. Format examples are shown in [Figure 38-13](#). 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:

- 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.
- 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.
- 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
DFCS	DFCS	Digital Flight Control System	Failure of a system WRA as shown below
ACCELEROMETER PITCH ACTUATOR PITCH COMPUTER PITCH SENSOR ROLL ACTUATOR ROLL COMPUTER ROLL SENSOR YAW ACTUATOR YAW COMPUTER YAW SENSOR	AFCAM AFCPA AFCPC AFCPS AFCRA AFCRC AFCRS AFCYA AFCYC AFCYS		Aircrew should check the DCP following DFCS IBIT to determine any flight control failures.
AICS AICS-L or AICS-R PROGRAMMER	AICS AILP AIRP	Air Inlet Control System Air Inlet Control (Left or Right)	Failure of AICL or AICR (See below) Indicates which AICS has failed. Used in conjunction with INLET/RAMPS caution lights. 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 RECEIVER AUG TRANSMITTER LOW TRANSMITTER HIGH TRANSMITTER AUG RWR INTERFACE	SPJRH SPJRA SPJTL SPJTH SPJTA SPJRI		High-band receiver failure Augmentation receiver failure Low-band transmitter failure High-band transmitter failure High-band augmentation transmitter failure 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 FILTER 1–RWR 315 FILTER 2–RWR 45 FILTER 3–ASPJ	BSF BSF1 BSF2 BSF3	Band Suppression Filters	BSF failure BSF filter FWD 315 deg BSF filter FWD 45 deg 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 ADAC MBUS 2 CHAN A ADAC MBUS 2 CHAN B ARDP MBUS 1 CHAN A	AAC2A AAC2B RDP1A	Data Bus	MIL-STD-1553 data bus channel failure (See below) Mission Bus NO. 2 channel A fail Mission Bus NO. 2 channel B fail 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
MDL MBUS 2 CHAN A	MDL2A		Mission Bus NO. 2 channel A fail
MDL MBUS 2 CHAN B	MDL2B		Mission Bus NO. 2 channel B 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	MC21A		Mission Bus NO. 1 channel A fail
MC2 MBUS 1 CHAN B	MC21B		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 INERTIAL NAV SYSTEM GPS INS BATTERY BACK-UP	DINS INS GPS DNSPS	Digital Inertial Navigation System Global Positioning System	INS or battery failure INS failure GPS failure INS battery failure
DLS	DLS	Data Link System	Data Link powered off. Run commanded BIT
JTIDS SDU BATTERY RCVR/XMTR DATA PROCESSOR INTERFACE UNIT	JTIDS JTSDU JTBAT JTRT JTDDP JTIU	Joint Tactical Information Distribution System Secure Data Unit JTIDS Battery JTIDS Receiver/Transmitter JTIDS Digital Data Processor JTIDS Interface Unit	JTIDS failure SDU (KGV-8) failure/JTIDS crypto keys are not loaded. JTIDS Battery Failure. Keys will not load/hold in STBY with a failed battery. JTIDS R/T failure. This can also affect TACAN operation. JTIDS DDP failure. This unit is part of the JTIDS Data Processor Group. 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 SENSOR UNIT ELECTRONIC UNIT	IRST IRSU IREU	Infrared Search and Track	IRST failure Sensor unit failure Electronic unit failure
IFI RECEIVER/ TRANSMITTER SWITCH/AMP KIR COMPUTER SYNCHRONIZER	IFI IFIRT IFISW IFN IFISYS	IFF Interrogator	APX-76 failure Receiver/transmitter failure Switch amplifier failure APX-76 computer failure/not installed Synchronizer failure

Figure 38-9. OBC Failure Acronyms (Sheet 6 of 11)

OBC ACRONYM	FHF ACRONYM	DEFINITION	REMARKS
IFX TRANSPONDER COMPUTER	IX IFXPN IFA	IFF Transponder	APX-100 failure IFF failure. Set MASTER switch on IFF control panel to NORM. Select test for each mode and observe light. 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 DISPLAY PROC- ESSOR PILOT CENTER – MFD 1 HUD PILOT RIGHT– MFD 2 RIO – MFD 3 HUD INTERFACE MFD 1 INTERFACE MFD 2 INTERFACE MFD 3 INTERFACE	DP1 MFD1 HUD MFD2 MFD3 HUDI MFD1I MFD2I MFD3I	Multifunction Display System NO. 1	MDS1 failure DP NO. 1 failure Pilot center MFD failure Head-up display failure Pilot right MFD failure RIO MFD failure Interface failure between DP NO. 1 and HUD, or HUD not powered up Interface failure between DP NO. 1 and MFD NO. 1, or MFD NO. 1 not powered up Interface failure between DP NO. 1 and MFD NO. 2, or MFD NO. 2 not powered up Interface failure between DP NO. 1 and MFD NO. 3, or MFD NO. 3 not powered up
MDS2 DISPLAY PROCESSOR	DP2	Multifunction Display System NO. 2	MDS2 failure 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
	PTID	Programmable Tactical Information Display	PTID 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

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)

FAILED COMPONENT	LIGHT	OBC ACRONYM
Pitch Rate Gyro (1)	FCS CAUTION	Pitch Sensor
Pitch Rate Gyro (2)	FCS CAUTION PITCH SAS	Pitch Sensor
Roll Rate Gyro (1)	FCS CAUTION	Roll Sensor
Roll Rate Gyro (2)	FCS CAUTION ROLL DGR ARI DGR ARI/SAS OUT	Roll Sensor
Yaw Rate Gyro (1)	FCS CAUTION	Yaw Sensor
Yaw Rate Gyro (2, 3)	FCS CAUTION ARI DGR YAW DGR ARI / SAS OUT	Yaw Sensor
Lateral Accel (1)	FCS CAUTION	Accelerometer
Lateral Accel (2, 3)	FCS CAUTION ARI DGR YAW DGR ARI / SAS OUT	Accelerometer
Pitch Series Actuator (1, 2)	PITCH SAS	Pitch Actuator
Roll Series Actuator (1)	ROLL DGR ARI DGR	Roll Actuator
Roll Series Actuator (2)	ROLL DGR ARI DGR ARI / SAS OUT	Roll Actuator
Yaw Series Actuator (1)	ARI DGR YAW DGR	Yaw Actuator
Yaw Series Actuator (2)	ARI DGR YAW DGR ARI / SAS OUT	Yaw Actuator
Spoilers (Any Inboard)	SPOILER	Roll Actuator
Spoilers (Any Outboard)	SPOILER	Pitch Actuator
Pitch Parallel Actuator	ACLS / AP AUTOPILOT	Pitch Actuator
DLC Trim Actuator	—	PITCH ACTUATOR
Pitch Autotrim Actuator	AUTOPILOT	PITCH ACTUATOR
Mach Trim Actuator	MACH TRIM	—
Lateral Authority Actuator	HZ TAIL AUTH	—
Rudder Authority Actuator	RUDDER AUTH	—

Figure 38-10. DFCS Caution Lights and Acronyms (Sheet 1 of 2)

FAILED COMPONENT	LIGHT	OBC ACRONYM
Pitch Feel Switches	ACLS / AP AUTOPILOT	—
Right AICS Static Pressure	FCS CAUTION ARI DGR	Pitch Sensor
Left AICS Static Pressure	FCS CAUTION ARI DGR	Pitch Sensor
Right AICS Total Pressure	FCS CAUTION ARI DGR	Pitch Sensor
Left AICS Total Pressure	FCS CAUTION ARI DGR	Pitch Sensor
Right AICS AOA	FCS CAUTION	Pitch Sensor
Left AICS AOA	FCS CAUTION	Pitch Sensor
ADD (AOA side-probe) AOA	FCS CAUTION	Pitch Sensor
ARI (alpha nose-probe) AOA	FCS CAUTION	Pitch Sensor
Two or more of L/R AICS AOA, ADD side-probe AOA, or ARI alpha nose-probe AOA	FCS CAUTION ARI DGR	Pitch Sensor
Any Internal DFCC Test	PITCH SAS FCS CAUTION ROLL DGR ARI DGR YAW DGR ARI / SAS OUT	Pitch Computer Roll Computer Yaw Computer (as applicable)

Figure 38-10. DFCS Caution Lights and Acronyms (Sheet 2 of 2)

38.3.3.2 DFCS IBIT

38.3.3.2.1 IBIT Initiation

DFCS IBIT is initiated automatically when OBC is initiated. It can also be initiated independently through the DFCS position on the MASTER TEST switch. IBIT can be initiated with the wings forward and the flaps down, or with the wings aft of 62°. Additional interlocks which must be satisfied include the PITCH, ROLL, and YAW STAB AUG switches must be ON, ANTISKID SPOILER BK switch must be OFF, the CADC must be operating properly, and the aircraft must have weight-on-wheels. If it is desired to test autopilot WRAs during IBIT, the AUTOPILOT switch must be ENGAGED while DFCS IBIT is armed. The aircraft must not be in motion during IBIT operation or IBIT failures will result.

38.3.3.2.2 IBIT Tests

The DFCS IBIT performs tests designed to detect faults within the DFCCs, the DFCC inputs and outputs, the various sensors and the actuators which are driven by the DFCCs.

Sensor tests include stimulation of the rate gyros and lateral accelerometers and reasonableness checks for the air data sensors. The actuators which are tested are the pedal shaker motor, the electro-mechanical actuators, and the electro-hydraulic actuators. The electro-hydraulic actuators are exercised if either combined or flight hydraulic pressure is present. In the absence of hydraulic pressure, the electrical circuits which drive the actuators are tested, but the actuators themselves are not exercised.

38.3.3.2.3 IBIT Indications

IBIT status and results are displayed to the aircrew through a combination of caution/advisory lights, TID acronyms, and DCP codes as shown in [Figures 38-10 and 38-11](#).

38.3.3.2.4 IBIT Armed

When IBIT is armed by raising the MASTER TEST switch and rotating it to the DFCS BIT position, and all interlocks are satisfied, the DCP will alternately flash the codes IBIT and ARM at a rate of 1 Hz.

DCP	IBIT	OFF	MEANING
115V	I		Aircraft 115 V _{AC} power supply out of tolerance fault.
28DC	I		Aircraft 28 V _{DC} power supply out of tolerance fault.
AC28	I	O	Alpha computer/pedal shaker 28 V _{DC} power supply input fault.
AD01		O	Air data computer (CADC) general fault.
AD02	I		Mach schedule (pitch) signal from CADC fault.
AD03		O	Air data computer valid input (pitch) fault.
AD04		O	Air data computer valid input (roll) fault.
AD05		O	Air data computer valid input (yaw) fault.
AD06		O	Mach trim schedule input fault.
AD07		O	Lateral authority schedule input fault.
AD08		O	Rudder authority schedule input fault.
AD09	I		Autopilot altitude error signal from CADC fault.
AD10	I		Autopilot altitude rate signal from CADC fault.
AD11	I		Mach trim schedule 1 signal from CADC fault.
AD12	I		Mach trim schedule 2 signal from CADC fault.
AD13	I		Lateral authority schedule 1 signal from CADC fault.
AD14	I		Lateral authority schedule 2 signal from CADC fault.
AD15	I		Rudder authority schedule 1 signal from CADC fault.
AD16	I		Rudder authority schedule 2 signal from CADC fault.
AHR1		O	Attitude and heading reference system invalid input fault.
AHR2		O	Attitude and heading reference system pitch synchro input fault.
AHR3		O	Attitude and heading reference system roll synchro input fault.
AICX		O	Disagreement between left and right AICS fault.
AOAC	I	O	ARI angle of attack sensor fault.
AOAL		O	Left AICS angle of attack sensor fault.
AOAR		O	Right AICS angle of attack sensor fault.
AOAT	I	O	ADD angle of attack sensor fault.
APCA	I		Normal accelerometer sensor fault.
APCS	I		Scheduled outputs to approach power compensator fault.
CA28	I	O	Flight controls authority 28 V _{DC} power supply input fault.
CSDC	I		Steering error signal from CSDC fault.
DGP1		O	DFCS control panel Pitch SAS switch fault.
DGP2		O	DFCS control panel Roll SAS switch fault.
DGP3		O	DFCS control panel Yaw SAS switch fault.
DGP4	I	O	DFCS control panel Autopilot switch fault.
DLCT	I		DLC thumb-wheel sensor fault.
DLT1	I	O	DLC trim servo fault.
DLT2		O	DLC trim servo isolation fault.
DPSL	I		Left AICS delta pressure (angle of attack) sensor fault.
DPSR	I		Right AICS delta pressure (angle of attack) sensor fault.

Figure 38-11. DFCS Fault Codes (Sheet 1 of 6)

DCP	IBIT	OFF	MEANING
EDPS		O	Emergency disengage paddle switch discrete input fault.
FLAP		O	Flaps down discrete input fault.
GRBS		O	Ground roll braking system discrete input fault.
HT28		O	Lateral authority actuator 28 V _{DC} power input fault.
HZTA	I	O	Lateral authority actuator fault.
IMU1		O	Inertial measurement unit INS invalid input fault.
IMU2		O	Inertial measurement unit pitch synchro input fault.
IMU3		O	Inertial measurement unit roll synchro input fault.
IMU4		O	Inertial measurement unit PQVM fault.
LAT1	I	O	Lateral accelerometer channel A fault.
LAT2	I	O	Lateral accelerometer channel B fault.
LAT3	I	O	Lateral accelerometer channel M fault.
LDG1		O	Main landing gear input 1 fault.
LDG2		O	Main landing gear input 2 fault.
LDG3		O	Main landing gear input 3 fault.
MACL		O	SCADC to AICS Mach miscompare while left AICS was selected.
MACR		O	SCADC to AICS Mach miscompare while right AICS was selected.
MRS1		O	Master reset switch input 1 fault.
MRS2		O	Master reset switch input 2 fault.
MRS3		O	Master reset switch input 3 fault.
MT28	I	O	Mach trim 28 V _{DC} power supply input fault.
MTRM	I	O	Mach trim actuator fault.
PC01		O	Pitch A computer 115 V _{AC} export power supply fault.
PC02		O	Pitch B computer 115 V _{AC} export power supply fault.
PC03	I		Pitch A computer 28 V _{DC} power supply monitor fault.
PC04	I		Pitch B computer 28 V _{DC} power supply monitor fault.
PC05		O	Pitch A computer general fault.
PC06		O	Pitch B computer general fault.
PC07	I		Pitch A computer general fault.
PC08	I		Pitch B computer general fault.
PC09	I		Probable Pitch A computer isolation fault.
PC10	I		Probable Pitch B computer isolation fault.
PC11		O	Pitch A from Pitch B computer CCDL fault.
PC12		O	Pitch B from Pitch A computer CCDL fault.
PC13		O	Pitch A from Roll B computer CCDL fault.
PC14		O	Pitch B from Yaw A computer CCDL fault.
PC15		O	Pitch A from Yaw B computer CCDL fault.
PC16		O	Pitch B from Roll A computer CCDL fault.
PC17	I		Pitch A computer ±12 V _{DC} exported power supply fault.
PC18	I		Pitch B computer ±12 V _{DC} exported power supply fault.

Figure 38-11. DFCS Fault Codes (Sheet 2 of 6)

DCP	IBIT	OFF	MEANING
PC19	I		Pitch computer consolidated exported power supply fault.
PC20	I		Servo isolation in Pitch A computer fault.
PC21	I		Servo isolation in Pitch B computer fault.
PC22	I		Pitch A computer ground test input fault.
PC23	I		Pitch B computer spoiler servo amplifier fault.
PC24	I		Pitch computer gyro input fault.
PC26	I		Pitch computer autotrim command monitor fault.
PC35	I		Pitch A computer consolidated exported power supply monitor fault.
PC36	I		Pitch B computer consolidated exported power supply monitor fault.
PC37	I		Pitch A computer 115 V _{AC} power supply monitor fault.
PC38	I		Pitch B computer 115 V _{AC} power supply monitor fault.
PC39	I		Probable Pitch A computer interface BIT circuit fault.
PC40	I		Probable Pitch B computer interface BIT circuit fault.
PC41	I		Pitch A computer AC analogue input interface fault.
PC42	I		Pitch B computer AC analogue input interface fault.
PC45		O	Pitch computer consolidated exported power supply fault.
PGY1	I	O	Pitch gyro channel A fault.
PGY2	I	O	Pitch gyro channel B fault.
PGY4	I	O	Pitch gyro channel A SMRD fault.
PGY5	I	O	Pitch gyro channel B SMRD fault.
PGY7	I		Pitch gyro common mode fault.
POR	NA	NA	In-flight power on reset.
PPA	I	O	Pitch parallel actuator fault.
PSA1	I	O	Pitch series servo channel A fault.
PSA2	I	O	Pitch series servo channel B fault.
PSA3		O	Pitch series servo channel A isolation fault.
PSA4		O	Pitch series servo channel B isolation fault.
PTRM	I	O	Pitch auto-trim actuator fault.
RC01		I	Roll A computer 115 V _{AC} export power supply fault.
RC02		I	Roll B computer 115 V _{AC} export power supply fault.
RC03	I		Roll A computer 28 V _{DC} power supply monitor fault.
RC04	I		Roll B computer 28 V _{DC} power supply monitor fault.
RC05		O	Roll A computer general fault.
RC06		O	Roll B computer general fault.
RC07	I		Roll A computer general fault.
RC08	I		Roll B computer general fault.
RC09	I		Probable Roll A computer isolation fault.
RC10	I		Probable Roll B computer isolation fault.
RC11		O	Roll A from Roll B computer CCDL fault.
RC12		O	Roll B from Roll A computer CCDL fault.

Figure 38-11. DFCS Fault Codes (Sheet 3 of 6)

DCP	IBIT	OFF	MEANING
RC13		O	Roll A from Yaw B computer CCDL fault.
RC14		O	Roll B from Pitch A computer CCDL fault.
RC15		O	Roll A from Pitch B computer CCDL fault.
RC16		O	Roll B from Yaw A computer CCDL fault.
RC17	I		Roll A computer internal power supply fault.
RC18	I		Roll B computer $\pm 12 V_{DC}$ exported power supply fault.
RC19	I		Roll computer consolidated exported power supply fault.
RC20	I		Servo isolation in Roll A computer fault.
RC21	I		Servo isolation in Roll B computer fault.
RC22	I		Roll A computer ground test input fault.
RC23	I		Roll A computer spoiler servo amplifier fault.
RC24	I		Roll computer gyro input fault.
RC27	I		Roll computer Mach trim actuator isolation fault.
RC28	I		Roll computer Mach trim current monitor fault.
RC35	I		Roll A computer consolidated exported power supply monitor fault.
RC36	I		Roll B computer consolidated exported power supply monitor fault.
RC37	I		Roll A computer 115 V_{AC} power supply monitor fault.
RC38	I		Roll B computer 115 V_{AC} power supply monitor fault.
RC39	I		Probable Roll A computer interface BIT circuit fault.
RC40	I		Probable Roll B computer interface BIT circuit fault.
RC41	I		Roll A computer AC analogue input interface fault.
RC42	I		Roll B computer AC analogue input interface fault.
RC45		O	Roll computer consolidated exported power supply fault.
RCP1		O	Roll stick position input 1 fault.
RCP2		O	Roll stick position input 2 fault.
RCP3		O	Roll stick position input 3 fault.
RD28		O	Rudder authority 28 V_{DC} power input fault.
RGY1	I	O	Roll gyro channel A fault.
RGY2	I	O	Roll gyro channel B fault.
RGY4	I	O	Roll gyro channel A SMRD fault.
RGY5	I	O	Roll gyro channel B SMRD fault.
RGY7	I		Roll gyro common mode fault.
RPP1		O	Rudder pedal position sensor input 1 fault.
RPP2		O	Rudder pedal position sensor input 2 fault.
RPP3		O	Rudder pedal position sensor input 3 fault.
RSA1	I	O	Roll series servo channel A fault.
RSA2	I	O	Roll series servo channel B fault.
RSA3		O	Roll series servo channel A isolation fault.
RSA4		O	Roll series servo channel B isolation fault.
RUDA	I	O	Rudder authority actuator fault.

Figure 38-11. DFCS Fault Codes (Sheet 4 of 6)

DCP	IBIT	OFF	MEANING
SHKR		O	Rudder pedal shaker fault.
SP1L	I	O	No. 1 left spoiler actuator fault.
SP1R	I	O	No. 1 right spoiler actuator fault.
SP2L	I	O	No. 2 left spoiler actuator fault.
SP2R	I	O	No. 2 right spoiler actuator fault.
SP3L	I	O	No. 3 left spoiler actuator fault.
SP3R	I	O	No. 3 right spoiler actuator fault.
SP4L	I	O	No. 4 left spoiler actuator fault.
SP4R	I	O	No. 4 right spoiler actuator fault.
SPSL	I		Left AICS static pressure sensor fault.
SPSR	I		Right AICS static pressure sensor fault.
TPSL	I		Left AICS total pressure sensor fault.
TPSR	I		Right AICS total pressure sensor fault.
WOW1		O	Weight-on-wheels input 1 fault.
WOW2		O	Weight-on-wheels input 2 fault.
WOW3		O	Weight-on-wheels input 3 fault.
WSP1		O	Wingsweep input to Roll computer fault.
WSP2		O	Wingsweep input to Pitch computer fault.
YC01		O	Yaw A computer 115 V _{AC} export power supply fault.
YC02		O	Yaw B computer 115 V _{AC} export power supply fault.
YC03	I		Yaw A computer 28 V _{DC} power supply monitor fault.
YC04	I		Yaw B computer 28 V _{DC} power supply monitor fault.
YC05		O	Yaw A computer general fault.
YC06		O	Yaw B computer general fault.
YC07	I		Yaw A computer general fault.
YC08	I		Yaw B computer general fault.
YC09	I		Probable Yaw A computer isolation fault.
YC10	I		Probable Yaw B computer isolation fault.
YC11		O	Yaw A from Yaw B computer CCDL fault.
YC12		O	Yaw B from Yaw A computer CCDL fault.
YC13		O	Yaw A from Pitch B computer CCDL fault.
YC14		O	Yaw B from Roll A computer CCDL fault.
YC15		O	Yaw A from Roll B computer CCDL fault.
YC16		O	Yaw B from Pitch A computer CCDL fault.
YC17	I		Yaw A computer ± 12 V _{DC} exported power supply fault.
YC18	I		Yaw B computer ± 12 V _{DC} exported power supply fault.
YC19	I		Yaw computer exported M' channel power supply fault.
YC20	I		Servo isolation in Yaw A computer fault.
YC21	I		Servo isolation in Yaw B computer fault.
YC22	I		Yaw B computer ground test input fault.
YC24	I		Yaw computer gyro input fault.
YC25	I		Yaw computer accelerometer input fault.
YC29	I		Yaw computer rudder authority actuator isolation fault.

Figure 38-11. DFCS Fault Codes (Sheet 5 of 6)

DCP	IBIT	OFF	MEANING
YC30	I		Yaw computer rudder authority current monitor fault.
YC31	I		Yaw computer lateral authority actuator isolation fault.
YC32	I		Yaw computer lateral authority actuator current monitor fault.
YC33	I		Yaw computer 28 V _{DC} power supply discrete input fault.
YC34	I		Yaw computer pedal shaker fault.
YC35	I		Yaw A computer exported 'M' channel power supply monitor fault.
YC36	I		Yaw B computer exported 'M' channel power supply monitor fault.
YC37	I		Yaw A computer 115 V _{AC} power supply monitor fault.
YC38	I		Yaw B computer 115 V _{AC} power supply monitor fault.
YC39	I		Probable Yaw A computer interface BIT circuit fault.
YC40	I		Probable Yaw B computer interface BIT circuit fault.
YC41	I		Yaw A computer AC analogue input interface fault.
YC42	I		Yaw B computer AC analogue input interface fault.
YC43		O	Yaw M AC export power supply fault.
YC44		O	Yaw M AC power supply monitor fault.
YC45		O	Yaw computer consolidated exported power supply fault.
YGY1	I	O	Yaw gyro channel A fault.
YGY2	I	O	Yaw gyro channel B fault.
YGY3	I	O	Yaw gyro channel M fault.
YGY4	I	O	Yaw gyro channel A SMRD fault.
YGY5	I	O	Yaw gyro channel B SMRD fault.
YGY6	I	O	Yaw gyro channel M SMRD fault.
YSA1	I	O	Yaw series servo channel A fault.
YSA2	I	O	Yaw series servo channel B fault.
YSA3		O	Yaw series servo channel A isolation fault.
YSA4		O	Yaw series servo channel B isolation fault.

Figure 38-11. DFCS Fault Codes (Sheet 6 of 6)

38.3.3.2.5 IBIT Run

While IBIT is running, the ACL mode caution light, and the AP mode reference light will flash at a rate of 1 Hz. Additionally, the DCP will alternately flash the codes IBIT and RUN. All other DFCS related caution/advisory lights will be illuminated, and all DFCS related TID acronyms will be displayed. During the last three seconds of IBIT, the DCP will display a test pattern which will allow the pilot to determine if all the display segments are operating properly.

38.3.3.2.6 Premature Termination

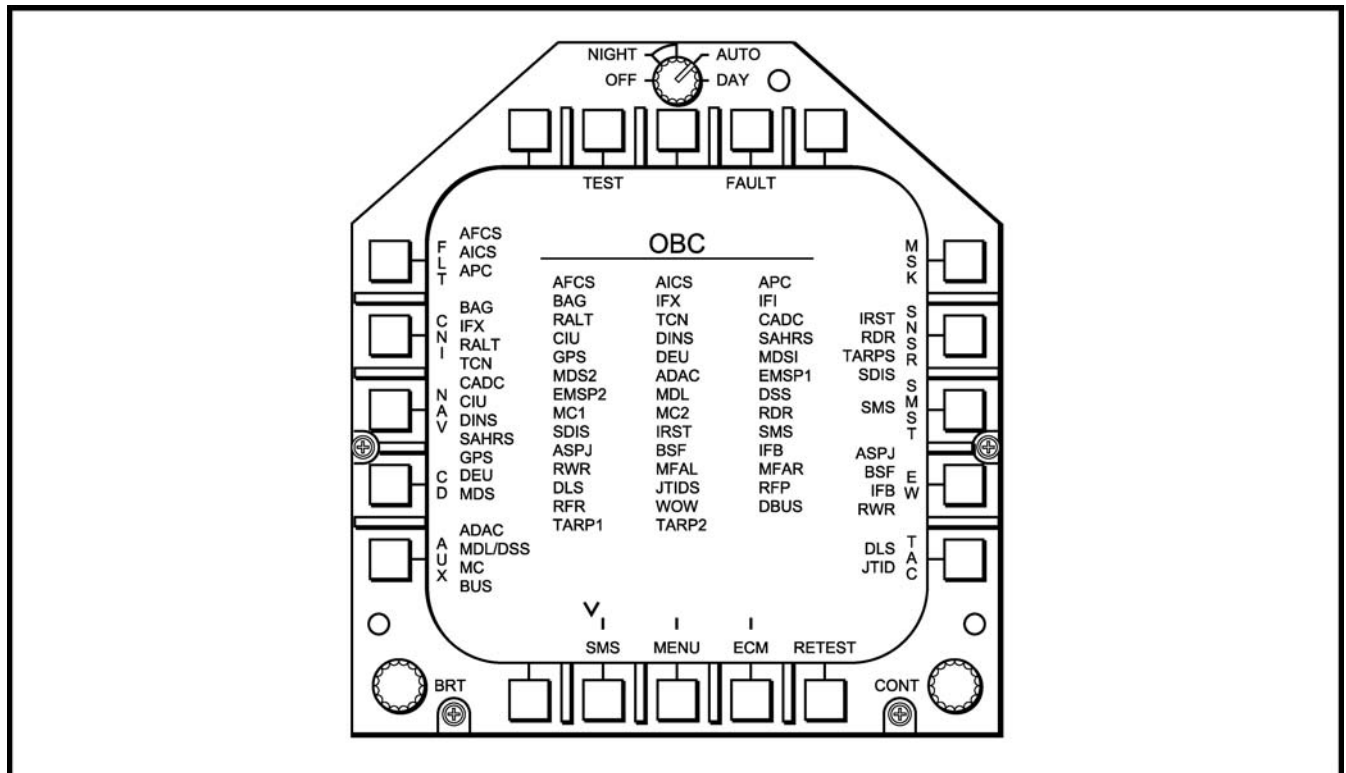
If any interlocks are broken while IBIT is running, IBIT will be aborted. This state will be indicated by extinguishing of the ACL mode caution, and AP mode reference lights, and illumination of all other DFCS related caution/advisory lights. The AUTOPILOT switch will revert to the OFF position. Additionally, the DCP will display the ABRT, RBRT, or IBRT codes. Depressing pilot MASTER RESET will reengage the DFCS and extinguish the ABRT DCP code.

38.3.3.2.7 Completion without Faults

Upon completion of IBIT without any faults being detected, all DFCS related caution/advisory lights, and acronyms will be returned to the state that existed prior to IBIT initiation, and the AUTOPILOT switch will revert to the OFF position. The DCP will display a PASS code which can be extinguished by depressing MASTER RESET. At that point the display will either be blanked or the IBIT ARM message will be displayed, depending on MASTER TEST switch position, and the DFCS will enter OFF.

38.3.3.2.8 Completion with Faults

If faults are detected during IBIT, they will be indicated to the aircrew through the caution/advisory lights and TID acronyms as indicated in [Figure 38-10](#) along with any caution/advisory indications which existed before IBIT was initiated. Additionally, the DCP will show a NOGO code.



CSC-F14D-1-38-015

Figure 38-12. OBC Basic Format

Depressing the INC button will display the IBIT code followed by specific WRA codes for failures detected during IBIT. Depressing MASTER RESET will clear the IBIT failure indications along with any previously existing resettable indications, but does not indicate that the detected failures have been resolved. The DCP display will either be blanked, or return to the IBIT ARM indication, depending on MASTER TEST switch position, and the DFCS will enter OFP. IBIT failure codes will still be stored in the DCP display and can be recalled with the INC/DEC buttons until another IBIT is run or aircraft power is secured



Following an IBIT, MASTER RESET will clear the IBIT failure indications including caution/advisory lights, but does not ensure the failures detected during IBIT are resolved. The DFCS should not be considered fully operational. Only the successful completion of another IBIT can verify proper system operation.

Note

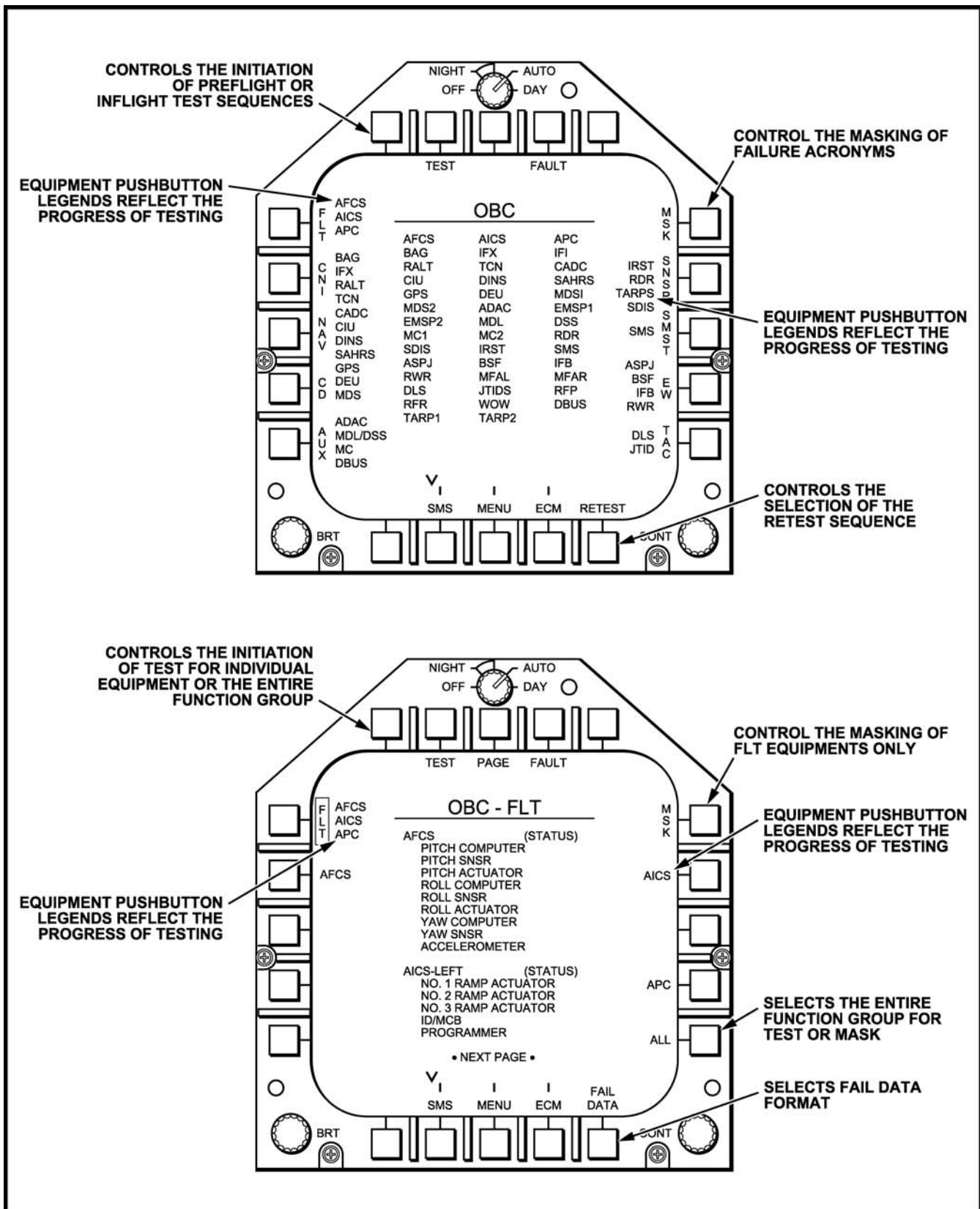
AFC acronyms following OBC are invalid because DFCS IBIT lasts longer than the rest of

the OBC tests. These should be cleared via the CLR pushbutton to allow subsequent fault reporting in OFP. Acronyms present following stand alone IBIT are generally valid.

38.3.3.3 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 38-13](#) 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.



CSC-F14D-1-38-016

Figure 38-13. Format Examples

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.

38.3.3.3.1 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.

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 38.3.3.3.3 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 38.3.3.3.3 for computer message descriptions.
8. If the interlock conditions are satisfied, the RE-TEST 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.

38.3.3.3.2 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 or 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.

38.3.3.3.3 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 38-14](#)).

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 38-15](#)).

38.3.3.3.4 OBC-Related Warning/Caution/Advisory Messages

[Figure 38-16](#) shows acronyms that are displayed on MFD3 in response to equipment failures or overheating.

38.3.3.3.5 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 MDL 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 equipment: MC1, MC2, CIU, SAHR, MDS1, MDS2, DEU, INS, ADAC, SMS, RWR, ASPJ, RDR, SDIS, IRST

Figure 38-14. OBC Computer Messages

COMPUTER 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 equipment 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 38-15. 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.
GPS FAIL	GPS is NO GO or NOT READY	GPS failed, or powered off.
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 38-16. 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 programmable 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 38-17](#)), 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 38-18](#)) 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 (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 MC 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.

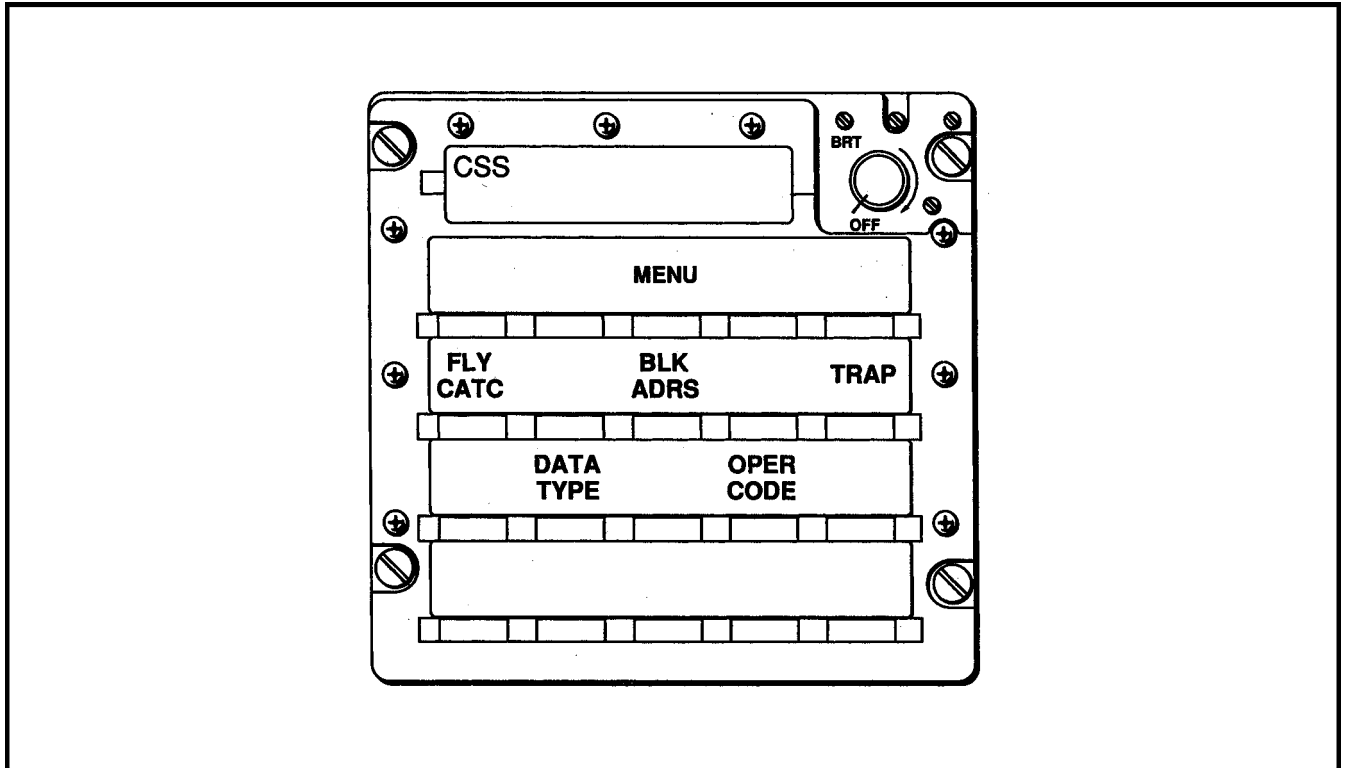
The CSS OPER CODE page format (see [Figure 38-18](#)) allows the optional selection of an operator code. This code is used to identify the operator/aircraft when CSS data is analyzed offline. The code is entered by pressing the corresponding numerics and then pressing ENT.

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.

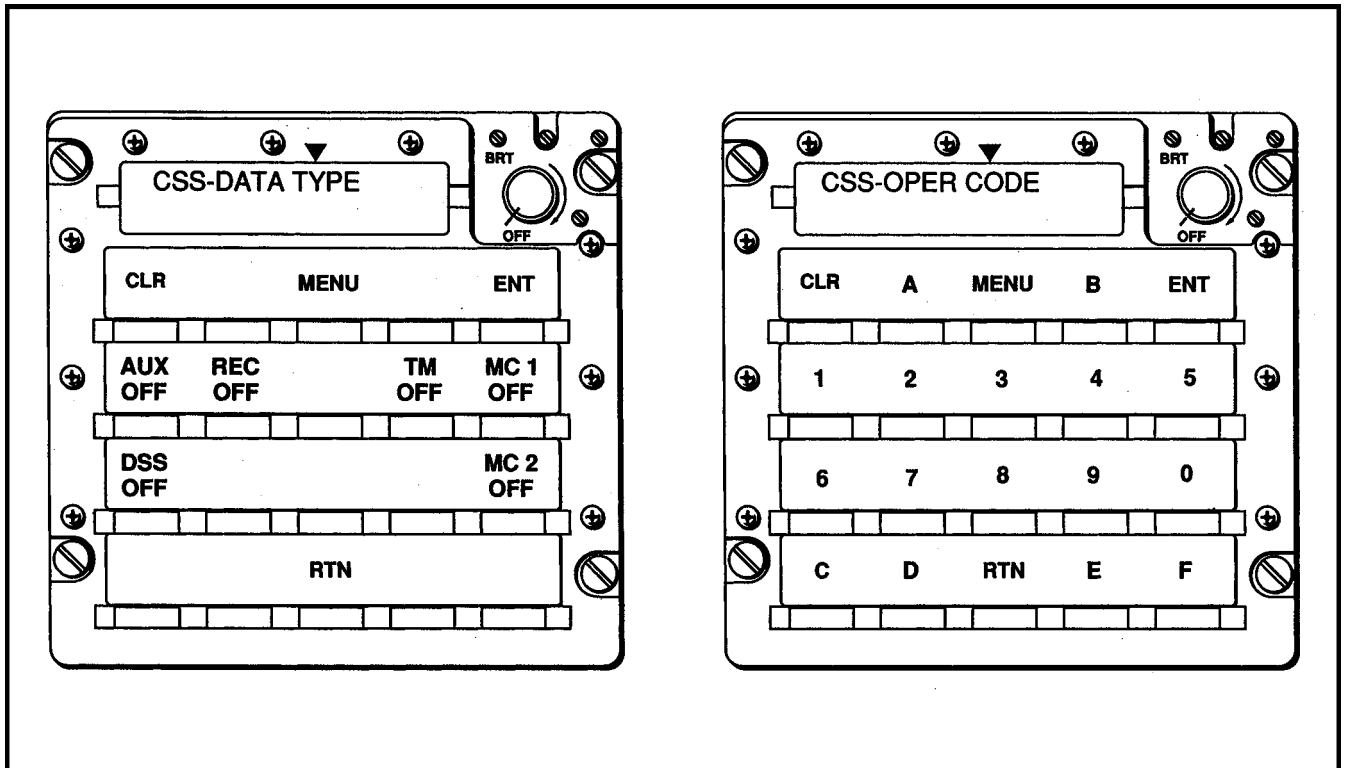
Flycatcher is initiated or terminated as follows, using the DEU (see [Figure 38-19](#)):

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.



