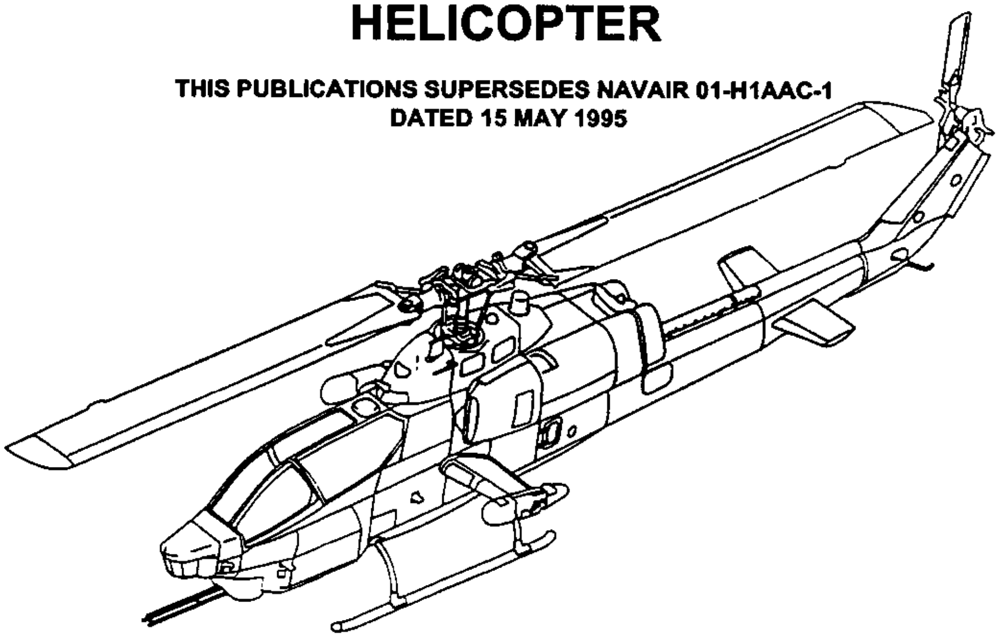
NATOPS FLIGHT MANUAL

NAVY MODEL

AH-1W

HELICOPTER

**THIS PUBLICATIONS SUPERSEDES NAVAIR 01-H1AAC-1
DATED 15 MAY 1995**



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

31 October 1997

LETTER OF PROMULGATION

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

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

3. Checklists and other pertinent extracts from this publication necessary to normal operations and training should be made and carried for use in naval aircraft.

J. B. NATHMAN
Rear Admiral, U.S. Navy
Director, Air Warfare

INTERIM CHANGE SUMMARY

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
1 thru 12	Previously incorporated

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

INTERIM CHANGE NUMBER(S)	REMARKS/PURPOSE
13	Corrects various emergency procedures and adds instrument flight and air taxi checklists.
14	On hold per Model Manager.
15	Single engine failure in flight.

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

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

RAAUZYUW RUENAAA0179 2911512-UUUU--RUENNSN.
ZNR UUUUU
R 171512Z OCT 00
FM CNO WASHINGTON DC//N889J//
TO ALL HUEY AND COBRA HELICOPTER ACTIVITIES
RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
BT
UNCLAS
MSGID/GENADMIN/N889J//
SUBJ/INTERIM CHANGE TO AH-1W AIRCRAFT NATOPS PUBLICATIONS, SAFETY OF /FLIGHT//
REF/A/DOC/NAVAIR/YMD:19971031//
REF/B/DOC/NAVAIR/YMD:19971031//
NARR/REF A IS NAVAIR 01-H1AAC-1 (AH-1W NATOPS FLIGHT MANUAL (NFM)). REF B IS NAVAIR 01-H1AAC-1B (AH-1W NATOPS PILOT-COPILOT POCKET CHECKLIST (PCL)).//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 19 TO REF A (AH-1W NFM), AND INTERIM CHANGE NUMBER 11 TO REF B (AH-1W PCL).
2. SUMMARY. COMBINES EMERGENCY PROCEDURE NARRATIVES FOR LOSS OF TAIL ROTOR THRUST AND LOSS OF TAIL ROTOR COMPONENTS INTO ONE NARRATIVE AND ONE INFLIGHT EMERGENCY PROCEDURE.
3. CHANGE REF A (AH-1W NFM), CHAPTER 15, PAGE 15-6, AS FOLLOWS:
A. PAGE 15-6, PARAGRAPH 15.6.1 LOSS OF TAIL ROTOR THRUST:
(1) DELETE ENTIRE PARAGRAPH AND WARNING.
(2) ADD:

15.6.1 LOSS OF TAIL ROTOR THRUST. THIS IS A SITUATION INVOLVING A BREAK IN THE DRIVE SYSTEM, SUCH AS A SEVERED DRIVE SHAFT, OR LOSS OF TAIL ROTOR COMPONENTS, SUCH AS THE 90-DEGREE GEARBOX OR TAIL ROTOR. FAILURES OF THESE TYPES IN POWERED FLIGHT WILL ALWAYS RESULT IN THE NOSE OF THE HELICOPTER SWINGING TO THE RIGHT (LEFT SIDESLIP) AND USUALLY A LEFT ROLL OF THE FUSELAGE. IF THE LOSS OF THRUST IS A RESULT OF THE LOSS OF TAIL ROTOR COMPONENTS, NOSEDOWN TUCKING MAY ALSO BE PRESENT DUE TO THE FORWARD CG SHIFT. THE SEVERITY OF THE AIRCRAFT'S INITIAL REACTION WILL BE AFFECTED BY AIRSPEED, GROSS WEIGHT, POWER SETTING, AND DENSITY ALTITUDE. IF AUTOROTATIVE FLIGHT IS NOT IMMEDIATELY ENTERED, RIGHT YAW RATES WILL LIKELY APPROACH 120-180 DEGREES PER SECOND.

THE MOST RECOGNIZABLE INDICATION OF LOSS OF THRUST IS RIGHT YAW. THE REACTION TO THIS YAW MUST BE A RAPID REDUCTION OF POWER (LOWERING THE COLLECTIVE TO FULL DOWN) AND COORDINATED CYCLIC INPUTS IN AN ATTEMPT TO REGAIN CONTROLLED FLIGHT. ONCE ESTABLISHED IN AN AUTOROTATIVE PROFILE, WITH TIME AND ALTITUDE PERMITTING, A COMBINATION OF COLLECTIVE, CYCLIC, AND THROTTLE MANIPULATIONS MAY BE MADE IN AN ATTEMPT TO ACHIEVE A REDUCED RATE OF DESCENT AND EXTENDED RANGE. A FULL AUTOROTATIVE LANDING MUST BE MADE WITH THE THROTTLES BEING CLOSED PRIOR TO THE FLARE. GROUND SPEED PRIOR TO LANDING SHOULD BE AS SLOW AS POSSIBLE TO MINIMIZE THE POSSIBILITY OF A ROLLOVER. AS COLLECTIVE IS INCREASED TO CUSHION THE LANDING, THE PILOT SHOULD BE PREPARED FOR A LEFT YAW DUE TO THE OVERRIDING FORCES OF FRICTION IN THE MAIN ROTOR DRIVETRAIN.

WARNING

CONTROL OF HEADING MAY NOT BE REGAINED DURING DESCENT. SOME ROTATION MAY BE PRESENT UNTIL

TOUCHDOWN. IF UNABLE TO STOP AIRCRAFT ROTATION, COORDINATE CYCLIC INPUTS IN ORDER TO EXECUTE A TOUCHDOWN IN AS LEVEL AN ATTITUDE AS POSSIBLE.

NOTE

FOR MOST GROSS WEIGHTS, IT IS UNLIKELY THAT THE HELICOPTER CAN ACHIEVE A STABILIZED POWERED FLIGHT CONDITION FOLLOWING THE LOSS OF TAIL ROTOR THRUST.

INFLIGHT INDICATIONS:

1. UNCONTROLLABLE RIGHT YAW.
2. LEFT ROLL.
3. POSSIBLE NOSE DOWN PITCH. IF THE LOSS OF THRUST IS DUE TO THE LOSS OF TAIL ROTOR COMPONENTS, THERE MAY BE NOSEDOWN TUCKING AND POSSIBLE HIGH-FREQUENCY AIRFRAME AND/OR PEDAL VIBRATIONS.

PROCEDURES:

*1. CONTROLS -- ADJUST (COLLECTIVE FULL DOWN, CYCLIC AS APPROPRIATE IN AN ATTEMPT TO REGAIN CONTROLLED FLIGHT).

WARNING

FAILURE TO IMMEDIATELY REDUCE COLLECTIVE CAN RESULT IN SUSTAINED RIGHT YAW RATES OF 120-180 DEGREES PER SECOND, THUS MAKING A SUCCESSFUL AUTOROTATION EXTREMELY DIFFICULT, AS THE AIRCRAFT MAY ENTER THE SHADED PORTION OF THE HV DIAGRAM.

*2. WING STORES -- JETTISON (AS APPROPRIATE).

NOTE

IF TIME AND ALTITUDE PERMIT, A COMBINATION OF COLLECTIVE, CYCLIC, AND THROTTLE MANIPULATIONS MAY BE MADE IN AN ATTEMPT TO REDUCE RATE OF DESCENT AND EXTEND RANGE.