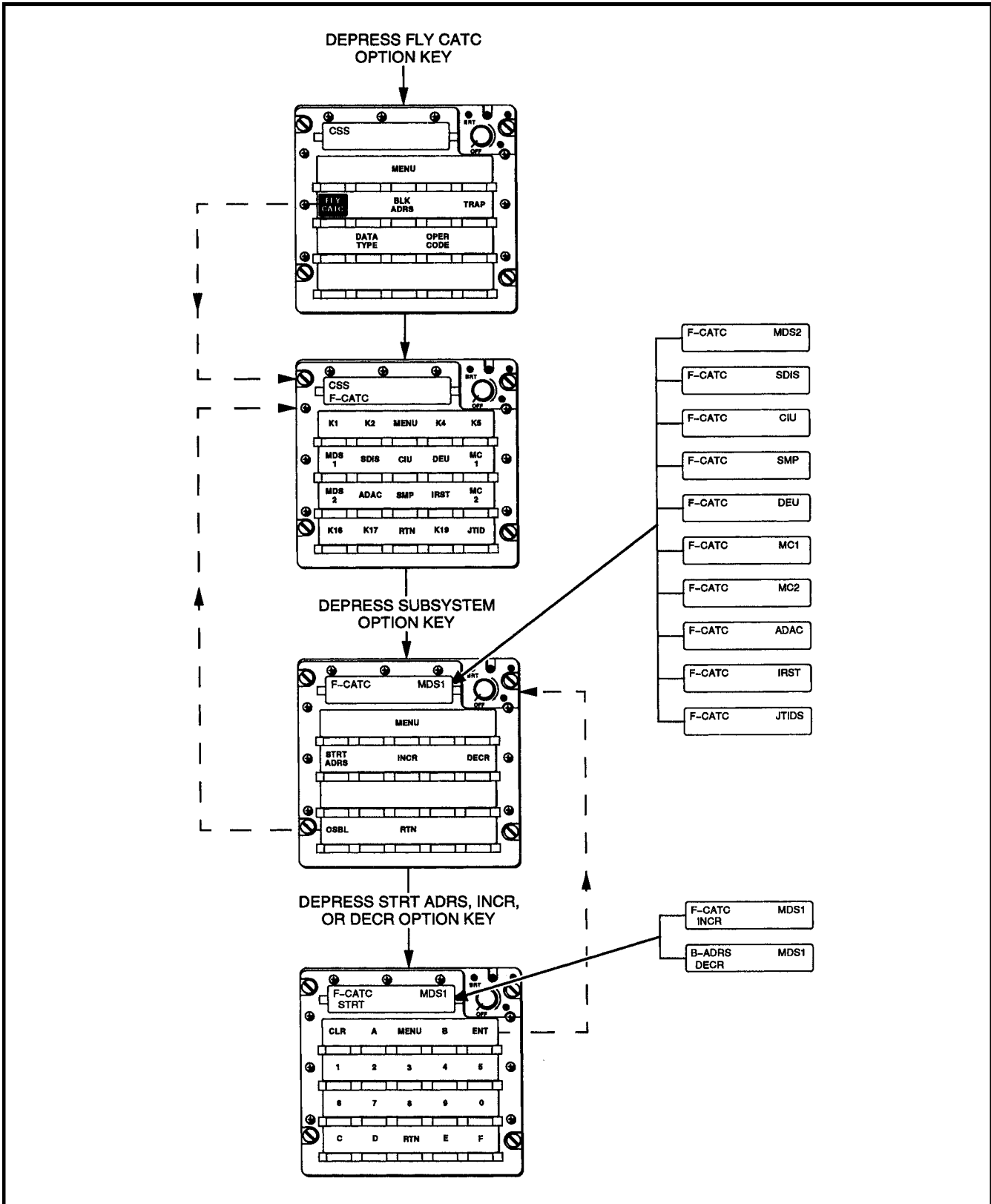
(AT)1-F50D-383-0

Figure 38-17. DEU CSS Page



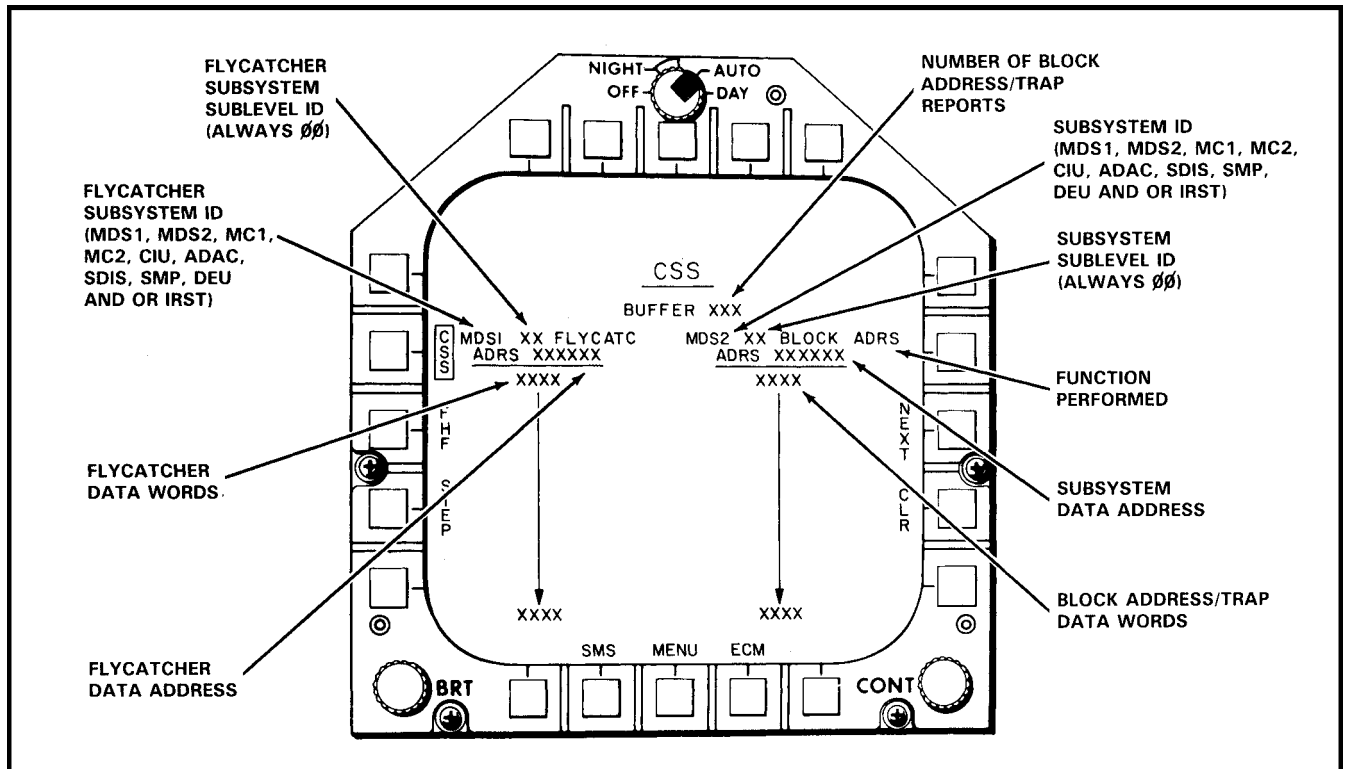
(AT)1-F50D-384-0

Figure 38-18. DEU Pages for Operator Code and Data Type



(AT)2-F50D-385-0

Figure 38-19. DEU Flycatcher Pages



0-F50D-386-0

Figure 38-20. MD 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 38-19](#)):

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 38-20](#)).

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 38-21](#) 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.

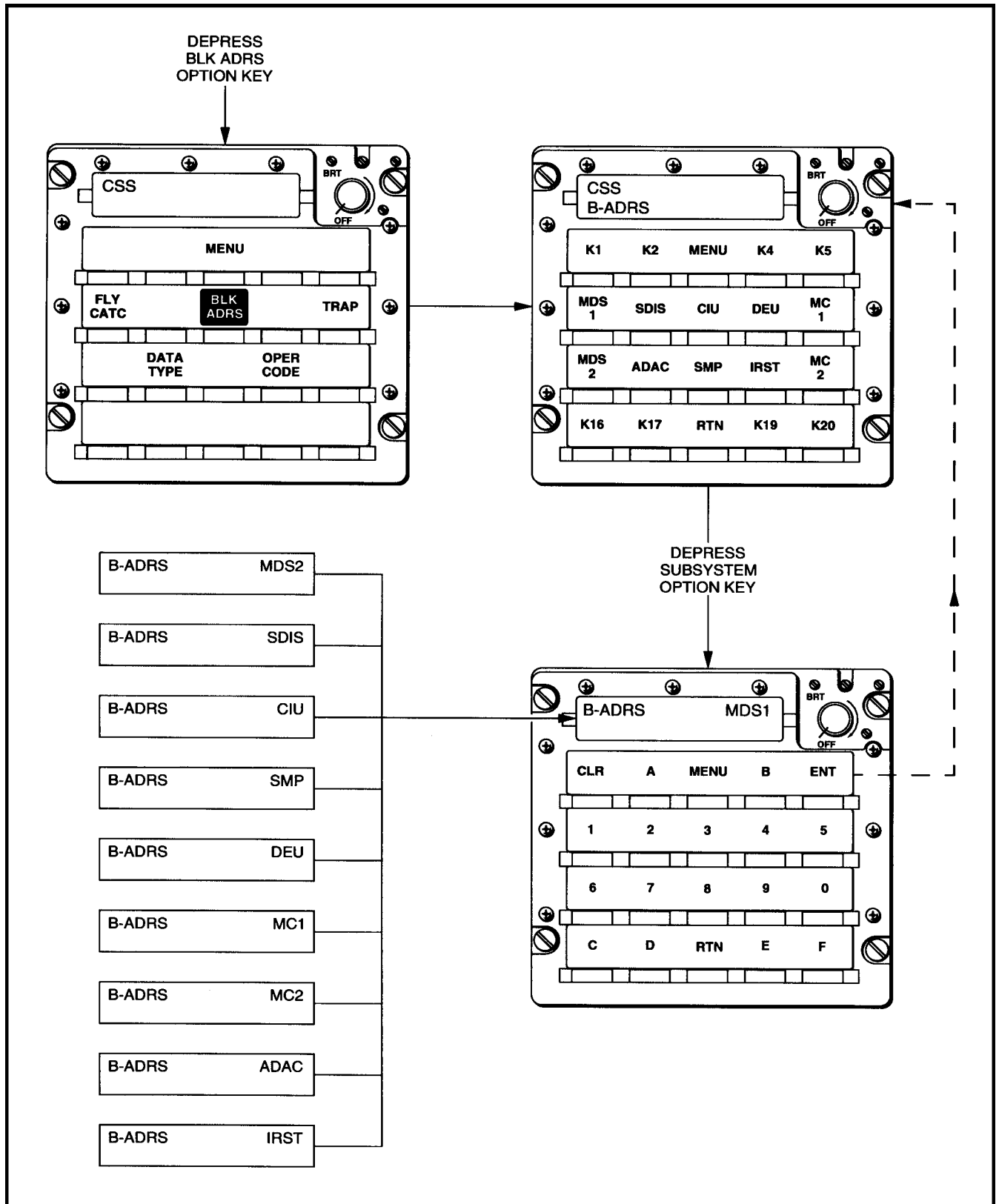
Block address is initiated as follows, using the DEU (see [Figure 38-22](#)) (note that block address terminates automatically after its activation):

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.
<p>Note:</p> <p>(1) {SSSS} identifies the affected CSS compatible subsystem.</p>	

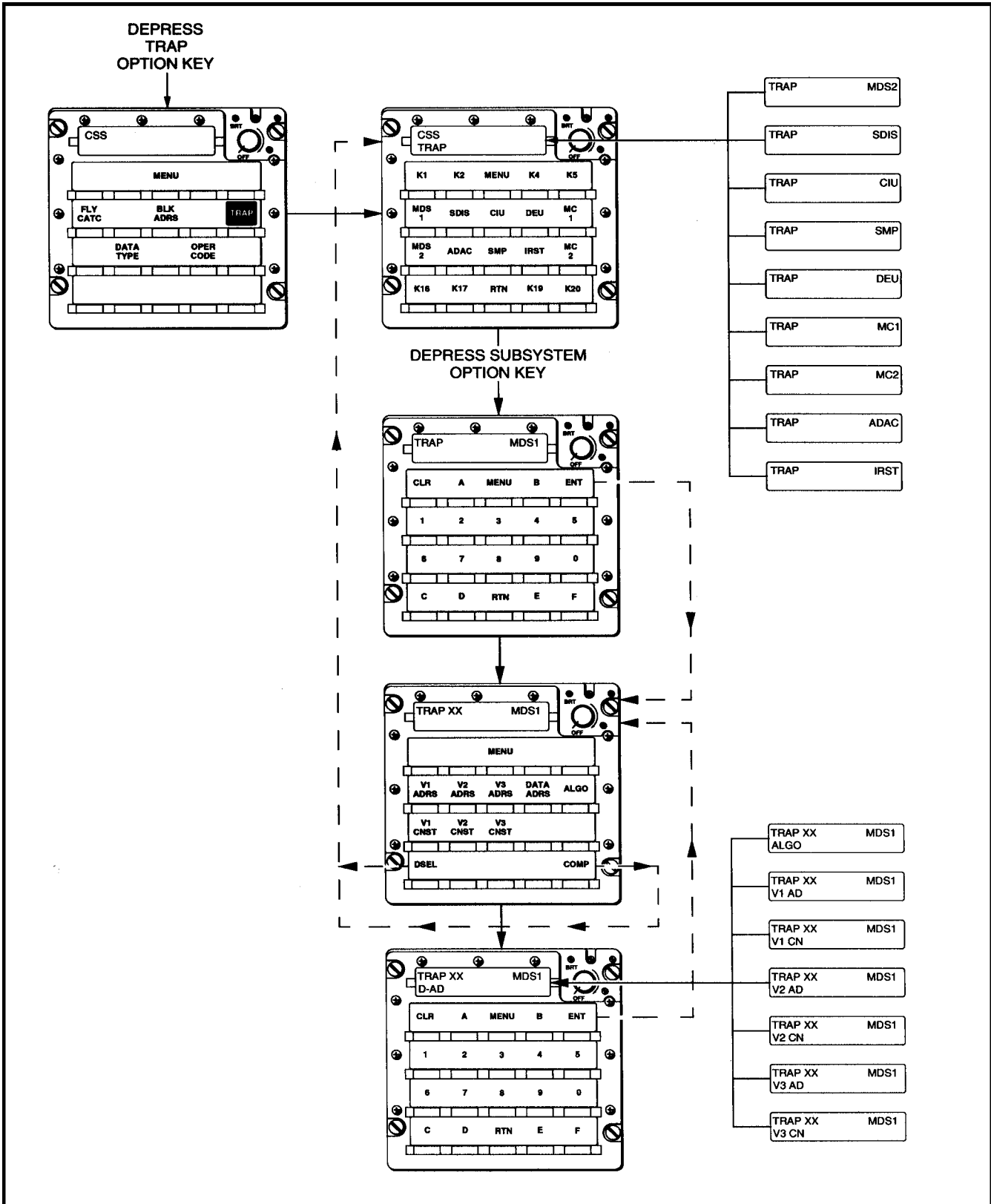
Figure 38-21. Flycatcher Error Messages

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 38-23](#)). There is a maximum of four taps 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 tap.
 5. Repeat steps 2 through 4 to initiate or terminate additional trap operations for other systems.



(AT)1-F50D-387-0A

Figure 38-22. DEU Block Address Pages



(AT)1-F50D-388-0

Figure 38-23. 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 38-24. 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:

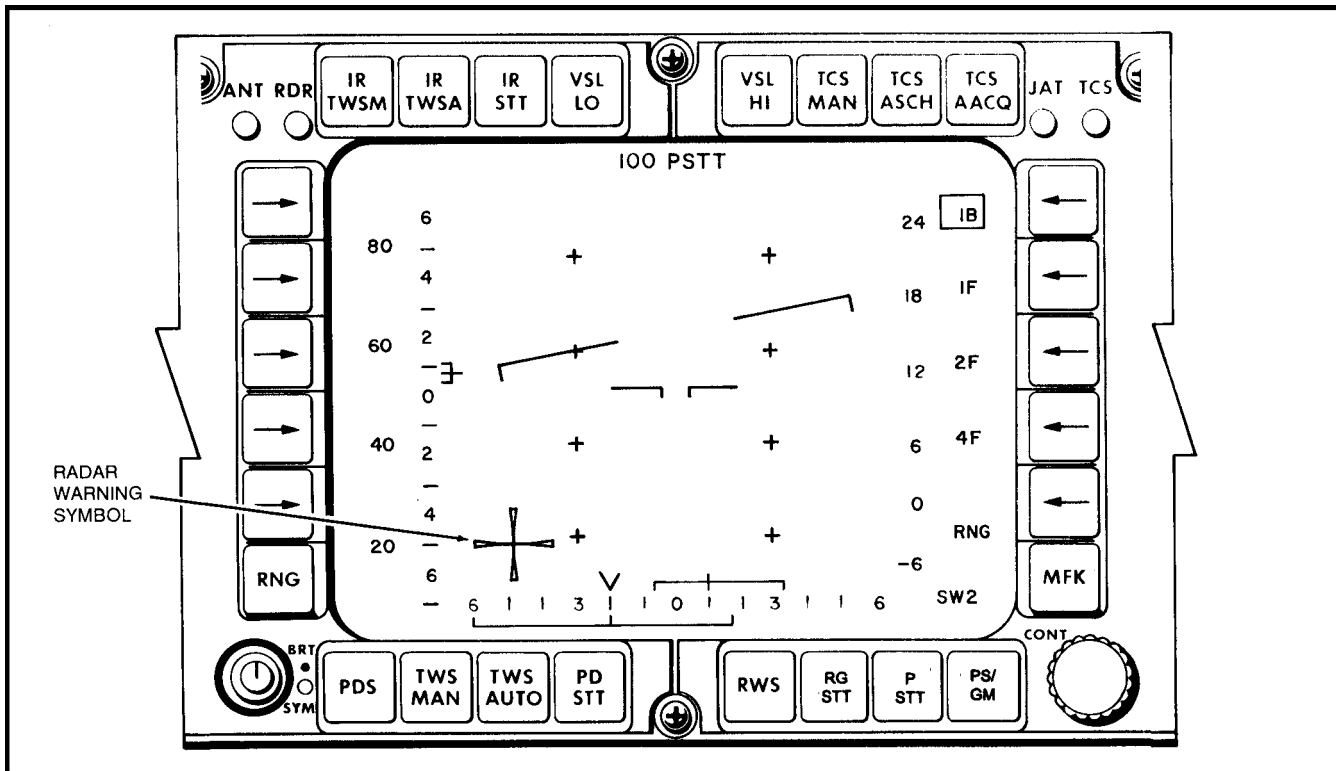
1. Select CSS format on any MFD by pressing FAULT pushbutton on OBC basic format, and then pressing CSS pushbutton on MAINT CURRENT FAILURES format.
2. Press NEXT pushbutton to display next data report. The number of block-address/trap reports indicates if any additional reports of data are available 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 38-24](#) 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-495-0A

Figure 38-25. 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 38-25). 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 PTID as two-character acronyms. Aircraft anomalies will appear on the PTID 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 PTID and the BIT menu will appear on the DD. 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 PTID 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 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 PTID, 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; display, 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 (IBIT)

The IBIT mode contains five submodes: radar BIT, displays BIT, television camera set BIT, digital display built-in self-test, and special tests BIT.

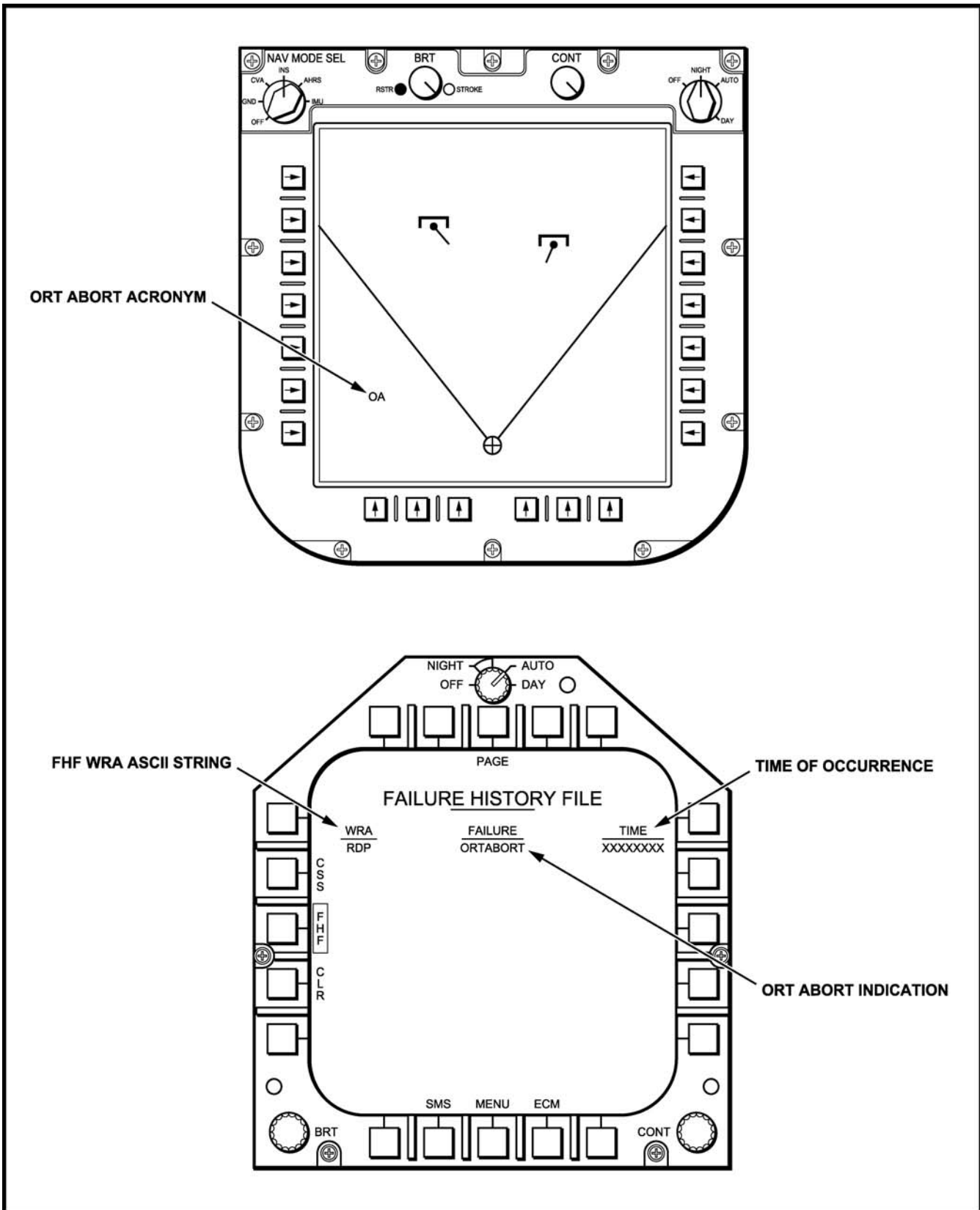
38.5.1.3.1 Radar BIT

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 PTID 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 PTID mode switch setting and DD keypad entry. The RIO must confirm visually that this subsystem is functioning properly.



CSC-F14D-1-38-004A

Figure 38-26. MFD/PTID 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 PTID 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 (BIST)

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 PTID.

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 is playing 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 test target display on the lower left position of the PTID.

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)

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, 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.

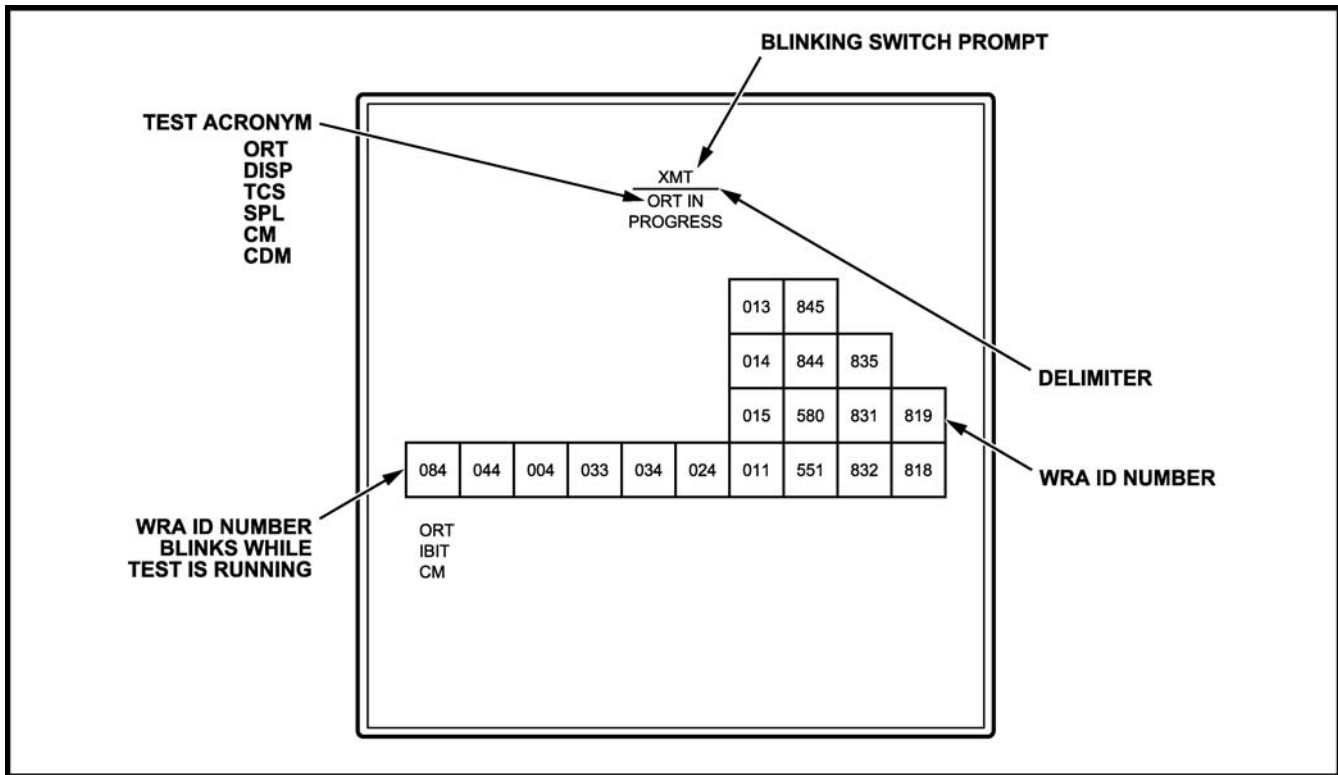
Radar anomalies appear on the PTID, in the lower left quadrant as two character acronyms. Acronyms will be displayed continuously while a failure condition exists. If multiple failures occur, the appropriate acronyms will be automatically updated at a 2-second rate. When an acronym is displayed, the RIO can select the LM 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 PTID, 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 XMT (to start ORT execution). After powerup, CDM or ORT



CSC-F14D-1-38-005

Figure 38-27. Test-in-Progress Display

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.

The test-in-progress display is presented on the PTID (see Figure 38-27). 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 PTID 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 PTID. 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 PTID display is presented upon initiation of ORT, CDM, or IRT (see Figure 38-27). 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 38-28.

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 PTID.

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	- Programmable tactical information display (PTID)
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 (BCU)
845	- Sensor hand control (SHC)

Figure 38-28. WRA Common Names and Designators

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 38-29](#)). 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.

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 38-30](#) is provided on the PTID 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 PTID and a pass (4), 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 PTID 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.

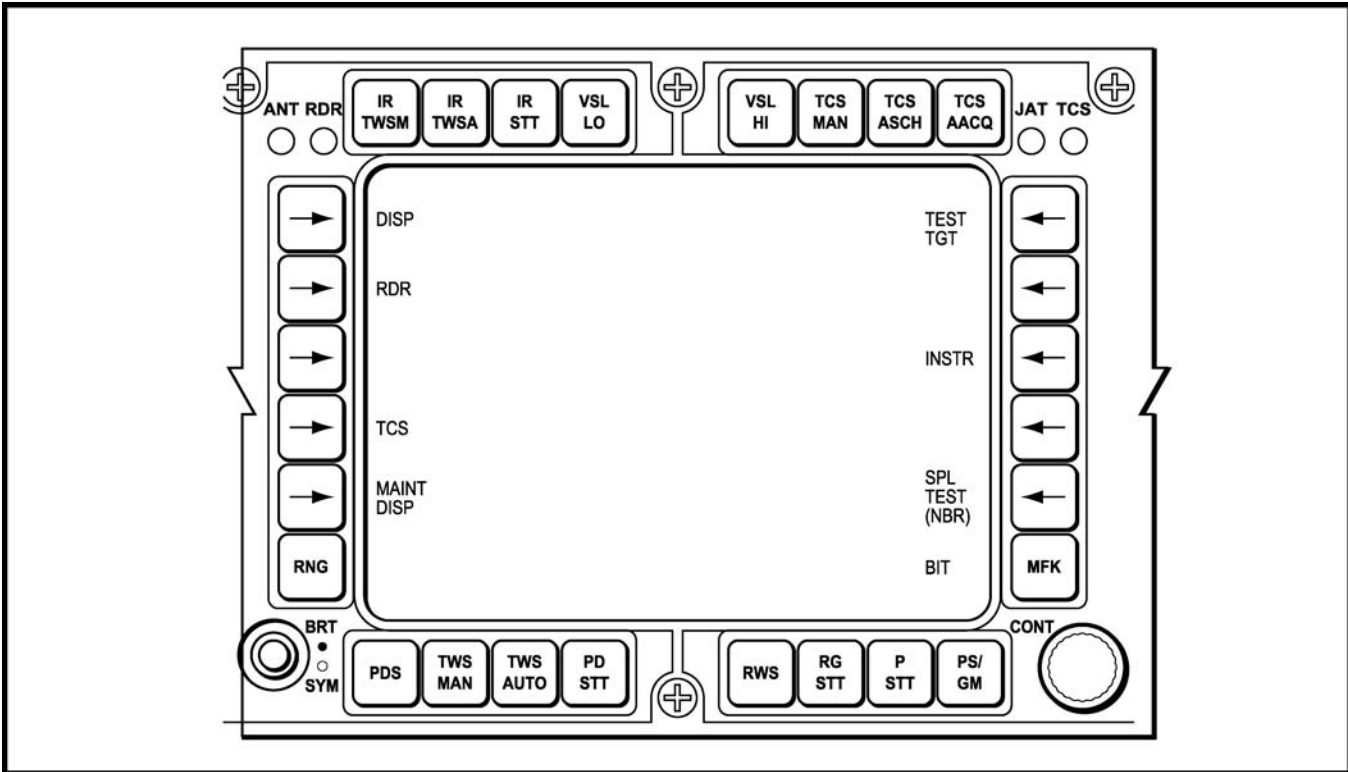
Note

After a tactical mode is entered, the DMA display format cannot be restored.

38.5.2.1.4 Maintenance Display Format

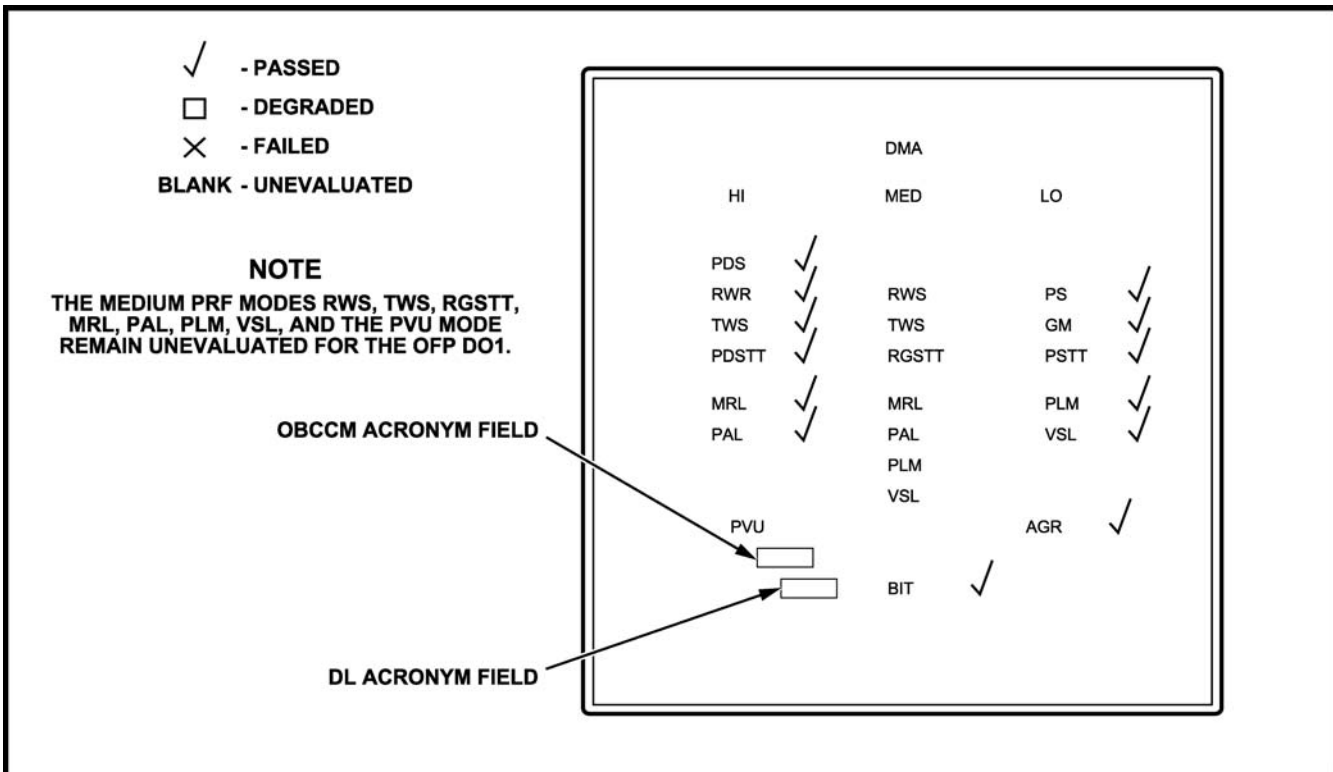
The maintenance display is obtained by depressing the DD BIT menu pushtile adjacent to MAINT DISP. It can be selected during displays test, a tactical radar mode, or special test. It can also be obtained by transitioning from the DMA display (described in paragraph 38.5.2.1.3).

The maintenance display provides test pass or fail status to the RIO. If no faults are detected, a RDR PASSED indication is displayed near the top of the PTID, no WRA designators are displayed, and a checkmark appears adjacent to the appropriate test (see [Figure 38-31](#)). If a failure is detected, a RDR FAILED indication is displayed near the top of the PTID, and the WRAs recommended for replacement along with the associated DPs, are displayed on the PTID (see [Figure 38-32](#)). The WRA designators and their corresponding common names are listed in [Figure 38-28](#).



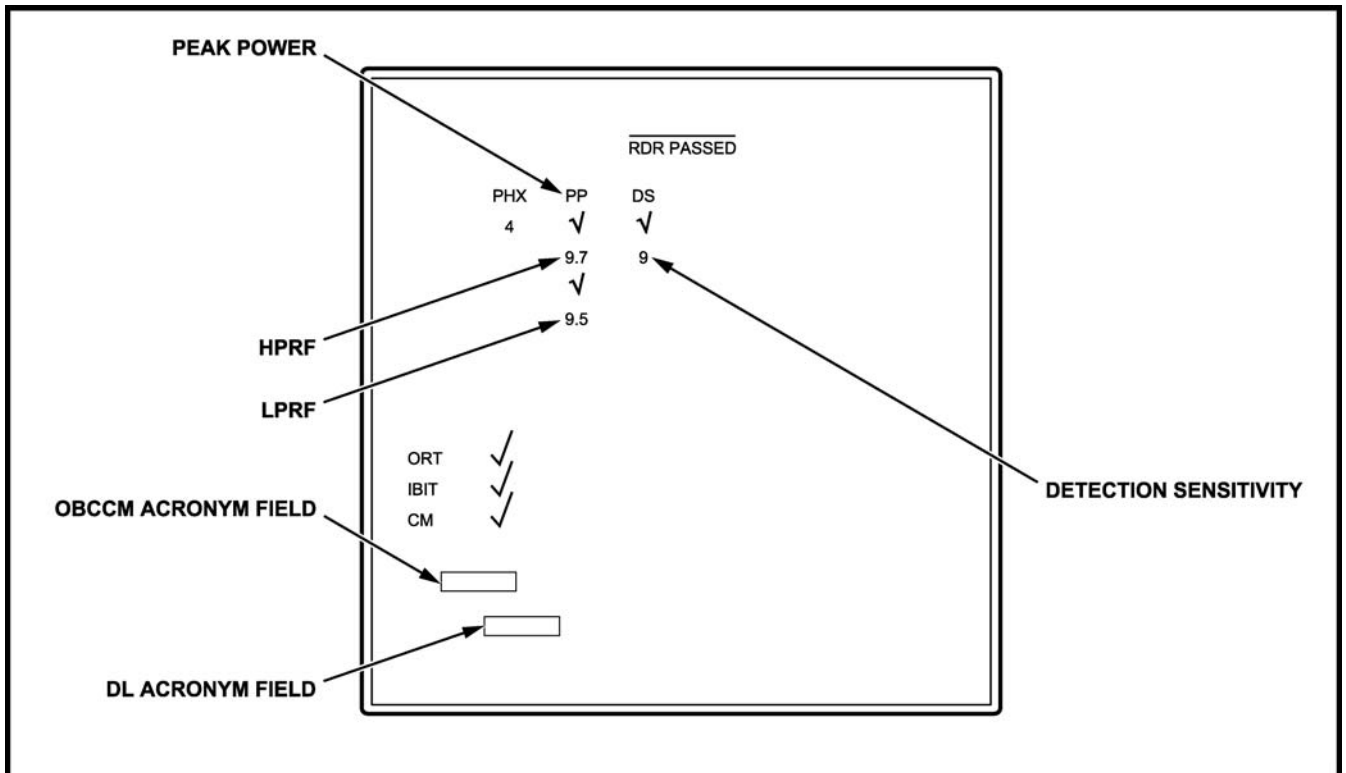
CSC-F14D-1-38-017

Figure 38-29. BIT Menu Display Format



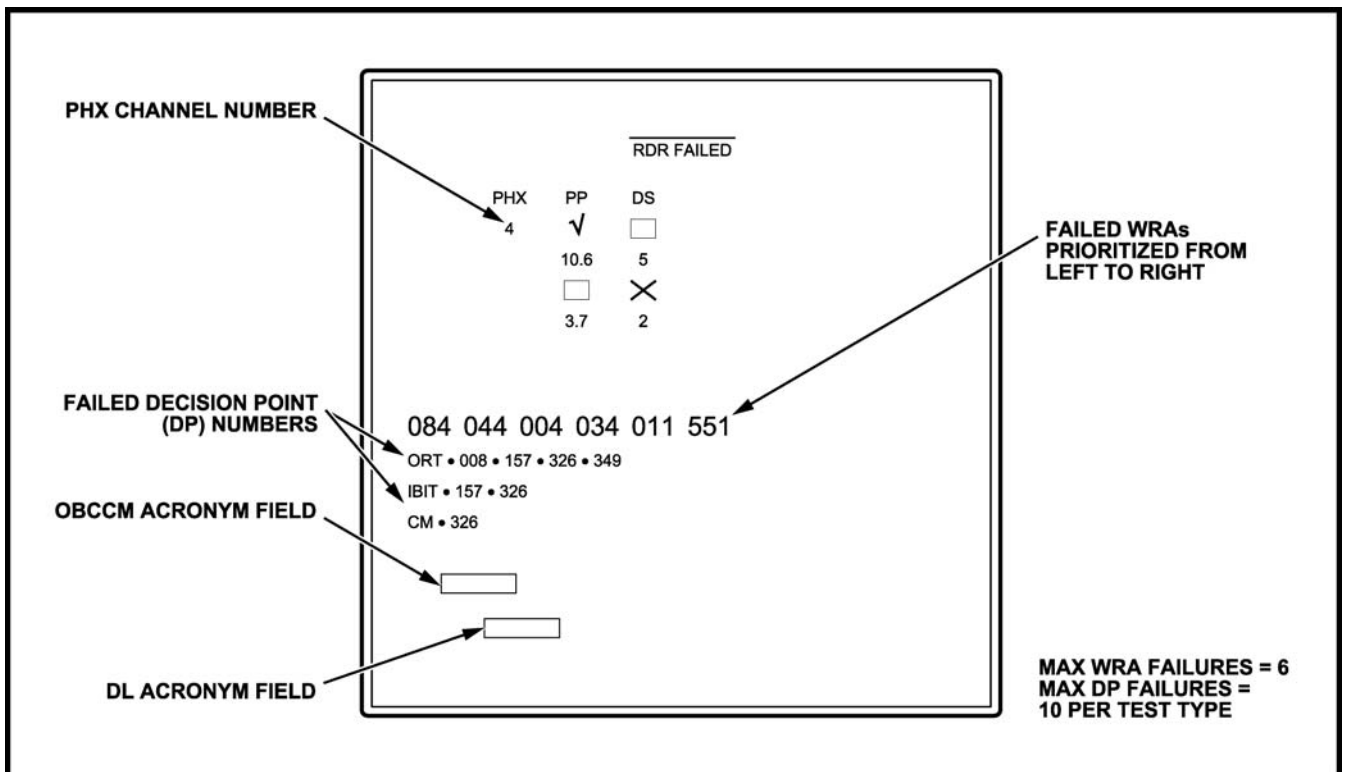
CSC-F14D-1-38-006

Figure 38-30. Degraded Mode Assessment Format



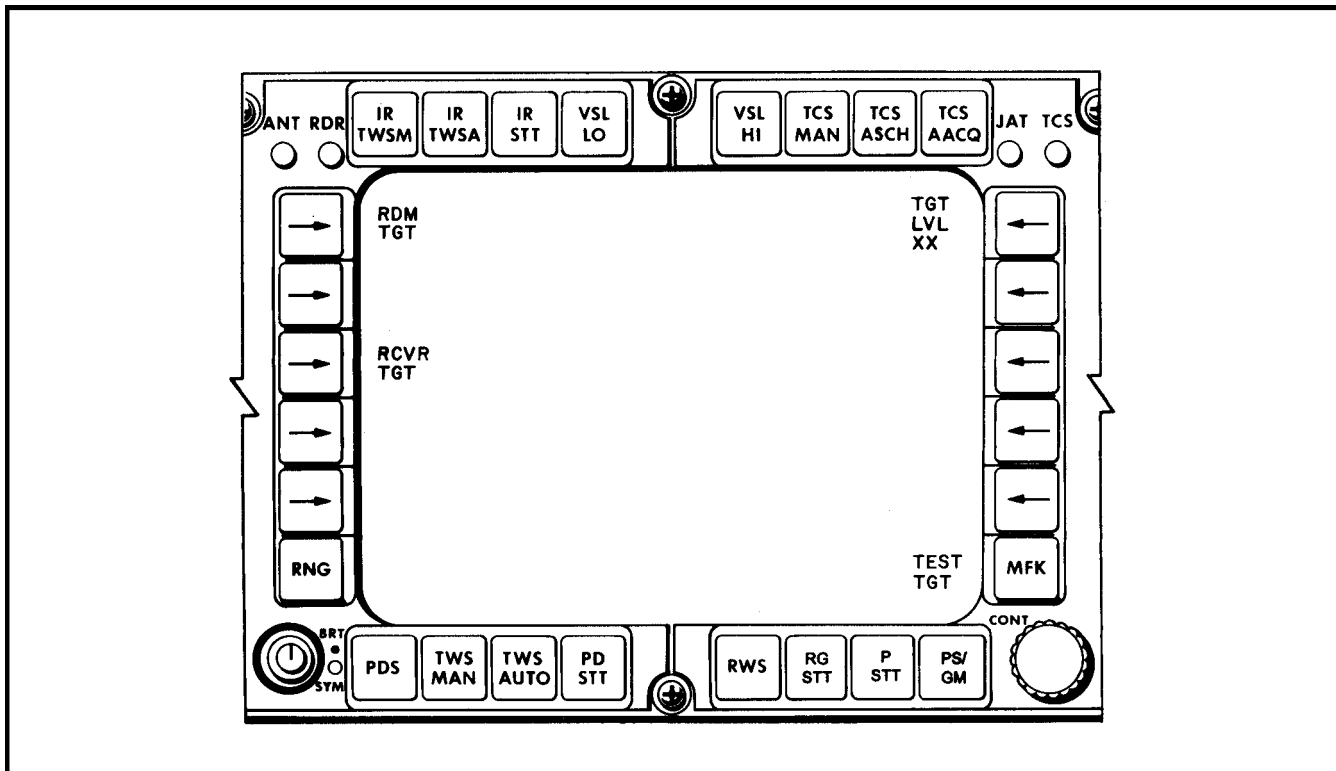
CSC-F14D-1-38-007

Figure 38-31. Maintenance Display Format (Test Complete)



CSC-F14D-1-38-008

Figure 38-32. Maintenance Display (Test Complete)



1-F50D-392-0A

Figure 38-33. 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 detection sensitivity and peak power for HPRF and LPRF modes are displayed on the PTID 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.