3. THROTTLES -- CLOSE (PRIOR TO FLARE).
4. AUTOROTATIVE LANDING -- ACCOMPLISH.
5. EMERGENCY SHUTDOWN -- ACCOMPLISH.

B. PAGE 15-6, PARAGRAPH 15.6.2 LOSS OF TAIL ROTOR COMPONENTS:
(1) DELETE ENTIRE PARAGRAPH.
(2) ADD (INSERT): "15.6.2 DELETED."

4. CHANGE REF B (AH-1W PCL), PAGE 54, AS FOLLOWS:

A. DELETE: NA

B. ADD NEW EMERGENCY PROCEDURE:

LOSS OF TAIL ROTOR THRUST IN FLIGHT -

*1. CONTROLS -- ADJUST.

WARNING

FAILURE TO IMMEDIATELY REDUCE COLLECTIVE CAN RESULT IN SUSTAINED RIGHT YAW RATES OF 120-180 DEGREES PER SECOND, THUS MAKING A SUCCESSFUL AUTOROTATION EXTREMELY DIFFICULT, AS THE AIRCRAFT MAY ENTER THE SHADED PORTION OF THE HV DIAGRAM.

*2. WING STORES -- JETTISON (AS APPROPRIATE).

NOTE

IF TIME AND ALTITUDE PERMIT, A COMBINATION OF COLLECTIVE, CYCLIC, AND THROTTLE MANIPULATIONS MAY BE MADE IN AN ATTEMPT TO REDUCE RATE OF DESCENT AND EXTEND RANGE.

3. THROTTLES -- CLOSE (JUST PRIOR TO FLARE).
4. AUTOROTATIVE LANDING -- ACCOMPLISH.
5. EMERGENCY SHUTDOWN -- ACCOMPLISH.

5. NAVAIR POC IS AIR-4.1.1.2 B. KOCH AT DSN 757-5521 OR COMM (301)757-5521, EMAIL KOCHBS@NAVAIR.NAVY.MIL.//BT

PAAUZYUW RUENAAA5527 2231909-UUUU--RUENNSN.
ZNR UUUUU
P 101859Z AUG 00 ZYB
FM CNO WASHINGTON DC//N889//
TO ALL HUEY AND COBRA HELICOPTER ACTIVITIES
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RUDJABF/NAVWARCOL NEWPORT RI//213//
BT
UNCLAS //N03711// SECTION 01 OF 02
MSGID/GENADMIN/N889//
SUBJ/INTERIM CHANGES (IC'S) TO AH-1W AIRCRAFT NATOPS FLIGHT
/PUBLICATIONS//
REF/A/DOC/NAVAIR/31OCT97//
REF/B/DOC/NAVAIR/31OCT97//
REF/C/MSG/CNO WASH DC/182125ZAPR97//
NARR/REF A IS NAVAIR 01-H1AAC-1 (AH-1W NATOPS FLIGHT MANUAL (NFM)).
REF B IS NAVAIR 01-H1AAC-1B (AH-1W NATOPS PILOT'S/COPILOT POCKET
CHECKLIST (PCL)). REF C IS AH-1W NFM IC 14 AND PCL IC 9
(DESALINIZATION WASH PROCEDURES.//
RMKS/1. THIS IS IC NUMBER 18 TO REF A (AH-1W NFM), AND IC NUMBER 10
TO REF B (AH-1W PCL).
2. CANCEL REF C (NFM IC 14 AND PCL IC 9).
3. SUMMARY. THIS MSG REISSUES THE ENGINE PERFORMANCE RECOVERY/GAS PATH CLEANING WASH AND THE ENGINE DESALINIZATION RINSE PROCEDURES PREVIOUSLY ISSUED BY REF C. REF C PROCEDURES REMAIN VALID, BUT HAVE NOT YET BEEN PUBLISHED WITHIN REFS A AND B. REISSUE IS NECESSARY BECAUSE THE REFS A AND B INTERIM CHANGE SUMMARY PAGES DO NOT CLEARLY INDICATE THAT REF C CONTAINS ACTIVE INTERIM CHANGES WHICH REQUIRE THAT PEN-AND-INK ENTRIES AND REPLACEMENTS BE MADE IN THOSE PUBLICATIONS.
4. CHANGE REF A (AH-1W NFM), AS FOLLOWS:
A. PAGE 5, INTERIM CHANGE SUMMARY:
(1) TOP PORTION OF PAGE, IN SECTION MARKED "THE FOLLOWING INTERIM CHANGES HAVE BEEN CANCELLED OR PREVIOUSLY INCORPORATED IN THIS MANUAL:":
(A) DELETE: 1 THRU 12 PREVIOUSLY INCORPORATED
(B) ADD: 1 THRU 12, 14 ---
(2) MIDDLE PORTION OF PAGE, IN SECTION MARKED "THE FOLLOWING INTERIM CHANGES HAVE BEEN INCORPORATED IN THIS CHANGE/ REVISION:":
(A) DELETE ALL INTERIM CHANGE 14 INFORMATION.
(B) ADD: NA
B. CHAPTER 3, PAGES 3-1 AND 3-8, PARAGRAPH 3.2.1 ENGINE PERFORMANCE RECOVERY/GAS PATH CLEANING WASH, FOLLOWING INITIAL CAUTION:
(1) DELETE ALL.
(2) ADD:
1. ARMAMENT -- OFF/SAFE.
2. WASH CART -- CONNECT TO ENGINE TO BE WASHED.
3. ROTOR BRAKE -- AS REQUIRED.
4. MASTER CAUTION CIRCUIT BREAKER -- PULL.
5. NO.1 AND NO.2 INLET HEATER PWR CIRCUIT BREAKERS - PULL.
6. BATT NO.1 AND NO.2 SWITCHES -- ON.
7. ANTI-ICE ENG NO.1 AND ENG NO.2 SWITCHES -- ON.
8. APU -- CONNECT.
9. ENG WASH SWITCH -- WASH.
10. ENG START SWITCH -- ON. MOTOR ENGINE FOR 15 SECONDS.
11. APPLY SOLUTION AT 16 PERCENT NG.

CAUTION

WHILE INGESTING WATER, DO NOT ALLOW NG SPEED TO DROP BELOW 16 PERCENT NG. OPERATING ENGINE LOWER THAN 16 PERCENT NG WHILE WATER WASHING CAN CAUSE DAMAGE TO COMPRESSOR BLADES.

12. ENG START SWITCH -- OFF. CONTINUE APPLYING CLEANING. SOLUTION FOR 15 SECONDS DURING COASTDOWN.
13. CLEANING SOLUTION SUPPLY -- OFF.
14. ALLOW SOLUTION TO SOAK IN ENGINE AND STARTER TO COOL FOR 10 MINUTES.
15. REPEAT STEPS 9 THROUGH 14.
16. CLEANING SOLUTION SUPPLY -- DISCONNECT.
17. RINSING SOLUTION SUPPLY -- CONNECT AND PRESSURIZE TANK.
18. ACCOMPLISH STEPS 9 THROUGH 14 WITH RINSING SOLUTION.
19. RINSING SOLUTION SUPPLY -- DISCONNECT.
20. ENG WASH SWITCH -- NORMAL START.

NOTE

DURING THE COOLDOWN PERIOD, ALLOW RESIDUAL WATER TO DRAIN FROM WASH MANIFOLD AND PREPARE FOR AN ENGINE RUN. THE TIME REQUIRED TO OBTAIN ENGINE LIGHT-OFF WILL BE SEVERAL SECONDS LONGER THAN WITH A FULLY DRIED ENGINE.

21. NO.1 AND NO.2 INLET HEATER PWR CIRCUIT BREAKERS -- IN.
22. PERFORM A NORMAL ENGINE START.
23. RUN ENGINE AT 100 PERCENT ENGINE RPM (NP) FOR A MINIMUM OF 5 MINUTES.

NOTE

ENSURE ENGINE ANTI-ICING OPERATES FOR THE LAST 3 MINUTES TO DRY OUT PIPING.

24. ANTI-ICE ENG NO.1 AND ENG NO.2 SWITCHES -- OFF.
25. SHUT DOWN ENGINE.
26. REPEAT PROCEDURES FOR REMAINING ENGINE.

NOTE

THE REMAINING ENGINE WASH MAY BE ACCOMPLISHED DURING THE SOAKING PERIOD OF THE FIRST ENGINE. ENGINE DRYING RUNS MAY BE DONE AT THE SAME TIME.

C. CHAPTER 3, PAGE 3-8, PARAGRAPH 3.2.2.1 PREFERRED METHOD, FOLLOWING INITIAL CAUTION:
(1) DELETE ALL.
(2) ADD:

1. ARMAMENT -- OFF/SAFE.
2. WASH CART -- CONNECT TO ENGINE TO BE RINSED.
3. ROTOR BRAKE -- AS REQUIRED.
4. MASTER CAUTION CIRCUIT BREAKER -- PULL.
5. NO.1 AND NO.2 INLET HEATER PWR CIRCUIT BREAKERS -- PULL
6. BATT NO.1 AND NO.2 SWITCHES -- ON.
7. ANTI-ICE ENG NO.1 AND ENG NO.2 SWITCHES -- ON.
8. APU -- CONNECT (SET 26 TO 29 VDC).
9. ECU AND RAIN RMV SWITCHES -- OFF.
10. ENG WASH SWITCH -- WASH.
11. ENG START SWITCH -- ON. MOTOR ENGINE FOR 15 SECONDS.
12. APPLY SOLUTION AT 16 PERCENT NG.

CAUTION

WHILE INGESTING WATER, DO NOT ALLOW NG SPEED TO DROP BELOW 16 PERCENT NG. OPERATING ENGINE LOWER THAN 16

PERCENT NG WHILE WATER WASHING CAN CAUSE DAMAGE TO COMPRESSOR BLADES.

13. ENG START SWITCH -- OFF. CONTINUE APPLYING RINSING SOLUTION FOR 15 SECONDS DURING COASTDOWN.
14. RINSING SOLUTION SUPPLY -- OFF.
15. ALLOW STARTER TO COOL FOR 10 MINUTES.
16. REPEAT STEPS 10 THROUGH 15.
17. ACCOMPLISH STEPS 2 THROUGH 15 FOR REMAINING ENGINE.
18. WASH CART -- DISCONNECT.
19. ENG WASH SWITCH -- NORMAL START.

NOTE

THE TIME REQUIRED TO OBTAIN ENGINE LIGHT-OFF WILL BE SEVERAL SECONDS LONGER THAN WITH A FULLY DRIED ENGINE.

20. NO.1 AND NO.2 INLET HEATER PWR CIRCUIT BREAKERS -- IN.
21. PERFORM A NORMAL ENGINE START (REFER TO PARAGRAPHS 7.9 AND 7.10) ON BOTH ENGINES.
22. RUN ENGINES AT 100 PERCENT ENGINE RPM (NP) FOR A MINIMUM OF 5 MINUTES.

NOTE

ENSURE ENGINE ANTI-ICING OPERATES FOR THE LAST 3 MINUTES TO DRY OUT PIPING.

23. ANTI-ICE ENG NO.1 AND ENG NO.2 SWITCHES -- OFF.
24. SHUT DOWN ENGINES (REFER TO PARAGRAPH 7.35).

5. CHANGE REF B (AH-1W PCL):

A. PAGE B, INTERIM CHANGE SUMMARY:

(1) TOP PORTION OF PAGE, IN SECTION MARKED "THE FOLLOWING INTERIM CHANGES HAVE BEEN CANCELLED OR PREVIOUSLY INCORPORATED INTO THIS MANUAL:", IN INTERIM CHANGE NUMBER(S) COLUMN:

(A) DELETE: 1 THRU 7

(B) ADD: 1 THRU 7, 9

(2) BOTTOM PORTION OF PAGE, IN SECTION MARKED "INTERIM CHANGES OUTSTANDING -- TO BE MAINTAINED BY THE CUSTODIAN OF THIS MANUAL:":

(A) DELETE ALL INTERIM CHANGE 9 INFORMATION.

(B) ADD: NA

B. PAGE 118, ENGINE PERFORMANCE RECOVERY/GAS PATH CLEANING WASH, FOLLOWING PROCEDURE TITLE:

(1) DELETE ALL.

(2) ADD:

1. ARMAMENT .... OFF/SAFE
2. WASH CART .... CONNECT
3. ROTOR BRAKE .... AS REQUIRED
4. MASTER CAUTION CIRCUIT BREAKER .... PULL
5. NO.1 AND NO.2 INLET HEATER PWR CIRCUIT BREAKERS .... PULL
6. BATT NO.1 AND NO.2 SWITCHES .... ON
7. ANTI-ICE ENG NO.1 AND NO.2 SWITCHES .... ON
8. APU .... CONNECT
9. ENG WASH SWITCH .... WASH
10. ENG START SWITCH .... ON. MOTOR ENGINE FOR 15 SECONDS.
11. APPLY SOLUTION AT 16 PERCENT NG.

CAUTION

WHILE INGESTING WATER, DO NOT ALLOW NG SPEED TO DROP BELOW 16 PERCENT NG. OPERATING ENGINE LOWER THAN 16 PERCENT NG WHILE WATER WASHING CAN CAUSE

DAMAGE TO COMPRESSOR BLADES.

12. ENG START SWITCH .... OFF
    CONTINUE APPLYING CLEANING SOLUTION
    FOR 15 SECONDS DURING COASTDOWN.
13. CLEANING SOLUTION SUPPLY .... OFF
14. ALLOW SOLUTION TO SOAK IN ENGINE AND STARTER TO COOL FOR 10 MINUTES.
15. REPEAT STEPS 9 THROUGH 14.
16. CLEANING SOLUTION SUPPLY .... DISCONNECT
17. RINSING SOLUTION SUPPLY .... CONNECT
18. ACCOMPLISH STEPS 9 THROUGH 14 WITH RINSING SOLUTION.
19. RINSING SOLUTION SUPPLY .... DISCONNECT
20. ENG WASH SWITCH .... NORMAL START
21. NO.1 AND NO.2 INLET HEATER PWR CIRCUIT BREAKERS .... IN
22. PERFORM A NORMAL ENGINE START.
23. RUN ENGINE AT 100 PERCENT ENGINE RPM (NP) FOR A MINIMUM OF 5 MINUTES.
24. ANTI-ICE ENG NO.1 AND ENG NO.2 SWITCHES .... OFF
25. SHUT DOWN ENGINE.
26. REPEAT PROCEDURES FOR REMAINING ENGINE.

C. PAGE 119, ENGINE DESALINIZATION RINSE -- PREFERRED METHOD, FOLLOWING PROCEDURE TITLE:

(1) DELETE ALL.

(2) ADD:

1. ARMAMENT .... OFF/SAFE
2. WASH CART .... CONNECT
3. ROTOR BRAKE .... AS REQUIRED
4. MASTER CAUTION CIRCUIT BREAKER .... PULL
5. NO.1 AND NO.2 INLET HEATER PWR CIRCUIT BREAKERS .... PULL
6. BATT NO.1 AND NO.2 SWITCHES .... ON
7. ANTI-ICE ENG NO.1 AND NO.2 SWITCHES .... ON
8. APU .... CONNECT
9. ECU AND RAIN RMV SWITCHES...................... OFF
10. ENG WASH SWITCH .... WASH
11. ENG START SWITCH .... ON
    MOTOR ENGINE FOR 15 SECONDS.
12. APPLY SOLUTION AT 16 PERCENT NG.

CAUTION

WHILE INGESTING WATER, DO NOT ALLOW NG SPEED TO DROP BELOW 16 PERCENT NG. OPERATING ENGINE LOWER THAN 16 PERCENT NG WHILE WATER WASHING CAN CAUSE DAMAGE TO COMPRESSOR BLADES.

13. ENG START SWITCH .... OFF
    CONTINUE APPLYING RINSING SOLUTION
    FOR 15 SECONDS DURING COASTDOWN.
14. RINSING SOLUTION SUPPLY .... OFF
15. ALLOW STARTER TO COOL FOR 10 MINUTES.
16. REPEAT STEPS 10 THROUGH 15.
17. ACCOMPLISH STEPS 2 THROUGH 15 FOR REMAINING ENGINE.
18. WASH CART .... DISCONNECT
19. ENG WASH SWITCH .... NORMAL START
20. NO.1 AND NO.2 INLET HEATER PWR CIRCUIT BREAKERS .... IN
21. PERFORM A NORMAL START OF BOTH ENGINES.
22. RUN ENGINES AT 100 PERCENT ENGINE RPM (NP) FOR A

MINIMUM OF 5 MINUTES.

23. ANTI-ICE ENG NO.1 AND ENG NO.2 SWITCHES .... OFF

24. SHUT DOWN ENGINES. //

BT

PAAUZYUW RUENAAA4011 1291949-UUUU--RUENNSN.
ZNR UUUUU
P R 081912Z MAY 00 ZYB
FM CNO WASHINGTON DC//N889//
TO ALL HUEY AND COBRA HELICOPTER ACTIVITIES
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RUDJABF/NAVWARCOL NEWPORT RI//213//
BT
UNCLAS //N03711//
MSGID/GENADMIN/N889//
SUBJ/INTERIM CHANGE TO AH-1W AIRCRAFT NATOPS FLIGHT MANUAL//
REF/A/DOC/NAVAIR/31OCT97//
AMPL/REF A IS NAVAIR 01-H1AAC-1 (AH-1W NATOPS FLIGHT MANUAL (NFM))//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 17 TO REF A (AH-1W NFM).
2. SUMMARY. DELETES ACM/EVM RESTRICTIONS IN REF A.
3. CHANGE REF A (AH-1W NFM), CHAPTER 4, OPERATING LIMITATIONS,
PAGES 4-4 AND 4-7, PARAGRAPH 4.11 PROHIBITED MANEUVERS, AS FOLLOWS:
A. DELETE ITEM 9:

9. ACM/EVM FLYING AND ABRUPT OR EXTREMELY AGGRESSIVE FLYING MANEUVERS ARE PROHIBITED EXCEPT IN EMERGENCY OR ACTUAL COMBAT CONDITIONS OR SPECIFICALLY WAIVED BY CNO. FOR THE PURPOSE OF WEAPON SYSTEM TRAINING, AIRBORNE EMPLOYMENT OF THE AIM-9 MISSILE SYSTEM IS AUTHORIZED.