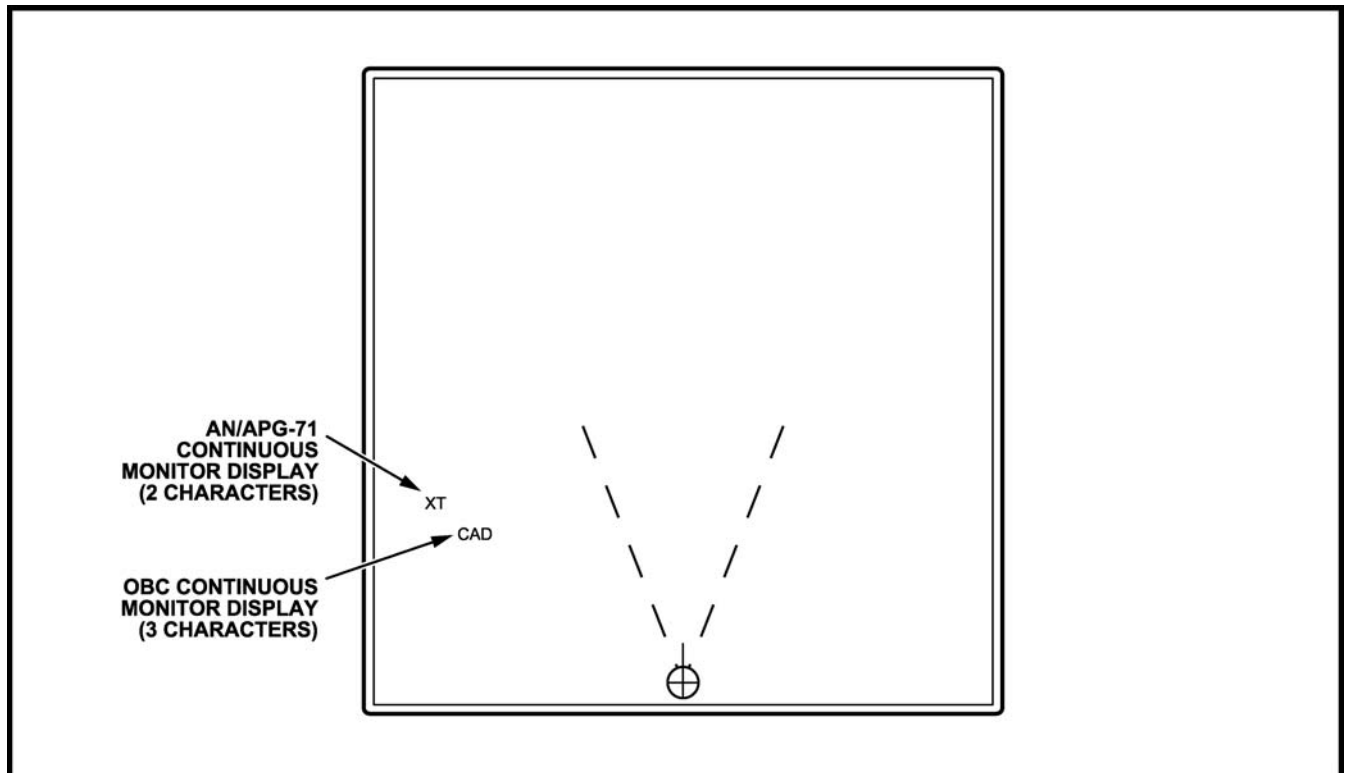
To initiate the test target, the DD MFK pushtile is used to select the BIT menu. The test target is selected by depressing the button adjacent to TEST TGT. The test-target menu is displayed on the DD (see Figure 38-33). The test target can be injected in two places depending on RIO switch activation. 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 PTID 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 PTID; 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.



CSC-F14D-1-38-009

Figure 38-34. 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 command:

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 PTID whenever a fault is detected (see [Figure 38-34](#)). 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 two letter acronyms that may appear as a result of radar CM failures is shown in [Figure 38-35](#).

Aircraft anomalies will appear on the PTID (lower left quadrant directly below the radar CM acronyms) whenever a fault is detected (see [Figure 38-35](#)). 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 38-36](#).

38.5.2.1.7 TCS Test Format

The TCS test is a 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 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 slaved to TCS,

ACRONYM	EQUIPMENT
BB	Computer bus backup enabled (DP 409)
BF	PTID 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, PTID, 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, ARS, RMO, ANT, ASC, TX)(DPs 197, 385, 386, 387, 388, 390)
SA	Semi-active decoder error (DP 187)
SI	PTID 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 38-35. Radar Continuous Monitor Acronyms

OBCCM ACRONYM	EQUIPMENT
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
DFC	Digital flight control system
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
IR	Infrared search and track system

OBCCM ACRONYM	EQUIPMENT
MC1	Mission computer no. 1
MC2	Mission computer no. 2
MDL	Mission data loader
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 38-36. OBC Continuous Monitor Acronyms

radar slaved to TCS pointing accuracy test, hand control forward right, hand control half-action, and TCS slewing test.

When the TCS test begins, the display in [Figure 38-37](#) shall appear on the PTID. 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 38-38](#) 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 PTID.

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 PTID.

After the C/D TEST is selected, the DD display will appear as shown in [Figure 38-39](#). 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 38-40](#)).

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 38-41](#) 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.

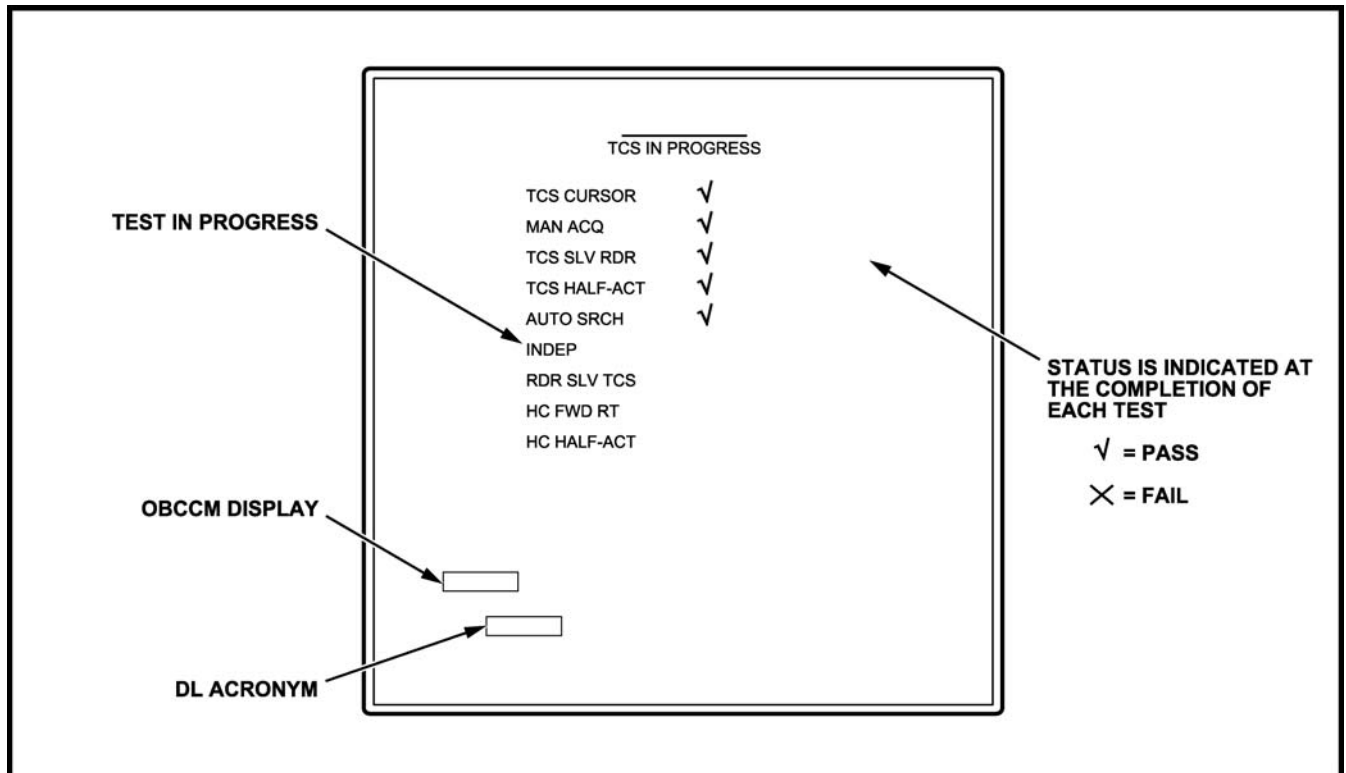
c. C/D TEST 3 Display. When C/D TEST 3 is selected, the DD display shown in [Figure 38-42](#) will appear. This display tests the capability of the DD to respond to signals from interfacing units and to other signals. When the SHC RDR switch is set to CMTR, and the commands shown in [Figure 38-43](#) 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 PTID controls. Selections and responses are shown in [Figure 38-44](#) and [Figure 38-45](#), respectively.

38.5.2.1.9 Display Test Formats

The displays test gives the RIO standard test patterns on the PTID 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 PTID MODE switch, the DD ANT, RDR, JAT, and TCS indicator lamps will illuminate. The PTID LAUNCH ZONE, VEL VECTOR, and CLSN indicator lamps will illuminate. The PTID center drum and steering drum will be blank. The test pattern shown in [Figure 38-46](#) will be displayed on the DD, and the pattern shown in [Figure 38-47](#) will be displayed on the PTID.

When A/C STAB or GND STAB is selected with the PTID MODE switch, all DD indicator lamps will go off. In addition, all PTID indicator lamps will go off, the PTID center drum will read SENSOR, and the steering drum will read MAN. The DD test pattern shown in [Figure 38-48](#) will be displayed, and the PTID will display the pattern shown in [Figure 38-49](#).

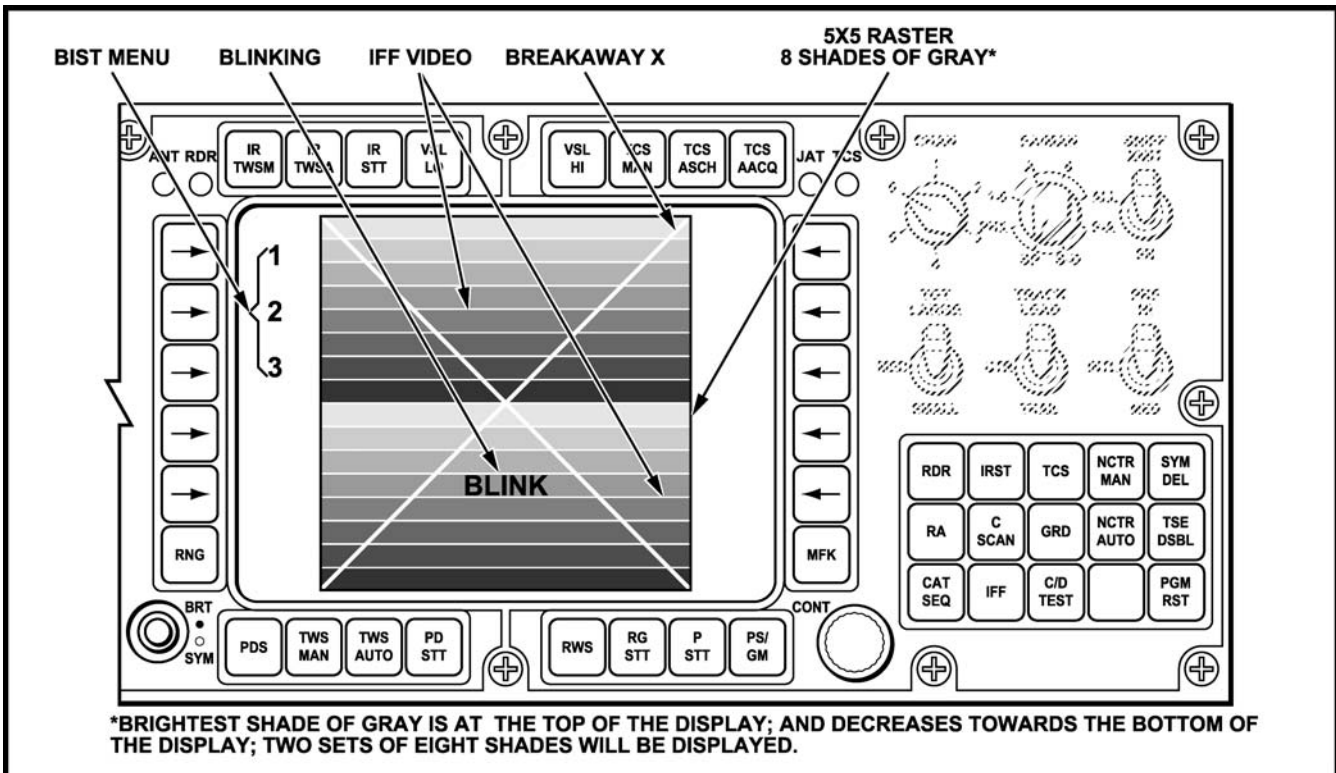


CSC-F14D-1-38-010

Figure 38-37. PTID Menu for TCS IBIT, In Progress

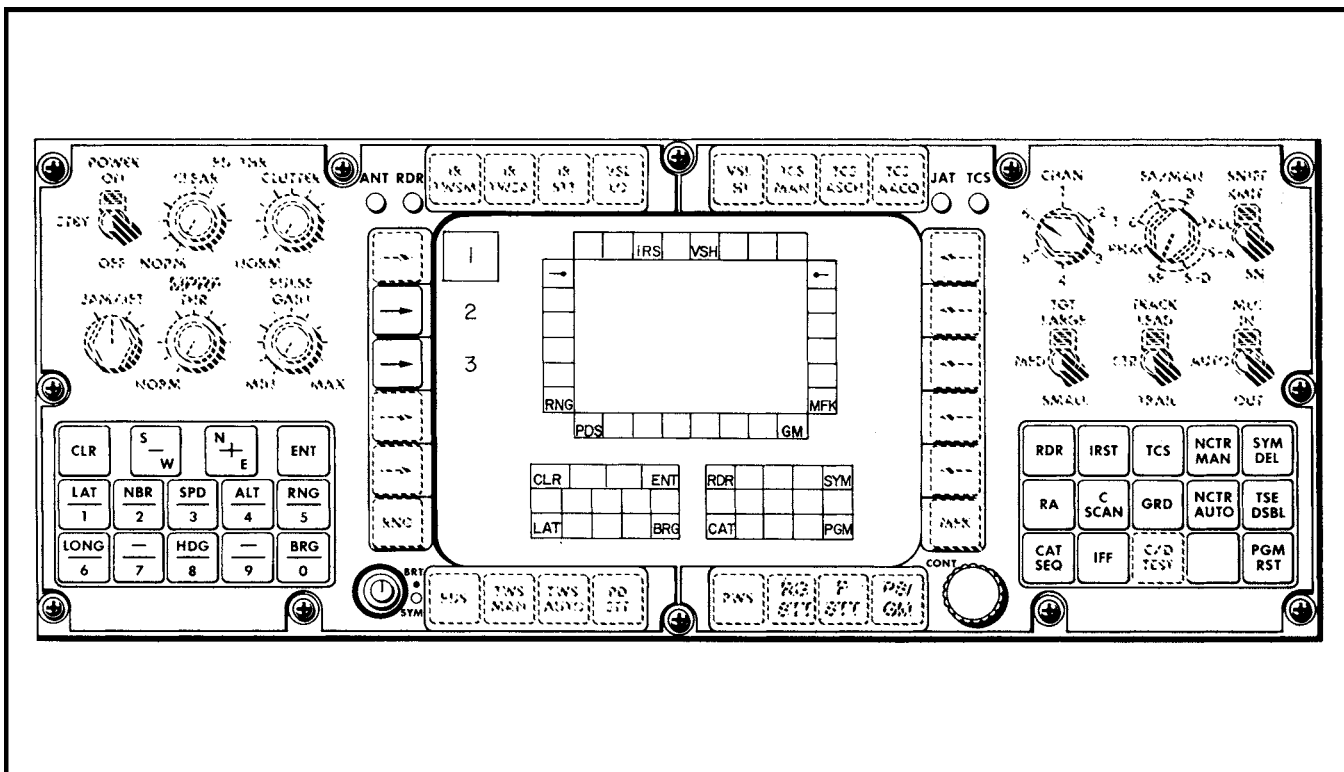
PROMPT DISPLAY ON PTID	RIO RESPONSE	
	UNIT	ACTION
TCS CURSOR	Sensor hand control	Select TGS cursor
MAN ACQ	Digital display	Depress TCS MAN pushtile
TCS SLV RDR	Sensor slaving panel	Select TCS slave
TCS HALF-ACT	Sensor hand control	Select half action and release
AUTO SRCH	Digital display	Depress TCS ASCH 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 38-38. TCS BIT Prompts and RIO Responses



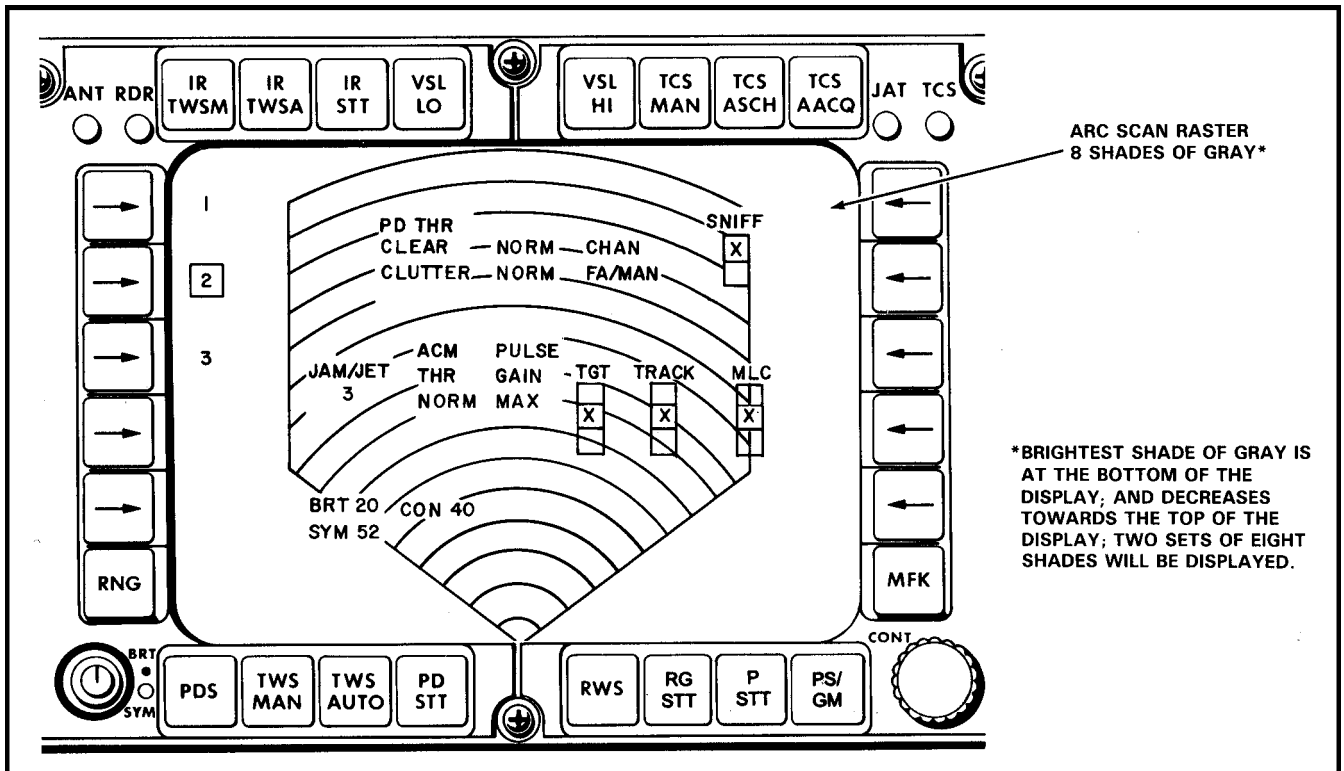
CSC-F14D-1-38-003

Figure 38-39. Initial C/D TEST Display



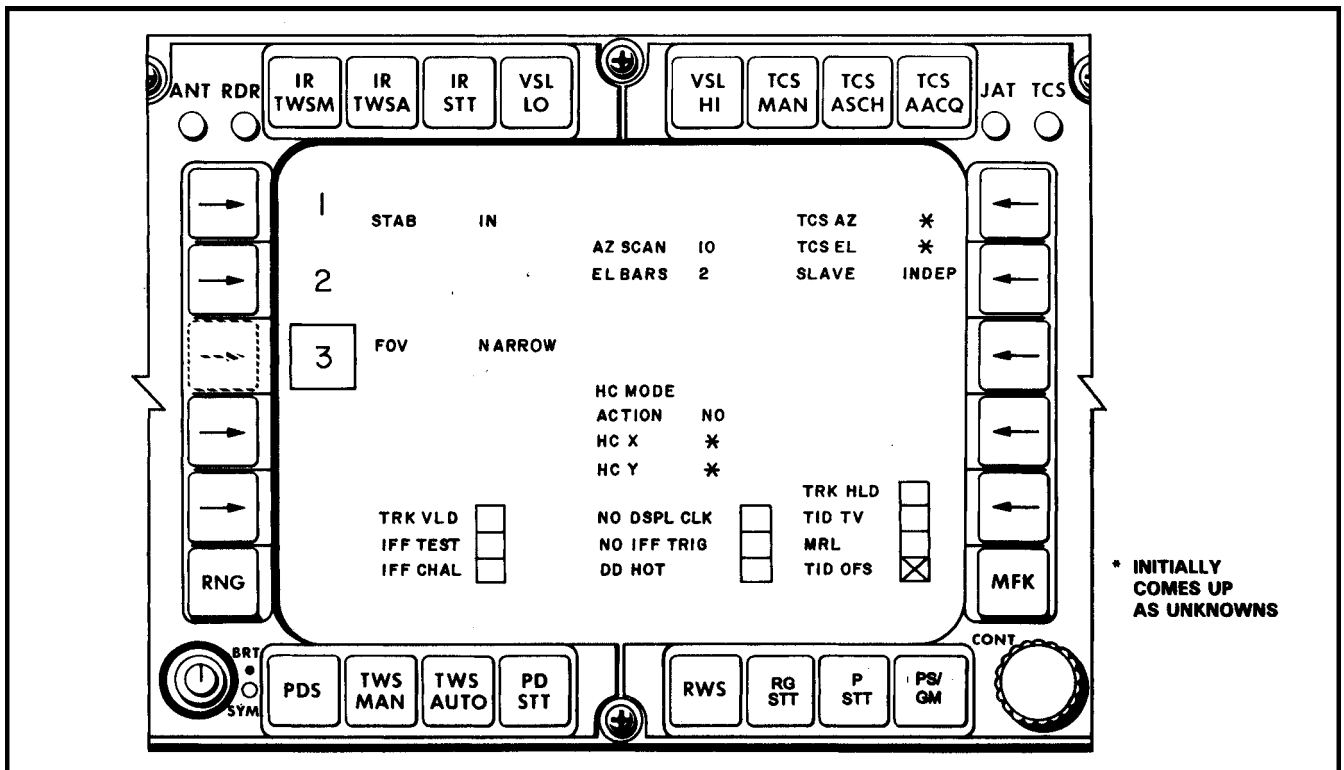
0-F50D-396-0

Figure 38-40. C/D TEST 1 Display (After Aging Is Completed)



0-F50D-397-0

Figure 38-41. C/D TEST 2 Display



0-F50D-398-0

Figure 38-42. 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
SLAV/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

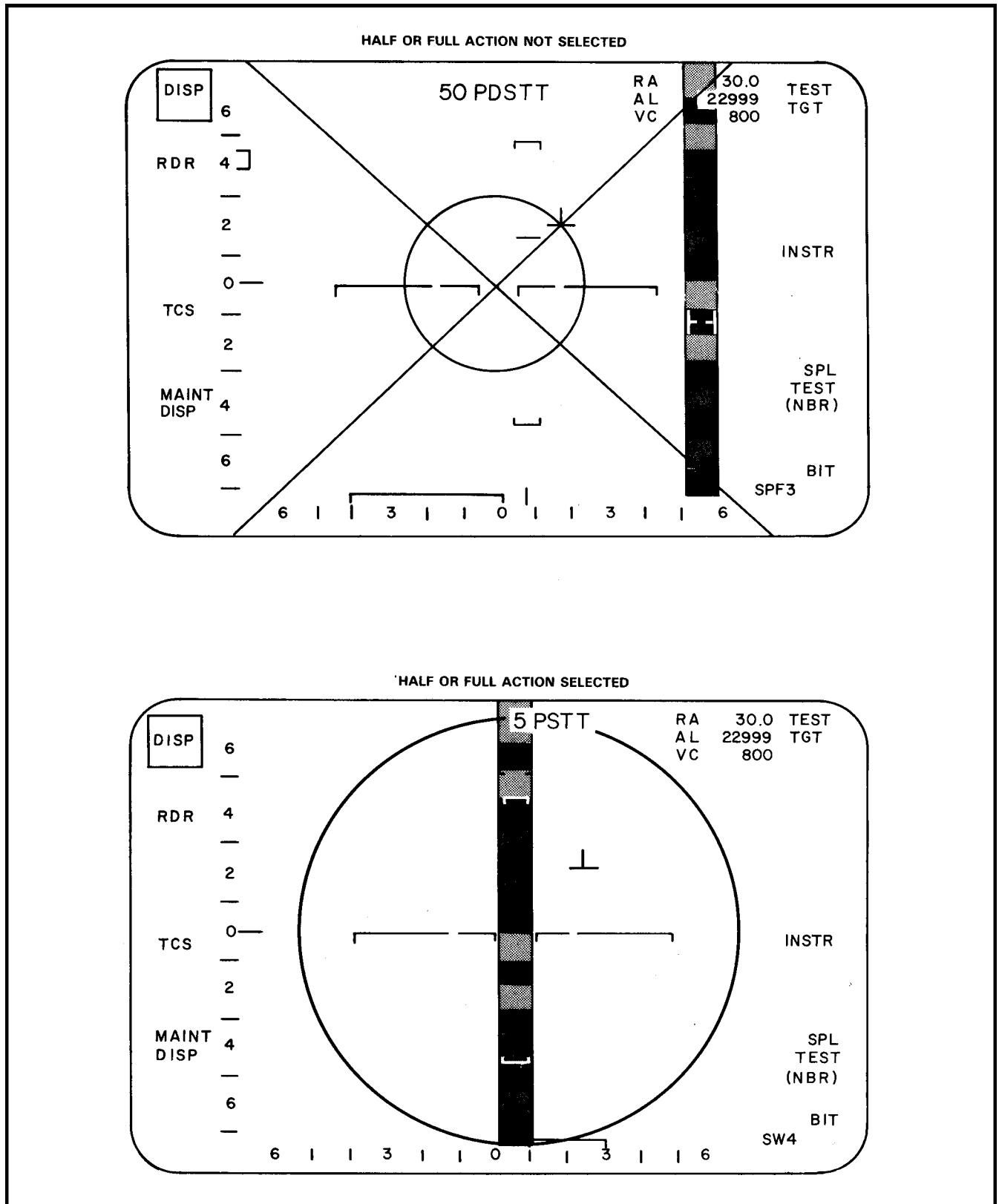
Figure 38-43. DD Responses for SCU/SSP/DD Select Tests

SHC CONTROL/SELECTION	DD RESPONSE
HC MODE/IR/TV	IR/TV
HC MODE/RDR	RDR
HC MODE/PTID CURSOR	PTID 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 38-44. DD Responses for SHC Select Tests

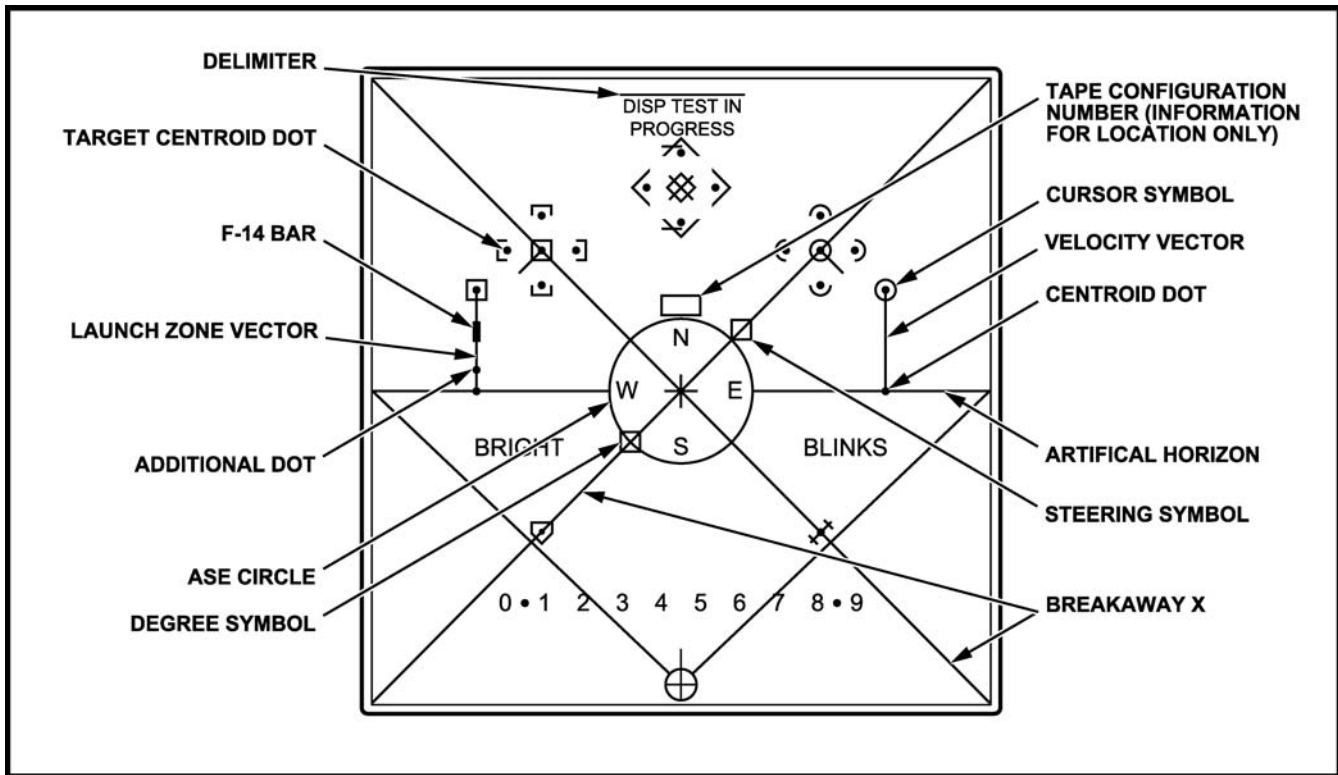
PTID CONTROL/SELECTION	DD RESPONSE
TRACK HOLD	X
PTID MODE/TV	C

Figure 38-45. DD Responses for PTID Select Tests



0-F50D-399-0

Figure 38-46. BIT Static DD Display (ATTK Selected)



CSC-F14D-1-38-011

Figure 38-47. BIT Static PTID 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 PTID cursor can be moved throughout the range of the PTID 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.

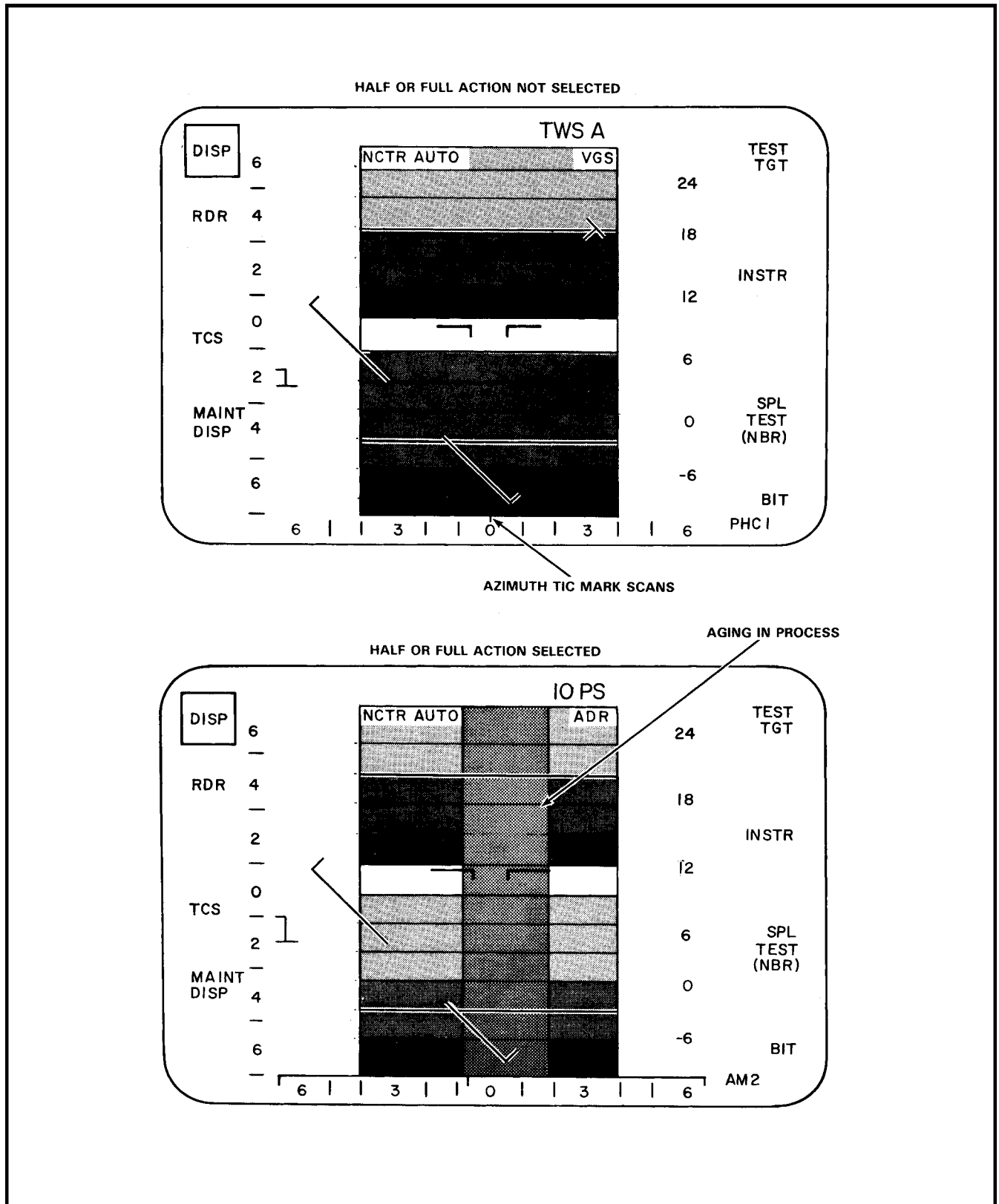
b. Dynamic Testing. The dynamic test consists of a visual evaluation of the movement of the artificial horizon, ASE circle, steering symbol, closing range rate indicator, launch zone symbols, and a velocity vector with TUIR and TUOR markers that sequentially vary in size or position. A fixed

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 PTID MODE switch, the displays on the PTID and DD (Figure 38-40 and Figure 38-41) will go through the following movements every 2 seconds:

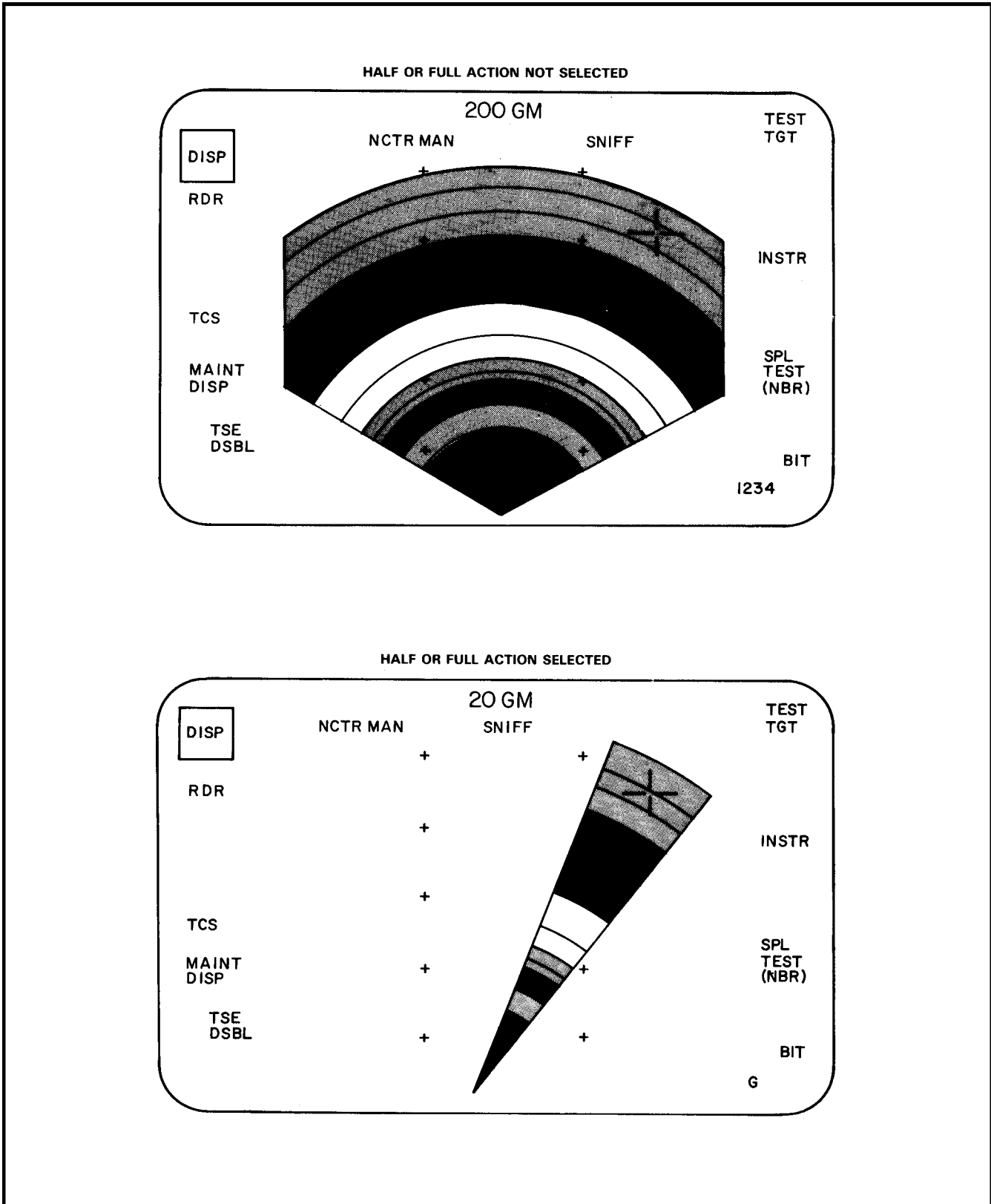
On the DD, the following occur simultaneously:

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.



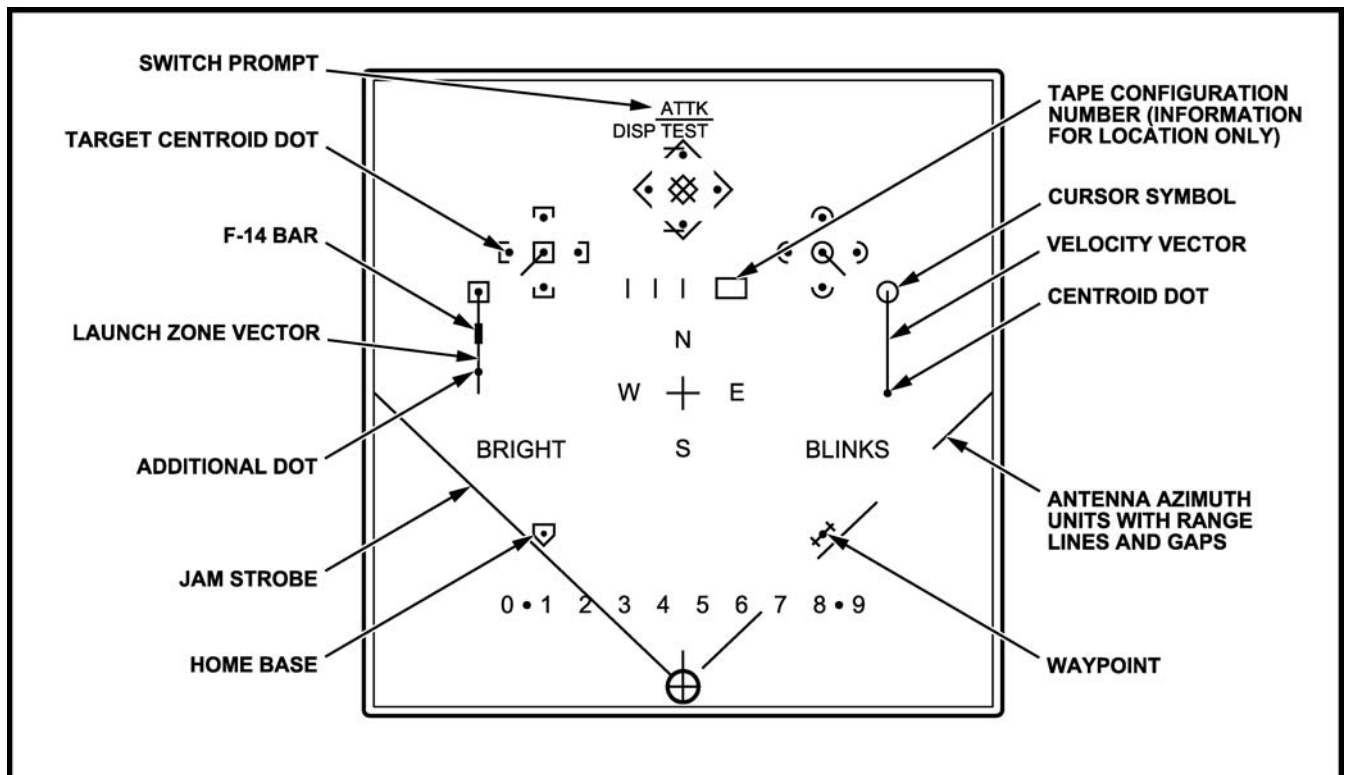
0-F50D-401-1

Figure 38-48. BIT Static DD Display (GND STAB or TV Selected)(Sheet 1 of 2)



0-F50D-401-2L

Figure 38-48. BIT Static DD Display (GND STAB or TV Selected)(Sheet 2 of 2)



CSC-F14D-1-38-012

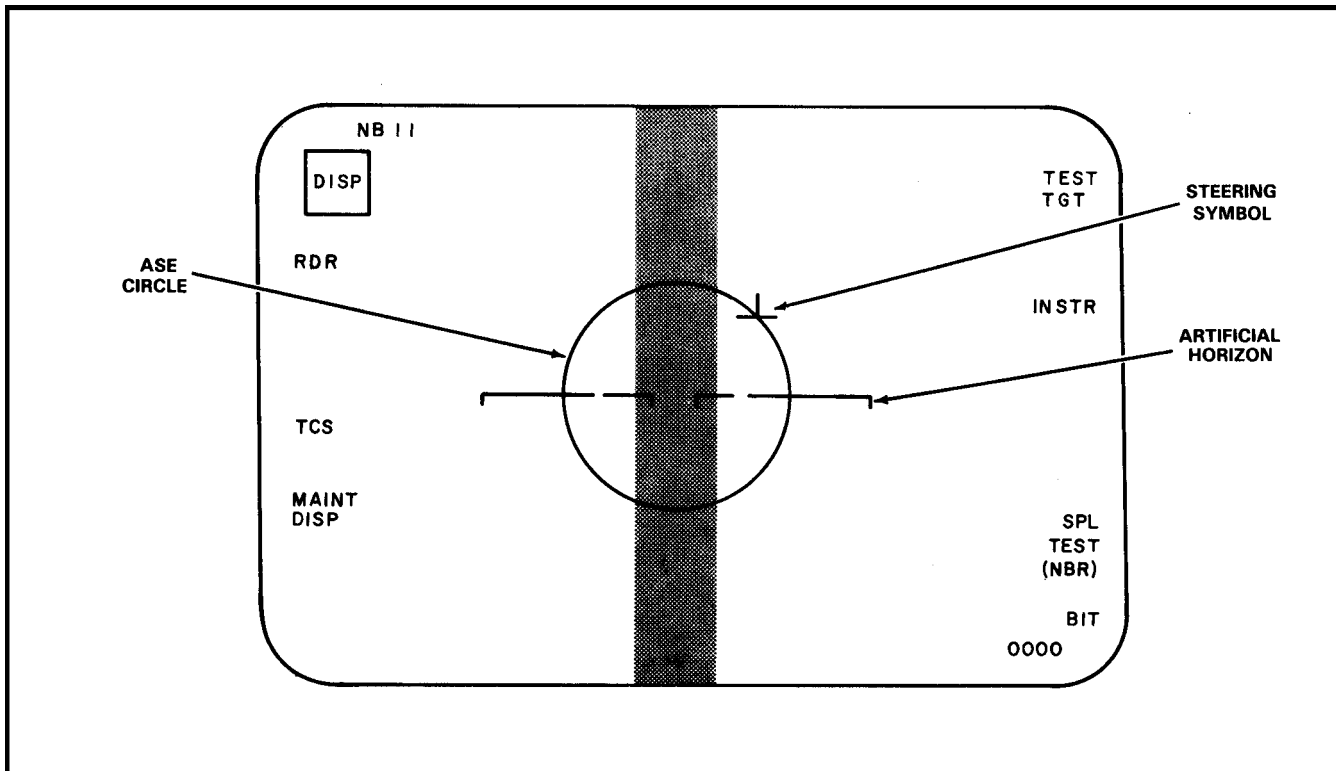
Figure 38-49. BIT Static PTID Display (Non-ATTK Selection)

On the PTID, 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 PTID 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 PTID MODE switch, the displays on the PTID and DD will go through the following movements every 2 seconds.



0-F50D-404-0

Figure 38-50. BIT DD Dynamic Display

Dynamic test in A/C STAB and GND STAB will have displays similar to those shown in Figures 38-50 and 38-51, 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 PTID 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 PTID.

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.

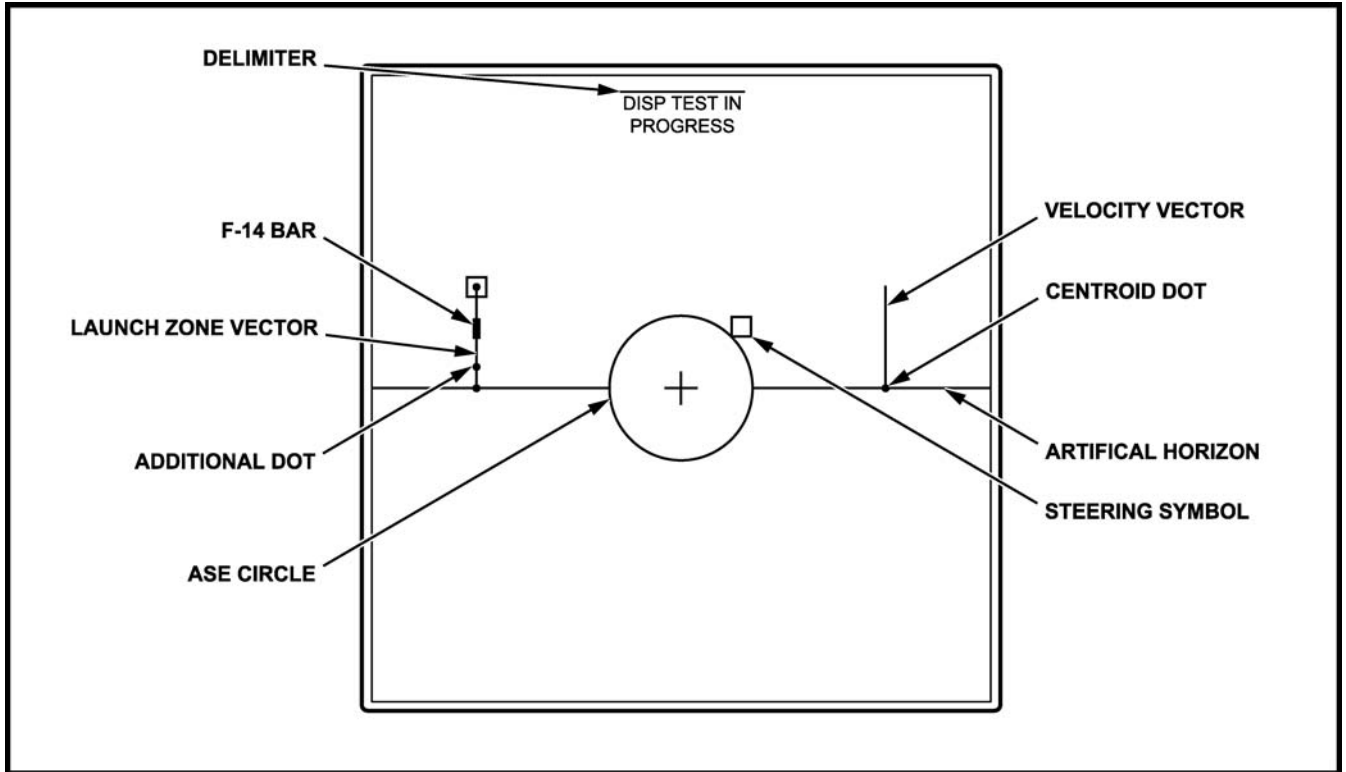
When commanded by this function, instrumentation modules in the RDP and RSP are configured to output repeatable test patterns to the instrumentation recorders. Failure indications are determined by analysis of these recordings offline. The display is shown in Figure 38-52.

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).

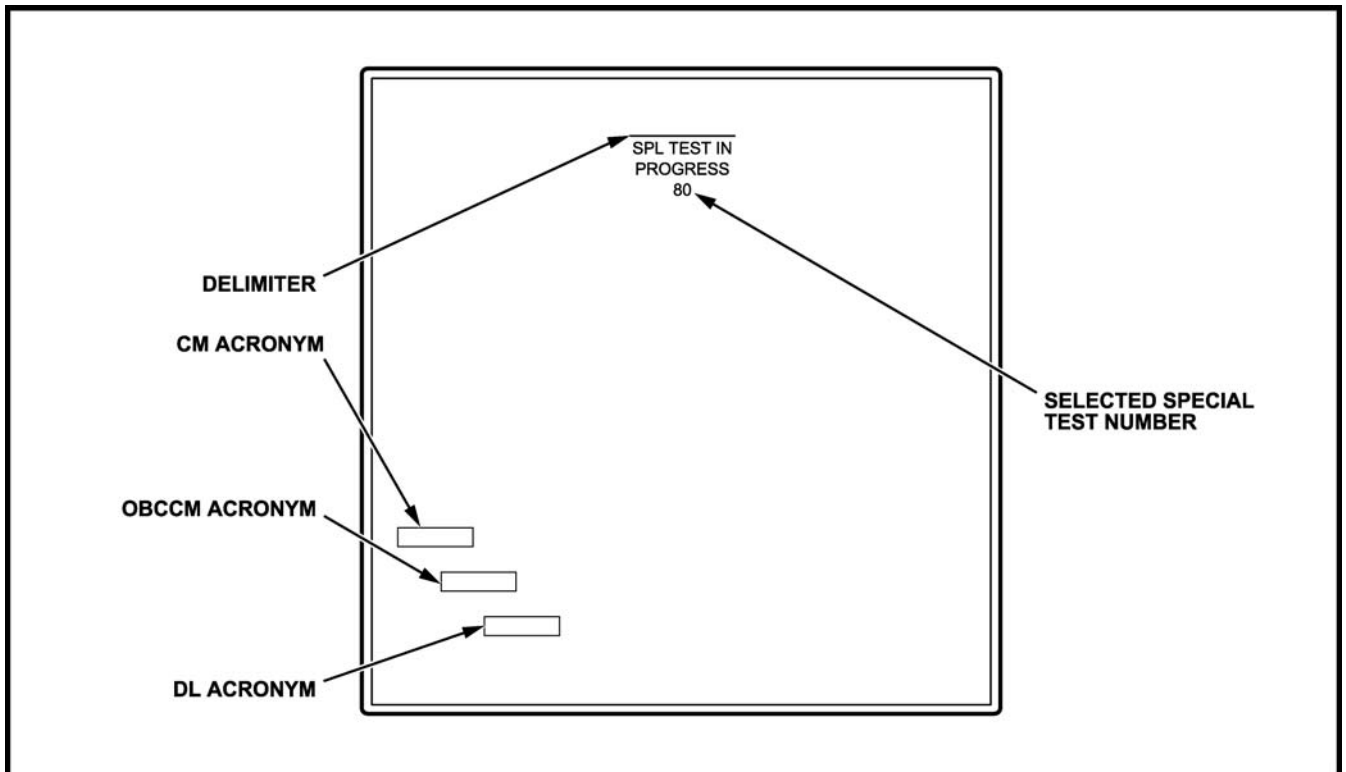
To initiate these readouts, the following sequence of entries on the CAP portion of the DD must be used:

1. CLR.
2. 7.
3. 1.
4. ENT.



CSC-F14D-1-38-013

Figure 38-51. BIT Dynamic PTID Display (ATTK Selected)



CSC-F14D-1-38-014

Figure 38-52. 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. Evaluatees 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/B 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 evaluatee.

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 evaluatee 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 evaluatee must obtain a minimum score of 3.5.

39.2.7.2 Closed-Book Examination

To obtain a grade of Qualified, an evaluatee 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 pilot.

39.6 FLIGHT EVALUATIONS

The areas and subareas in which pilot 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

39.6.4 (*) Takeoff and Transition

1. ATC clearance (pilot)

2. Takeoff (pilot)
3. Transition to climb schedule.

39.6.5 Climb and Cruise

1. Departure (pilot)
2. Climb and level-off (pilot)
3. Procedures en route (pilot)

39.6.6 (*) Approach and Landing

1. Radar, TACAN (pilot)
2. Recovery (pilot).

39.6.7 Communications

1. Receiving and transmitting procedures (pilot and RIO)
2. Visual signals (pilot and RIO)
3. IFF and SIF procedures (RIO).

39.6.8 (*) 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.

39.6.9 Postflight Procedures

1. Taxi in (pilot)
2. Shutdown (pilot and RIO)
3. Inspection and records (pilot and RIO)
4. Flight debriefing (pilot and RIO).

39.6.10 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 evaluatee'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	(Date)	(Authenticating signature)
(Aircraft Model)		
(Crew Position)		(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 evaluatee 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 evaluatee 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 shorebased and shipboard operations and tactical missions are listed below:

1. F-14D tactical manuals
2. NWP's
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 wing span 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:

<u>SPEED</u>	<u>Ramp Hydraulic Power</u>	
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:

<u>Speed Range</u>	<u>Ramp Resultant</u>
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 augments 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. _____

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.
- True
 - False
23. Normal ranges of nozzle position are:
- IDLE weight on wheels _____
 - In-flight MRT _____
 - MIN A/B _____
 - MAX A/B _____
24. What interlocks must be satisfied to activate the nozzle to the full-open position to reduce residual thrust?
- _____
 - _____
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.
- True
 - 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.
- True
 - 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?
- Failure of a motive flow pump.
 - Failure of a main fuel pump stage.
55. Failure of the second stage on the main engine fuel pump will have what effect on engine operation?
56. 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?
- _____
 - _____
 - _____
 - _____
 - _____
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.
- True
 - 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:
- Engine bleed air
 - 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:
- _____
 - _____
 - _____
 - _____
 - _____

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 _____.
87. With total loss of fluid from either main hydraulic system, the hydraulic transfer pump will _____.
88. The cockpit handpump will charge the brake accumulator in flight if _____.
89. Loss of all hydraulic fluid from the flight hydraulic system will mean loss of power to the right inlet ramps.
- True
 - False
90. With loss of the combined hydraulic system (combined system pressure zero), the main flaps are powered by _____ and the auxiliary flaps are _____.
91. With the landing gear emergency blown down, the nosewheel steering and normal brakes will operate after touchdown.
- True
 - False
92. The outboard spoiler module uses combined system fluid.
- True
 - False
93. Outboard spoilers are inoperative with wing-sweep angles aft of _____.
94. The outboard spoiler module thermal cutout is inhibited when _____.
95. The ON-OFF flag in the spoiler window of the hydraulic indicator indicates:
- The outboard spoiler module is energized.
 - The outboard spoiler system is pressurized.
96. With loss of the combined hydraulic system (combined system pressure zero) the inboard spoilers will: _____.
97. The backup flight control module powers the _____ and the _____.
98. With the backup flight control module switch in AUTO, the module is automatically energized when _____.
99. The backup flight control module switch has three positions: AUTO, _____ and _____.

100. The backup flight control module operates in the high-speed mode when _____.
101. Operational status of the backup flight control module is indicated in the cockpit by _____.
102. DLC requires an operable outboard spoiler module.
- a. True
 - b. False
103. Failure of either the combined or flight hydraulic system will have what effect on wing-sweep?
104. On the wing-sweep indicator, there are three position indicators. These show _____ and _____ wing-sweep position.
105. 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 _____.
106. The most forward wing-sweep angle allowed in bomb mode is _____.
107. 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.
108. Illumination of the WING SWEEP warning light means: _____.
109. Appearance of the W/S warning legend on the MFD means: _____.
110. Transient failures in the CADC may be reset by: _____.
111. The CADC is self-tested in _____.
112. List the caution, advisory, and warning lights activated by the CADC directly or via the DFCS:
- a. _____
 - b. _____
 - c. _____
 - d. _____
 - e. _____
 - f. _____
 - g. _____
 - h. _____
113. 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

114. A degraded mode of EIG operation is indicated by _____.
115. Maneuver flaps can be lowered at any wing-sweep angle between 20° and _____.
116. 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.
117. What is the meaning of the following (besides CADC failure) ?
- a. FLAP caution light
 - b. REDUCE SPEED warning
 - (1) _____
 - (2) _____
 - (3) _____
118. Power for emergency extension of the landing gear is supplied by _____.
119. 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).
120. Full lateral trim in the direction of stick displacement will reduce maximum spoiler deflection to _____ on that side.
121. Full slat asymmetry of 17° can result in an out-of-control situation at _____ units AOA or greater, even with 55° of spoilers available.
122. The rudder pedal shaker is armed with main flaps greater than _____ ° and the _____ computer operating.
123. With DLC engaged, full-up DLC positions the inboard spoilers at _____ ° and the horizontal stab trailing edges _____.
124. The initial position for spoilers when DLC is engaged is _____.
125. The correct positioning for stabilizers when DLC is given a full-down command (from trim) is _____ trailing edge _____.
126. Full rudder throw of ± _____ ° corresponds to ± inches of rudder pedal travel.
127. Control surface authority of the stability augmentation system is:
- Pitch ± _____ °.
 - Roll ± _____ °.
 - Yaw ± _____ °.
128. 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?
- _____
- _____

129. The ANTI SKID SPOILER BK switch is OFF and the BRAKE light is illuminated. This would indicate:
- a.
 - b.
130. 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
131. The two procedures for lowering the launch bar are: _____ or _____.
132. Nosewheel steering cannot be engaged until weight is on wheels.
- a. True
 - b. False
133. With the nosewheel $<70^\circ$, the nosewheel assumes the position commanded by the rudder pedals when nosewheel steering is engaged.
- a. True
 - b. False
134. BLEED DUCT light indicates temperatures in excess of _____ $^\circ\text{F}$ between engine and primary heat exchanger or greater than _____ $^\circ\text{F}$ between primary heat exchanger and the ECS turbine.
135. The ram air door can be opened only if the _____ or _____ button is depressed on the ECS control panel.
136. 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
137. The ram air door requires _____ seconds to go full open.
138. The RIO has a low-cockpit-pressure caution light (CABIN PRESS) that illuminates if _____ or _____.
139. With the OBOGS light on, each flightcrewmember should have _____ hours of oxygen at 20,000 feet (8,000 feet cabin altitude).
140. Pulling the emergency oxygen actuator releases gaseous oxygen charged to psi and will provide approximately a _____ minute supply.
141. 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 _____.
142. Maximum allowable headwind for the open canopy is _____ knots.

143. When the canopy is jettisoned, the sill locks are released by _____.
144. The canopy pneumatic reservoir must be serviced by ground servicing unit.
- True
 - False
145. The pilot can tell the position of the command ejection lever by _____.
146. The RIO can eject both himself and the pilot with EJECT CMD handle set to PILOT.
- True
 - False
147. The pilot can eject both himself and the RIO with the EJECT CMD handle set to MCO.
- True
 - False
148. In the event the canopy does not separate from the aircraft when either flightcrewmember has initiated ejection, “through the canopy” ejection will not occur.
- True
 - False
149. There are _____ safety pins per ejection seat.
150. Command ejection by either flightcrewmember will eject the RIO in ____ seconds and the pilot _____ seconds later.
151. For a high-altitude ejection, the seat is allowed to free-fall to \pm _____ feet.
152. 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.
153. When the wings are swept aft of _____, the _____ position lights are disabled and the glove position lights are operable.
154. When the ANTI-COLLISION light switch is ON, the _____ position lights flasher switch is disabled.
155. A proper indicator lights test has the MASTER CAUTION light on steady.
- True
 - False
156. The RIO can monitor SW tones by selection of _____ position on the ICS panel.
157. The standby attitude indicator is capable of providing reliable attitude information within _____ for up to _____ minutes after a complete loss of power.
158. On deck, the allowable error between the pilot and RIO altimeter readings is _____ feet at field elevation.

159. The angle-of-attack indicator is checked during _____ and the indexer during _____. Proper indications are:

- a. Indicator — _____
- b. Indexer — _____.

160. In the landing configuration, 15 units AOA is equivalent in airspeed for:

- a. 48,000 pound (DLC not engaged) = _____ KIAS
- b. 48,000 pound (DLC engaged/neutral) = _____ KIAS
- c. 50,000 pound (DLC not engaged) = _____ KIAS

161. 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 a OPT. ALT. _____.

162. Stores jettison is controlled by which aircraft system?

163. ACM jettison requires MASTER ARM ON.

- a. True
- b. False

164. Selective jettison can be completely controlled by either flightcrewmember.

- a. True
- b. False

165. In the emergency jettison mode, the weight-on-wheels interlock is bypassed.

- a. True
- b. False

166. Emergency jettison mode will jettison Sidewinders.

- a. True
- b. False

167. Sidewinder is jettisoned by firing the motor and safing the warhead.

- a. True
- b. False

168. The pretaxi (weight-on-wheels) OBC master test is a complete check of the SMS.
- a. True
 - b. False
169. Selection of any pulse dogfight mode automatically provides stab out aircraft reference.
- a. True
 - b. False
170. The pilot must clear maintenance display prior to running OBC for current test results
- a. True
 - b. False
171. For normal UHF operation with the ARC-182, the AM/FM switch should be in the _____ position.
172. 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
173. The navigation system may be updated by five methods; they are:
- a. _____
 - b. _____
 - c. _____
 - d. _____
 - e. _____
174. In TACAN BIT, the range and bearing on the HSD and BDHI should indicate _____ nm and _____ °.
175. The target designator is valid to \pm _____ ° off the nose.
176. With MASTER ARM OFF, the HUD and VDI armament legend will appear with _____.
177. To obtain an attack presentation, the air-to-air button must be selected on the PDCP.
- a. True
 - b. False
178. 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

179. The PTID is oriented to _____ north, with selection of GND STAB on the PTID mode switch.

180. Which of the following presentations are available to the pilot:

- a. IRSTS
- b. PS
- c. PDS
- d. All of the above.

181. A _____ acronym indicates a failure of the SMS, thus preventing normal separation of stores in any launch mode.

182. The RADAR COOLING switch in the RIO cockpit controls liquid coolant to _____.

183. Hostile area altitude is entered in the _____ pseudo file to properly reject altitude line return.

184. Wind is automatically computed by the system in the INS mode.

- a. True
- b. False

185. A wind of 35 knots and 057° relative to the duty runway represents a headwind component of _____ knots and crosswind of _____ knots.

186. A blinking SHOOT cue indicates _____.

187. 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.

CHAPTER 40

Tactical Imaging Set AN/AVX-3

40.1 AN/AVX-3 TACTICAL IMAGING SET

The Tactical Imaging Set, as installed in the F14D aircraft, captures, digitizes, and compresses imagery from an external RS 170 video source, then stores and/or transmits it over a secure communications link. The external video source is typically a camera/video system such as the nose mounted Television Camera System (TCS), Low Altitude Navigation and Targeting System for Night (LANTIRN), Head Up Display (HUD) camera, or other similar systems. Maximum image capture rate is 4 images/second. The Tactical Imaging Set can also receive images transmitted by other Tactical Imaging Sets or compatible systems (such as ground or base stations). Selected images can be displayed on the forward (Video Display Indicator-VDI) and/or aft (Programmable Tactical Information Display - PTID) cockpit display. The Tactical Imaging Set converts standard National Television Standards Committee (NTSC) video to allow viewing of still-frame (single-image) imagery or recorded video.

The Tactical Imaging Set consists of a Remote Control Unit (RCU), Image Transceiver, Video Tape Recorder (VTR), Interface Box, and four interconnecting cables (not including connecting aircraft wiring). The RCU mounts in the aft cockpit at the inboard front of the right side console. The Image Transceiver, VTR, Interface Box, and cables are mechanically mounted as one unit, called the Naval Airborne Video Recorder and Image Transceiver (NAVRIT) Unit, which is mounted in bay 2221-3. Controls and indicators are shown in [Figure 40-1](#).

40.1.1 Remote Control Unit (RCU)

The RCU interfaces with the Image Transceiver via an RS-232 serial bus to enable the Radar Intercept Officer to remotely control the Image Transceiver functions. Command signals are sent from the RCU to the Image Transceiver, and data is sent from the Image Transceiver to the RCU for display. The RCU display contains 2 lines of 24 green, night vision compatible, alphanumeric characters each. The top line provides status and messages. The bottom line provides a command menu. The command menu defines the functions of six pushbutton switches located below the display. The command menu, and thus the switch functions,

varies depending on the selected operating mode. Display brightness is controlled via menu selection.

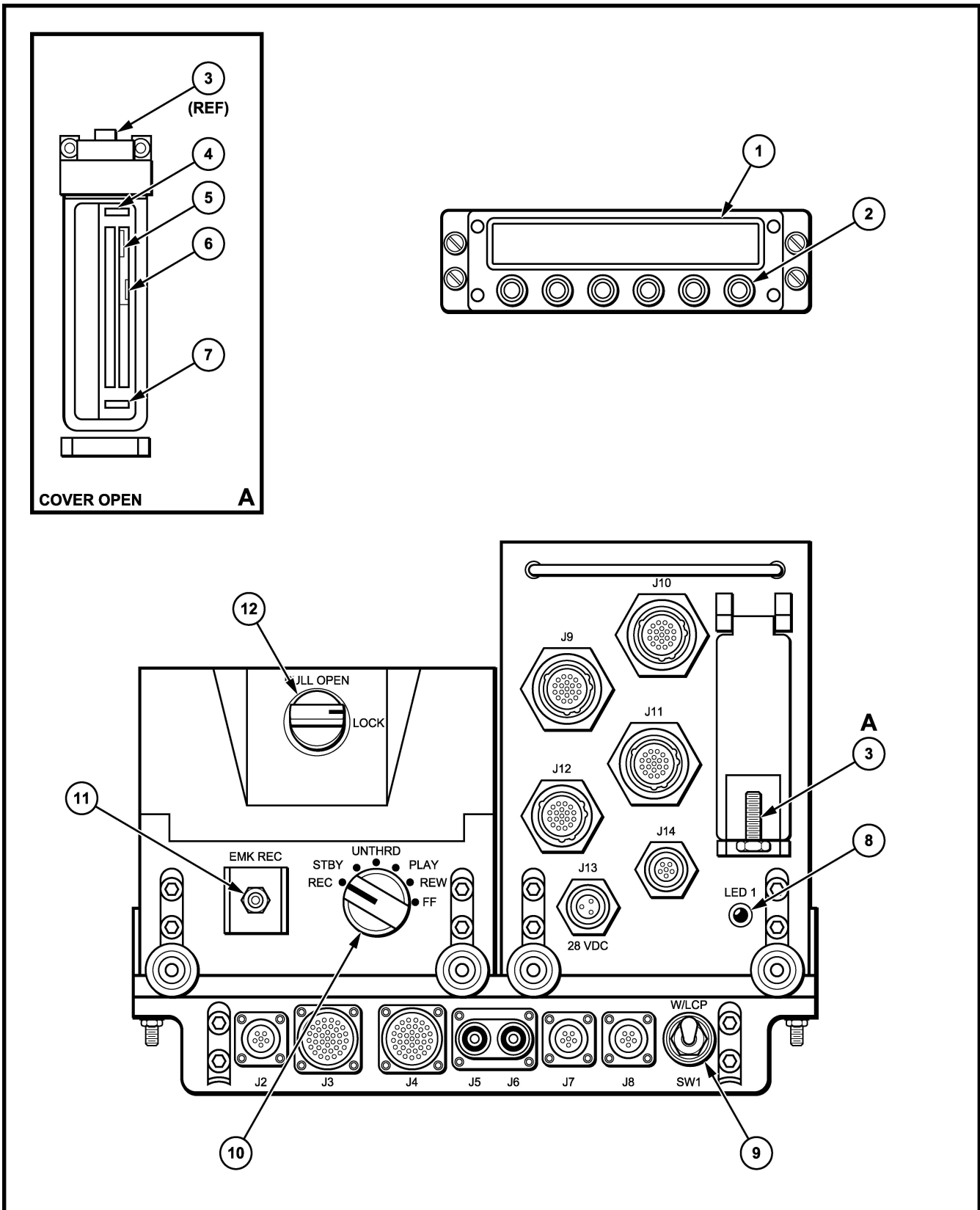
40.1.2 Image Transceiver

Image Transceiver functions are controlled by a microprocessor. The Image Transceiver also has two Personal Computer Memories Card International Association (PCMCIA) card slots. The microprocessors executable program firmware is stored on an 8 Mbyte flash random access memory, called the Program card, in slot 1 (left slot). Upon power up or reset, the firmware is loaded into 6 Mbytes of the Image Transceiver 32 Mbyte image memory. The remaining 26 Mbytes of image memory is allocated for storage of uncompressed image frames. The image memory is volatile, and so stored image frames are lost when power is removed. The RCU sends RS-232 serial commands to this microprocessor to direct the functions of the Image Transceiver.

The Image Transceiver accepts an RS 170 format video input from the VTR (or an external video source via the VTR), digitizes the video to create an image frame, and passes the image frame to an image buffer for output to the aircraft cockpit display. The image memory stores selected image frames. Image frames stored in memory can be randomly accessed for viewing and/or cropping before compression. An image compressor (software algorithm) reduces the size of image frames selected to be stored and routes them to a 4 Mbyte non volatile static random access memory (SRAM) PCMCIA card, called the Image card, in slot 0 (right slot) for storage or transmission. The stored image frame includes a clock time code.

40.1.3 Video Tape Recorder (VTR)

The VTR is an airborne video recorder that can record and play back up to 2 hours of information on a standard Hi 8 format cassette tape. It contains an internal heater to prevent condensation. The VTR front panel controls are disabled; thus all VTR control is remotely performed. RS 422 serial command signals are sent from the Image Transceiver to the VTR, and VTR status data is sent from the VTR to the Image Transceiver. Discrete control signals from the aft cockpit Sensor Control Panel are sent to the VTR via the



CSC-F14D-1-40-001

Figure 40-1. Tactical Imaging Set Controls and Indicators (Sheet 1 of 2)

INDEX	NAME	FUNCTION
①	Display (RCU)	48-character alphanumeric display consisting of 2 rows of 24 characters each. Upper row shows operating status. Lower row identifies functions of switches.
②	Switches (RCU)	Six pushbutton switches. Functions are as defined by lower row of display.
③	PCMCIA Card Cover Latch (Image Transceiver)	Opens/closes cover for PCMCIA card compartment.
④	Image Card Release Button (Image Transceiver)	Releases image card for removal.
⑤	R-W/WP switch	Permits (R-W) or prevents (WP) recording (writing) on image card. (Reading of image card is always permitted.)
⑥	LOCKED latch (Image Card)	Latches and unlatches image card battery compartment.
⑦	Program Card Release Button (Image Transceiver)	Releases program card for removal.
⑧	LED 1 lamp (Image Transceiver)	Indicates +28 VDC power is applied to Image Transceiver.
⑨	SW1 switch (Interface Box)	Selects video output level. UP – nominal 2.2 V (for use with LANTIRN Control Panel installed) DOWN – nominal 1.25 V (for use with LANTIRN Control Panel not installed)
⑩	REC/STBY/UNTHRD/PLAY/REW/FF control (VTR)	Non-functional
⑪	EMK REC switch (VTR)	Non-functional
⑫	PULL OPEN/LOCK latch (VTR)	Opens/closes VTR cassette compartment.

Figure 40-1. Tactical Imaging Set Controls and Indicators (Sheet 2 of 2)

Interface Box. Discrete status signals for certain VTR modes are also sent to the Sensor Control Panel Interface Box.

40.1.4 Interface Box

The Interface Box provides mechanical mounting for the VTR and Image Transceiver. Additionally, it provides electrical connections for dc input power, and connections and switching for digital and video input and output signals. The Interface Box also modifies the RS 170 video to make it compatible with the cockpit displays.

40.2 OPERATING INSTRUCTIONS

40.2.1 Powerup Sequence

Power up is accomplished using the aft cockpit Sensor Control Panel. Once power is applied, the Remote Control Unit (RCU) controls all functions, although the Sensor Control Panel can control some Video Tape Recorder (VTR) functions. The top line of the RCU display shows status and data. The bottom line of the RCU display shows up to six

available commands which are selected using the corresponding six pushbutton switches below the display.

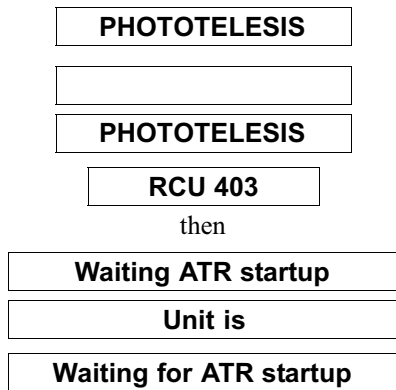
1. In bay 2221-3:
 - a. Ensure Program card is installed in Image Transceiver slot 1 (left slot).
 - b. Ensure formatted Image card is installed in Image Transceiver slot 0 (right slot).
 - c. Ensure tape cassette is not record protected (red tab should not show) and is installed in VTR.

Note

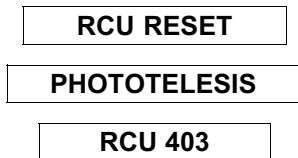
The VTR can record on either Hi 8 or standard 8 mm tape; however, image quality can be substantially degraded when using standard tape.

- d. Set Interface Box SW1 switch as appropriate up if LANTIRN Control Panel is installed; down if LANTIRN Control Panel is not installed.

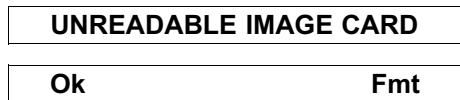
- Set aft cockpit Sensor Control Panel selector to STBY. RCU displays following sequence:



- After Image Transceiver startup, the following message sequence appears:



- The following message should NOT appear. If it does appear, there is no Image card in slot 0, or the Image card installed is not formatted.

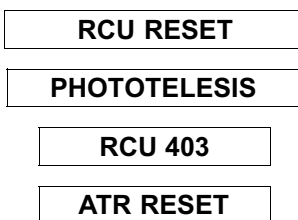


Note

Pressing OK switch enables process to proceed without resetting, but results are unpredictable.

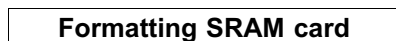
If message appears, either:

- (1) Install formatted Image card and simultaneously press OK and FMT switches to reset RCU and Image Transceiver. Following message sequence appears:

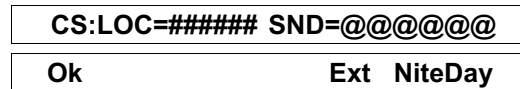


or

- (2) Ensure Image card is installed, and press FMT switch to format card. Following message appears:



- Boot up menu appears.



Where ##### is the local call sign and @@@@@@ is the first entry in the send to call sign directory. (These entries can be changed using the Settings menus.)

- Press switch corresponding to desired display brightness level (if current level is satisfactory, do not press a switch):

EXT-Not used

NITE-Nighttime level from Settings menus

DAY-Daytime level from Settings menus

- Press OK switch. Main menu appears at currently selected brightness level.



Where ### is the number of image frames in the send queue, @@@ is the number of image frames in the hold queue, &&& is the number of image frames in the receive queue, % is the VTR mode (S = standby, U = unthreaded, P = playback, flashing R =recording, all others = blank), ± is either a – or a + indicating tape location is before or after the reset point, and \$\$\$ is the VTR tape counter time in minutes. When the system is in data mode (voice communication disabled), the &&& field flashes. (Specific switch functions displayed may vary depending on previous actions; for example, when the send and hold queues are empty, the SEND switch label is not displayed.)

Note

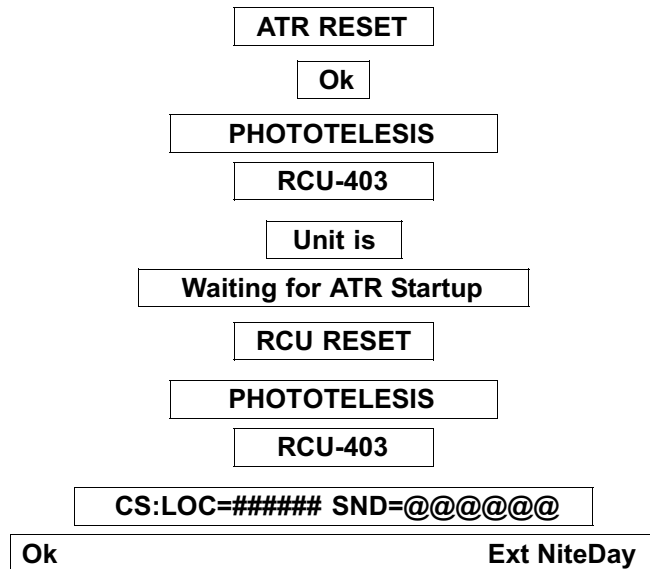
If a value in a field is greater than 999, the display shows ***.

40.3 RESETTING RCU AND IMAGE TRANSCIEVER

The RCU and Image Transceiver may be reset (rebooted) at any time by simultaneously pressing the two outermost switches. When this is done, the following message sequence appears:

Note

The hold and compress queues are erased during reset.



Where ##### is the local call sign and @@@@@@ is the first entry in the send to call sign directory.

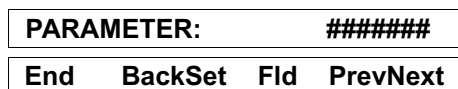
Pressing the OK switch displays the Main menu.

40.4 SETTINGS MENUS

The Settings menus are used to modify configuration parameters for capturing, compressing, transmitting, and receiving image frames, as well as other system level functions. The Settings menus are accessed and processed in sequence from the Main menu (by pressing the SET switch) as shown in Figure 40-2.

40.4.1 Settings Menus' Format

The Settings menus follow the general format:



Where ##### (flashing) is the value of the parameter being set. Switch functions vary somewhat among menus, and are explained as each menu is described.

Note

The FLD, PREV, and NEXT switches are used to cycle through sets of fields or values. When the last entry in the set is displayed and the FLD or NEXT switch is pressed, the first entry in the set is displayed. When the first entry in the set is displayed and the PREV switch is pressed, the last entry in the set is displayed.

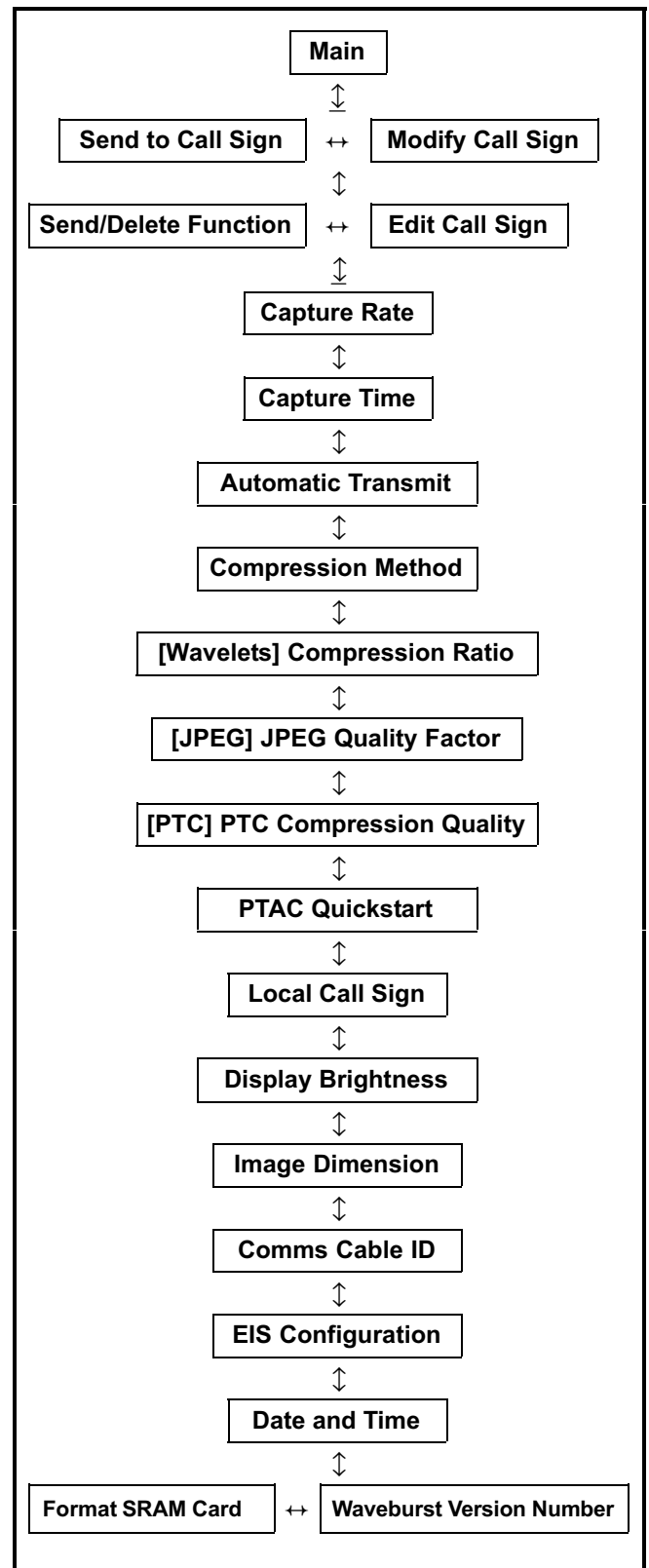


Figure 40-2. Settings Menu Sequence

40.4.2 Send-to-Call-Sign-Menu

This menu is used to select/deselect the call signs to be included in the next transmission. It provides access to submenus, which are used to maintain the call sign directory. The menu contains one value field. When selected, the first call sign in the directory is listed whether or not it is selected for transmission. The directory can be stepped through using the NEXT switch, and each entry can be selected or deselected, as desired. The displays for a call sign value differ slightly depending on whether that value is selected or not selected.

For a selected call sign value:

SENDTO CALLSIGN <#####>
End Mod Set Yes No Next

For a non-selected call sign value:

SENDTO CALLSIGN -#####-
End Mod Set Yes No Next

- END** - Return to Main menu
- MOD** - Display Modify Call Sign menu
- SET** - Select next menu in sequence
- YES** - Select call sign
- NO** - Deselect call sign
- NEXT** - Change currently displayed call sign to next call sign in directory

40.4.3 Modify Call Sign Menu

This menu is used to add a new call sign to the directory or delete an existing call sign from the directory. It also provides access to the Edit Call Sign menu, which is used to define a newly added call sign.

MODIFY CALLSIGN -#####-
DoneDel New EditPrevNext

- DONE** -Return to Send to Call Sign menu
- DEL** - Delete the current call sign from the directory and display the next value (if no next value, default is 000000)
- NEW** - Create new unselected call sign with value of 000000 (if value 000000 already exists, switch has no effect)
- EDIT** - Display Edit Call Sign menu

- PREV** - Change currently displayed call sign to previous call sign in directory
- NEXT** - Change currently displayed call sign to next call sign in directory

40.4.4 Edit Call Sign Menu

This menu is used to change the name of an existing call sign, including a newly added call sign (000000). Each character in the call sign is considered a separate value field. Valid entries for each character are numerals, upper case letters, and blanks (■, located in sequence between Z and 0). Blanks are not permitted within the body of the call sign; however, if a call sign has less than 6 characters, trailing blanks must be added to complete the 6 character call sign. Trailing blanks appear on the display only when the call sign value field is being edited.

MODIFY CALLSIGN -#####-
Ok Fld PrevNext

- OK** - Return to Modify Send to Call Sign menu
- FLD** - Select next field in call sign
- PREV** - Change currently selected call sign character to previous letter or number
- NEXT** - Change currently selected call sign character to next letter or number

40.4.5 Send/Delete Function Menu

This menu is used to toggle the send/delete mode parameter on or off. In send/delete mode, captured images are deleted as they are sent. With send/delete mode turned off, images are copied to the receive queue as they are sent. Valid values are YES and NO.