B. ADD: NA//
BT

PAAUZYUW RUENAAA1402 3022314-UUUU--RUENNSN.
ZNR UUUUU
P 292301Z OCT 99 ZYB
FM CNO WASHINGTON DC//N889//
TO ALL HUEY AND COBRA HELICOPTER ACTIVITIES
INFO RUCTPOH/NAVOPMEDINST PENSACOLA FL//06//
RUDJABF/NAVWARCOL NEWPORT RI//213//
BT
UNCLAS //N03711//
MSGID/GENADMIN/N889//
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REF/A/DOC/NAVAIR/31OCT97//
REF/B/DOC/NAVAIR/31OCT97//
NARR/REF A IS NAVAIR 01-H1AAC-1 (AH-1W NATOPS FLIGHT MANUAL (NFM)), AND REF B IS NAVAIR 01-H1AAC-1B (AH-1W NATOPS PILOT/COPILOT POCKET CHECKLIST (PPCL)).//
RMKS/1. THIS IS INTERIM CHANGE NUMBER 16 TO REF A (AH-1W NFM).
2. SUMMARY. CORRECTS ERRORS TO EMERGENCY PROCEDURES IN REF A.
3. CHANGE REF A (AH-1W NFM), CHAPTER 15, IN-FLIGHT EMERGENCIES, AS FOLLOWS:

A. PAGE 15-10, PARAGRAPH 15.9.2.2 DUAL-ENGINE FAILURE - HOGE, INDICATION 1:
   (1) DELETE ASTERISK BY ITEM NUMBER 1 WHICH DESIGNATES ITEM 1 AS A CRITICAL ITEM.
   (2) ADD: NA.
B. PAGE 15-11, PARAGRAPH 15.9.3 SINGLE-ENGINE FAILURE - HIGE, IN PROCEDURES STEP 1:
   (1) DELETE THE WORD "ALTITUDE".
   (2) ADD (REPLACE WITH) "ATTITUDE", SO STEP 1 READS:
      *1. ATTITUDE CONTROL -- MAINTAIN (AS APPROPRIATE TO ACCOMPLISH LANDING).
C. PAGE 15-18, PARAGRAPH 15.11.3 DUAL-ENGINE FIRE IN FLIGHT, IN PROCEDURES STEP 7:
   (1) DELETE: NA
   (2) ADD ASTERISK BY STEP NUMBER 7 TO DESIGNATE STEP 7 AS A CRITICAL STEP.
D. PAGE 15-19, PARAGRAPH 15.11.4 SINGLE-ENGINE FIRE IN FLIGHT, IN PROCEDURES STEPS 6 AND 7:
   (1) DELETE ASTERISKS BY STEP NUMBERS 6 AND 7 WHICH DESIGNATE THEM AS CRITICAL STEPS.
   (2) ADD: NA.
E. PAGE 15-20, PARAGRAPH 15.12.2, ENGINE-DRIVEN SUCTION PUMP FAILURE, IN PROCEDURES STEP 4:
   (1) DELETE THE WORD "POSSIBLE".
   (2) ADD (REPLACE WITH) "PRACTICABLE", SO STEP READS:
      4. LAND AS SOON AS PRACTICABLE.

4. CORRESPONDING TEXT IN REF B (AH-1W PPCL) IS CORRECT AS PUBLISHED.
//
BT

SUMMARY OF APPLICABLE TECHNICAL DIRECTIVES

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

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION

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

CHANGE NUMBER	DESCRIPTION	DATE INC. IN MANUAL	VISUAL IDENTIFICATION

RECORD OF CHANGES

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

AH-1W NATOPS FLIGHT MANUAL

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LIST OF ABBREVIATIONS AND ACRONYMS

A

AAU Aural alerting unit

ACM Air combat maneuvering

ACQ Acquisition

ADF Automatic direction finder

ADI Attitude direction indicator

ADL Armament datum line

AGL Above ground level

AI Airborne intercept

AJ Anti-jam

ALT Alternate

AM Amplitude modulated

ANVIS HUD Aviators Night Vision Imaging System Head-Up Display

APU Auxiliary power unit

AS Anti-spoofing

ATTK Attack

AUT Auto

AZ Azimuth

B

BC 1553 Bus controller

BDHI Bearing, distance, heading indicator

BF (THCDP key) Varies intensity of battle flags

BF (THCDP screen) Missile has failed BIT

BIT Built-in test

BRC Base recovery course

BRST Boresight

BRT Bright

BSX Roll calibration input

BSY Pitch calibration input

BSZ Yaw calibration input

C

CAM Camera

CCD Charge-coupled device

CCM Counter-countermeasures

CCS Cockpit control system

CCU Cockpit control unit

CCUP Cockpit control unit panel

CDCP Countermeasures dispenser control panel

CDS Control display subsystem

CDU Control display unit

CEP Circular error probability

cg Center of gravity

CKPT Checkpoint

CM Canopy Mod

CM (THCDP screen) missile counter-countermeasure features turned on

CMD Command

CNU Communication/navigation upgrade

CONST Constraints

cps Cycles per second

CPU Central processor unit

CRS Canopy removal system

CRS Course

CRT Cathode ray tube

CSC Communication system control

CSP	Commence search point
CU	Control unit
CV	Crypto-variables
cw	Continuous wave

D

D	Down
DA	Drift angle
DCVM	Direct current voltmeter
DES	(MFD/CRT display) Designation
DF	Direction finder
DH	Decision height
DIR	Direct-to
DIS	Distance
DISP	Display
DNS	Doppler navigation system
DTD	Data transfer device
DVO	Direct view optics

E

ECCM	Electronic counter-countermeasures
ECS	Environmental control system
ECU	Environmental control unit; Electronic control unit
EECU	Engine electrical control unit
EGI	Embedded global positioning system/ inertial navigation system
EIA	Electronic interface assembly
EPS	Electronic power supply
ERF	ECCM remote fill
ETA	Estimated time of arrival
EXP	Expanding

F

FAA	Federal Aviation Administration
FAE	Fuel air explosive
FAM	Familiarization
FEB	FLIR electronic box
FFSP	Full function signal processor
FLIR	Forward looking infrared
FM	Figure of merit
FM	Frequency modulated
FMT	Frequency managed training net
FOC	(LHG switch) FLIR manual/auto focus
FOD	Foreign object damage
FOR	Field of regard
FOV	Field of view
FPLN	Flight plan
fps	Feet per second

G

GAIL	Glide angle indicator light
GCA	Ground controlled approach
GCA	Gyro compass align
GHS	Gunner helmet sight
GIC	Gunner in control
GMT	Greenwich mean time
GND	Ground
GNR	Gunner
GPS	Global positioning system
GS	Ground speed
GUV	Group unique variable

H

HELLFIRE	Heliborne-launched fire and forget (also a trade name)

HDU	Helmet display unit
HF	HELLFIRE
HF	(THCDP screen) Hangfire
HIGE	Hover in ground effect
HML	HELLFIRE missile launcher
HMS	HELLFIRE missile system
HMU	Hydromechanical unit
HOGE	Hover out of ground effect
HPCP	HELLFIRE pilot control panel
HQ	HAVEQUICK
HS	Helmet sight
HSS	Helmet sight subsystem
HUD	Head-up display
HVPS	High voltage power supply

I

ICS	Intercommunication set
ICU	Interface control unit
IDX	Index
IFA	In-flight alignment
IFF	Identification friend or foe
IGE	In ground effect
IMA	In-motion align
IMC	Instrument meteorological conditions
INLC	Interlock
INS	Inertial navigation system
IR	Infrared
ISA	International standard atmosphere

J

K

km	Kilometers
kn	Knot (speed)
kt	Knot (speed)
kts	Knots (speed)

L	Left
LCP	Laser code panel
LDS	Load demand spindle
LDRS	Laser designating and ranging system
LHG	Left-hand grip
L/L	Latitude/longitude
LOAL	Lock-on after launch
LOBL	Lock-on before launch
LOS	Line of sight
LRA	Line replaceable assemblies
LRF	(LHG switch) Laser rangefinding
LRP	Laser range panel
LRU	Line replaceable units
LS	Line select
LSE	Landing signalman enlisted
LSR	(THCDP key) Cycles the laser mode
LST	Last

M

MAN	Manual
MCA	Missile command amplifier
MDL	Mission data loader
MF	(THCDP screen) Missile has failed (other than BIT)
MFD	Multifunction display
MGT	Measured gas temperature
mi	Statute miles
MOAT	Missile on aircraft test
MRTU	Multiplex remote terminal unit

MSL	Mean sea level
MSL	Missile
MWOD	Multiple word-of-day

N

NARCADS	Navy armament rocket control and delivery system
Ng	Gas generator speed
NIU	Nitrogen inerting unit
nmi	Nautical mile
NOE	Nap of the Earth
Np	Constant power turbine speed
Nr	Rotor rpm
NTS	Night targeting system
NV	Net variable
NVG	Night vision goggles
NVM	Non volatile memory
NXT	Next

O

OAT	Outside air temperature
ODA	Optical display assembly
ODV	Overspeed and drain valve
OEI	One engine inoperative
OFT	Operational flight trainer
OGE	Out of ground effect
ORT	Optical relay tube

P

PAC	Pilot at the controls
PAS	Power available spindle
PEB	Processor electronics box
PHS	Pilot helmet sight
PIC	Pilot in control
PIM	Position and intended movement
PLT	Pilot
PMBR	Practice multiple bomb rack
PNAC	Pilot not at the controls
POR	Pilot override
PPS	Precision positioning service
PPSN	Present position
PQM	Pilot qualified in model
PRE	Previous
PRI	Primary
PriFly	Primary flight control
PRU	Power relay unit
PTA	Planned time of arrival
PTT	Push-to-talk

Q

R

R	Right
RALT	Radar altitude
RCV	Receive
RDY	(THCDP screen) Ready
RF time	Radio frequency time
RFTDL	Range finder target designator laser
RIP	(THCDP screen) Ripple launch sequence selected
RIPL	Ripple
RHE	Remote HELLFIRE electronics
RLG	Ring-Laser gyro
RMI	Radio magnetic indicator
rpm	Revolutions per minute
RT	Receiver/transmitter
RTCL	Reticle (TSU)
RTE	Route
RTN	Return

S

SA Selective availability

SAM Surface-to-air missile

SAR Search and rescue

SBA Shipboard alignment

SCA Stabilizer control amplifier

SCAS Stability and control augmentation system

SCP Store control panel

SECU Servo electronic control unit

SEL Select

SEQ Sequence

SF (THCDP screen) Station failed

SGSI Stabilized glideslope indicator

SHA Stored heading alignment

SHC Sight hand control

SINCGARS Single channel ground and airborne radio system

SPD Speed

SPS Standard positioning service

SSPD Ship speed

SVHS Super VHS

T

TAS True airspeed

TCN TACAN

TERF Terrain flight

TGT Target

THCDP TOW/HELLFIRE control display panel

THCDS TOW/HELLFIRE control display system

TKE Track error

TML TOW missile launcher

TMS TOW missile system

TNS Tactical navigation system

TOD Time-of-day

TOW Tube-launched, optically tracked, wire guided

TR (MFD/CRT display) TOW/GUN trigger pull

TRANSEC Transmission security variable

TRK Track

TSU Telescopic sight unit

TTG Time-to-go

TTH (MFD/CRT display) Time-to-hit

TVC Television camera

TVT TV tracker

U

UNL (THCDP screen) Unlatched

UTC Universal time coordinated

UTM Universal transverse mercator

V

VCR Video cassette recorder

VIDS/MAF Visual information display system/ maintenance action form

VMC Visual meteorological conditions

VOX Voice activated ICS

VSS Vibration suppression system

VSWR Voltage standing wave ratio

W

WOD Word-of-day

WPT Waypoint

WRA Weapon replaceable assemblies

WRDU Wing rocket delivery unit

WS Wind speed

WST Weapon systems trainer

X

XTK Cross track

Y

Z

Z Zulu time

PREFACE

SCOPE

The 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 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 judgement. Compound emergencies, available facilities, adverse weather or terrain, or considerations affecting the lives and property of others may require modification of the procedures contained herein. Read this manual from cover to cover. It's your responsibility to have a complete knowledge of its contents.

APPLICABLE PUBLICATIONS

The following applicable publications complement this manual:

NAVAIR 01-H1AAC-1B (NATOPS Pilot's/ Copilot's Pocket Checklist)

NAVAIR 01-H1AAC-1F (NATOPS Functional Checkflight Checklist)

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

Routine change recommendations are submitted directly to the model manager on OPNAV 3710/6 (4-90) shown on the next page. The address of the model manager of this aircraft is:

Commanding Officer
HMT-303, MAG-39, MCAS
Camp Pendleton, CA 92055
(Attention: NATOPS)

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

DATE ____________

TO BE FILLED IN BY ORIGINATOR AND FORWARDED TO MODEL MANAGER

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

Recommendation (be specific)

☐ CHECK IF CONTINUED ON BACK

Justification

Signature	Rank	Title

Address of Unit or Command

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

FROM	DATE

TO

REFERENCE

(a) Your Change Recommendation Dated ____________

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

☐ Your change recommendation is reclassified URGENT and forwarded for approval to ____________ ____________ by my DTG ____________

/S/ ____________ MODEL MANAGER | ____________ AIRCRAFT

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

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NATOPS FLIGHT MANUAL INTERIM CHANGES

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

CHANGE SYMBOLS

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

WARNINGS, CAUTIONS, AND NOTES

The following definitions apply to "WARNINGs," "CAUTIONS," and "Notes" found throughout the manual.

WARNING

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

CAUTION

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

Note

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

WORDING

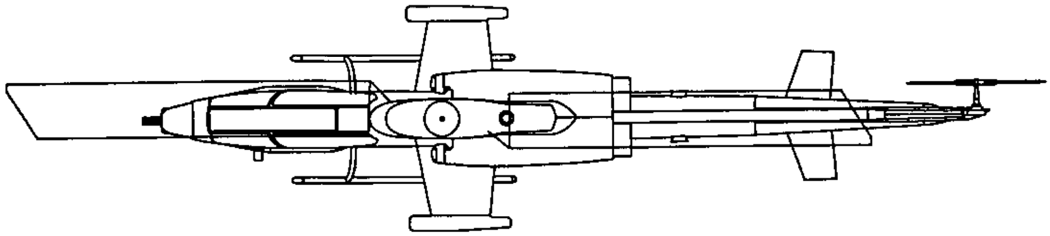
The concept of word usage and intended meaning that has been adhered to in preparing this manual is as follows:

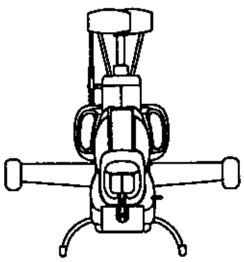
"Shall" has been used only when application of a procedure is mandatory.

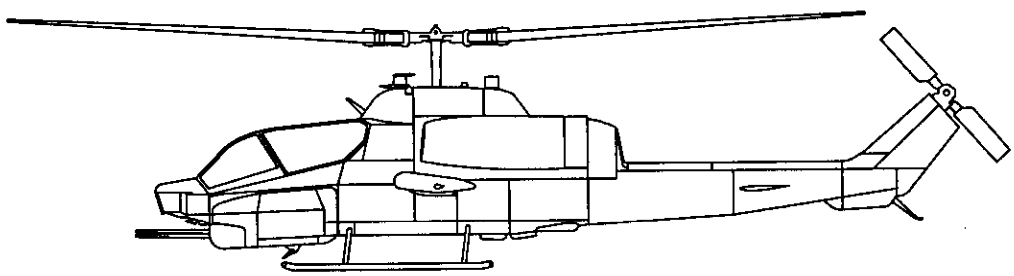
"Should" has been used only when application of a procedure is recommended.

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

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







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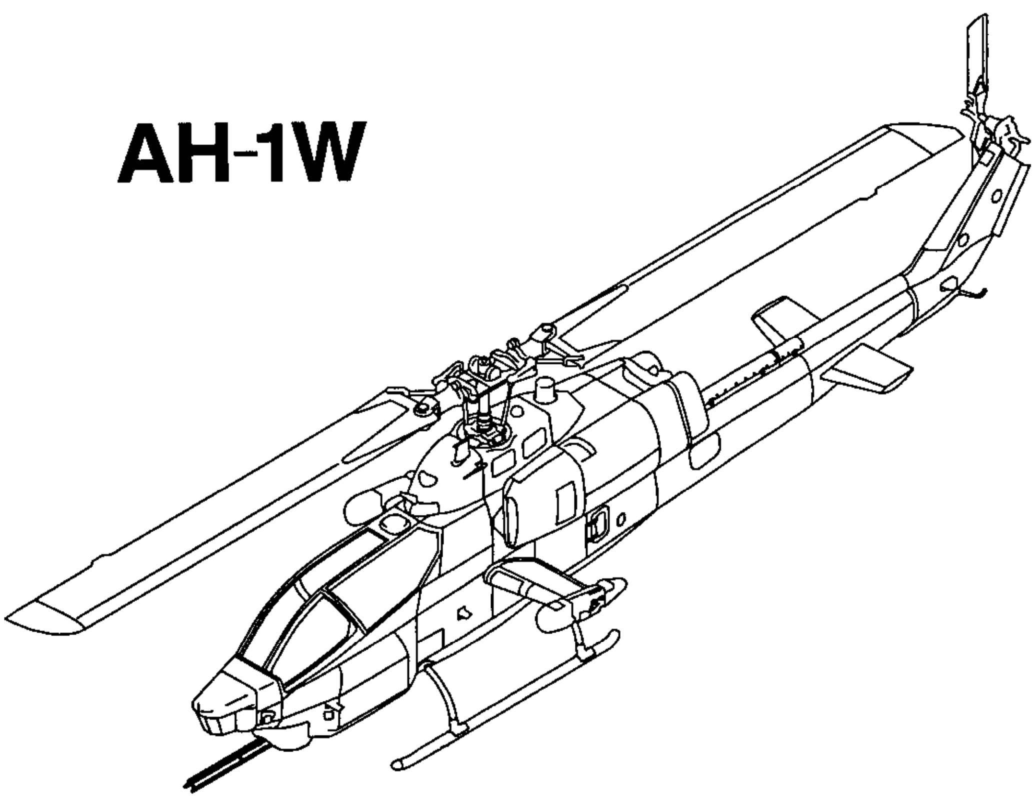

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PART I

The Helicopter

CHAPTER 1

Helicopter and Engines

1.1 HELICOPTER

The AH-1W helicopter is an armed, tactical helicopter manufactured by Bell Helicopter Textron. Tandem seating is provided for a pilot and copilot/gunner.