SEND AND DELETE: ###
End BackSet Next

- END** - Return to Main menu
- BACK**- Display Send-to Call Sign menu
- SET** - Display Capture Rate menu
- NEXT** - Toggle send and delete mode value

40.4.6 Capture Rate Menu

This menu is used to change the time interval between image captures in burst mode. Valid values range from 0.1 to

999.0. Values are incremented or decremented in 0.1-second steps when the value is less than 1 second, and in 1-second steps when the value is greater than 1 second. Incrementing once from 999.0 or decrementing once from 0.1 disables burst mode and enables single shot mode. In this case, the value field indicates SINGLESHOT.

Note

The capture rate can be set to 0.1 or 0.2 seconds/image; however, these settings are below the Tactical Imaging Set minimum capture rate value (fastest capture). If the capture rate is set to 0.1 or 0.2 seconds/image, the Tactical Imaging Set will capture image frames at its fastest speed, which is approximately 0.28 second/image in capture/hold mode. In capture/send mode, the minimum capture rate value is substantially higher due to the compression required to transfer image frames to the send queue.

CAPTURE RATE:	##### SEC
End	BackSet PrevNext

- END** - Return to Main menu
- BACK**- Display Send/Delete menu
- SET** - Display Capture Time menu
- PREV** - Decrement currently displayed
- NEXT** - Increment currently displayed value

40.4.7 Capture Time Menu

This menu is used to change the duration of image captures in burst mode. Valid values range from 001 to 999. Values are incremented or decremented in 1-second steps. Incrementing once from 999 or decrementing once from 001 selects continuous capturing. In this case, the value field indicates CONTINUOUS.

CAPTURE TIME	###	SECS
End	BackSet	PrevNext

- END** - Return to Main menu
- BACK**- Display Capture Rate menu
- SET** - Display Max Key Time menu
- PREV** - Decrement currently displayed value
- NEXT** - Increment currently displayed value

40.4.8 Max Key Time

This menu is used to change the duration of time that the Tactical Imaging Set transmits image data to a receiving station. This menu allows the maximum transmitting time to be set between 10 and 180 seconds, using the change interval of 1 second. The carrier DCRS stations are programmable and are set for a Max Transmit Time of 30 seconds. The Tactical Imaging Set default setting is 30 seconds. The Tactical Imaging Set will always boot to the last set Max Transmit Time.

MAX KEY TIME	##	SECS
End	BackSet	PrevNext

- END** - Return to Main menu
- BACK**- Display Capture Time menu
- SET** - Display Automatic Transmit menu
- PREV** - Decrement currently displayed menu
- NEXT** - Increment currently displayed value

40.4.9 Automatic Transmit Menu

This menu is used to toggle the capture mode parameter between capture/hold and capture/send modes. In capture/hold mode, captured images are placed in the hold queue. In capture/send mode, captured images are placed in the compress queue for transmission. Valid values are CAPT&HOLD and CAPT&SEND.

AUTO TRANSMIT:	#####
End	BackSet PrevNext

- END** - Return to Main menu
- BACK**- Display Capture Time menu
- SET** - Display Compression Method menu
- PREV** - Toggle automatic transmission mode value
- NEXT** - Toggle automatic transmission mode value

40.4.10 Compression Method Menu

This menu is used to select the compression method parameter. Valid values are WAVELET, JPEG, and PTC. (PhotoTelesis Classic (PTC) compression is used mainly for compatibility with older analysis systems.)

COMPRESS METHOD: #####
End BackSet PrevNext

END - Return to Main menu

BACK- Display Automatic Transmit menu

SET - Display next menu depending on current compression method value:

WAVELET - Compression Ratio menu

PTC - PTC Compression Quality menu

PREV - Select previous compression method value

NEXT - Select next compression method value

40.4.11 Compression Ratio Menu

This menu is used to select the compression ratio parameter when using Wavelet compression. Compression ratio can be selected from fixed ratios of from 10:1 to 75:1 in increments of 5, or a specific (variable) ratio between 10:1 and 150:1 can be selected by incrementing or decrementing the displayed value in steps of 1.

For fixed compression ratio values:

COMPRESSION RATIO: ### :1
End BackSet Var PrevNext

END - Return to Main menu

BACK- Display Compression Method menu

SET - Display PTAC Quick Start menu

VAR - Select variable ratio parameter entry

PREV - Select previous fixed compression ratio value

NEXT- Select next fixed compression ratio value

For variable compression ratio values:

COMPRESSION RATIO: ### : 1
End BackSet Fix PrevNext

END - Return to Main menu

BACK- Display Compression Method menu

SET - Display PTAC Quick Start menu

JPEG - JPEG Quality Factor menu

FIX - Select fixed ratio parameter entry

PREV - Decrement compression ratio value

NEXT- Increment compression ratio value

40.4.12 PTAC Quick Start Menu

This menu is used to toggle the PhotoTelesis Tactical (PTAC) quick start parameter on or off. Valid values are OFF and ON. The parameter indicates whether the PTAC protocol used during transmission attempts to verify established connections before attempting to transmit images.

PTAC QUICK START: ###
End BackSet PrevNext

END - Return to Main menu

BACK- Display previous menu depending on current compression method value:

WAVELET - Compression Ratio menu

JPEG - JPEG Quality Factor menu

PTC - PTC Compression Quality menu

SET - Display Local Call Sign menu

NEXT- Toggle quick start on/off value

40.4.13 Local Call Sign Menu

This menu is used to modify the call sign associated with the Tactical Imaging Set. Each character in the call sign is considered a separate value field. Valid entries for each character are numerals, upper case letters, and blanks (4, located in sequence between Z and 0). Blanks are not permitted within the body of the call sign; however, if the call sign has less than 6 characters, trailing blanks must be added to complete the 6 character call sign. Trailing blanks

appear on the display only when the call sign value field is being edited.

LOCAL CALLSIGN -#####-
End BackSet Fld PrevNext

- END** - Return to Main menu
- BACK**- Display PTAC Quick Start menu
- SET** - Display Brightness menu
- FLD** - Select next field in call sign
- PREV** - Change currently selected call sign character to previous letter or number
- NEXT** - Change currently selected call sign character to next letter or number

40.4.14 Display Brightness Menu

This menu is used to set RCU display brightness level for daytime or nighttime viewing, Valid values are EXTERNAL (not used), DAY, and NIGHT.

ADJUST DISPLAY: #####
End BackSet Dim Brt Next

- END** - Return to Main menu
- BACK**- Display Local Call Sign menu
- SET** - Display Image Dimension menu
- DIM** - Decrease brightness of display for selected DAY or NIGHT value
- BRT** - Increase brightness of display for selected DAY or NIGHT value
- NEXT** - Change currently selected brightness value to next value

40.4.15 Image Dimension menu

This menu is used to toggle the image dimension parameter value. This parameter defines the image size of captured images. Valid values are 640 × 480 pixels (full resolution, normal value) and 592 × 440 pixels (center 85%, used with PTC compression only).

IMAGE DIMENSION: #####
End BackSet PrevNext

- END** - Return to Main menu

- BACK** - Display Brightness menu
- SET** - Display View Communications Cable Identification menu
- PREV** - Toggle image dimension parameter value
- NEXT** - Toggle image dimension parameter value

40.4.16 View Communications Cable Identification Menu

This menu is used to view the type communications cable connected to the Image Transceiver. (The cable code is hard-wired into the cable connection.) No changes can be made from this menu. Normal value is KY-58 DATA.

CABLE: #####
End BackSet

- END** - Return to Main menu
- BACK**- Display Image Dimension menu
- SET** - Display EIS Configuration menu

40.4.17 EIS Configuration Menu

This menu is used to change the internal Encryption Interface Subsystem (EIS) configuration file. Viewing file names and exiting the menu does not change the configuration file. The file is changed only by loading a new file. EIS files are stored on the Program Card. To load a configuration file, use the PREV and/or NEXT switches such that the name of the desired file is displayed, then press the LOAD switch to reboot. Normal value is EIS 0001.INI.

EIS CONFIG: #####
End BackSet LoadPrevNext

- END** - Return to Main menu
- BACK**- Display View Communications Cable Identification menu
- SET** - Display Date and Time menu
- LOAD** -Load selected EIS configuration file
- PREV** - Change currently displayed file name to previous file name in directory
- NEXT** - Change currently displayed file name to next file name in directory

When the LOAD switch is pressed, the display reads:

Loading EIS Config

When file loading is complete, the RCU and Image Transceiver are automatically reset (rebooted).

40.4.18 Date and Time Menus

This menu is used to change the Tactical Imaging Set date and time. The date and time are expressed in Zulu time format. There are five parts of the date and time parameter. Each part is considered a separate value field. Valid entries for each field are as follows:

FIELD/VALUES

- day of month (dd) / 1 thru 28, 1 thru 29, 1 thru 30, 1 thru 31 (depending on month and year)
- hour of day (hh) / 00 thru 23
- minute of hour (mm) / 00 thru 59
- month of year (####) / JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC
- Year (yy) / 00 thru 99 (indicates 1994 thru 2093)

DATE/TIME: ddhhmmZ ####yy
End BackSet Fld PrevNext

END - Return to Main menu

BACK- Display EIS Configuration menu

SET - Display Format SRAM Card menu

FLD - Select next field

PREV - Change currently selected parameter part field to previous value in sequence

NEXT - Change currently selected parameter part field to next value in sequence

40.4.19 Format SRAM Card Menu

This menu is used to format the Image card (also called the Static Random Access Memory (SRAM) card) used to store the image frames in the send and receive queues. Valid values are YES and NO (NO is default).

FORMAT SRAM CARD: ###
End BackSet Fmt Next

END - Return to Main menu

BACK- Display Date and Time menu

SET - Display View Version Number menu

FMT - Format Image card if format value is YES (if format value is NO, this switch has no effect)

NEXT- Toggle format yes/no value

Formatting an Image card causes all stored image frames in the send and receive queues to be deleted and the display to momentarily read:

Dumping SEND & RECV

When all images are deleted, the display momentarily changes to read:

Formatting SRAM card

40.4.20 Waveburst Version Menu

When formatting is complete, View Version Number menu is displayed.

This menu is used to view the firmware version number. No changes can be made from this menu.

WAVEBURST VERSION: #####
End BackSet

END - Return to Main menu

BACK- Display Format SRAM Card menu

SET - Display Main menu

40.5 POWER DOWN SEQUENCE

1. Ensure tape in VTR is in unthreaded condition.
 - a. On Main menu, observe VTR mode field (%).

S=### H=@@@ R=&&& %:\$\$\$

BrstSnapSet ViewDataSend

- b. If field is any character other than U, sequentially press VIEW, VTR, and UNTH switches.

2. Set aft cockpit Sensor Control Panel selector to OFF.

40.6 CAPTURING/COMPRESSING/SAVING/TRANSMITTING/RECEIVING IMAGES

40.6.1 Voice and Data Modes

The type of communications cable being used is coded in the cable wiring, and can be observed on the View Communications Cable Identification menu. The VOC switch name appearing on the Main menu indicates the

Tactical Imaging Set is in voice mode (data mode selectable). Pressing the VOC switch sets the Tactical Imaging Set to data mode (voice mode selectable), and causes the following menu to appear:

S=### H=@@@ R=### %:\$\$\$	
BrstSnapSet	ViewDatasend

Pressing the DATA switch sets the Tactical Imaging Set to voice mode (data mode selectable), and the Main menu appears.

S=### H=@@@ R=### %:\$\$\$	
BrstSnapSet	ViewVoc Send

40.6.2 Capturing Images

Image frames are captured in either burst mode or snap mode. In burst mode, image frames are captured at predetermined intervals for a predetermined length of time. In snap (single shot) mode, a single image frame is captured. The captured image frames are then either transmitted immediately (capture/send mode) or stored in the image buffer/hold queue (capture/hold mode). All modes and parameters are set using the Settings menu.

40.6.2.1 Capturing Images in Burst Mode

Note

If the specified capture rate is SINGLESHOT, the BRST switch label does not appear.

40.6.2.1.1 Capture/Hold Mode

1. From the Main menu, press the BRST or SNAP switch. The capture sequence proceeds automatically with image frames being captured at the specified rate for the specified duration (capture time).
2. While the image frames are being captured, the menu appears as follows:

S=### H=@@@ R=### %:\$\$\$	
Stop	Voc Send

3. The hold queue field (@@@) increases by 1 as each image frame is captured.

Note

If the hold queue is full (typically 188 image frames), burst mode is discontinued automatically.

40.6.2.1.2 Capture/Send Mode

1. From the Main menu, press the BRST or SNAP switch. The capture sequence proceeds automatically with image frames being captured at the specified rate for the specified duration (capture time).

Note

Due to the processor time required to compress images, the maximum capture rate (minimum time/image) is substantially slower in capture/send mode than in capture/hold mode.

2. While the image frames are being captured and sent, the following menu sequence appears:

S=### H=@@@ R=### %:\$\$\$	
----------------------------	--

Stop	Voc Send
------	----------

S=### H=@@@ R=### %:\$\$\$	
----------------------------	--

Stop	Abrt
------	------

3. When the burst duration has expired (image frames no longer being captured) but image frames are still being sent, the following menu sequence appears:

S=### H=@@@ R=### %:\$\$\$	
----------------------------	--

BrstSnap	View	Abrt
----------	------	------

4. The send queue field (###) increases by 1 as each image frame is captured. When the last captured image frame is compressed and sent, the send queue field changes to read 0.

Note

Normally, image frames are continuously sent until the send queue is empty; however, at certain capture rate/time settings, transmission may cease prior to emptying the send queue, leaving image frames in the send queue unsent. In these cases, the send queue field is not 0 when the Main menu appears. Pressing the SEND switch on the Main Menu transmits the remaining images.

5. When the last image frame in the send queue has been sent and the next image frame has not yet been captured (send and hold queues are empty), the following menu appears:

S= 0 H= 0 R=### %:\$\$\$	
--------------------------	--

Stop	Voc
------	-----

6. If it is desired to discontinue sending image frames before the send queue has been emptied, press the ABRT switch. The ABRT switch label flashes to

indicate the command has been received, and the transmission of image frames ceases. Image capture continues until the burst duration has expired or the STOP switch is pressed.

7. If it is desired to discontinue capturing image frames before the specified burst duration (capture time) has expired, press the STOP switch.
8. If the capture rate is CONTINUOUS, press the STOP switch when desired to discontinue capturing image frames.

Note

- If the send queue is full, burst mode is discontinued automatically.
- When the burst duration has expired (image frames no longer being captured) and transmission has ceased, the Main menu appears.

40.6.2.2 Capturing Images in Snap Mode

40.6.2.2.1 Capture/Hold Mode

From the Main menu, press the SNAP switch. The capture sequence proceeds automatically with one image frame being captured. The Main menu remains unchanged, except that the hold queue field (@@@) increases by 1.

40.6.2.2.2 Capture/Send Mode

From the Main menu, press the SNAP switch. The capture sequence proceeds automatically with one image frame being captured. The following menu appears:

S=### H=@@@ R=### %:\$\$\$
BrstSnap View Abrt

1. When the SNAP switch is pressed, the send queue field (###) increases by 1. When the last captured image frame is compressed and sent, the send queue field changes to read 0. Image frames are continuously sent until the send queue is empty.
2. If it is desired to discontinue sending image frames before the send queue has been emptied, press the ABRT switch. The ABRT switch label flashes to indicate the command has been received, image capture is discontinued, the transmission of the image frames ceases, and the Main menu appears.

40.6.3 Compressing/Saving Images

Image compression is performed automatically when an image frame is to be transmitted (sent) and/or stored on the Image card in slot 0. The image frame is either placed directly into the compress queue as it is received (capture/send mode) or manually selected and transferred from the hold queue. The transfer from the hold queue can be of all image frames (using SAVE switch) or of individual image. Compression method and parameters are set using the Settings menu. When the image frame has been compressed, it is placed in the send queue for transmission and/or storage with no further user intervention.

40.6.3.1 Saving Images

In capture/hold mode when no call signs are selected for transmission and reception is not occurring, all captured-but-not-compressed image frames in the hold queue can be compressed and stored in the send queue. In this situation, the following menu appears:

S=### H=@@@ R=### %:\$\$\$
BrstSnapSet ViewVoc Save

Pressing the SAVE switch transfers all image frames currently in the hold queue to the compress queue for compression and storage in the send queue.

40.6.3.2 Image Card Full

If the Image card memory becomes full during compression, one of the following occurs, depending on transmit/receive status:

1. If transmission is occurring, all image frames in the compress queue are transferred to the rear of the hold queue. When the Image card memory becomes available (by image frames being deleted), the image frames in the hold queue are automatically transferred into the compress queue for compression and storage on the Image card.
2. If reception is occurring, the Tactical Imaging Set must be reset (press the two outer switches simultaneously).

Note

All image frames in the hold and compress queues are lost during reset.

- If neither transmission nor reception is occurring, the following menu appears:

IMAGES NOT SAVED: ###	
Abrt	Cont

Where ### is the number of image frames in the compress queue including the image frame which is causing the full-card condition: In flight, the operator must press the ABRT switch to transfer all image frames in the compress queue to the rear of the hold queue.

40.6.4 Transmitting Images

Image frames which have been captured and compressed can be automatically transmitted (capture/send mode only) or sent using the SEND switch on the Main menu. The SEND switch appears when the Tactical Imaging Set is not currently transmitting or receiving image frames, there is at least one image frame in the send and/or hold queue, and at least one send-to call sign is selected. New image frames can be captured during transmission. The PhotoTelesis Tactical (PTAC) protocol is used for communication with the external stations. The PTAC quick start parameter indicates whether the PTAC protocol attempts to verify established connections before attempting to transmit images. The mode (capture/send or capture/hold), the send-to call signs, and PTAC quick start status are set using the Settings menu. Transmission in capture/send mode is automatic with no user intervention. Transmission of image frames on command is accomplished as follows:

Note

The Tactical Imaging Set transmits image frames to all selected call signs, but it does so sequentially, that is, it transmits all image frames to the first selected call sign, receives an acknowledgement (depending on PTAC protocol), then sends all image frames to the second selected call sign, etc. It does not broadcast the image frames to multiple call signs simultaneously.

- On the Main menu, press the SEND switch. The Tactical Imaging Set automatically shifts into data mode, and the following menu appears:

S=00% H=1 R=1 U+:\$\$\$			
BrstSnap Set	View Doc	Send	

- If there are image frames in the send queue, those image frames are transmitted. Image frames from the compress queue, which are placed into the send queue before the send queue is emptied,

are also transmitted. Image frames in the hold queue are not transmitted. After transmission is complete, the Main menu appears.

- If there are no image frames in the send queue, all image frames in the hold queue are transferred to the compress queue, then to the send queue and transmitted. After transmission is complete, the Main menu appears and the Tactical Imaging Set automatically shifts to voice mode.

- The S=00% displays to the aircrew the percentage of transmitted data successfully received by the receiving station.

- If it is desired to discontinue transmitting image frames before all image frames have been sent, press the ABRT switch. The ABRT switch label flashes to indicate the command has been received, the transmission of the image frames ceases, and the Main menu appears.

40.6.5 Receiving Images

Image reception is normally accomplished after coordinating voice communication with the transmitting station. The Tactical Imaging Set must be in data mode to receive image frames, and the Main menu is normally active on the RCU. Image reception cannot occur during transmission, and the Image card must have sufficient memory available to store the received images. Reception is initiated when a transmission to a call sign matching the local call sign is received. The local call sign is set using the Settings menu. Once reception is initiated, it proceeds until complete with no user intervention, although it can be aborted by user command. When reception is complete, the Tactical Imaging Set sends an acknowledgement to the sending station, and the Main menu appears on the RCU.

- On the Main menu, press the VOC switch. The Tactical Imaging Set shifts into data mode, and the following menu appears with the &&& field flashing to indicate data mode is selected:

S=### H=@@@ R=&&& %:\$\$\$			
BrstSnapset	ViewDataSend		

- When reception begins, the following menu appears with the &&& field continuing to flash:

S=### H=@@@ R=&&& %:\$\$\$			
BrstSnapset	View	Abrt	

- If it is desired to discontinue receiving image frames before all image frames have been received, press the ABRT switch. The ABRT switch label flashes to indicate the command has been received, but the reception of image frames continues until the sending station ceases transmission or times out, at which time the following menu appears with the &&& field continuing to flash:

S=### H=@@@ R=&&& %:\$\$\$	
BrstSnapSet	ViewDataSend

Note

When the ABRT switch has been pressed, the Tactical Imaging Set does not send an acknowledgement to the sending station.

- Reception proceeds automatically until complete. The &&& field is incremented as image frames are received. When reception is complete, the Main menu appears with the &&& field continuing to flash:

S=### H=@@@ R=&&& %:\$\$\$	
BrstSnapSet	ViewDataSend

Note

The Tactical Imaging Set does not automatically revert to voice mode; therefore, voice mode must be selected to restore voice communications.

- Press the DATA switch. The Tactical Imaging Set shifts into voice mode, and the Main menu appears:

S=### H=@@@ R=&&& %:\$\$\$		
BrstSnapSet	ViewVoc	Send

Alphabetical Index

40.7 VIEWING IMAGES

Images available for viewing are captured image frames in the hold queue, captured, marked, or sent image frames in the send queue, received, sent, or uploaded image frames in the receive queue, and live/playback VTR output. When no viewing option is selected, Television Camera System (TCS) output is displayed on the cockpit display. Image frames in the hold, send, and/or receive queue can also be deleted. All functions are accomplished using the View menu.

- Pressing the VIEW switch on the Main menu accesses the View menu.

The View menu appears as follows:

Note

The View menu also provides access to the View VTR menu which is used to control the VTR.

S=### H=@@@ R=&&& %:\$\$\$	
End	DumpSendHoldRecvVtr

Switch functions are as follows:

- END** - Return to Main menu
- DUMP** - Display View Dump menu
- SEND** - Display View Send menu
- HOLD** - Display View Hold menu
- RECV** - Display View Receive menu
- VTR** - Display View VTR menu (for VTR control)

Note

If the send, hold, or receive queue is empty, the corresponding switch name label is not displayed. If all queues are empty, the DUMP switch label is also not displayed.

- The View menu function menus (except for the View Dump menu) follow the general format:

FUNCTION ### OF @@@		
End	Del	MarkCropPrevNext

Where ### is the currently selected image index number and @@@ is the total number of image frames in the selected queue. An image index number is automatically assigned to an image frame as it is stored, thus the more recent the image frame, the higher the index number. As image frames are deleted, index numbers are reassigned to the remaining image frames so that the index numbers are always sequential from 1 to the total number of image frames with no gaps.

Switch functions vary somewhat among menus, and are explained as each menu is described.

Note

The PREV and NEXT switches are used to cycle through the list of image index numbers in each queue. If the index number displayed is the last index number in the list, pressing the NEXT switch displays the first index number in the list. If the index number displayed is the first index number in the list, pressing the PREV switch displays the last index number in the list.

- c. If the selected image frame is to be deleted, press the DEL switch

The image frame is deleted, the index number of the next image frame in the queue is displayed, the total number of image frames is updated, and the next image appears on the cockpit display. (If the image frame deleted is the only one in the hold queue, the Main menu is displayed.)

Note

Pressing the DEL switch automatically and immediately deletes the image frame. There is no further prompt to confirm the deletion.

- d. If the selected image frame is to be transferred to the compress queue for storage and/or sending:

- (1) Select the portion of the image frame to be transferred by pressing the CROP switch. The cropping window over the image on the cockpit display is initially set to select the entire image (100%). Pressing the CROP switch successively reduces the selected portion to the center 75%, 50%, or 25% of the image, as shown by the cropping window on the cockpit display. Pressing the CROP switch when 25% is selected restores the 100% selection.

Note

The center of the cropping window is fixed at the center of the image.

- (2) When the desired image frame portion has been selected, press the MARK switch to transfer the selected portion to the compress queue. (The portion of the image frame outside the cropping window is discarded.) The image frame is automatically deleted from the hold queue, the total number of images in the hold queue is updated, the next image frame in the hold queue is selected, and the selected image appears on the cockpit display. (If the image frame transferred is the only one in the hold queue, the Main menu is displayed.)

5. Viewing, Deleting, and Sending Image Frames in the Receive Queue

Compressed image frames in the receive queue can be viewed, sent, or deleted using the View Receive menu.

- a. From the View menu, press the RECV switch. The View Receive menu sequence appears as follows, and the image frame with the displayed index number is decompressed and appears on the cockpit display:

RECV IMAGE	OF
End Del Mark	PrevNext
SEND IMAGE	OF
■■■■■■■	.

(Progress bar indicating status of decompression)

RECV IMAGE	1 OF @@@
End Del Mark	PrevNext

Switch functions are as follows:

- END** - Return to Main menu
- DEL** - Delete current image
- MARK** - Transfer image frame to send queue
- PREV** - Display image with previous index number
- NEXT** - Display image with next index number

- b. Press the PREV or NEXT switch until the desired image frame is displayed

The decompressed image appears on the cockpit display. The number of the image frame displayed is its position in the queue. This position is based on the image frames assigned image code (time code for FTI-captured image frames, externally assigned for received and previously loaded image frames). The queue wraps around so that the image frame selected by pressing the NEXT switch when viewing the last image frame in the queue is image frame number 1, and the image frame selected by pressing the PREV switch when viewing image frame number 1 is the last image frame in the queue.

- c. If the image frame is to be deleted, press the DEL switch

The image frame is deleted, the index number of the next image frame in the queue is displayed, the total number of image frames is updated, and the decompressed next image appears on the cockpit display. (If the image frame deleted is

the only one in the receive queue, the Main menu is displayed.)

Note

Pressing the DEL switch automatically and immediately deletes the image frame. There is no further prompt to confirm the deletion.

- d. If the selected image frame is to be sent (forwarded), press the MARK switch to copy the selected image frame to the send queue.

The image frame is retained in the receive queue. While the image remains in the send queue, it cannot be marked again for transmission.

6. Deleting All Image Frames in One or More Queues

The send, hold, and/or receive queues can be emptied of image frames using the View Dump menu.

- a. From the View menu, press the DUMP switch

The View Dump menu appears as follows:

SELECT IMAGES TO DUMP	
End	SendHoldRecvAll

Switch functions are as follows:

- END** - Return to Main menu
- SEND** - Delete all image frames in the send queue
- HOLD**- Delete all image frames in the hold queue
- RECV**- Delete all image frames in the receive queue
- ALL** - Delete all image frames in all queues

Note

If the send, hold, or receive queue is empty, the corresponding switch name position is blank.

- b. Press the switch corresponding to the desired queue(s) from which image frames are to be deleted

All image frames in the selected queue(s) are deleted, and the Main menu is displayed.

Note

Pressing the SEND, HOLD, RECV, or ALL switch automatically and immediately deletes all image frames in the selected queue(s). There is no further prompt to confirm the deletion.

40.8 CONTROLLING VTR FUNCTIONS

The VTR can be controlled from either the RCU or the aft cockpit Sensor Control Panel, with the Sensor Control Panel taking precedence. When the Sensor Control Panel RECORD switch is set to OFF, power is removed from the Tactical Imaging Set, and the VTR tape is unthreaded. When the Sensor Control Panel RECORD switch is set to RECD, the VTR is commanded to record. When the Sensor Control Panel is set to STBY (normal situation), the VTR is commanded to perform the function set by the RCU. In either case, the Sensor Control Panel indicator lights indicate standby, end of tape (EOT), or unthreaded VTR status, as applicable. In practice, it is recommended that if the Sensor Control Panel is used to control the VTR record function, the RCU have STBY selected. If the RCU is used to control the VTR functions, the Sensor Control Panel selector must be set to STBY.

- 1. VTR control functions are part of the Tactical Imaging Set view functions

The View menu is accessed by pressing the VIEW switch on the Main menu. The View menu appears as follows:

S=### H=@@@ R=&&& %:\$\$\$				
End	DumpSnd	Hld	Rcv	Vtr

- 2. There are two levels of recorder functions menus; the Record Level menu (indicated by the presence of the REC switch name), and the Play Level menu (indicated by the presence of the PLAY switch name).

- a. Record Level Menu

To access the Record Level recorder functions menu, press the VIEW switch on the Main menu, then press the VTR switch on the View menu. The Record Level menu appears on the RCU.

\$\$\$\$\$\$\$\$\$\$\$\$\$\$\$ +hh:mm:ss	
End	Set StbyRec UnthRset

Where \$\$\$\$\$\$\$\$\$\$\$\$ is the current VTR function, ± is either a - or a + indicating tape location is before (-) or after (+) the tape counter reset point, and hh:mm:ss is the tape counter time since reset in hours, minutes, and seconds.

VTR function indications are as follows:

- BOT** - Tape has been rewound to beginning
- EOT** - Tape has been forwarded to end

- F-FWD** - VTR is fast-forwarding the tape
- PLAY** - VTR is playing back a tape
- RECORD** - VTR is recording video
- REWIND** - VTR is rewinding the tape
- SCAN FORWARD** - VTR is scanning the tape in the forward direction
- SCAN REVERSE** - VTR is scanning the tape in the reverse direction
- STANDBY** - Tape is stopped and threaded on VTR tape heads; VTR is not recording or playing back video
- STILL** - Tape is stopped and threaded on VTR tape heads, and VTR is outputting single video image (pause or freeze frame)
- UNTHREAD** - Tape is unthreaded from VTR tape heads

Note

If the VTR function is RECORD, the RSET switch is replaced by an EMK switch.

Switch functions are as follows:

- END** - Return to Main menu
- SET** - Display Play Level menu
- STBY** - Set VTR to standby function
- REC** - Set VTR to record function
- UNTH** - Set VTR to unthread function
- RSET** - Reset tape counter to +00:00:00
- EMK** - Place event mark signal on tape (during recording only)

b. Play Level Menu

To access the Play Level recorder functions menu, press the SET switch on the Record Level menu. The Play Level menu appears on the RCU.

\$\$\$\$\$\$\$\$\$\$\$\$\$\$ +hh:mm:ss
End BackStilPlay REW FF

Field definitions and VTR function indications are the same as for the Record Level menu. Switch functions are as follows:

- END** - Return to Main menu
- BACK** - Display Record Level menu
- STIL** - Set VTR to pause (freeze frame) function
- PLAY** - Set VTR to play function
- REW** - Set VTR to rewind function
- FF** - Set VTR to fast forward function

40.8.1 Function Operations

1. Changing Between Record Level and Play Level Menus
 - a. To change to the Play Level menu from the Record Level menu, press the SET switch.
 - b. To change to the Record Level menu from the Play Level menu, press the BACK switch.
2. Recording Video

On the Record Level menu, press the REC switch. The VTR terminates whatever function it, was performing and shifts into record mode. Tape moves forward (unless it is at end of tape), and video is recorded.
3. Event Marking

On the Record Level menu while recording, press the EMK switch. An event mark signal is recorded on the tape when the EMK switch is pressed. Any number of event marks can be placed on the tape.
4. Resetting Tape Counter

On the Record Level menu while performing any function except recording, press the RSET switch. The tape counter is reset to +00:00:00.
5. Playing Back Video

On the Play Level menu, press the PLAY switch. The VTR terminates whatever function it was performing and shifts into play mode. Tape moves forward (unless it is at end of tape), and video is reproduced (played back) from the tape.

6. Pausing (Freeze Framing)

On the Play Level menu while in play function, press the STIL switch. The tape stops moving, and the VTR outputs the image recorded at that point on the tape. If this function is active for 5 consecutive minutes, the VTR automatically shifts into unthread function to protect the tape.

7. Scanning Forward

On the Play Level menu, press the PLAY switch, then the FF switch. The VTR terminates whatever function it was performing and shifts into play, then scan forward mode. Tape moves forward (unless it is at end of tape) at 7 times normal playback speed, and video is reproduced (played back) from the tape. If an event mark is encountered while scanning forward, VTR shifts into play function.

8. Scanning in Reverse

On the Play Level menu, press the PLAY switch, then the REW switch. The VTR terminates whatever function it was performing and shifts into play, then scan reverse mode. Tape moves backward (unless it is at beginning of tape) at 7 times normal playback speed, and video is reproduced (played back) from the tape. If an event mark is encountered while scanning in reverse, VTR shifts into play function.

9. Fast-Forwarding

On the Play Level menu when not in play function, press the FF switch, or on the Play Level menu when in play function, press the FF switch twice. The VTR terminates whatever function it was performing and shifts into fast forward mode. Tape moves forward (unless it is at end of tape) at high speed. Video is not reproduced (played back) from the tape.

10. Rewinding

On the Play Level menu when not in play function, press the REW switch, or on the Play Level menu when in play function, press the REW switch twice. The VTR terminates whatever function it was performing and shifts into rewind mode. Tape moves backward (unless it is at beginning of tape) at high speed. Video is not reproduced (played back) from the tape.

11. Stopping Tape

On the Record Level menu, press the STBY switch. The tape stops moving, but remains threaded. Video is not reproduced (played back) from the tape. If this function is active for 5 consecutive minutes, the VTR automatically moves the tape forward for 0.5 seconds to protect the tape.

12. Unthreading Tape

On the Record Level menu, press the UNTH switch. The tape stops moving, and the tape is unthreaded from the VTR tape heads. Video is not reproduced (played back) from the tape. (Tape must be unthreaded before the tape cassette can be removed from the VTR).

40.9 ERROR MESSAGES

If a problem with the VTR exists, an error message appears in the VTR function indication field of the Record Level or Play Level menu, whichever is active. Possible error messages include:

40.9.1 DEW

Condensation has occurred in the VTR (tape motion and unthreading is inhibited until condensation evaporates).

40.9.2 COMMS ERROR

An error, such as a framing or parity error, has occurred in an RS-422 command to the VTR

40.9.3 INTERNAL ERROR

A problem inside the VTR (e.g., with the tape path, heads, or motors) exists.

40.9.4 COMMAND ERROR

An impossible function (e.g., playing or recording with no tape installed, playing or recording when tape is at its end, recording on write-protected tape) has been commanded.

INDEX

	<i>Page No.</i>	<i>Page No.</i>
A		
Abnormal Start	12-1	
Aborted takeoff	13-1	
Checklist	13-1	
Accelerated Departures	11-14	
Acceleration limits	4-5	
Aft hung ordnance landings	15-16	
Aft wing-sweep landings	11-27, 15-11	
After landing, cold-weather operations	18-6	
Afterburner:		
Fuel control	2-13, 2-23	
Ignition	2-32	
Air inlet control system	2-1	
Malfunctions	14-16	
Air-conditioning, cockpit	2-151	
Aircraft	Part I	
Fuel system	2-40	
Lighting during night formation flight	9-4	
Self-test	Chapter 38	
Subsystems	17-2	
Aircrew coordination	37-1	
Single-engine failure field/catapult launch waveoff	13-2	
Airspeed:		
Limitations	4-1	
Subsonic	11-5	
Airstart(s)	2-32, 2-34, 14-7	
Envelope	4-1	
External	2-32	
Twenty thousand feet	10-20	
All-weather operations	Part VI	
AN/APN-194(V) radar altimeter system	2-250	
AN/APX-76 identification friend or foe interrogator	21-6	
AN/APX-100 identification transponder	21-1	
AN/ARC-182 V/UHF radio	19-7	
AN/ARN-118 tactical air navigation system	20-8	
AN/ASN-139 inertial navigation set	20-1	
AN/ASW-27C data link	20-11	
AN/AVX-3 Tactical imaging set	40-1	
AN/URC-107 joint tactical information distribution system	20-8, 20-12	
AN/USN-2(V) standard attitude heading reference system	20-5	
Angle-of-attack:		
Limits	4-5	
System	2-251	
Antennas, communications	19-1	
Anti-ice, engine	2-27	
Antiskid	2-138	
APG-71 PM acronym	14-28	
Applicable publications	39-4	
Approach:		
Lights	2-251	
Pilot functional checkflight procedures	10-27	
RIO functional checkflight procedures	10-31	
Approach power compensator:		
Performance	17-3	
Technique	8-9	
Area around aircraft, inspection of	7-1	
Arrested landing and exit from landing area	8-10	
Night	8-13	
Arresting hook:		
Emergency down	15-21	
System	2-145	
Ascent checklist	7-23	
Asymmetric-thrust-induced departures	11-14	
Asymmetric thrust flight characteristics	11-22	
In combat and cruise configuration	11-4	
Asymmetric wing sweep	11-31, 15-11	
Flight characteristics	11-32	
Audio warning signals	19-5	
Authorized stores loading	4-21	
Automatic carrier landing system	17-1	
Beacon augmentor	17-2	
Displays	17-3	
Procedures	17-10	
Automatic fuel electrical controls	2-59	
Automatic landing system (AN/SPN-42)	17-8	
Autopilot	2-125	
Emergency disengage	2-126	
Light	14-48	
Limits	4-1	
Auxiliary brake	2-140	
Auxiliary canopy open control	2-77	
Auxiliary flap failure	15-10	
Avionic bit operation	38-10	
B		
Backup flight control system	2-73	
Backup flight module malfunction	14-35	
Backup ignition	2-32	
Backup oxygen supply servicing data	3-8	
Backup oxygen system	2-159	
Banner towing	9-4	
Restrictions	4-20	
Barricade arrestment	15-18	
Barricade engagement limits	4-18	
Bearing distance heading indicator	20-11	

	<i>Page No.</i>		<i>Page No.</i>
Before leaving aircraft, cold-weather operations	18-6	Center of gravity:	
Binding/jammed flight controls on deck	12-4	Aft locations, flight characteristics with	11-38
Bingo fuel	8-9	Position limits	4-18
Bleed air, engine	2-27	Checkflight procedures	10-1
Block Numbers	1-2	Checkout, on-board	38-3
Blown tire:		Clean and symmetric stores loading	4-13
During takeoff	13-3	Climb:	
Landing	15-10	Flight evaluation	39-3
Boarding ladder	2-283	Pilot functional checkflight procedures	10-2
Bolter	8-12	RIO functional checkflight procedures	10-27
Technique	8-9	Climb to thirty-five thousand feet	
Both combined and flight pressure zero	14-33	Pilot functional checkflight procedures	10-20
Brake:		RIO functional checkflight procedures	10-29
Characteristics	2-138	Closed-book examination, NATOPS	39-2
Failure at taxi speed	12-4	Cockpit	1-1
BRAKES warning light	2-140	Air-conditioning	2-151
Break formation	9-3	Overpressurization on deck	14-28
Briefing:		Temperature control malfunction	14-28
Carrier-based procedures	8-1	Cold-weather operations	18-4
Mission	39-3	Combined dynamic and viscous hydroplaning	18-3
Preflight	6-1	Combined pressure approximately	
B/U OXY LOW light	14-29, 14-30	2,400 to 2,600 psi	14-31
Built-in test:		Combined pressure zero	14-32
Description	38-7	Command ejection lever	2-263
Engine instrument group	2-37	Communications	Chapter 19
C			
CABIN PRESS light	14-28	And associated equipment	19-1
CADC light	14-47	Antenna	19-1
Canopy:		Emergency procedures	14-1
Control, normal	2-77	Failure	14-1
Open control, auxiliary	2-77	Flight evaluation	39-3
System	2-254	In-flight visual	19-27
Carrier:		Communications-navigation equipment	
Landing pattern (VFR)	8-7	and procedures	Part VII
Preflight	8-1	Compressor stall	14-5
Carrier-based procedures	Chapter 8	Controllability check	14-35
Carrier-controlled approaches	8-10	Controller processor signal unit	22-2
Catapult:		Converter interface unit	20-6
Launch	8-5, 8-12	COOLING AIR light	14-27
System, nosegear	2-143	Cooling, electronic equipment	2-152
Trim requirements	8-5	Cooperative support software	38-40
Catapult abort procedures		Coordination, aircrew	37-1
Day	8-6	Coupling, inertia	11-14
Night	8-13	Crank, engine	2-32
Catapult hookup		Critique	39-4
Day	8-4	Cross-control-induced departures	11-13
Night	8-12	Crossbleed start	2-34
Caution legends, multifunction display engine	2-38	Crosswind limits	4-1
Caution light, OIL HOT	2-35	Cruise:	
Ceiling/visibility requirements	5-2	And combat flight characteristics with aft cg	11-38
		Flight evaluation	39-3
		Formation	9-3
		Cursor controls	2-174

	<i>Page No.</i>	<i>Page No.</i>
D		
Danger areas, ground handling	3-8	
Data:		
Display system	22-2	
Entry unit	2-242	
Link	17-2	
Deck-launched intercept procedures	7-35	
Definitions, NATOPS evaluation	39-1	
Defueling	2-56	
Degraded approach configuration	11-27	
Degraded electrical operation	2-62	
Departure:		
From controlled flight	11-10	
Recovery	11-15	
Spin	14-49	
Descent	7-23	
RIO functional checkflight procedures	10-29	
Diamond four-plane formation	9-3	
Digital data system	22-26	
Digital flight control system	2-109, 17-2	
Digital flight control system test	2-129	
Dihedral effect	11-6	
Direct lift control	2-109	
Directional (yaw) control	11-1	
Directional stability	11-6	
Directives, technical	1-2	
Display system, TARPS	22-2	
Displays	2-161	
Subsystem	20-6	
Distance measuring equipment fix	8-10	
■ Double generator failure	14-20a	
Double transformer-rectifier failure	14-22	
Dual hydraulic failures backup flight		
control module flight characteristics	11-33	
Dual-engine landing, one or both engines in		
secondary mode	15-1	
Dump, fuel	2-55	
Dutch roll	11-3	
Dynamic hydroplaning	18-2	
Dynamic longitudinal response characteristics	11-2	
E		
Ejection:		
Envelope	16-1	
Preparation	16-5	
System	2-256a	
Ejection initiation	2-263, 16-6	
Ejection seat	2-258	
Inspection	7-6	
Operation limits	4-1	
Electrical controls, automatic fuel	2-59	
Electrical failure	14-20	
Total	14-24	
Electrical fire	14-22	
Electrical operation:		
Degraded	2-62	
Normal	2-59	
Electrical power:		
Distribution	2-61	
Supply system	2-59	
Electronic equipment cooling	2-152	
Electronic nomenclature	1-5	
Emergency entrance	12-2	
Emergency gear extension	2-77, 2-136	
Emergency jettison	14-2	
Emergency oxygen supply	2-160	
Emergency procedures	39-3, Part V	
Engaging speeds	15-18	
Engine	Chapter 1, 2-9	
Anti-ice	2-27	
Bleed air	2-27	
Compartment ventilation	2-30	
Control, main	2-21	
Crank	2-32	
Emergencies	14-5	
Feed	2-43	
Fire on the deck	12-1	
Fuel boost pump	2-21	
Fuel system	2-21	
Ignition system	2-30	
Instruments	2-35	
Limit	4-1	
Monitor display format	2-37	
Overspeed	14-12	
Overtemperature warning	2-38	
RPM indicator	2-35	
Runup, pilot functional checkflight procedures	10-13	
Stall warning	2-38	
Stalls	11-5	
START VALVE light	14-12	
Starting system	2-32	
Transfer to SEC mode	14-12	
Engine instrument		
Group built-in test	2-37	
Group self-test	2-37	
Engine oil:		
Pressure indicator	2-37	
Servicing data	3-4	
System	2-34	
Engine start:		
Cold-weather operations	18-5	
Pilot	7-11	
RIO	7-30	
Environmental control system	2-148	
Leak detection	2-29	
Malfunctions/failures	14-25	
Equipment:		
Circuit breakers, TARPS	22-2	