CM Identifies the Canopy Mod helicopter configuration. This includes a new canopy configuration, copilot/gunner control display unit, and night targeting system.

Note

Canopy Mod configured helicopters may have an older style TSU instead of the night targeting system.

B Identifies the Basic Model helicopter configuration without canopy modification.

CNU Identifies Communication/Navigation Upgrade (Comm/Nav Upgrade) which includes modifications to hardware and software of Canopy Mod helicopters.

NTS Identifies an aircraft with the Night Targeting System installed.

TNS Identifies an aircraft with the Tactical Navigation System installed.

Data pertaining to the Basic Model B and Comm/Nav Upgrade CNU has been included where necessary. Refer to chapter 19 and chapter 20 for further explanation of communications and navigation equipment. These deviations will be identified by their effectivity codes.

1.2 ENGINES

Two General Electric T700-GE-401, turboshaft engines are installed. Each engine is rated (uninstalled) at 1,690 shp (intermediate power).

1.3 SPEED RANGE

The speed range of this helicopter in a clean configuration is 0 to 190 knots, based on standard day conditions at sea level.

1.4 MISSIONS

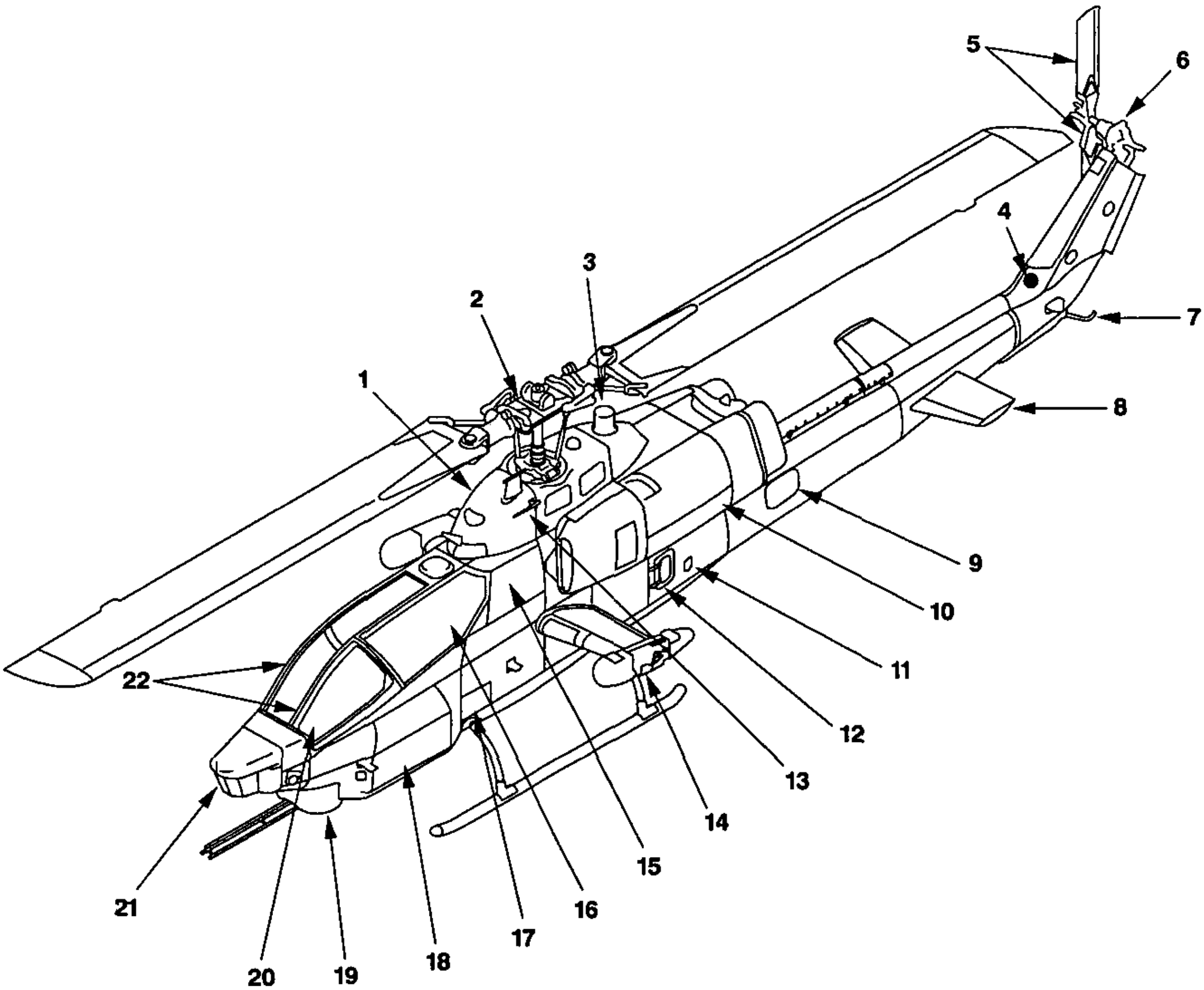
The primary mission is that of an armed, tactical helicopter, capable of search and target acquisition; laser designation and rangefinding; low-altitude, high-speed flight; multiple weapon fire support; reconnaissance by fire; and assault support escort. Mission profiles cover the air-to-ground and air-to-air environment. The helicopter is capable of performing these missions from prepared or unprepared areas during day or night conditions.

1.5 TAKEOFF GROSS WEIGHT

The maximum gross weight for takeoff is 14,750 pounds.

1.6 HELICOPTER ARRANGEMENT

1. General Arrangement (Figure 1-1)
2. Principal Dimensions (Figure 1-2)
3. Pilot Station (Figure 1-3)
4. Copilot/Gunner Station (Figure 1-4)



1. Hydraulic system 1 compartment
2. Main rotor hub and blades
3. IR jammer
4. Intermediate gearbox
5. Tail rotor hub and blade
6. Tail rotor gearbox
7. Tail skid
8. Elevator
9. Aft avionics compartment
10. Engine compartment
11. External power receptacle
12. Utility hydraulics, main engine fire extinguisher
13. Pitot tube
14. Wing pylon
15. ECU, rotor brake and hydraulic system 2 compartment
16. Pilot station
17. Left battery compartment
18. Access door
19. 20 mm gun turret
20. Copilot/gunner station
21. Telescopic sight unit
22. Wire strike deflectors

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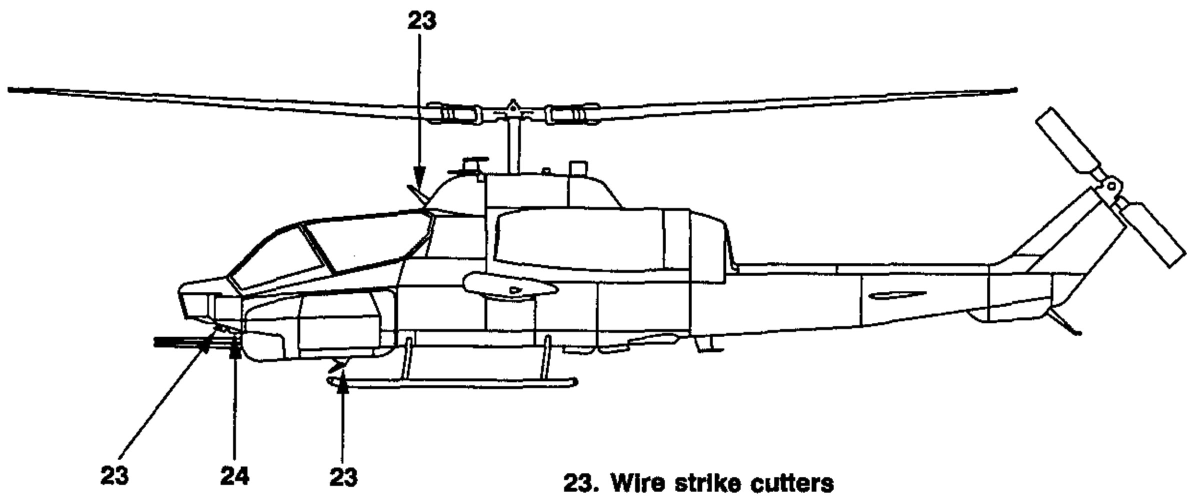
Figure 1-1. General Arrangement (Sheet 1 of 2)



23. Wire strike cutters
24. Vibration suppressor assembly
25. 20 mm ammunition compartment
26. Right battery compartment
27. Gravity fill fuel port
28. Pressure fueling receptacle
29. Oil cooler (transmission/combining gearbox) and reserve engine fire extinguisher
30. Aft electrical compartment/antitorque hydraulic actuator
31. Combining gearbox/transmission compartment

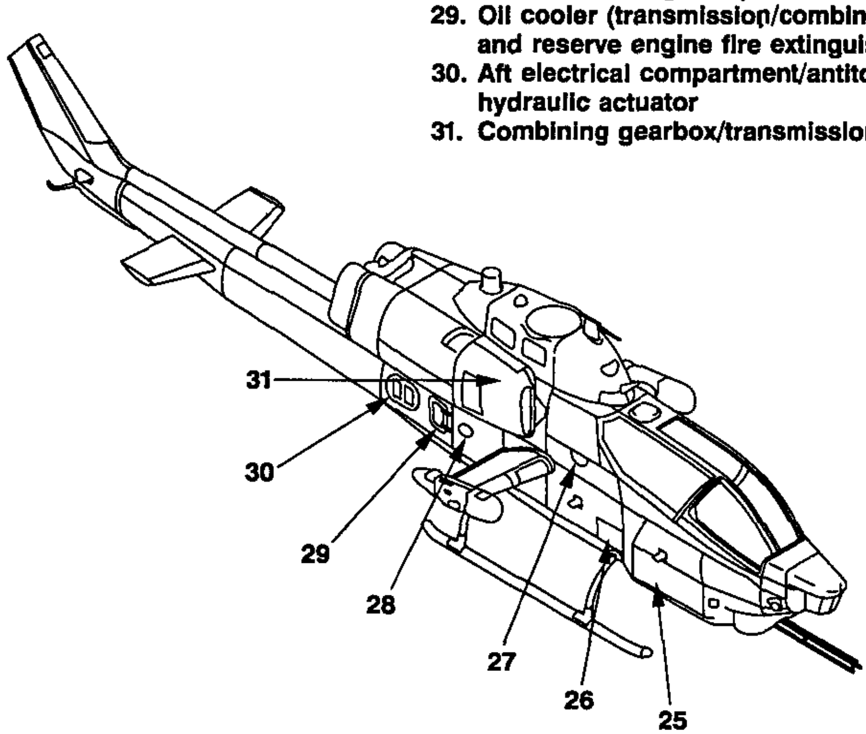


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Figure 1-1. General Arrangement (Sheet 2 of 2)

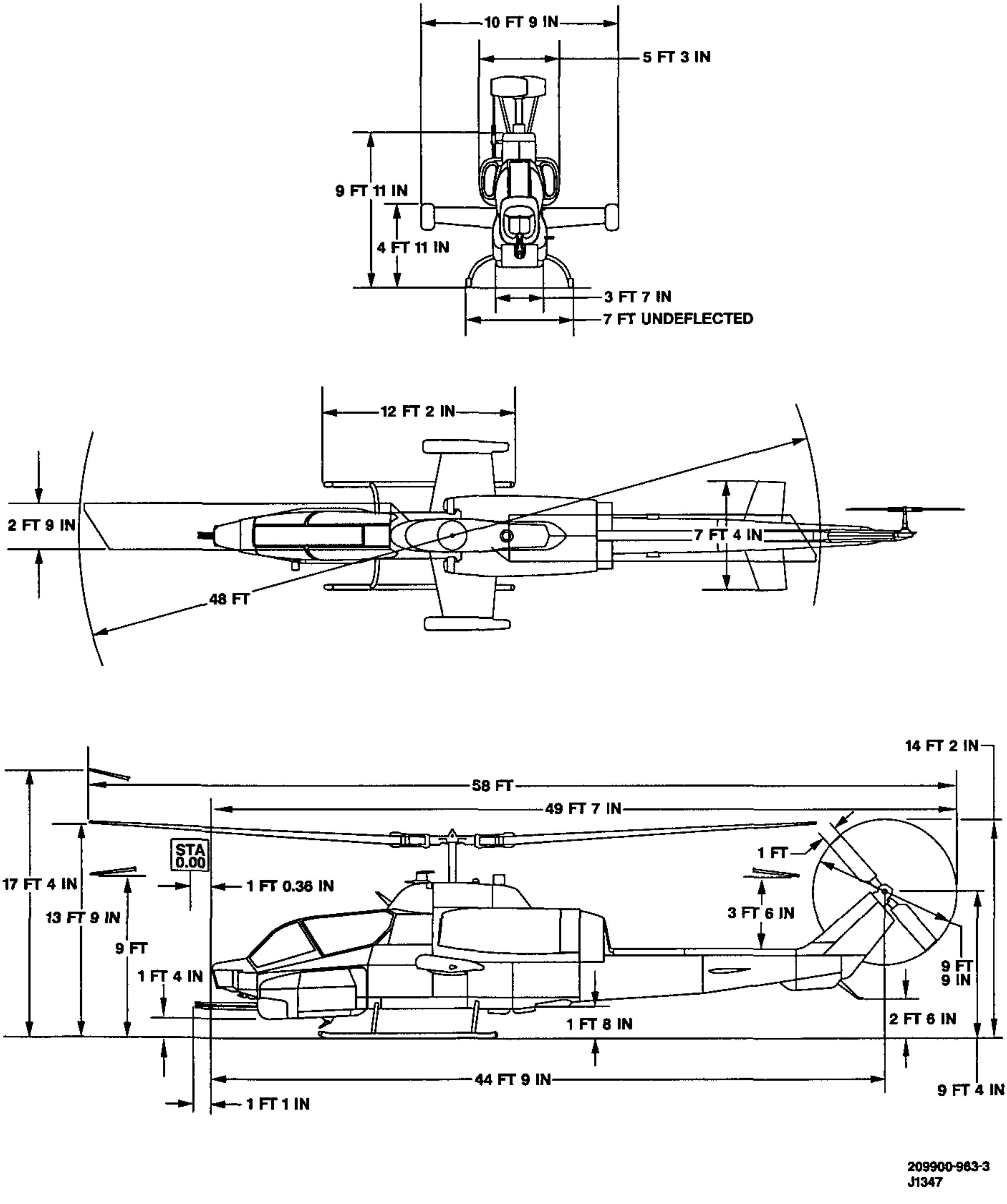


Figure 1-2. Principal Dimensions

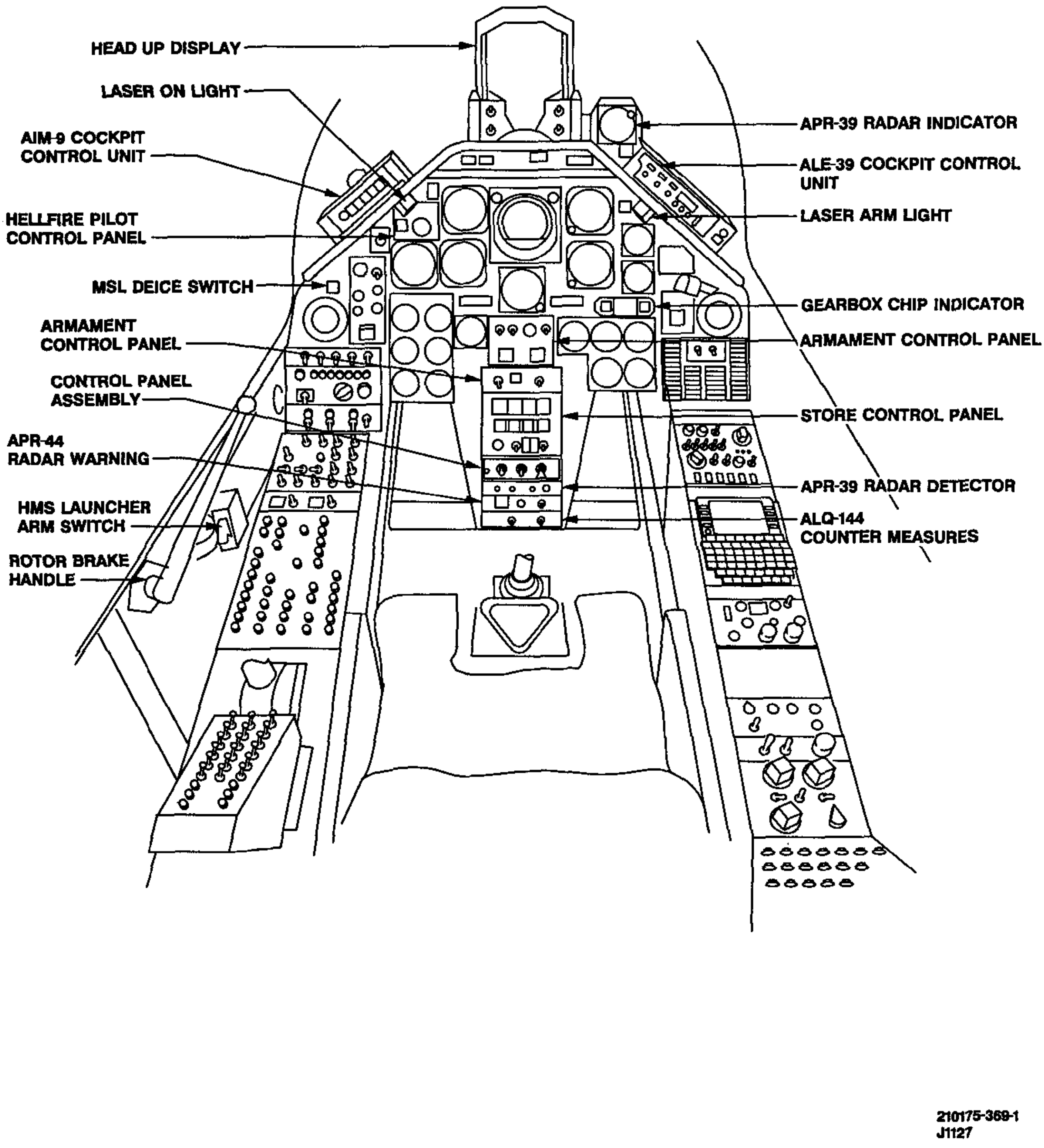


Figure 1-3. Pilot Station (Sheet 1 of 2)

NOTE: For Basic Model B and Comm Nav Upgrade CNU configurations refer to FO-1 and FO-3.