	<i>Page No.</i>		<i>Page No.</i>
Communications and associated	19-1	General	11-2
Miscellaneous	2-283	High angle of attack	11-6
Evaluation:		Single engine	14-11
Flight	39-3	With aft cg locations	11-38
NATOPS	Chapter 39	Flight control systems	2-97
Exhaust gas temperature indicator	2-35	Backup	2-73
Exhaust nozzle:		Failures or malfunctions	14-35
Failed (no nozzle response to throttle movement)	14-15	Flight evaluation(s)	39-3
Position indicator	2-37	Grade determination	39-4
Variable	2-16	Grading criteria	39-4
Exterior inspection	7-1	Flight pressure:	
Exterior lights	2-265	Approximately 2,400 to 2,600 psi	14-31
External airstart	2-32	Zero	14-33
External baggage container	2-284	Flightcrew:	
External stores limits	4-19	Attention signals	14-1
Extreme weather operations	Chapter 18	Coordination	Chapter 37
		Flight training syllabus	5-2
		Forced landing	15-21
		Foreign object damage and leak inspection	7-1
		Formation flight	9-2, 37-4
		Aircrew coordination	37-1
		Takeoff	7-22
		Formats	2-176
		Fuel:	
		Boost pump, engine	2-21
		Dump	2-55
		Flow indicator	2-37
		Leak	14-19
		Management system operational check	9-7
		Pressure caution lights/Low Fuel Pressure Warning Tone	14-18
		Pump	2-21
		Quantity balancing	2-54
		Quantity system	2-42
		Tankage	2-42
		Fuel system:	
		Aircraft	2-40
		Engine	2-21
		Malfunctions	14-18
		Fuel transfer	2-50
		During single-engine operation	2-54
		Failures	14-19
		Fueling	2-56
		Functional checkflight procedures	Chapter 10
		Aircrew coordination	37-1
		Pilot	10-2
		RIO	10-27
		G	
		Gear extension, emergency	2-77
		Generator failure	14-20
		Grade determination, flight evaluation	39-4
		Grading criteria, flight evaluation	39-4

	<i>Page No.</i>		<i>Page No.</i>
Grading instructions, ground evaluation	39-2	In-flight emergencies	Chapter 14
Gross weight limits, takeoff/launch/landing	4-18	In-flight reconnaissance system check, RIO	7-32
Ground clearances, towing	3-15	In-flight refueling	2-57, 9-1
Ground egress without parachute and survival kit	12-2	In-flight visual communications	19-27
Ground emergencies	Chapter 12	Indicator(s):	
Ground evaluation, NATOPS	39-2	Engine oil pressure	2-37
Ground handling	3-8	Engine RPM	2-35
Signals	19-27	Exhaust gas temperature	2-35
Ground operations limits	4-1	Exhaust nozzle position	2-37
Ground procedures, banner towing	9-4	Fuel flow	2-37
Ground refueling	3-1	Lights	2-269
Ground roll braking failures	15-21	Multistatus	2-170
Ground safety devices and covers, inspection of	7-1	Oil pressure	2-35
Ground training requirements/syllabus	5-1	Indoctrination	Chapter 5
Gun:		Inertial navigation set (AN/ASN-139)	20-1
Burst limits	4-19	INLET ICE light	14-17
Gas purging	2-154	Inspection:	
Limits	4-19	Areas	7-2
		Exterior	7-1
H		Instrument:	
Handling	Chapter 3	Engine	2-35
Heads-up display	2-169	Flight evaluation	39-2
Heads-up display symbology	22-13	Procedures	Chapter 17
High angle of attack flight characteristics	11-6	Instrument landing system:	
High energy ignition, main	2-30	AN/ARA-63	17-5
High speed dash (thirty-five thousand feet):		AN/SPN-41	17-8
Pilot functional checkflight procedures	10-21	Displays	17-3
RIO functional checkflight procedures	10-29	Integrated drive generator oil servicing data	3-4
Hold phase	8-10	Integrated trim system	2-97
Holdback fitting	2-145	Intercommunications	19-1
Horizontal tail authority figure	14-42	Interference, mutual	19-1
Hot refueling	2-58	Interim AIM-7 as ballast	4-21
Procedures	7-34	Interior inspection:	
Hot switch procedures	7-36	Pilot	7-8
Hot-weather and desert operations	18-6	RIO	7-28
Hydraulic power:		Interior lights	2-268
Distribution	2-72	Internal tank pressurization and vent	2-56
Supply systems	2-69	Inverted departure/spin	14-50
Hydraulic system:		Inverted spin	11-21
Malfunctions	14-31	Inverted stall/departure	11-20
Servicing data	3-4		
Hydroplaning	18-2	J	
		Jettison:	
I		Emergency	14-2
Ice	18-1	Limits	4-20
Identification	Chapter 21	Joint tactical information distribution system	19-19
Friend or foe interrogator (AN/APX-76)	21-6	AN/URC-107	20-8, 20-12
Transponder (AN/APX-100)	21-1	On board check	38-36
Ignition system, engine	2-30		
In chocks, RIO functional checkflight procedures	10-32	L	
		L or R FUEL LOW light	14-19
		LAD/CANOPY light	14-30, 14-31

	<i>Page No.</i>		<i>Page No.</i>
Landing	7-24	Manual bailout	16-6
Carrier pattern (VFR)	8-7	Manual man/seat separation	16-7
Checklist	7-26	Master test panel checks	38-1
Cold-weather operations	18-6	Master test switch operation	38-3
Emergencies	Chapter 15	Maximum airspeeds	4-5
Flaps, slats, and direct lift control	11-2	Meatball contact	8-12
Gross weight limits	4-18	Medium and high-subsonic airspeed	11-5
Hot weather and desert operations	18-6	MFT procedures evaluation	39-2
On wet runway	18-4	Minimum flightcrew requirements	5-5
Preparation, parachute	16-9	Minimum ground training syllabus	5-1
RIO functional checkflight procedures	10-32	Miscellaneous equipment	2-283
With aft hung ordnance	15-17	Mission commander	5-4, 37-1
Landing configuration flight characteristics	11-21	Mission computer system	2-77, 20-5
With aft cg	11-38	Mission evaluation	39-3
Landing gear:		Mission planning and briefing	39-3
Emergencies	15-6	Motive flow fuel pump	2-21
Emergency lowering	15-6	Movable surfaces, inspection of	7-2
Handle	2-132	Multifunction display(s)	2-174
Malfunctions	15-8	Engine caution legends	2-38
Normal operation	2-135	Formats	2-176
Systems	2-132	Reconnaissance data status format	22-9
Lateral control	2-102	Multistatus indicator	2-170
Reversal	11-7	Mutual interference	19-1
Lateral-stick-induced departures	11-13		
Launch:		N	
Bar	2-145	NATOPS evaluation	Part X
Carrier-based procedures	8-1	Program	39-1
Gross weight limits	4-18	Qualification and currency requirements	5-3
Limits	4-19	Question bank	39-4
Single-engine failure field/catapult	13-2	Navigation	Chapter 20
Leak(s)	7-2	Command and control grid	Chapter 23
Detection, environmental control system	2-29	Navigation data:	
Lighting system	2-265	Display	20-12
Lights, approach	2-251	Emergency procedures	14-1
Limitations	4-1	Initialization	20-6
Lineal coverage	22-22	Navigation system	20-1
Long-field arrestment	15-18	Data distribution	20-12
Long-range oblique photography camera		Operation	20-20
(KS-153A with 610-mm lens)	22-24	NAVRIIT	40-1
Longitudinal control	2-97	Negative angle-of-attack departures	11-20
Low brake accumulator pressure	14-35	Night field carrier landing practice	7-37
Low subsonic airspeed	11-6	Night flying	8-12
		No-flaps and no-slats landing	15-10
M		Nomenclature, electronic	1-2, 1-5
Main landing gear	2-133	Normal electrical operation	2-59
Malfunction procedures	39-3	Normal procedures	Part III
Maneuvering:		Normal stalls	11-22
Flaps and slats	11-2, 11-7	Nose landing gear	2-133
Limits	4-10	Nose radome	2-283
Stick force	11-2	Nose strut keel	2-143
Maneuvers, prohibited	4-10	Nosegear catapult system	2-143
Manual approach technique	8-7	Nosewheel steering system	2-141

	<i>Page No.</i>		<i>Page No.</i>
O			
OA-8697 V/UHF automatic direction finder	19-18	Postflight:	
OBOGS light	14-29	Procedures	39-3
Oil:		RIO functional checkflight procedures	10-32
Cooling	2-35	Postlanding:	
Pressure indicators	2-35	Pilot	7-27
OIL HOT caution lights	2-35	RIO	7-34
Oil system:		Poststart:	
Engine	2-34	Carrier-based procedures	8-1
Malfunction	14-17	Night flying	8-12
On-board checkout	38-3	Pilot	7-13
On-board oxygen generating system	2-157	Pilot functional checkflight procedures	10-6
On-deck emergencies	12-1	RIO	7-29
Open-book examination, NATOPS	39-2	RIO functional checkflight procedures	10-27
Operating criteria	5-2	Power supply system:	
Operating limitations	Chapter 4	Electrical	2-59
Operational deployable squadrons	39-3	Hydraulic	2-69
Oral examination, NATOPS	39-2	Pneumatic	2-77
Outboard spoiler module:		Preflight:	
Failure	11-27	And line operations	39-3
Malfunction	14-44	Briefing	6-1
Outboard spoiler system	2-73	Carrier-based procedures	8-1
Overspeed, engine	14-12	Cold-weather operations	18-5
Oxygen system	2-157	Night flying	8-12
Failure	14-29	Preland	7-23
P			
Panels, security of	7-2	Pressurization	2-152
Panoramic camera	22-2, 22-23	Prestart:	
Parachute:		Pilot	7-10
Landing preparation	16-9	Pilot functional checkflight procedures	10-2
Steering	16-9	RIO	7-29
Parade formation	9-2	RIO functional checkflight procedures	10-27
Parking brake	2-140	Primary flight controls	11-1
Pattern entry	7-24	Programmable tactical information display	20-6
Photographic film	22-26	Prohibited maneuvers	4-10
Pilot tone volume/TACAN command panel	19-7	Publications, applicable	39-4
Pilot:		PUMP phase circuit breakers popped	14-28
Procedures	7-8	Q	
Reconnaissance operation	22-21	Question bank, NATOPS	39-4
Relief and guidance modes	2-126	R	
Responsibilities	37-1	Radar:	
Pitch:		Altimeter system, AN/APN-194(V)	2-250
Control	11-1	Beacon (AN/APN-154)	17-2
SAS degrade	14-38	Radiation areas	3-8
SAS light	14-38	System built-in test	38-47
Pitot-static system	2-160	Radar intercept officer:	
Failures	14-1	Procedures	7-28
Planning, mission	39-3	Responsibilities	37-1
Platform	8-10	Raft boarding	16-9
Pneumatic power supply systems	2-77	Rain	18-1
Pneumatic systems servicing data	3-8		

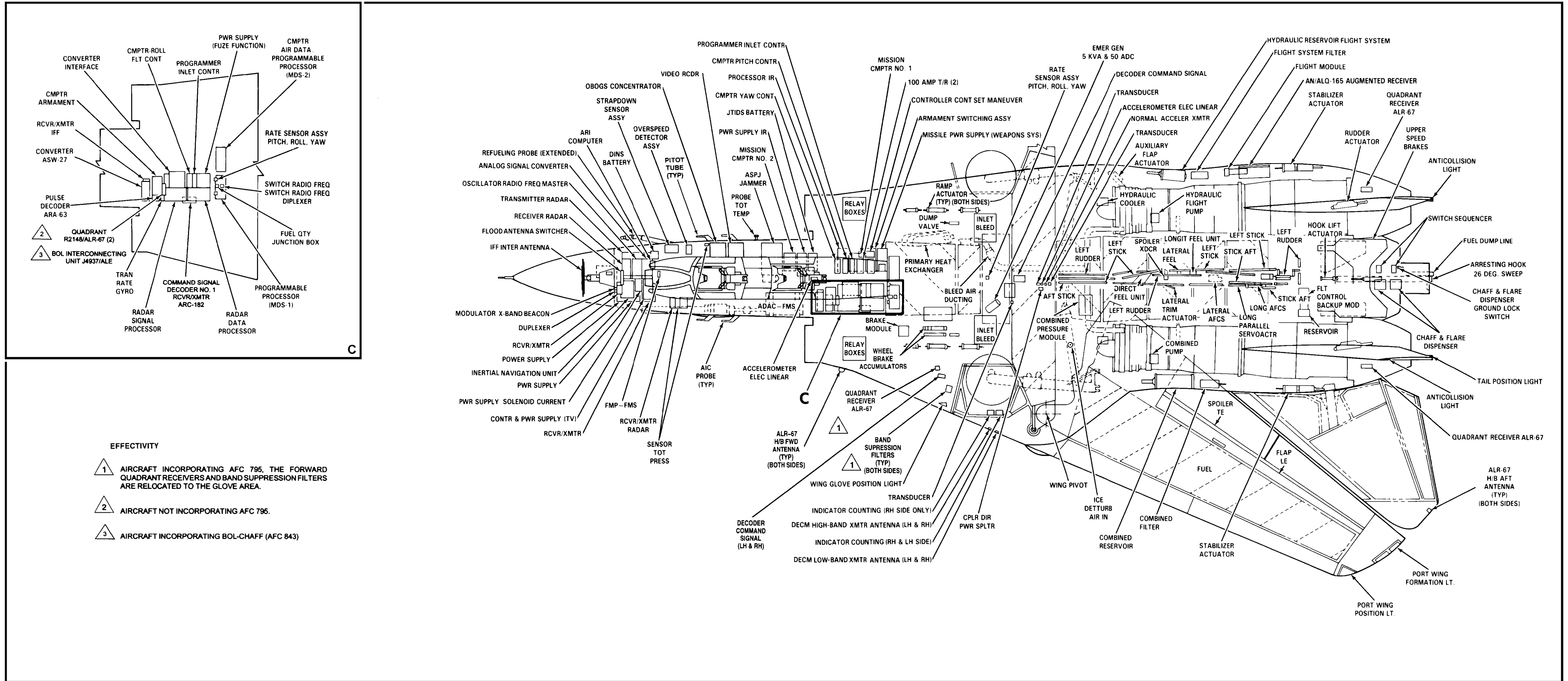
	<i>Page No.</i>		<i>Page No.</i>
Reconnaissance:		Single-engine landing:	
Displays and formats	22-9	Operation fuel transfer/feed	2-54
Fault/problem reporting	22-9	Primary mode	15-1
Steering selection	22-11	SEC mode	15-3
Reconnaissance system	22-1	Six-mile DME fix	8-10
Operation	22-13	Slats, maneuvering	11-7
Records and reports	39-3	Special consideration	37-4
Recovery, stall	11-22	Special procedures	Chapter 9
Refueling:		Specific responsibilities, aircrew	37-1
Ground	3-1	Speedbrakes	2-95, 11-2
Hot	2-58	Spin:	
In-flight	2-57	Flat	11-20
Requirements for various flight phases	5-4	Inverted	11-21
Reverted rubber skids	18-3	Spoiler:	
Roll:		Control	2-105
Control	11-1	Malfunction	14-42
DGR light	14-39	Stability augmentation	11-1
Performance	11-3	Transients	14-40
Response	11-3	Stability augmentation system	2-110, 11-1
SAS degrade	14-39	DFCS	11-6
SAS failure	14-39	Limits	4-13
Uncommanded	14-37	Off	11-27
Rolling limits	4-10	Stability, wing-sweep effects on	11-38
Rpm decay, uncommanded SEC mode	14-13	Stall(s):	
Rudder authority failure	14-40	Characteristics	11-9
Rudder-induced departures	11-13	Compressor	14-5
Runup, flight evaluation	39-3	Normal	11-22
		Recovery	11-22
		Vertical	11-9
		Warning, engine	2-38
		Standard attitude heading reference system	
		(AN/USN-2(V))	20-5
		Standard central air data computer	2-79, 20-6
		Standby airspeed indicator	2-250
		Standby altimeter	2-250
		Standby attitude indicator	2-248
		Start:	
		Abnormal	12-1
		Carrier-based procedures	8-1
		Crossbleed	2-34
		Pilot functional checkflight procedures	10-2
		START VALVE light, engine	14-12
		After engine start	12-1
		Starter limits	4-1
		Static longitudinal stability	11-2
		Store(s)	11-6
		Effects on cg location	11-38
		Management system/jettison	2-278
		Stores loading:	
		Authorized	4-21
		Clean and symmetric	4-13
		Stuck/jammed throttle(s)	14-15
		Surface condition	7-2
		Surface subsystems	17-8

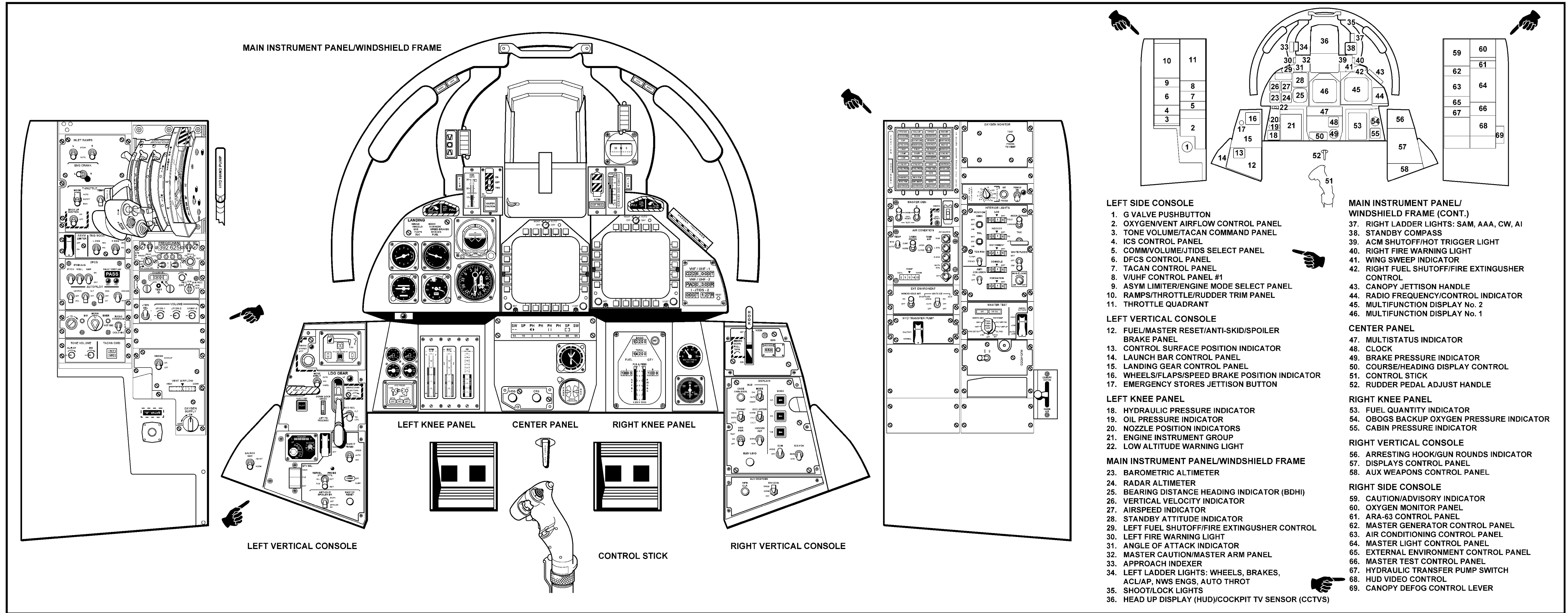
S

Search and rescue	37-4
Seat:	
Ejection	2-258
Operation after ejection	2-265
Secondary flight controls	11-2
Security of panels	7-2
Self-test, engine instrument group	2-37
Sensor capabilities and limitations	22-22
SENSOR COND light illuminated	14-28
Serial frame camera	22-2, 22-22
Servicing	Chapter 3
Shimmy damping	2-143
Shipboard procedures	9-4
Shore-based procedures checklists	7-1
Short-field arrestment	15-18
Sideslip limits	4-10
Signals:	
Audio warning	19-5
Flightcrew attention	14-1
Ground handling	19-27
Single-engine failure field/catapult	
launch/waveoff	13-2
Single-engine flight characteristics	14-11

	<i>Page No.</i>		<i>Page No.</i>
Survival kit deployment	16-7	Towing turn radii and ground clearances	3-15
Survival/postejction procedures	16-6	Training:	
Symbology	2-176	Aircrew coordination	37-4
HUD/VDI	22-13	Evaluation squadrons	39-3
Systems	Chapter 2	TRANS/RECT light	14-22
Test and system power ground panel	2-283	Transfer, fuel	2-50
T			
Tactical air navigation system		Trim characteristics	11-4
(AN/ARN-118)	20-8, 22-1	TSEC/KY-58 UHF voice security equipment	19-19
Tactical air reconnaissance pod system	22-1	Turbulence	18-4
Checklist	7-1	Turn radii, towing	3-15
Degraded mode procedures	7-33	Twenty thousand foot checks:	
Environmental control system	22-2	Pilot functional checkflight procedures	10-22
Limitations	4-21	RIO functional checkflight procedures	10-29
Subsystem	Chapter 22	U	
Tactical Imaging Set	40-1	UHF automatic direction finder	20-11
Takeoff	7-20	UHF voice security equipment (TSEC/KY-58)	19-19
Aborted	7-22, 13-1	Uncommanded dump	14-19
And landing flap/slat transition limits	4-13	Uncommanded engine acceleration:	
Blown tire during	13-3	Airborne (no throttle movement)	14-15
Checklist	7-22	On deck	12-1
Cold-weather operations	18-5	Uncommanded roll and/or yaw	14-37
Emergencies	Chapter 13	Uncommanded SEC mode rpm decay	14-13
Gross weight limits	4-18	Unscheduled wing sweep	14-47
Hot weather and desert operations	18-6	Upright departure	14-49
Pilot functional checkflight procedures	10-14	Recovery	11-15
RIO functional checkflight procedures	10-28	V	
Takeoff configuration flight characteristics	11-21	Variable exhaust nozzle	2-16
With aft cg	11-38	Ventilation, engine compartment	2-30
TARPS ECS light illuminate	14-27	Vertical display indicator symbology	22-13
Taxi:		Vertical recovery	14-49
Flight evaluation	39-3	Vertical stalls	11-9
Night flying	8-12	Viscous hydroplaning	18-3
Pilot	7-20	Voltage monitoring	2-125
Pilot functional checkflight procedures	10-13	V/UHF automatic direction finder (OA-8697)	19-18
RIO	7-32	V/UHF radio (AN/ARC-182)	19-7
RIO functional checkflight procedures	10-28	W	
Taxiing	7-18, 8-4	Waiving of minimum ground training	
Carrier-based procedures	8-4	requirements	5-1
Cold-weather operations	18-5	Warning light	2-269
Hot-weather and desert operations	18-6	Waveoff	8-9, 8-12
Technical directives	1-2	Single-engine failure field/catapult launch	13-2
Temperature warning, engine	2-38	Technique	8-9
Ten thousand foot check, pilot functional		Weapon systems	Part VIII
checkflight procedures	10-15	Procedures evaluation	39-2
Ten-mile DME fix	8-10	Weight, aircraft	1-1
Test prerequisites/restrictions	38-9	Weight on-off wheels switch malfunction	12-2, 14-48
Throttles	2-23	Wheel antirotation	2-141
Stuck/jammed	14-15		
Thunderstorms	18-4		
Tiedown points	3-15		
Total electrical failure	14-24		

	<i>Page No.</i>		<i>Page No.</i>
Wheelbrake system	2-136		
Windshield air and anti-ice	2-154		
WING SWEEP advisory light and W/S caution legend	14-47		
Wing-sweep design limitations	11-31		
Wing-sweep effects on stability	11-38		
Wing-sweep emergencies	15-11		
Wing-sweep system	2-82		
WSHLD HOT light	14-28		
		Y	
		Yaw:	
		Control	2-107
		SAS failure	14-39
		Uncommanded	14-37
		Z	
		Zoom (forty thousand feet) pilot functional checkflight procedures	10-22





MAIN INSTRUMENT PANEL/WINDSHIELD FRAME

LEFT VERTICAL CONSOLE

LEFT KNEE PANEL

CENTER PANEL

RIGHT KNEE PANEL

CONTROL STICK

RIGHT VERTICAL CONSOLE

LEFT SIDE CONSOLE

1. G VALVE PUSHBUTTON
2. OXYGEN/VENT AIRFLOW CONTROL PANEL
3. TONE VOLUME/TACAN COMMAND PANEL
4. ICS CONTROL PANEL
5. COMM/VOLUME/JTIDS SELECT PANEL
6. DFCS 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 INDICATOR
20. NOZZLE POSITION INDICATORS
21. ENGINE INSTRUMENT GROUP
22. LOW ALTITUDE WARNING LIGHT

MAIN INSTRUMENT PANEL/WINDSHIELD FRAME

23. BAROMETRIC ALTIMETER
24. RADAR ALTIMETER
25. BEARING DISTANCE HEADING INDICATOR (BDHI)
26. VERTICAL VELOCITY INDICATOR
27. AIRSPEED INDICATOR
28. STANDBY ATTITUDE INDICATOR
29. LEFT FUEL SHUTOFF/FIRE EXTINGUISHER CONTROL
30. LEFT FIRE WARNING LIGHT
31. ANGLE OF ATTACK INDICATOR
32. MASTER CAUTION/MASTER ARM PANEL
33. APPROACH INDEXER
34. LEFT LADDER LIGHTS: WHEELS, BRAKES, ACL/AP, NWS ENGS, AUTO THROT
35. SHOOT/LOCK LIGHTS
36. HEAD UP DISPLAY (HUD)/COCKPIT TV SENSOR (CCTVS)

MAIN INSTRUMENT PANEL/WINDSHIELD FRAME (CONT.)

37. RIGHT LADDER LIGHTS: SAM, AAA, CW, AI
38. STANDBY COMPASS
39. ACM SHUTOFF/HOT TRIGGER LIGHT
40. RIGHT FIRE WARNING LIGHT
41. WING SWEEP INDICATOR
42. RIGHT FUEL SHUTOFF/FIRE EXTINGUISHER CONTROL
43. CANOPY JETTISON HANDLE
44. RADIO FREQUENCY/CONTROL INDICATOR
45. MULTIFUNCTION DISPLAY No. 2
46. MULTIFUNCTION DISPLAY No. 1

CENTER PANEL

47. MULTISTATUS INDICATOR
48. CLOCK
49. BRAKE PRESSURE INDICATOR
50. COURSE/HEADING DISPLAY CONTROL
51. CONTROL STICK
52. RUDDER PEDAL ADJUST HANDLE

RIGHT KNEE PANEL

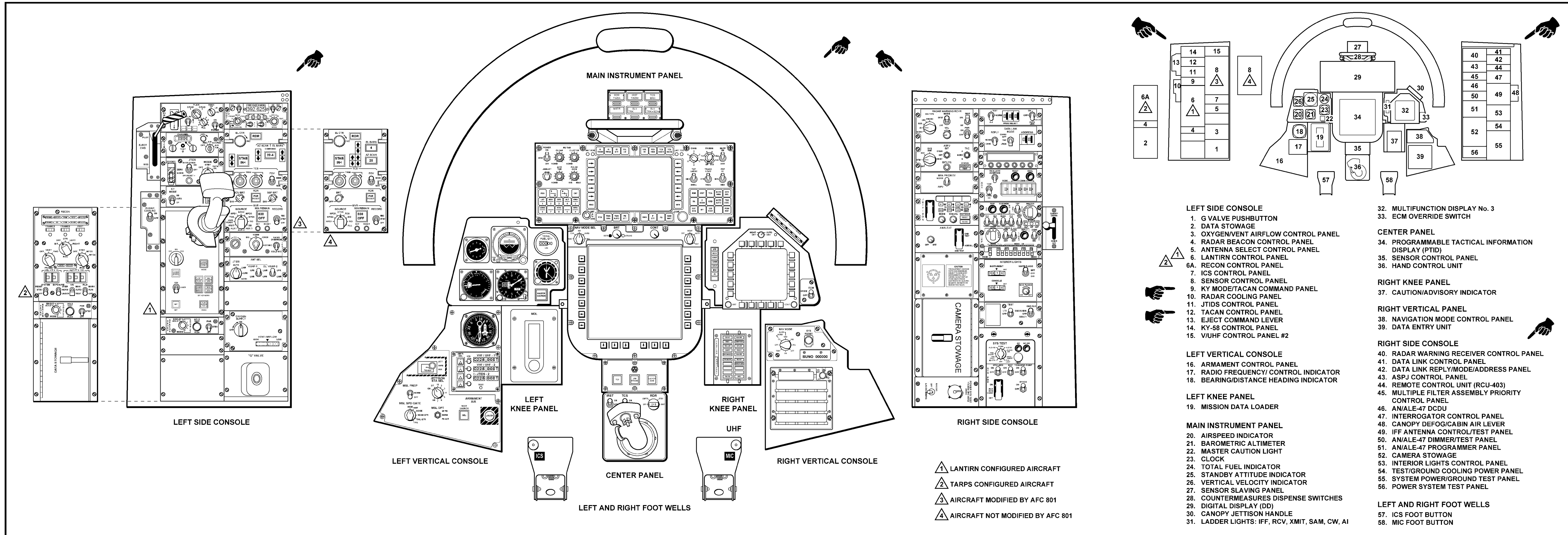
53. FUEL QUANTITY INDICATOR
54. OBOGS BACKUP OXYGEN PRESSURE INDICATOR
55. CABIN PRESSURE INDICATOR

RIGHT VERTICAL CONSOLE

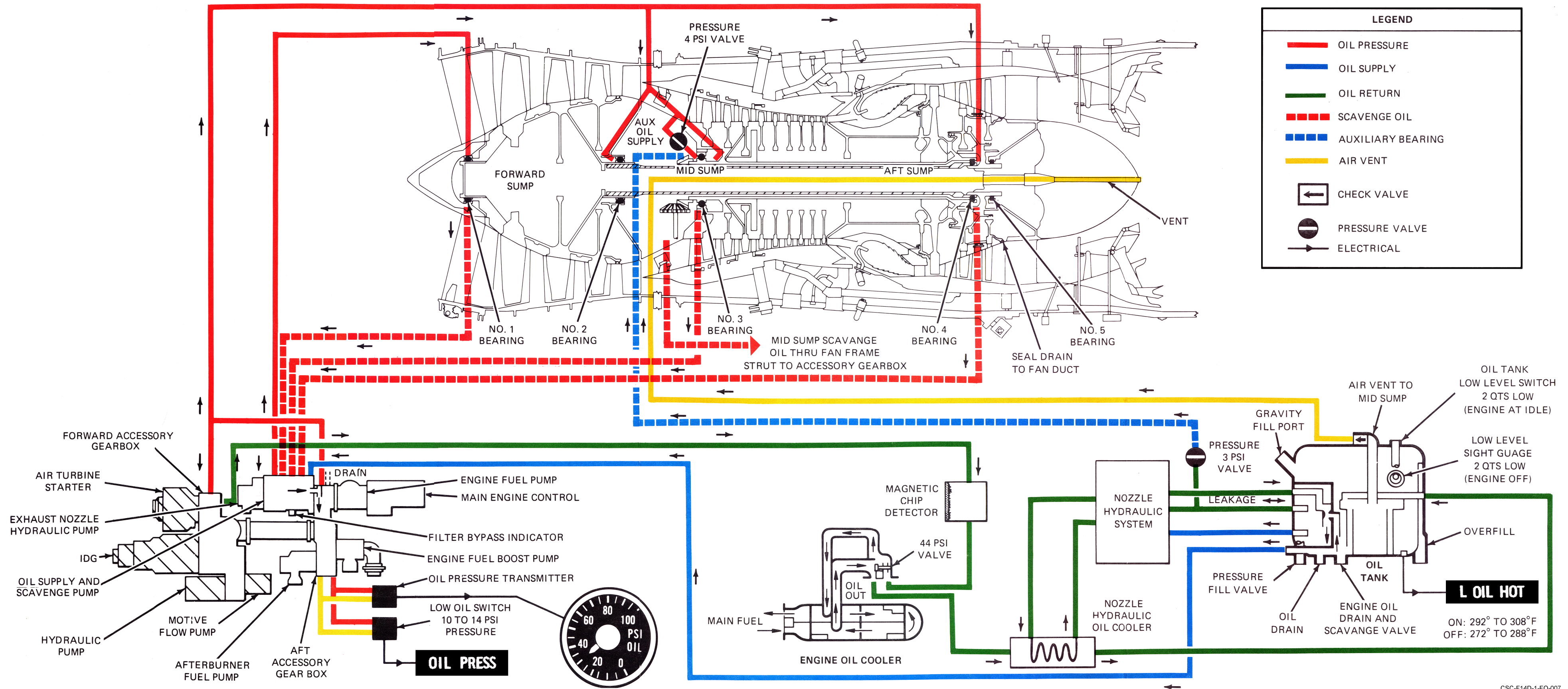
56. ARRESTING HOOK/GUN ROUNDS INDICATOR
57. DISPLAYS CONTROL PANEL
58. AUX WEAPONS CONTROL PANEL

RIGHT SIDE CONSOLE

59. CAUTION/ADVISORY INDICATOR
60. OXYGEN MONITOR PANEL
61. ARA-63 CONTROL PANEL
62. MASTER GENERATOR CONTROL PANEL
63. AIR CONDITIONING CONTROL PANEL
64. MASTER LIGHT CONTROL PANEL
65. EXTERNAL ENVIRONMENT CONTROL PANEL
66. MASTER TEST CONTROL PANEL
67. HYDRAULIC TRANSFER PUMP SWITCH
68. HUD VIDEO CONTROL
69. CANOPY DEFOG CONTROL LEVER



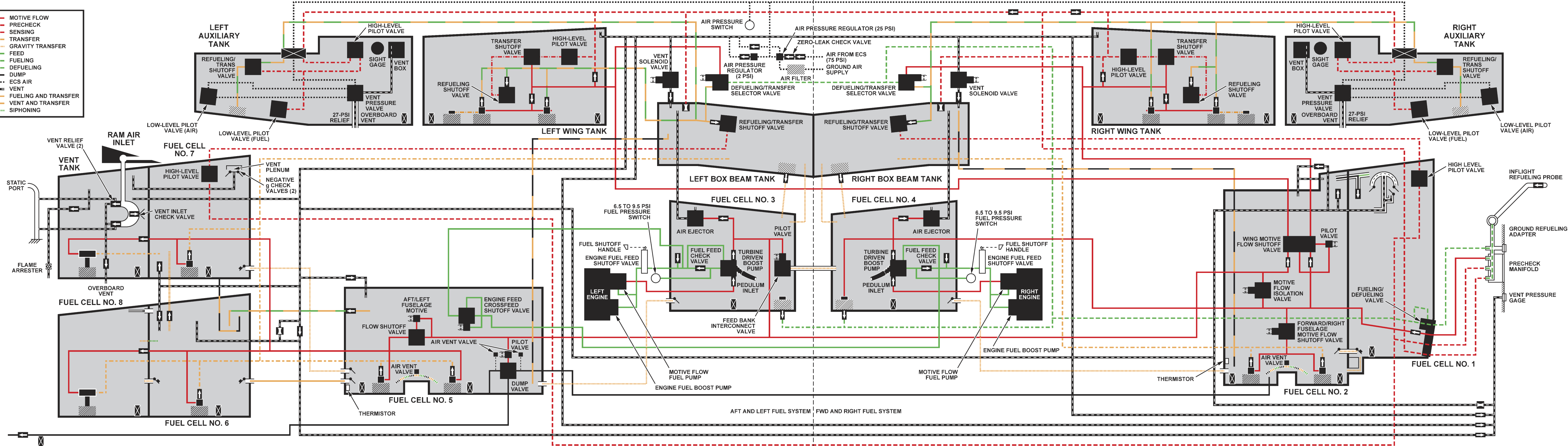
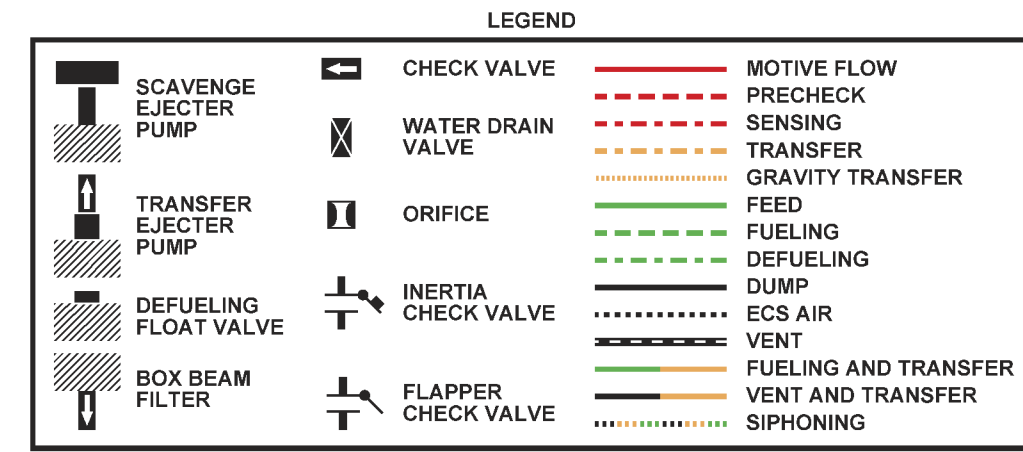
- LEFT SIDE CONSOLE**
1. G VALVE PUSHBUTTON
 2. DATA STOWAGE
 3. OXYGEN/VENT AIRFLOW CONTROL PANEL
 4. RADAR BEACON CONTROL PANEL
 5. ANTENNA SELECT CONTROL PANEL
 6. LANTIRN CONTROL PANEL
 7. RECON CONTROL PANEL
 8. ICS CONTROL PANEL
 9. KY MODE/TACAN COMMAND PANEL
 10. RADAR COOLING PANEL
 11. JTIDS CONTROL PANEL
 12. TACAN CONTROL PANEL
 13. EJECT COMMAND LEVER
 14. KY-58 CONTROL PANEL
 15. V/UHF CONTROL PANEL #2
- LEFT VERTICAL CONSOLE**
16. ARMAMENT CONTROL PANEL
 17. RADIO FREQUENCY/ CONTROL INDICATOR
 18. BEARING/DISTANCE HEADING INDICATOR
- LEFT KNEE PANEL**
19. MISSION DATA LOADER
- MAIN INSTRUMENT PANEL**
20. AIRSPEED INDICATOR
 21. BAROMETRIC ALTIMETER
 22. MASTER CAUTION LIGHT
 23. CLOCK
 24. TOTAL FUEL INDICATOR
 25. STANDBY ATTITUDE INDICATOR
 26. VERTICAL VELOCITY INDICATOR
 27. SENSOR SLAVING PANEL
 28. COUNTERMEASURES DISPENSE SWITCHES
 29. DIGITAL DISPLAY (DD)
 30. CANOPY JETTISON HANDLE
 31. LADDER LIGHTS: IFF, RCV, XMIT, SAM, CW, AI
- RIGHT SIDE CONSOLE**
32. MULTIFUNCTION DISPLAY No. 3
 33. ECM OVERRIDE SWITCH
- CENTER PANEL**
34. PROGRAMMABLE TACTICAL INFORMATION DISPLAY (PTID)
 35. SENSOR CONTROL PANEL
 36. HAND CONTROL UNIT
- RIGHT KNEE PANEL**
37. CAUTION/ADVISORY INDICATOR
- RIGHT VERTICAL PANEL**
38. NAVIGATION MODE CONTROL PANEL
 39. DATA ENTRY UNIT
- RIGHT SIDE CONSOLE**
40. RADAR WARNING RECEIVER CONTROL PANEL
 41. DATA LINK CONTROL PANEL
 42. DATA LINK REPLY/MODE/ADDRESS PANEL
 43. ASPJ CONTROL PANEL
 44. REMOTE CONTROL UNIT (RCU-403)
 45. MULTIPLE FILTER ASSEMBLY PRIORITY CONTROL PANEL
 46. AN/ALE-47 DCDU
 47. INTERROGATOR CONTROL PANEL
 48. CANOPY DEFOG/CABIN AIR LEVER
 49. IFF ANTENNA CONTROL/TEST PANEL
 50. AN/ALE-47 DIMMER/TEST PANEL
 51. AN/ALE-47 PROGRAMMER PANEL
 52. CAMERA STOWAGE
 53. INTERIOR LIGHTS CONTROL PANEL
 54. TEST/GROUND COOLING POWER PANEL
 55. SYSTEM POWER/GROUND TEST PANEL
 56. POWER SYSTEM TEST PANEL
- LEFT AND RIGHT FOOT WELLS**
57. ICS FOOT BUTTON
 58. MIC FOOT BUTTON

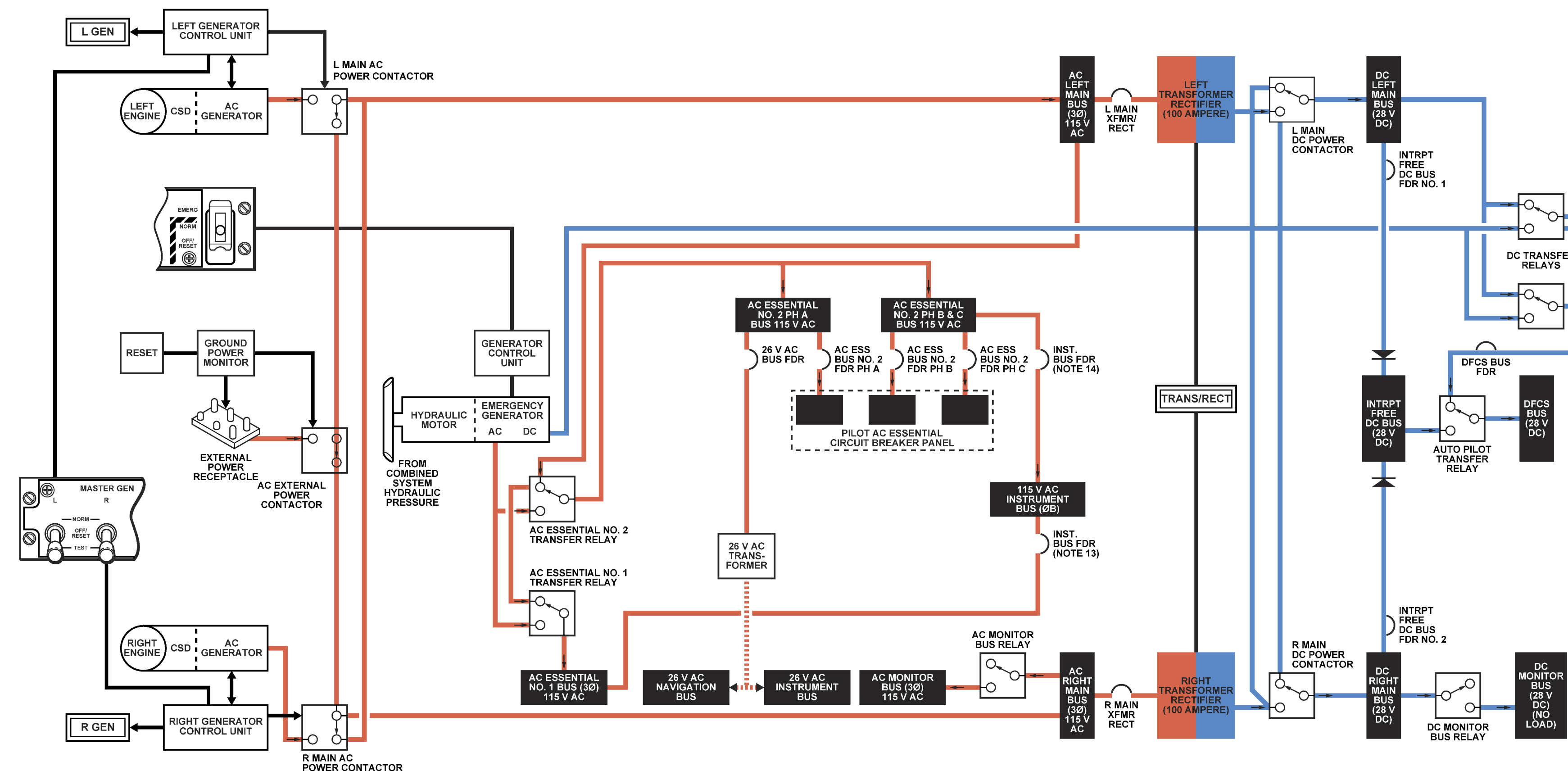


LEGEND	
—	OIL PRESSURE
—	OIL SUPPLY
—	OIL RETURN
- - -	SCAVENGE OIL
- - -	AUXILIARY BEARING
—	AIR VENT
	CHECK VALVE
	PRESSURE VALVE
	ELECTRICAL

Engine Oil System

CSC-F14D-1-FO-007





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.

NOTES

- 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 AC 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
 - WINGS 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
 - INST BUS FDR
 - R ENG BACKUP IGN
 - L ENG BACKUP IGN
 - INST LTS
 - MSN CMPTR NO. 2 PH A
 - STBY ATTD IND PH A
 - 26 V AC 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
 - CU PH A
 - UTILITY LTS
 - ADF AC
 - OBOGS CONC
 - FUEL QTY IND AC
 - TAIL / RUDDER / FLAP IND
 - GPS

- 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

- 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
 - RDJ PH B
 - JTIDS DPG PH B
 - MSN CMPTR NO. 1 PH C
 - ASPJ AUG PH C
 - ASPJ BASIC PH C
 - RDJ PH C
 - SOL PWR SUP PH C
 - JTIDS DPG PH C
 - APG-71 XMTR 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

- MSL PWR SUP PH C**
- MSL PWR SUP PH B
 - MSL PWR SUP PH A
 - STA 3 PWR PH C
 - STA 3 PWR PH A
 - AN / AWW 4 PH C
 - AN / AWW 4 PH B
 - 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. 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 / DFCS
 - AIR SOURCE CONTROL
 - MACH TRIM DC
 - FLAP / SLAT CONTR SHUT-OFF
 - FLT CONTR AUTH DC
 - ENG / PROBE / ANTI-ICE

- 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
 - ASW-27
 - ASPJ DC
 - IFF A / A DC
 - ALR-67 CONTR
 - GND PWR / COOLING INTLK
 - RECON ECS/LANTIRN POD CONT
 - RECON CONTR/LANTIRN POD PWR
 - 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
 - PTID DC
 - RDP
 - RDP / DD ENABLE
 - LIQUID COOLING CONTR DC
 - ECS TEMP CONTR DC
 - ALE-39 SEQ 1 & 2 SQUIBS
 - ALE-39 CHAFF / FLARE DISP
 - AUTO THROT DC
 - ANN PNL PWR
 - HOOK CONT
 - APG-71 XMTR DC
 - ASC
 - TCS SEL
 - DYHR UNIT
 - ANT LOCK EXCIT
 - RSP
 - MDL
 - DSS

- STARTER VALVE LT**
- MSL PWR HUD TEST
 - ENG STALL TONE
 - SNRS / CURSOR CONT
- DC MAIN BUS — 28 V DC**
- MASTER ARM
 - MPRU DC PWR
 - DC ESS NO. 2 FDR
 - 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 I DCDR / REL PWR
 - STA 1 TYPE II DCDR / REL PWR
 - GUN PWR NO. 2
 - GUN PWR NO. 1
 - HYD PUMP SPOILER CONTR
 - STA 6 NO. 1/2 DC
 - STA 4 NO. 1/2 DC
 - STA 3 NO. 1/2 DC
 - STA 1B NO. 1/2 DC
 - STA 1A AIM-9 PWR DC
 - STA 8 AIM-9 COOL
 - STA 8 AIM-9 COOL
 - STA 4 / 5 IFOL
 - STA 3 / 6 IFOL
 - STA 1 IFOL

- AC LEFT MAIN BUS — 115 V AC**
- ROLL B AC
 - R AICS
 - L AICS
 - PITCH A AC
 - PITCH B AC
 - CHAN 1 CADG PH A
 - AUTO PITCH DRIVE TRIM
 - YAW A AC
 - YAW B AC
 - YAW M/ROLL A
 - FLT CONTR AUTH AC
 - MACH TRIM AC
 - ICE DET
 - WING SWEEP DRIVE NO. 1
 - WG SWP DR NO. 2 / MANUV FLAP
 - CHAN 2 CADG
 - CHAN 1 CADG PH B
 - CHAN 1 CADG PH C

- AC RIGHT MAIN BUS — 115 V AC**
- R AICS HTR
 - STORM FLOOD LT
 - L AICS HTR
 - SEAT ADJ / STDY POS LT
 - NFO CONSOLE LT
 - ANTICOLL / SUPP POS / POS LT
 - LIQUID COOLING CONTR AC
 - ALR-67 RCVR PH C
 - R PH C TEST
 - ALR-67 RCVR PH B
 - OXY CONC HTR
 - 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
 - FUEL TRANS ORIDE
 - INBD SPOILER CONTR
 - EXT LT CONTR
 - HYD PUMP SPOILER CONTR
 - FUEL VENT VALVE

- 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
 - CU PH B
 - ANL ATTK / TOTAL TEMP HTR
 - CU 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 B
 - 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

- ASW-27 AC**
- AUTO THROT AC
 - IFF A / A AC
 - SAHRS PH C
 - SAHRS PH B
 - SAHRS PH A
 - ANT SVG 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 SVG HYD PH B
 - ANT SVG HYD 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 XFMR / RECT
 - HV PWR SUP PH C
 - HV PWR SUP PH B
 - HV PWR SUP PH A
 - INTEG TRIM AC
 - RECON HTR/LANTIRN PWR 3 PH
 - STA 1 BOL PWR
 - STA 8 BOL PWR

- AC RIGHT MAIN BUS (3Ø) 115 V AC**
- AC MONITOR BUS RELAY
 - AC RIGHT MAIN BUS (3Ø) 115 V AC
 - R MAIN XFMR RECT
 - R MAIN DC POWER CONTACTOR
 - DC RIGHT MAIN BUS (28 V DC)
 - DC MONITOR BUS RELAY
 - DC MONITOR BUS (28 V DC) (NO LOAD)

- ICS PILOT**
- ICS NFO
 - MLG SAFETY RLY NO. 2
 - MLG SAFETY RLY NO. 1
 - VHF / UHF CONTR
 - APX-100
 - 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
 - FUEL TRANS ORIDE
 - INBD SPOILER CONTR
 - EXT LT CONTR
 - HYD PUMP SPOILER CONTR
 - FUEL VENT VALVE

- DC ESSENTIAL NO. 1 BUS — 28 V DC**
- HYD VALVE CONTR
 - APN-154
 - JTIDS DPG / BOTH
 - 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
 - DFCS BUS FDR
 - ROLL A DC
 - ROLL B DC
 - PITCH A DC
 - PITCH B DC
 - YAW A DC
 - YAW B DC
 - CABIN PRESS
 - DC ESS NO. 2 FDR
 - NLG STRUT LCH BAR ADVSY
 - R ENG AFT CONTR / EXHAUST
 - NOZZLE
 - L ENG AFT CONTR / ARMT GAS /
 - RATS IND
 - ILS ARA-63 DC
 - FUEL TRANS ORIDE
 - EXT LT CONTR
 - HYD PUMP SPOILER CONTR
 - FUEL VENT VALVE

- DC ESSENTIAL NO. 1 BUS — 28 V DC**
- HYD VALVE CONTR
 - APN-154
 - JTIDS DPG / BOTH
 - 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
 - DFCS BUS FDR
 - ROLL A DC
 - ROLL B DC
 - PITCH A DC
 - PITCH B DC
 - YAW A DC
 - YAW B DC
 - CABIN PRESS
 - DC ESS NO. 2 FDR
 - NLG STRUT LCH BAR ADVSY
 - R ENG AFT CONTR / EXHAUST
 - NOZZLE
 - L ENG AFT CONTR / ARMT GAS /
 - RATS IND
 - ILS ARA-63 DC
 - FUEL TRANS ORIDE
 - EXT LT CONTR
 - HYD PUMP SPOILER CONTR
 - FUEL VENT VALVE

- DC ESSENTIAL NO. 1 BUS — 28 V DC**
- HYD VALVE CONTR
 - APN-154
 - JTIDS DPG / BOTH
 - 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
 - DFCS BUS FDR
 - ROLL A DC
 - ROLL B DC
 - PITCH A DC
 - PITCH B DC
 - YAW A DC
 - YAW B DC
 - CABIN PRESS
 - DC ESS NO. 2 FDR
 - NLG STRUT LCH BAR ADVSY
 - R ENG AFT CONTR / EXHAUST
 - NOZZLE
 - L ENG AFT CONTR / ARMT GAS /
 - RATS IND
 - ILS ARA-63 DC
 - FUEL TRANS ORIDE
 - EXT LT CONTR
 - HYD PUMP SPOILER CONTR
 - FUEL VENT VALVE

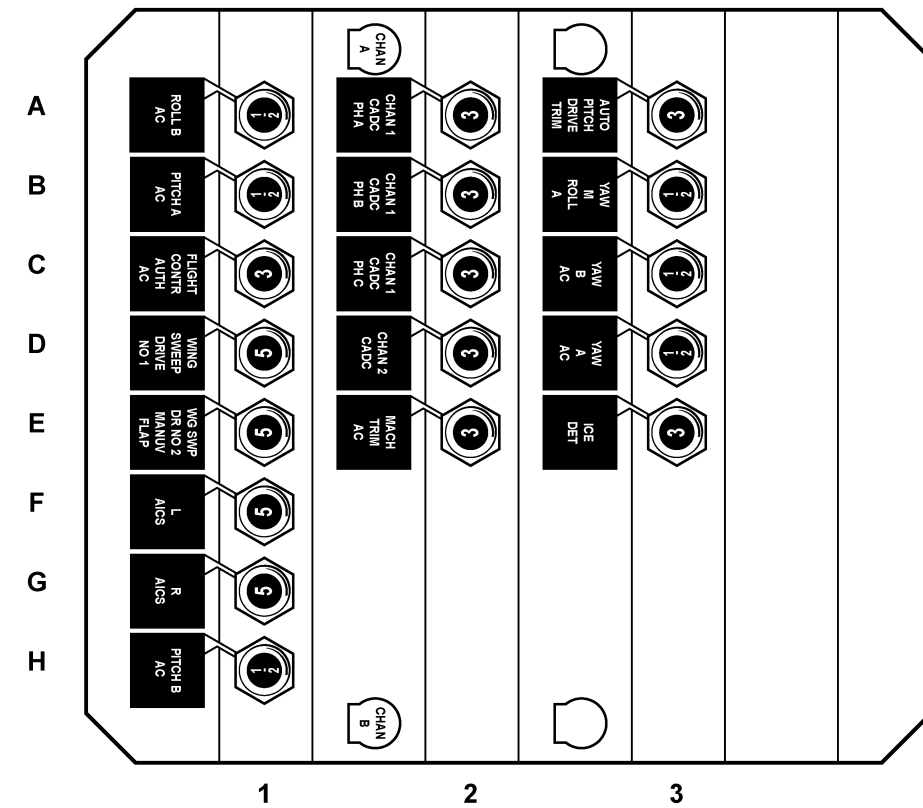
- DC ESSENTIAL NO. 1 BUS — 28 V DC**
- HYD VALVE CONTR
 - APN-154
 - JTIDS DPG / BOTH
 - ENG OIL COOL
 - R OIL HOT
 - ENG SEC
 - ECS TEMP CONTR DC
 - ADF DC
 - ANN PNL PWR
 - WSHLD / AIR / ANTI ICE CONTR
 - HOOK CONT
 - WSHLD DEFOG CONTR
 - CAN / LAD CAUTION / EJECT CMD
 - IND
 - DFCS BUS FDR
 - ROLL A DC
 - ROLL B DC
 - PITCH A DC
 - PITCH B DC
 - YAW A DC
 - YAW B DC
 - CABIN PRESS
 - DC ESS NO. 2 FDR
 - NLG STRUT LCH BAR ADVSY
 - R ENG AFT CONTR / EXHAUST
 - NOZZLE
 - L ENG AFT CONTR / ARMT GAS /
 - RATS IND
 - ILS ARA-63 DC
 - FUEL TRANS ORIDE
 - EXT LT CONTR
 - HYD PUMP SPOILER CONTR
 - FUEL VENT VALVE

- DC ESSENTIAL NO. 1 BUS — 28 V DC**
- HYD VALVE CONTR
 - APN-154
 - JTIDS DPG / BOTH
 - 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
 - DFCS BUS FDR
 - ROLL A DC
 - ROLL B DC
 - PITCH A DC
 - PITCH B DC
 - YAW A DC
 - YAW B DC
 - CABIN PRESS
 - DC ESS NO. 2 FDR
 - NLG STRUT LCH BAR ADVSY
 - R ENG AFT CONTR / EXHAUST
 - NOZZLE
 - L ENG AFT CONTR / ARMT GAS /
 - RATS IND
 - ILS ARA-63 DC
 - FUEL TRANS ORIDE
 - EXT LT CONTR
 - HYD PUMP SPOILER CONTR
 - FUEL VENT VALVE

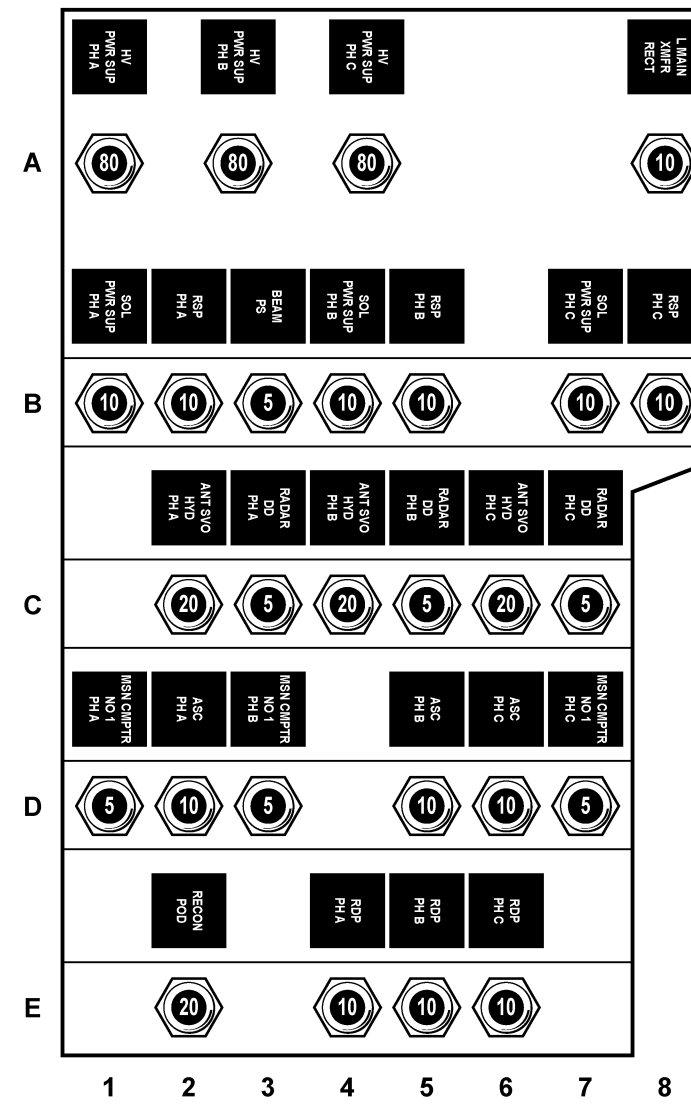
PILOT

RIO

AC ESSENTIAL CIRCUIT BREAKER PANEL (LEFT KNEE)

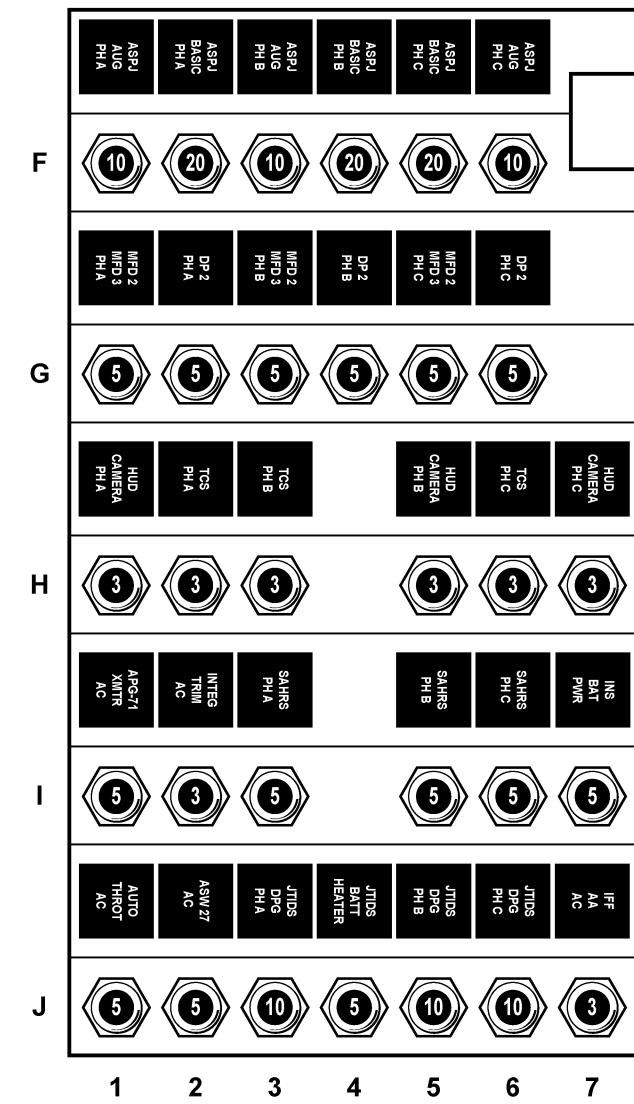


AC LEFT MAIN CIRCUIT BREAKER PANEL (LEFT AFT) (PANEL NO. 1 — UPPER SEGMENT)

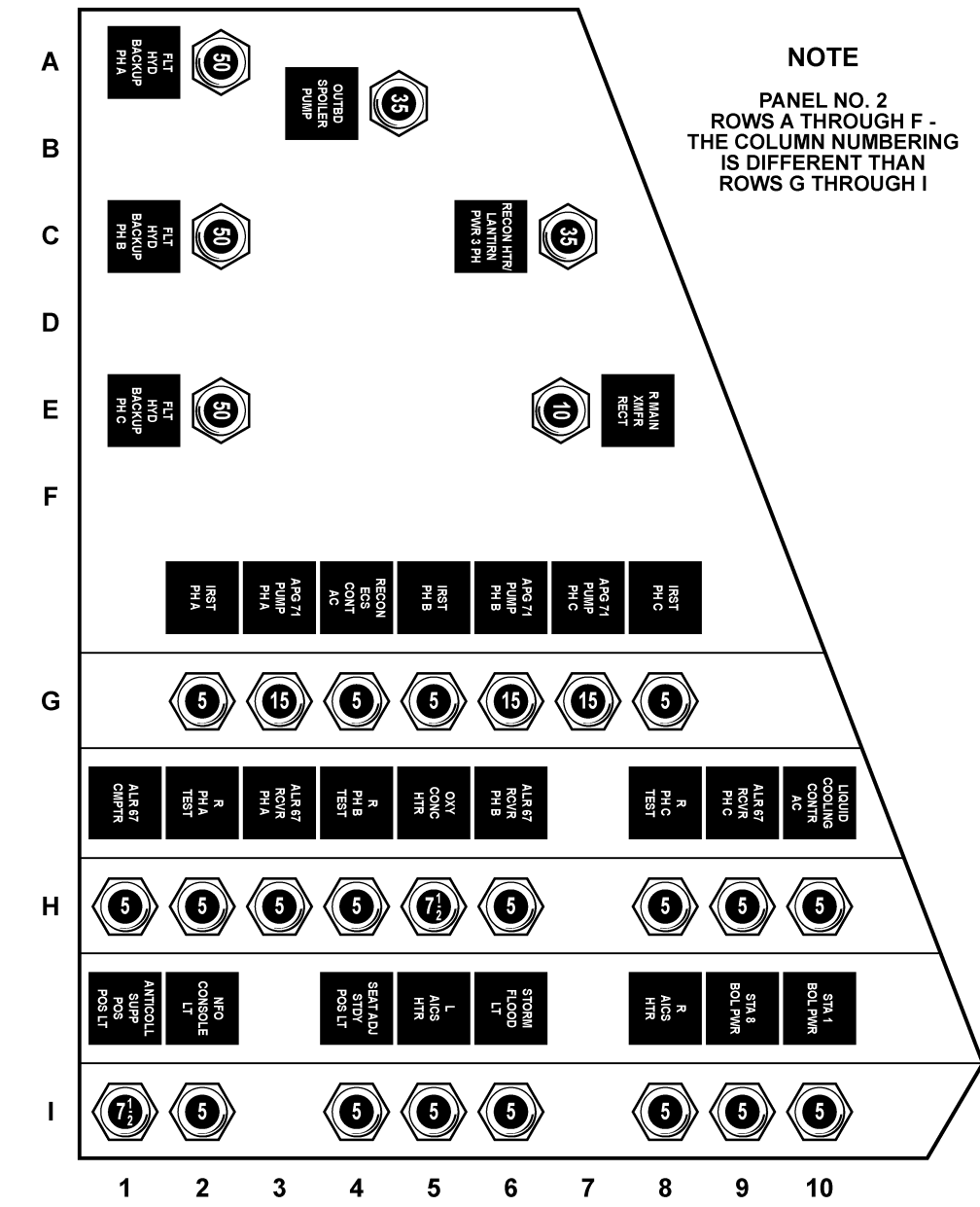


NOTE
PANEL NO. 1
ROW A -
THE COLUMN NUMBERING
IS DIFFERENT THAN
ROWS B THROUGH J

AC LEFT MAIN CIRCUIT BREAKER PANEL (LEFT AFT) (PANEL NO. 1 — LOWER SEGMENT)

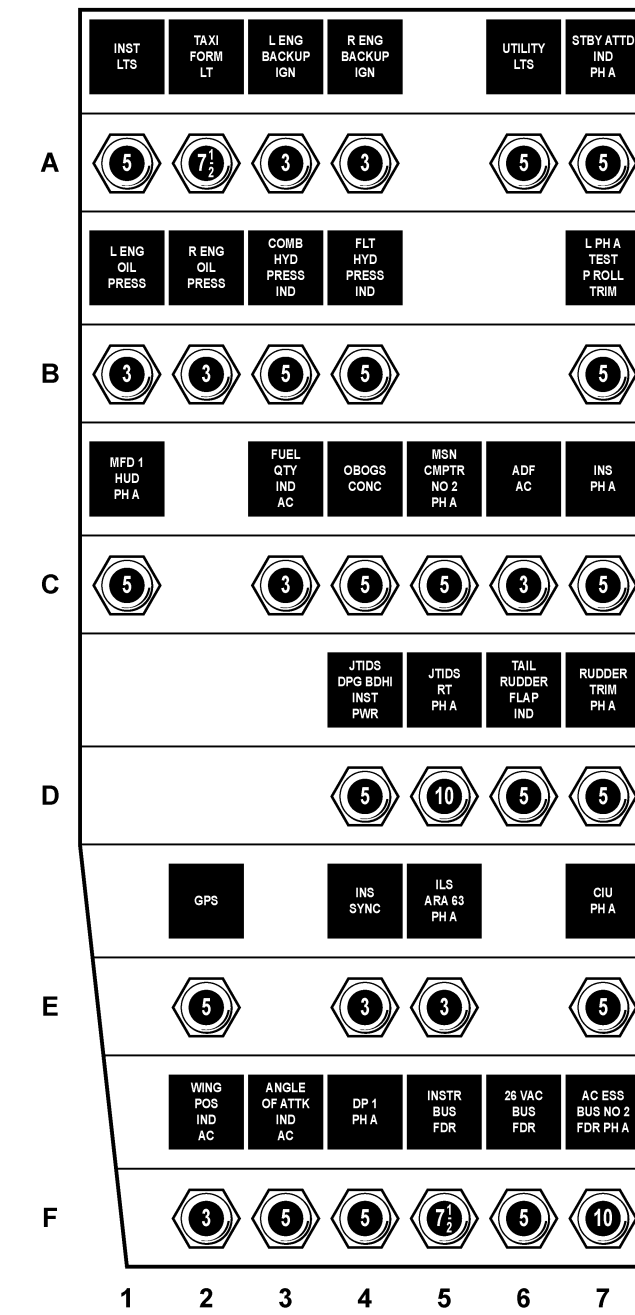


AC RIGHT MAIN NO. 1 CIRCUIT BREAKER PANEL (LEFT AFT) (PANEL NO. 2)

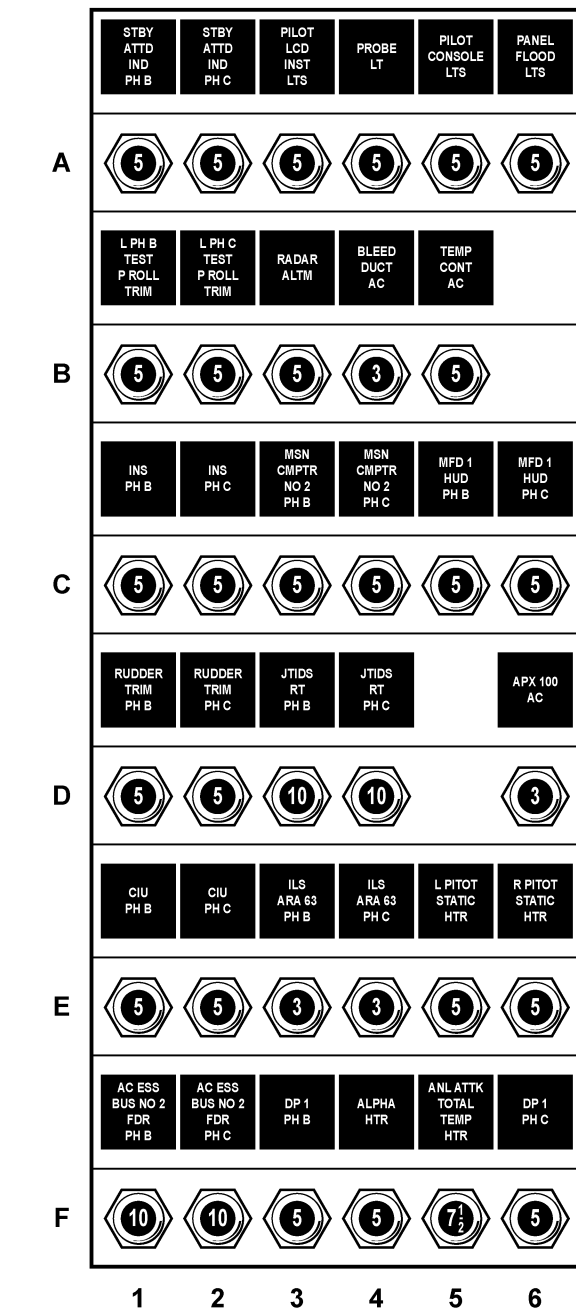


NOTE
PANEL NO. 2
ROWS A THROUGH F -
THE COLUMN NUMBERING
IS DIFFERENT THAN
ROWS G THROUGH I

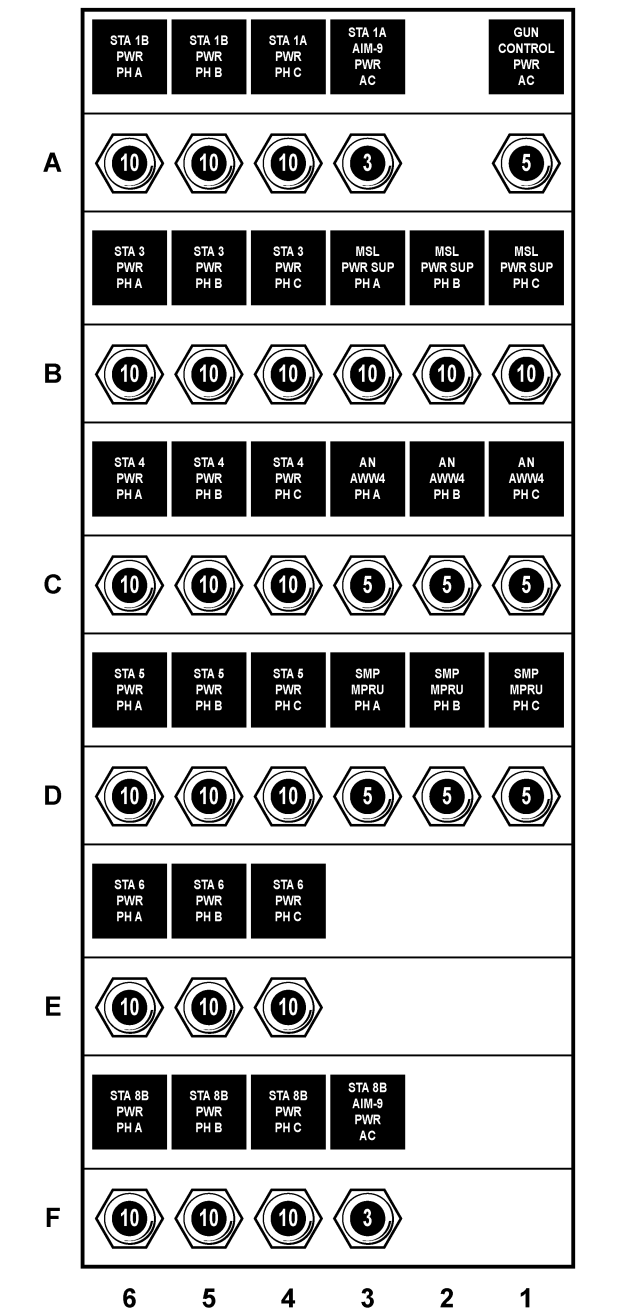
AC ESSENTIAL NO. 1 AND NO. 2 PHASE A CIRCUIT BREAKER PANEL (LEFT) (PANEL NO. 3)



AC ESSENTIAL NO. 1 AND NO. 2 PHASE B AND C CIRCUIT BREAKER PANEL (LEFT) (PANEL NO. 4)

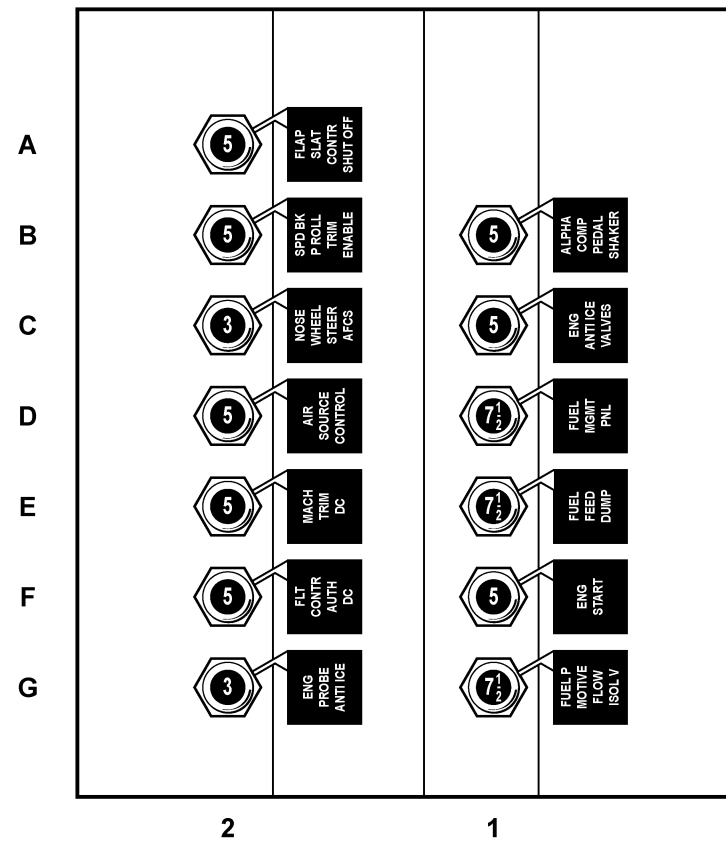


AC RIGHT MAIN NO. 2 CIRCUIT BREAKER PANEL (RIGHT SIDE) (PANEL NO. 6)

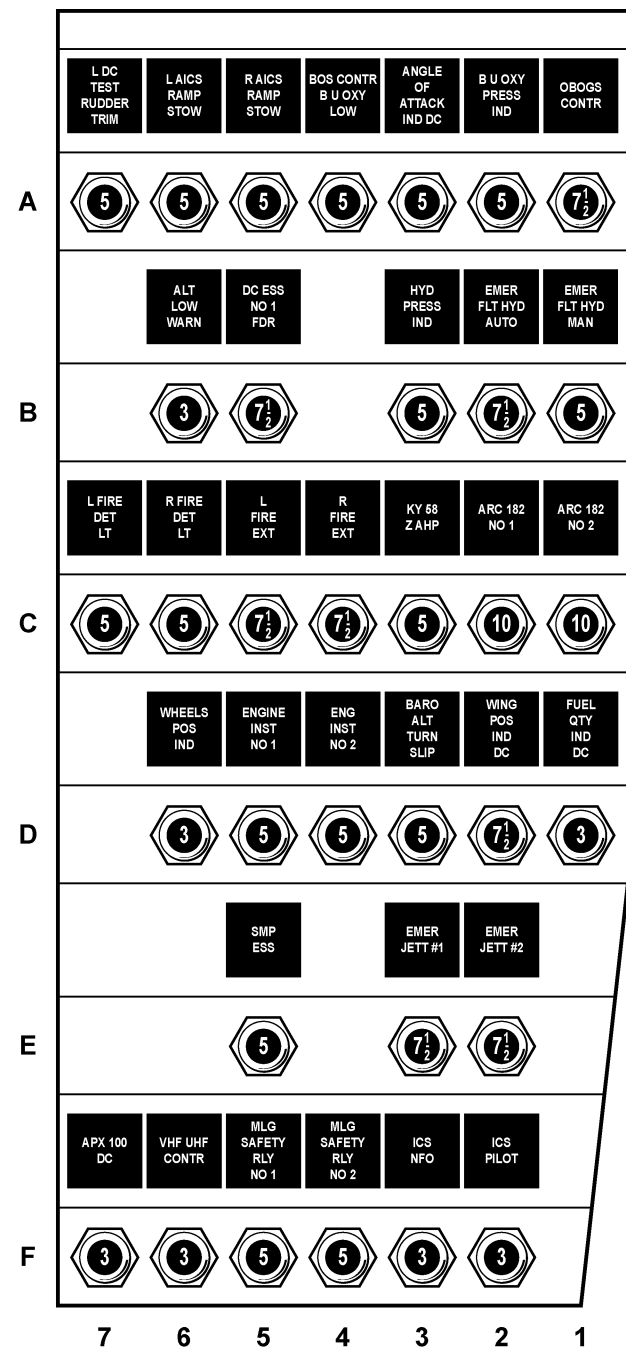


PILOT

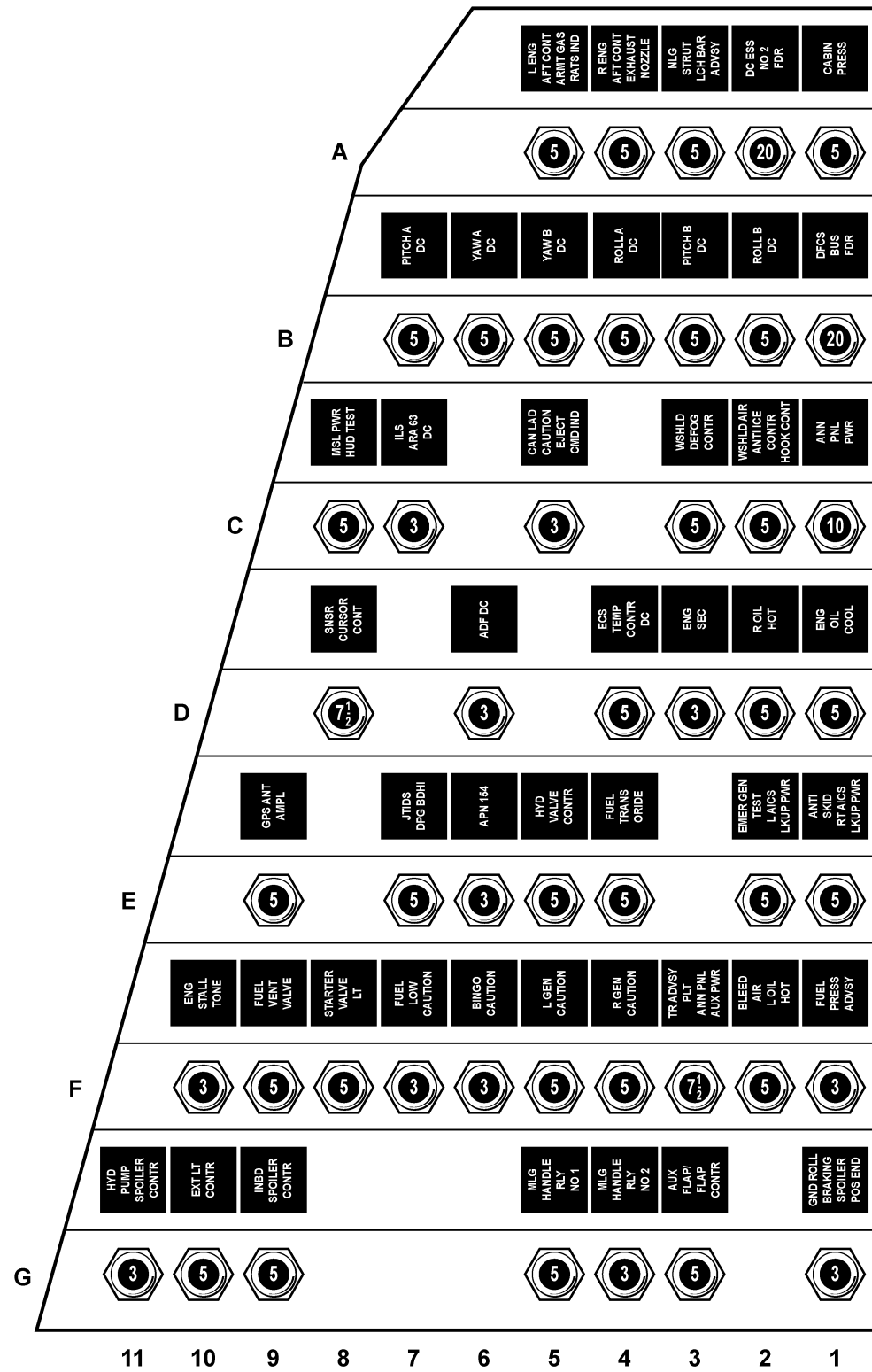
DC ESSENTIAL CIRCUIT BREAKER PANEL (RIGHT KNEE)



DC ESSENTIAL NO. 1 CIRCUIT BREAKER PANEL (RIGHT SIDE) (PANEL NO. 7)

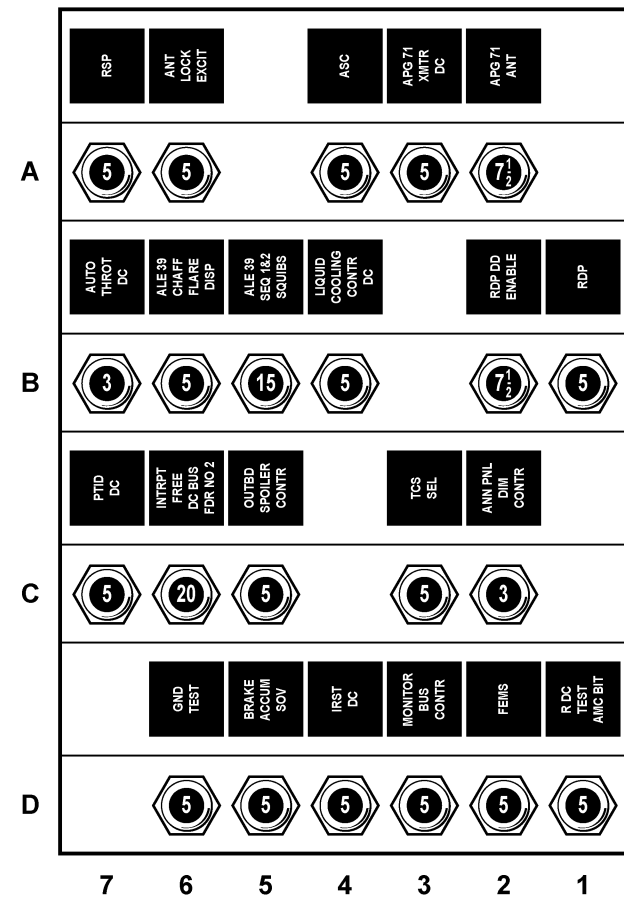


DC ESSENTIAL NO. 2 CIRCUIT BREAKER PANEL (RIGHT AFT) (PANEL NO. 8)

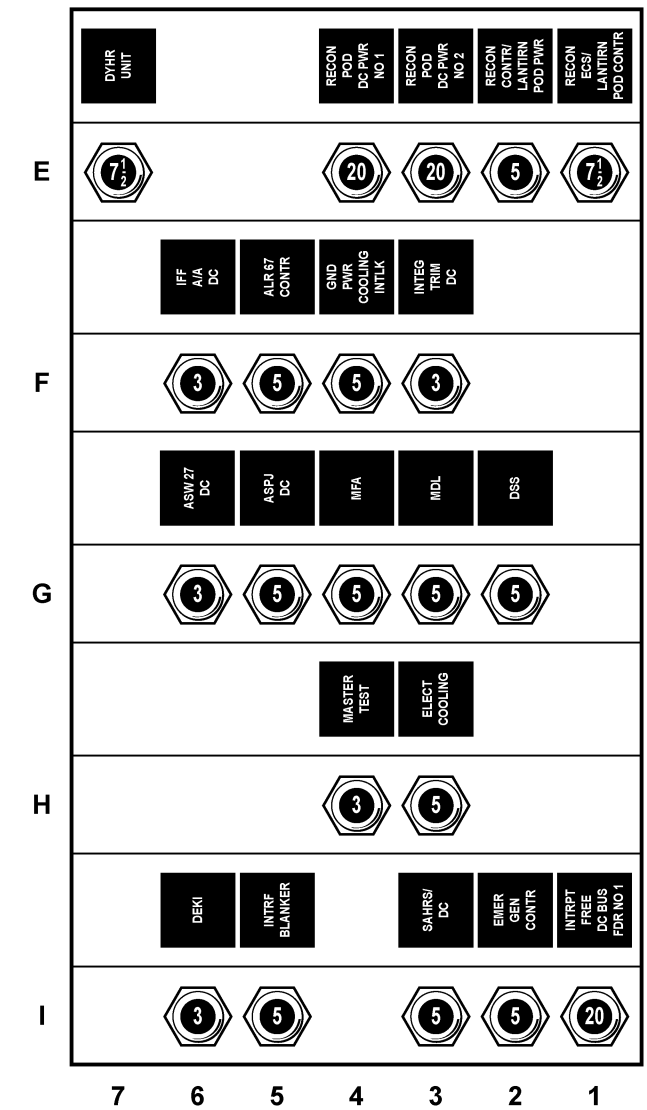


RIO

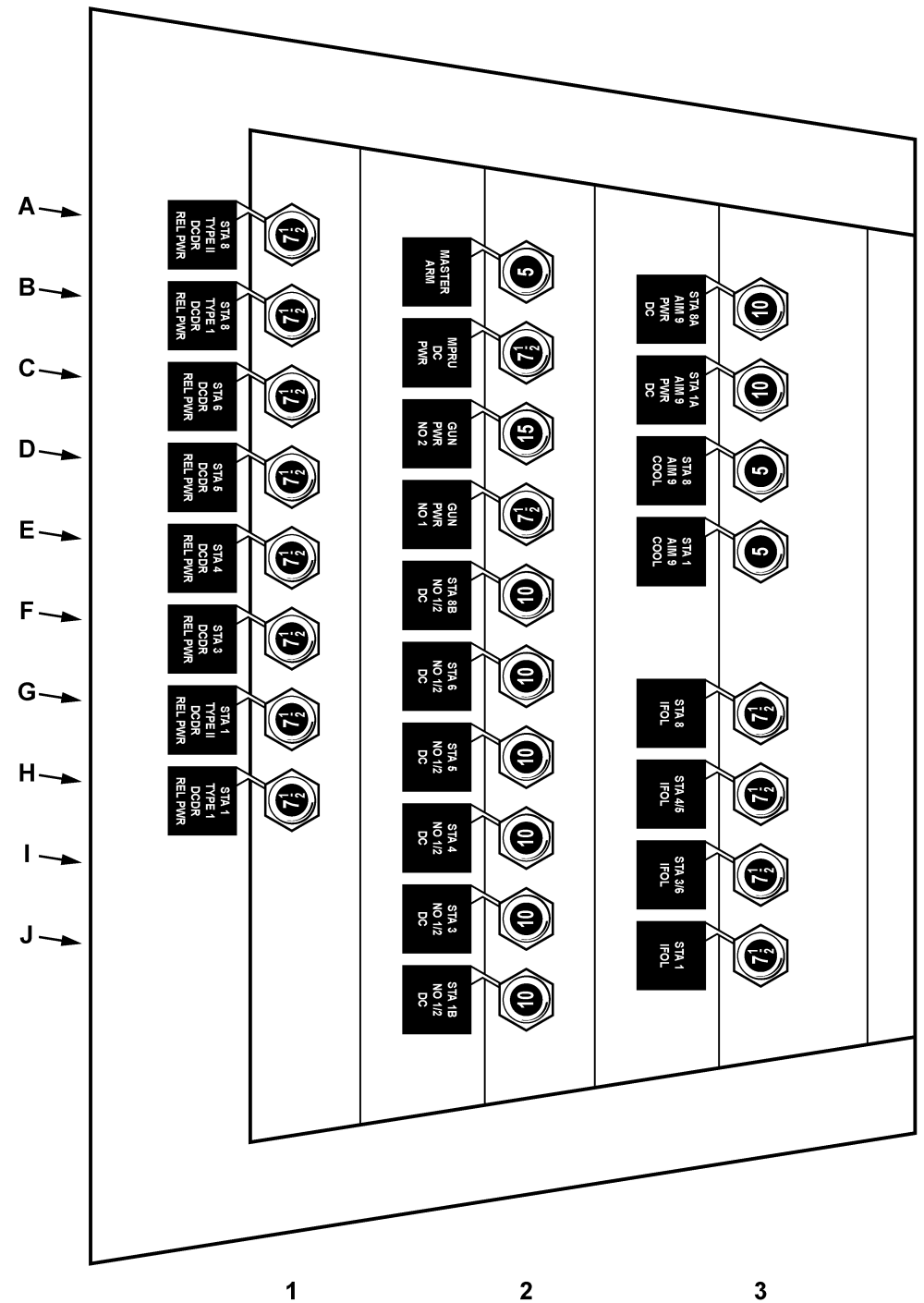
DC MAIN CIRCUIT BREAKER PANEL (RIGHT AFT) (PANEL NO. 9 — UPPER SEGMENT)

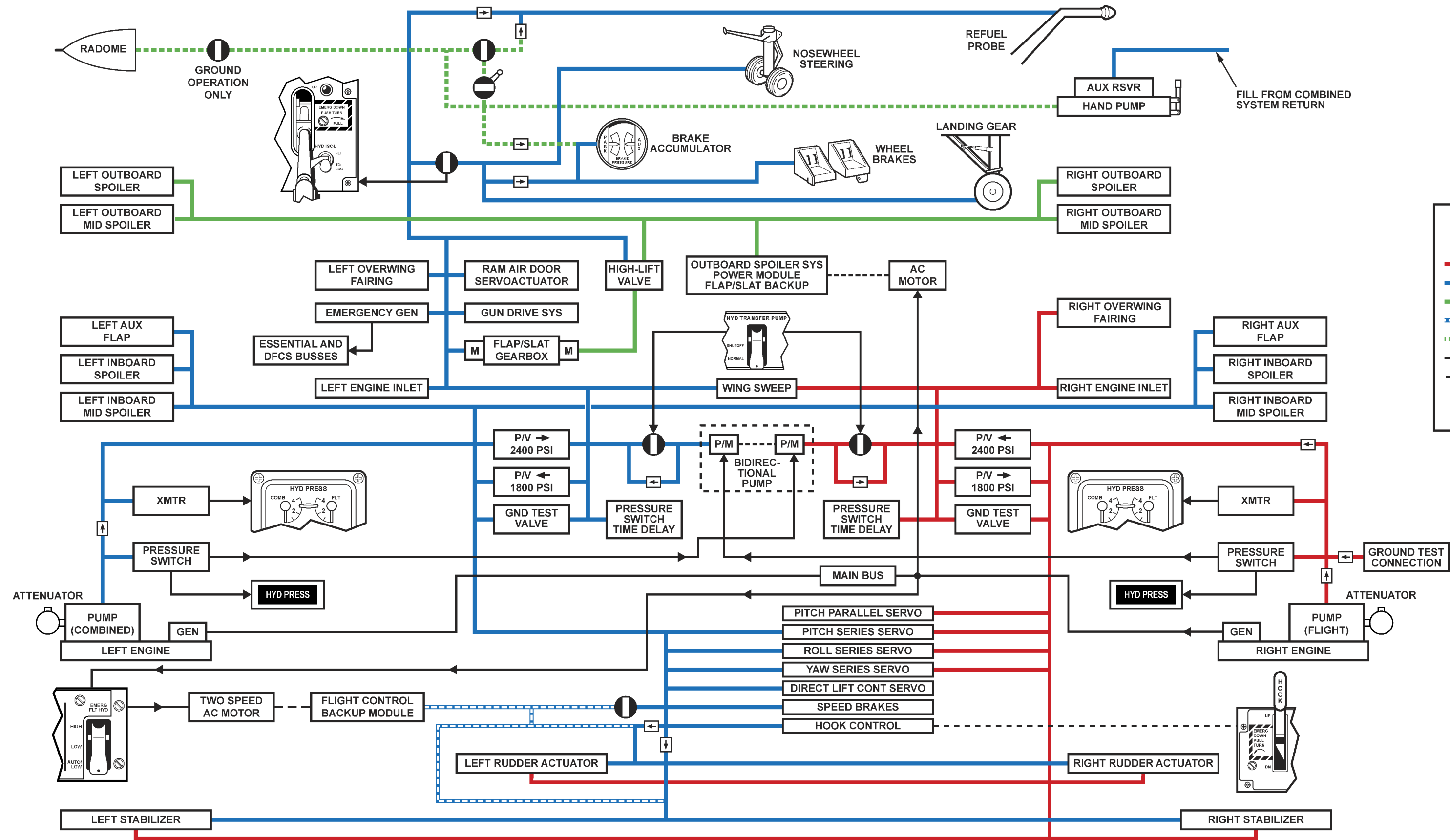


DC MAIN CIRCUIT BREAKER PANEL (RIGHT AFT) (PANEL NO. 9 — LOWER SEGMENT)



DC ARMAMENT CIRCUIT BREAKER PANEL (LEFT KNEE) (PANEL NO. 5)



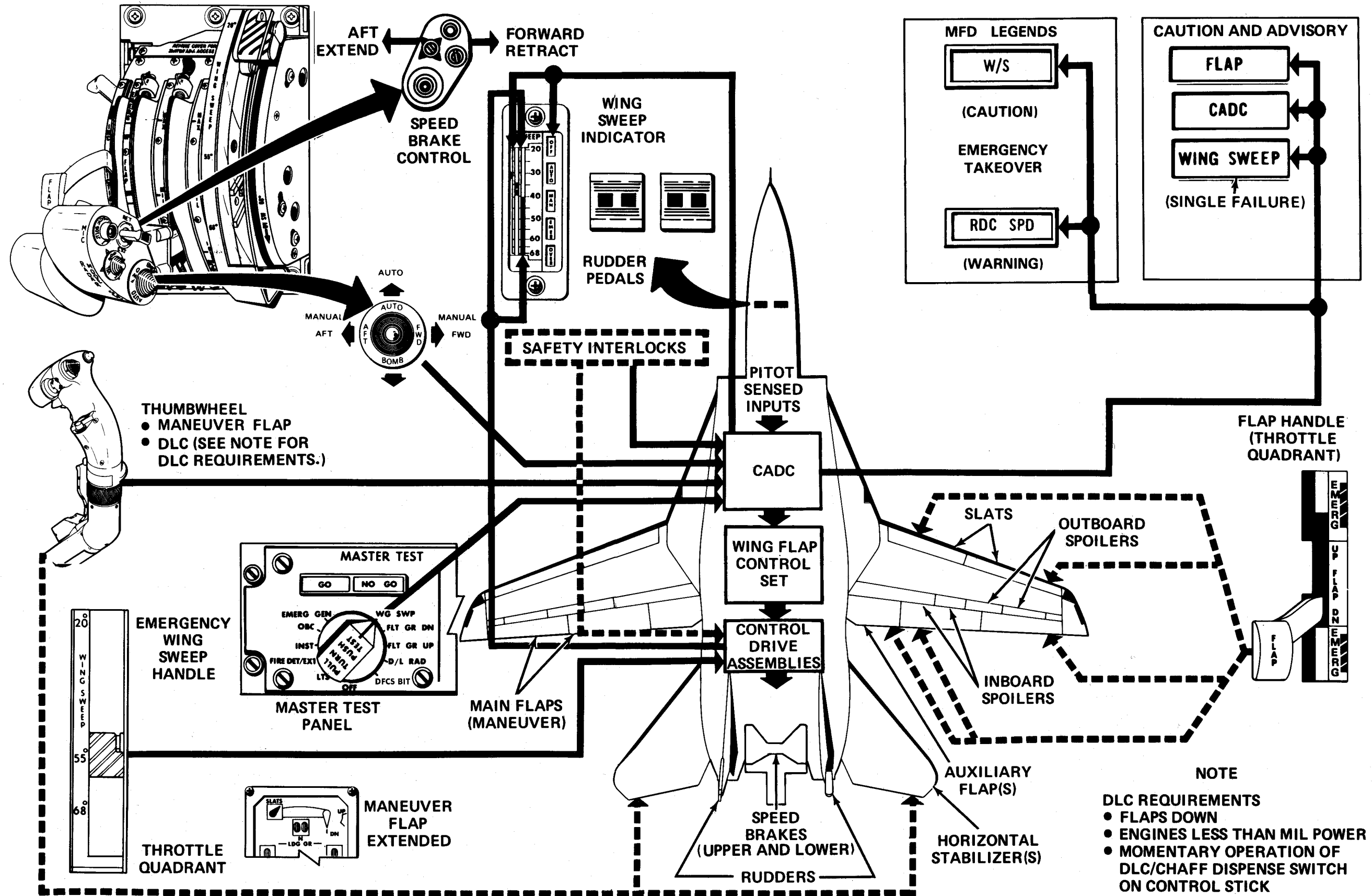


NOTE

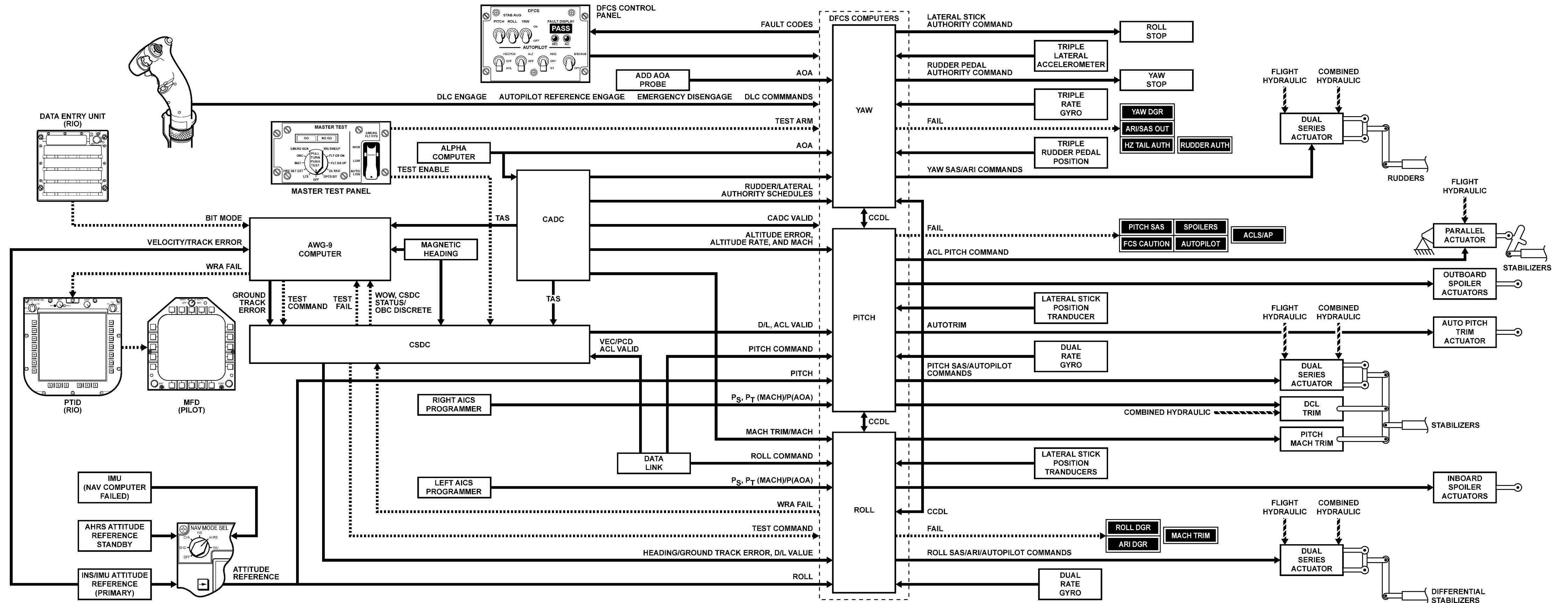
ISOLATION LOGIC

- HYDRAULIC ISOLATION SWITCH
- FLIGHT-COMBINED SYSTEM SHUTOFF TO: LANDING GEAR, NOSEWHEEL STEERING, WHEEL BRAKES
 - T.O./LANDING (WEIGHT-ON-WHEELS) COMBINED SYSTEM AVAILABLE TO ALL COMPONENTS BARRING AUTO ISOLATE.

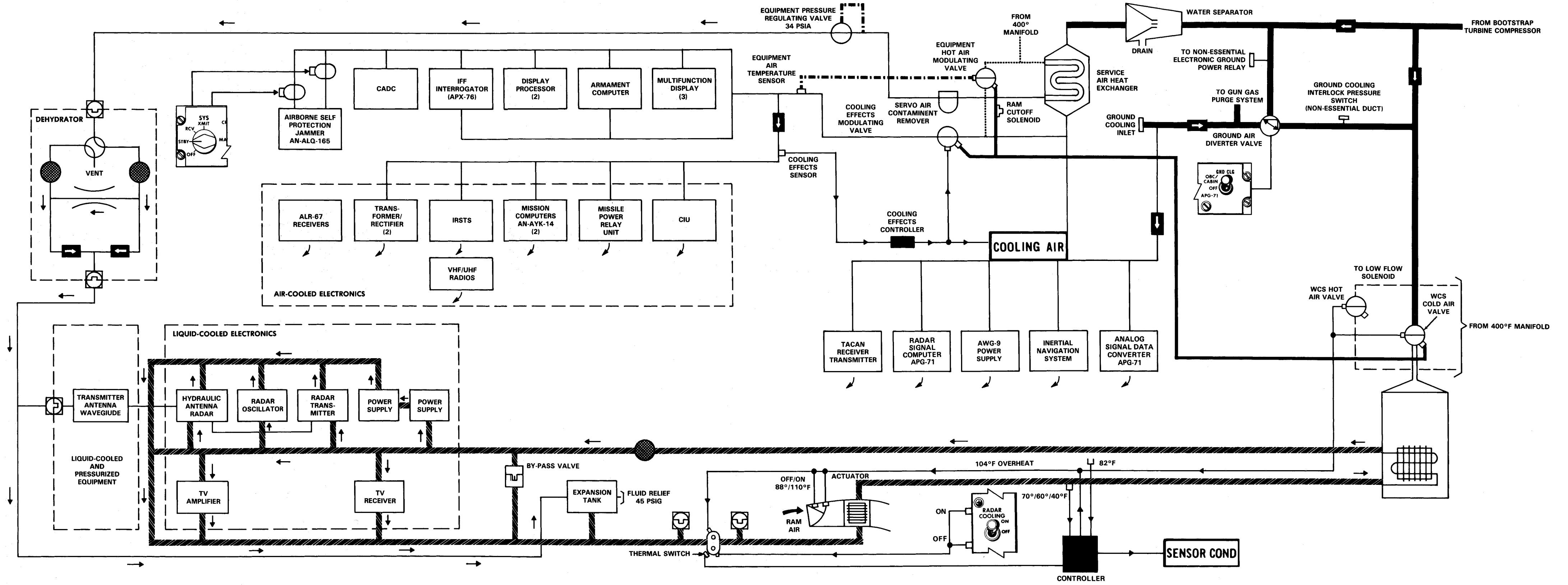
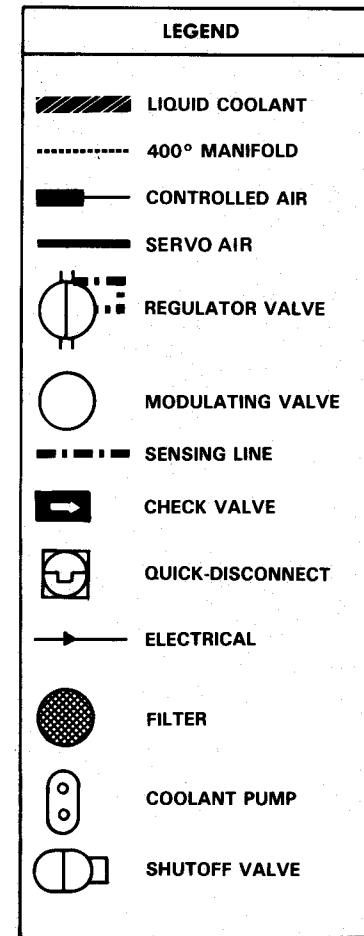
P/M	PUMP MOTOR
P/V	PRIORITY VALVE
—	FLIGHT HYDRAULIC SYSTEM
—	COMBINED HYDRAULIC SYSTEM
—	SPOILER SYSTEM POWER SOURCE
—	COMBINED BACKUP POWER SOURCE
—	HANDPUMP
\rightarrow	ELECTRICAL
- - - - -	MECHANICAL CONNECTION
\rightarrow (in box)	CHECKVALVE (ARROW SHOWING FLOW DIRECTION)

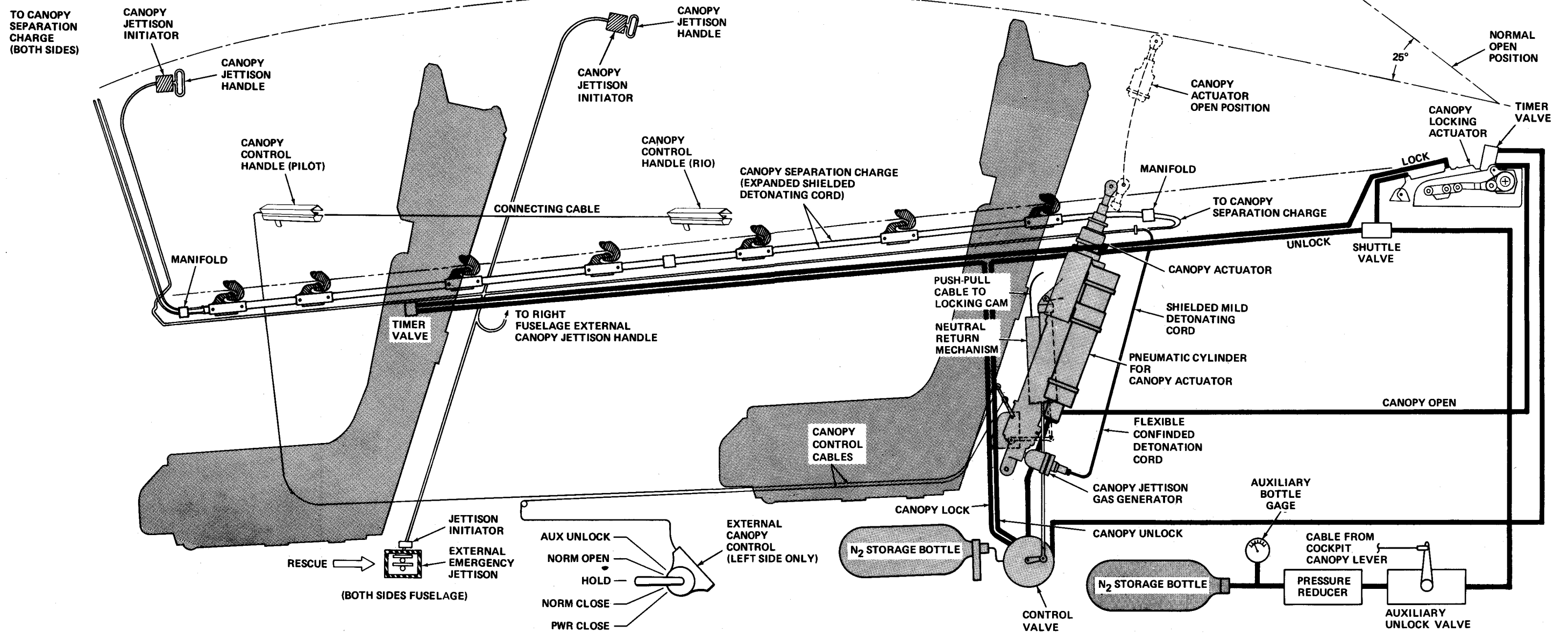
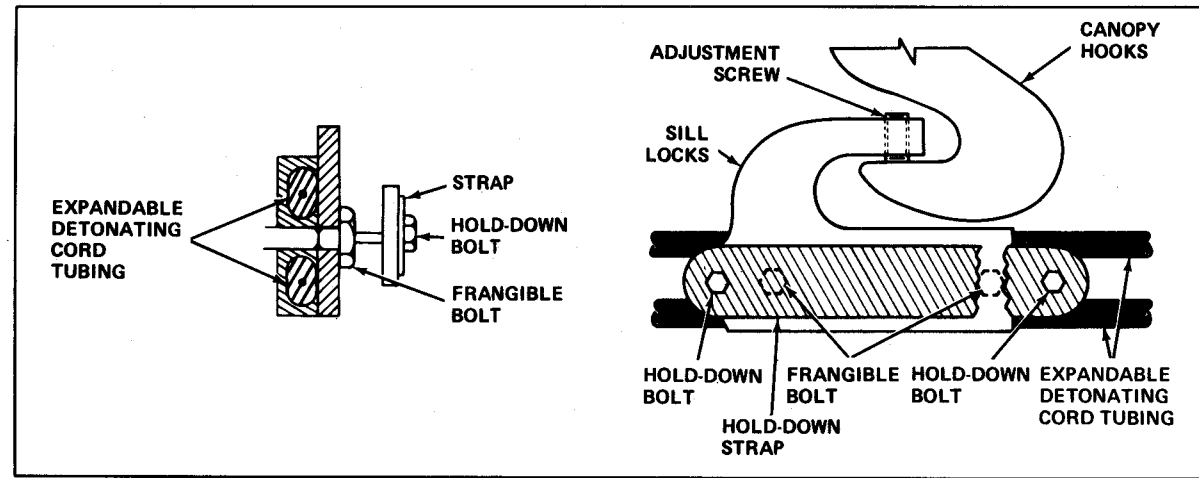


CSC-F14D-1-FO-011



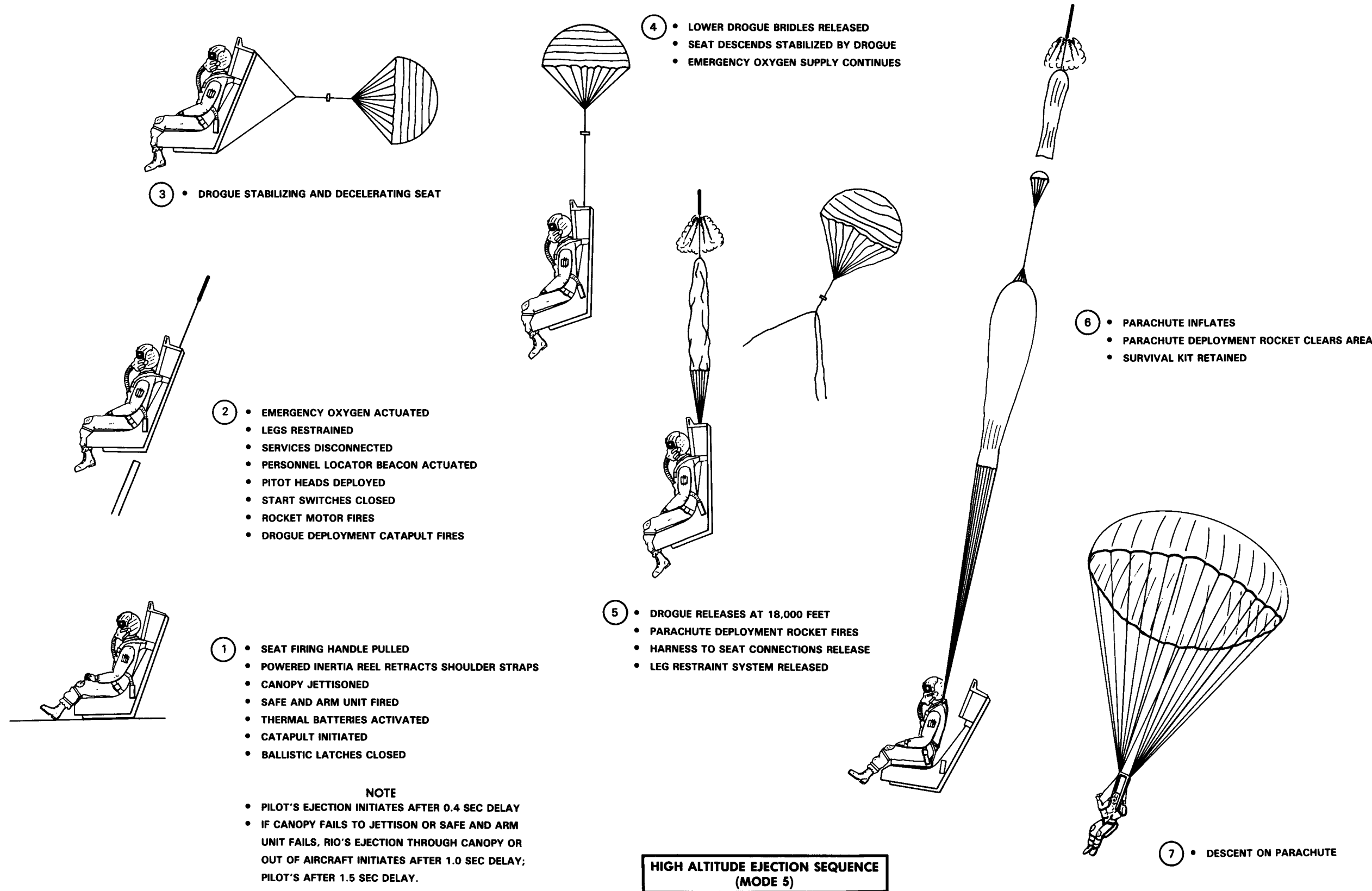
CSC-F14D-1-FO-012A





CSC-F14D-1-FO-015

Canopy Pneumatic and Pyrotechnic Systems

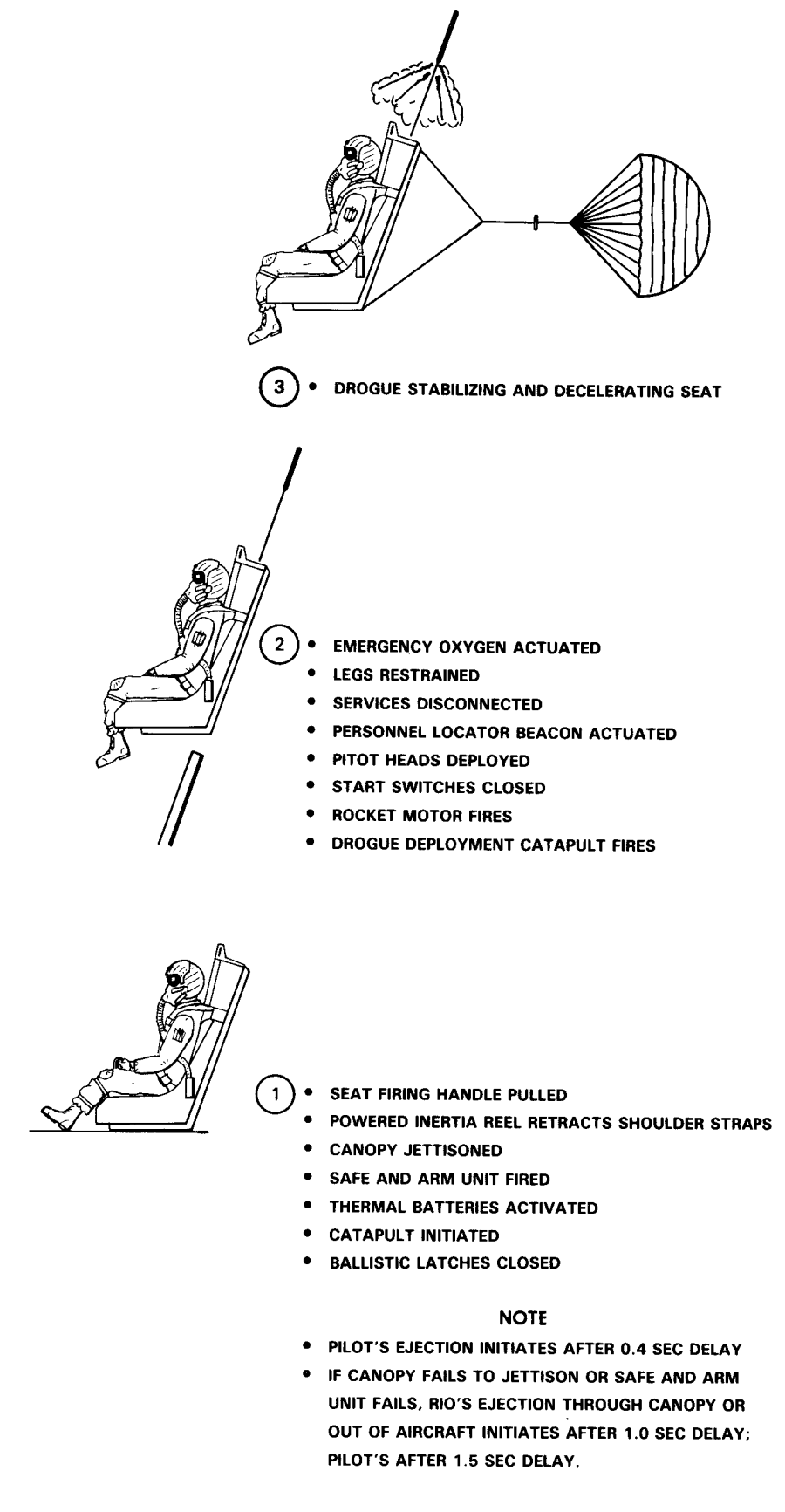
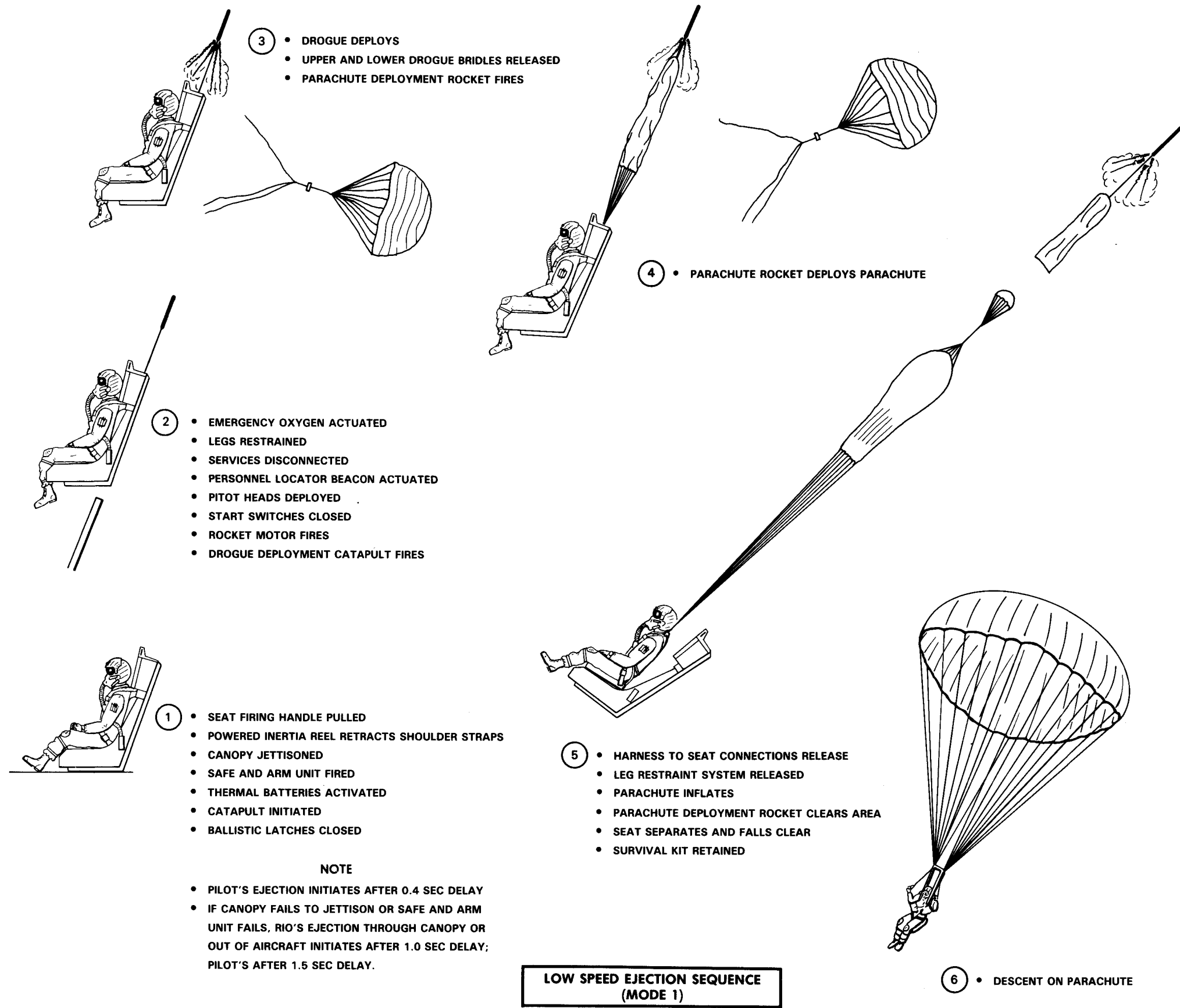


	ALTITUDE FT	0 - 8K			8K - 18K	18K +
	KEAS	0-350	350-500	500-600	ALL	ALL
	MODE	1	2	3	4	5
HOT GAS FROM EJECTION INITIATOR FIRES SEAT CATAPULT		0.00	0.00	0.00	0.00	0.00
AFTER 35 INCHES OF SEAT TRAVEL, START SWITCHES ACTIVATED.		0.18	0.18	0.18	0.18	0.18
SEQUENCER FIRES DUAL PULSE TO FIRE DROGUE CATAPULT		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

- ALL TIMES ARE REFERENCED TO EJECTION-CATAPULT INITIATION. (TO OBTAIN TIMES REFERENCED TO SEQUENCER START SWITCH, SUBTRACT 0.18 SECONDS).
- ENVIRONMENTAL SENSING FOR MORE SELECTION IS TO TAKE PLACE DURING THE TIME WINDOW 0.25 TO 0.30 SECONDS.
- 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.



LIST OF EFFECTIVE PAGES

Effective Pages	Page Numbers	Effective Pages	Page Numbers
Change 2	1 (Reverse Blank)	Original	2-137 thru 2-139
Original	3 (Reverse Blank)	Change 1	2-140
Change 2	5 (Reverse Blank)	Change 2	2-141
Change 1	7 (Reverse Blank)	Original	2-142 thru 2-148
Original	9 (Reverse Blank)	Change 1	2-149
Original	11 thru 14	Original	2-150
Change 1	15	Change 1	2-151
Original	16 thru 22	Original	2-152 thru 2-164
Change 2	23	Change 1	2-165
Original	24 thru 27	Original	2-166, 2-167
Change 1	28, 29	Change 1	2-168
Original	30	Original	2-169 thru 2-221
Change 1	31, 32	Change 2	2-222
Original	33, 34	Original	2-223 thru 2-242
Change 1	35	Change 1	2-243
Original	36 thru 40	Original	2-244 thru 2-249
Original	41, 42	Change 1	2-250, 2-251
Change 1	43, 44	Original	2-252 thru 2-255
Original	45	Change 1	2-256, 2-256a (Reverse Blank)
Change 1	46, 47	Original	2-257 thru 2-262
Original	48 thru 50	Change 1	2-263
Original	51 thru 54	Original	2-264 thru 2-268
Original	55 (Reverse Blank)	Change 1	2-269
Original	1-1 thru 1-5 (Reverse Blank)	Change 2	2-270, 2-271
Original	2-1 thru 2-26	Original	2-272 thru 2-280
Change 1	2-27	Change 1	2-281, 2-282
Original	2-28 thru 2-45	Original	2-283 thru 2-284
Change 2	2-46	Original	3-1 thru 3-19 (Reverse Blank)
Original	2-47	Change 1	4-1
Change 2	2-48	Original	4-2 thru 4-19
Original	2-49 thru 2-51	Change 1	4-20
Change 1	2-52	Original	4-21 (Reverse Blank)
Original	2-53 thru 2-57	Original	57 (Reverse Blank)
Change 1	2-58	Original	5-1
Original	2-59 thru 2-60	Change 2	5-2
Change 2	2-61	Original	5-3 thru 5-5 (Reverse Blank)
Change 1	2-62	Original	59 (Reverse Blank)
Original	2-63	Original	6-1 thru 6-4
Change 1	2-64	Original	7-1 thru 7-16
Original	2-65 thru 2-77	Change 2	7-17
Change 1	2-78, 2-78a (Reverse Blank)	Original	7-18 thru 7-20
Original	2-79 thru 2-120	Change 1	7-21
Change 1	2-121 thru 2-124	Original	7-22
Original	2-125 thru 2-131	Change 2	7-23
Change 1	2-132	Change 1	7-24
Original	2-133	Original	7-25 thru 7-28
Change 1	2-134	Change 1	7-29
Original	2-135	Original	7-30
Change 1	2-136	Change 1	7-31

NAVAIR 01-F14AAD-1

Effective Pages	Page Numbers
Original	7-32 thru 7-38
Original	8-1 thru 8-13 (Reverse Blank)
Original	9-1 thru 9-6
Change 1	9-7 (Reverse Blank)
Original	10-1 thru 10-5
Change 2	10-6
Original	10-7 thru 10-30
Change 1	10-31
Original	10-32
Original	61 (Reverse Blank)
Original	11-1 thru 11-8
Change 2	11-9 thru 11-10a (Reverse Blank)
Original	11-11 thru 11-38
Original	63, 64
Change 2	65
Original	66 thru 68
Change 2	69
Original	70 thru 84
Change 2	12-1
Original	12-2 thru 12-5 (Reverse Blank)
Original	13-1 thru 13-3 (Reverse Blank)
Change 1	14-1
Original	14-2 thru 14-9
Change 2	14-10, 14-11
Original	14-12 thru 14-16
Change 2	14-17 thru 14-20a (Reverse Blank)
Original	14-21 thru 14-30
Change 1	14-31
Original	14-32 thru 14-41
Change 1	14-42, 14-43
Original	14-44 thru 14-48
Change 2	14-49, 14-50
Original	15-1 thru 15-8
Change 1	15-9, 15-10
Original	15-11, 15-12
Change 1	15-13
Original	15-14
Change 1	15-15
Original	15-16
Change 1	15-17
Original	15-18 thru 15-20
Change 1	15-21 (Reverse Blank)
Original	16-1 thru 16-4
Change 1	16-5, 16-6
Original	16-7 thru 16-9 (Reverse Blank)
Original	85 (Reverse Blank)
Original	17-1 thru 17-7
Change 2	17-8
Original	17-9 thru 17-14
Original	18-1 thru 18-6

Effective Pages	Page Numbers
Original	87 (Reverse Blank)
Original	19-1 thru 19-17
Change 1	19-18
Original	19-19 thru 19-31 (Reverse Blank)
Original	20-1 thru 20-4
Change 1	20-5
Original	20-6 thru 20-50
Change 1	20-51 thru 20-52b (Reverse Blank)
Original	20-53 thru 20-105 (Reverse Blank)
Original	21-1 thru 21-8
Change 1	89 (Reverse Blank)
Original	22-1 thru 22-26
Original	23-1 thru 23-5 (Reverse Blank)
Original	91 (Reverse Blank)
Original	37-1 thru 37-5 (Reverse Blank)
Original	38-1 thru 38-72
Original	93 (Reverse Blank)
Original	39-1 thru 39-14
Change 1	39-15
Original	39-16 thru 39-18
Original	95 (Reverse Blank)
Original	40-1 thru 40-3
Change 1	40-4
Original	40-5, 40-6
Change 1	40-7, 40-8
Original	40-9 thru 40-12
Change 1	40-13
Original	40-14 thru 40-19 (Reverse Blank)
Original	Index-1
Change 1	Index-2
Change 2	Index-3 thru Index-5
Original	Index-6 thru Index-10
Original	FO-1 (Reverse Blank)
Original	FO-2 (Reverse Blank)
Change 1	FO-3 (Reverse Blank)
Change 1	FO-4 (Reverse Blank)
Original	FO-5 (Reverse Blank)
Original	FO-7 (Reverse Blank)
Original	FO-8 (Reverse Blank)
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Original	FO-12 (Reverse Blank)
Original	FO-13 (Reverse Blank)
Original	FO-14 (Reverse Blank)
Original	FO-15 (Reverse Blank)
Original	FO-16 (Reverse Blank)
Original	FO-17 (Reverse Blank)
Change 2	LEP-1, LEP-2