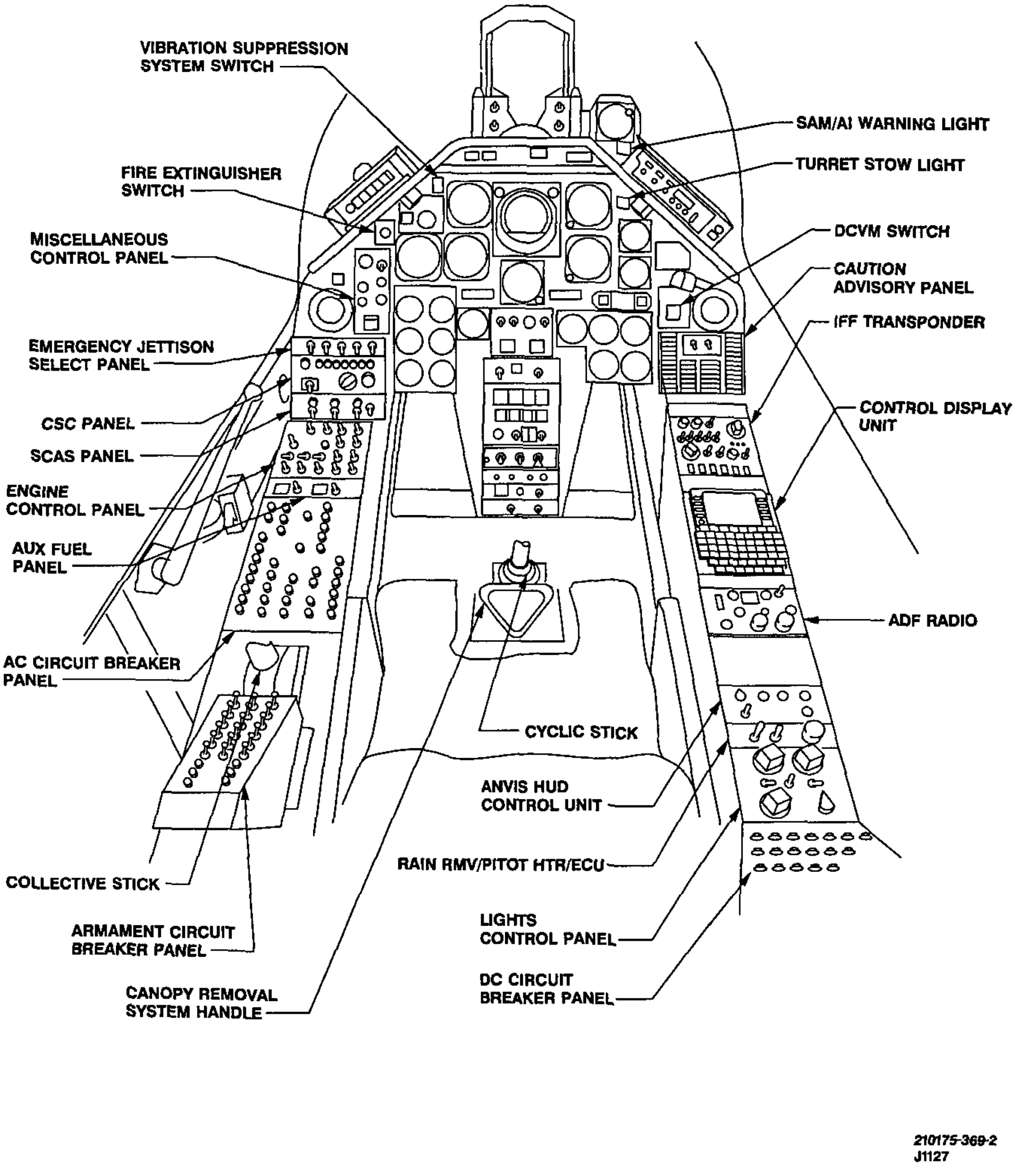


Figure 1-3. Pilot Station (Sheet 2 of 2)

NOTE: For Basic Model B and Comm Nav Upgrade CNU configurations refer to FO-1 and FO-3.

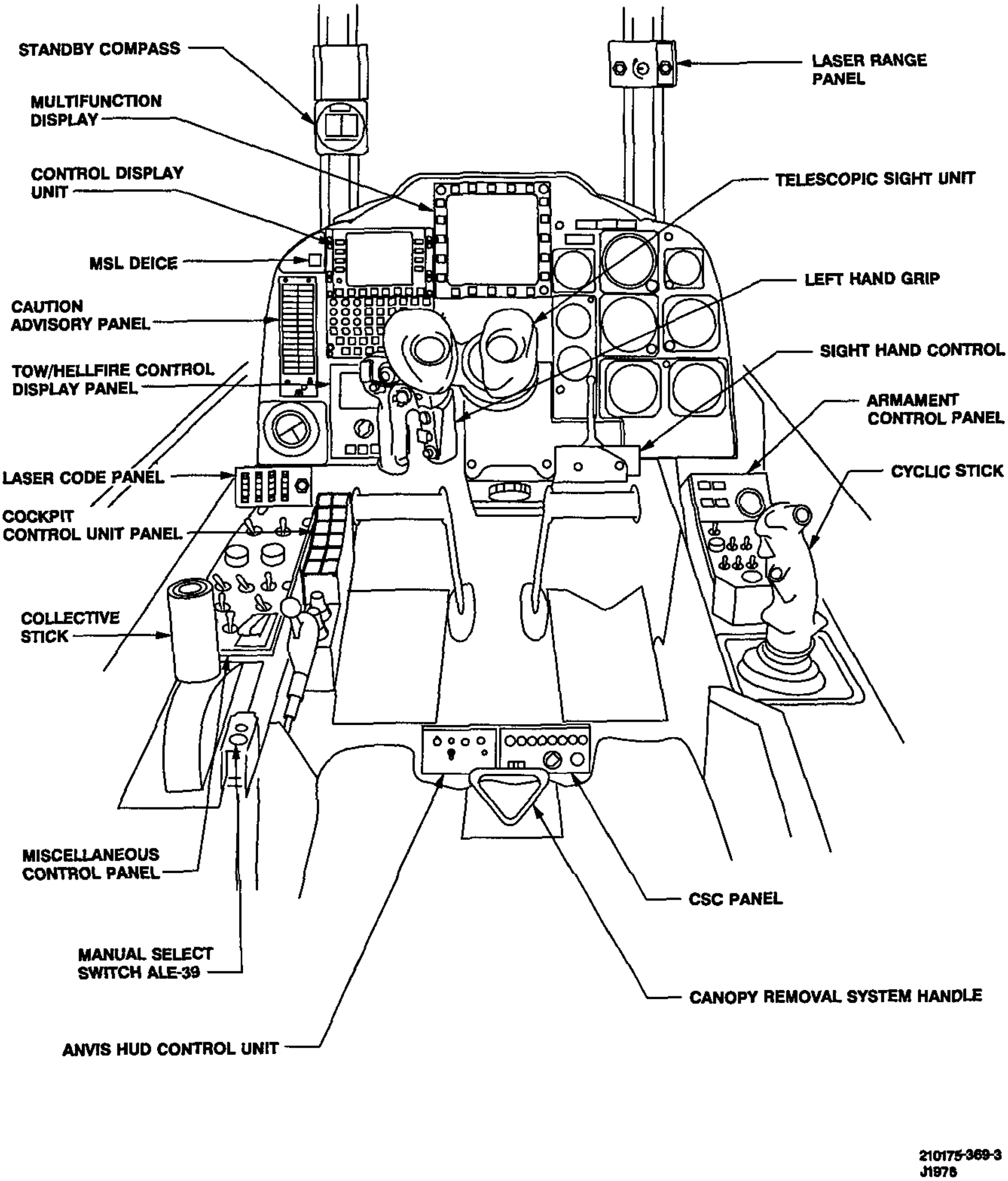


Figure 1-4. Copilot/Gunner Station

CHAPTER 2

Systems

2.1 POWERPLANT SYSTEMS

The powerplant system includes two turboshaft engines, engine-driven accessories, air induction system, exhaust system, cooling system, lubricating system, fuel system, starting system, and engine controls.

2.1.1 Engines. The T700-GE-401 engines (Figure 2-1) are front drive, turboshaft engines of modular construction. Each engine is composed of a combination axial/centrifugal six-stage compressor, an annular combustor with central fuel injectors, and a two-stage power turbine. A coaxial driveshaft extends from the power turbine forward through the two-stage gas generator turbine and compressor. The driveshaft is connected by a splined joint to the engine output shaft. The compressor has stage 1 and stage 2 variable vanes in the casing, inlet guide vanes in the mainframe, three actuating rings (one for each stage), and a starting bleed air valve to aid in efficient engine operation throughout the entire operating range. An integral air inlet particle separator protects the engine from the ingestion of sand and dust. Each engine incorporates fittings and a water wash spray ring for compressor cleaning.

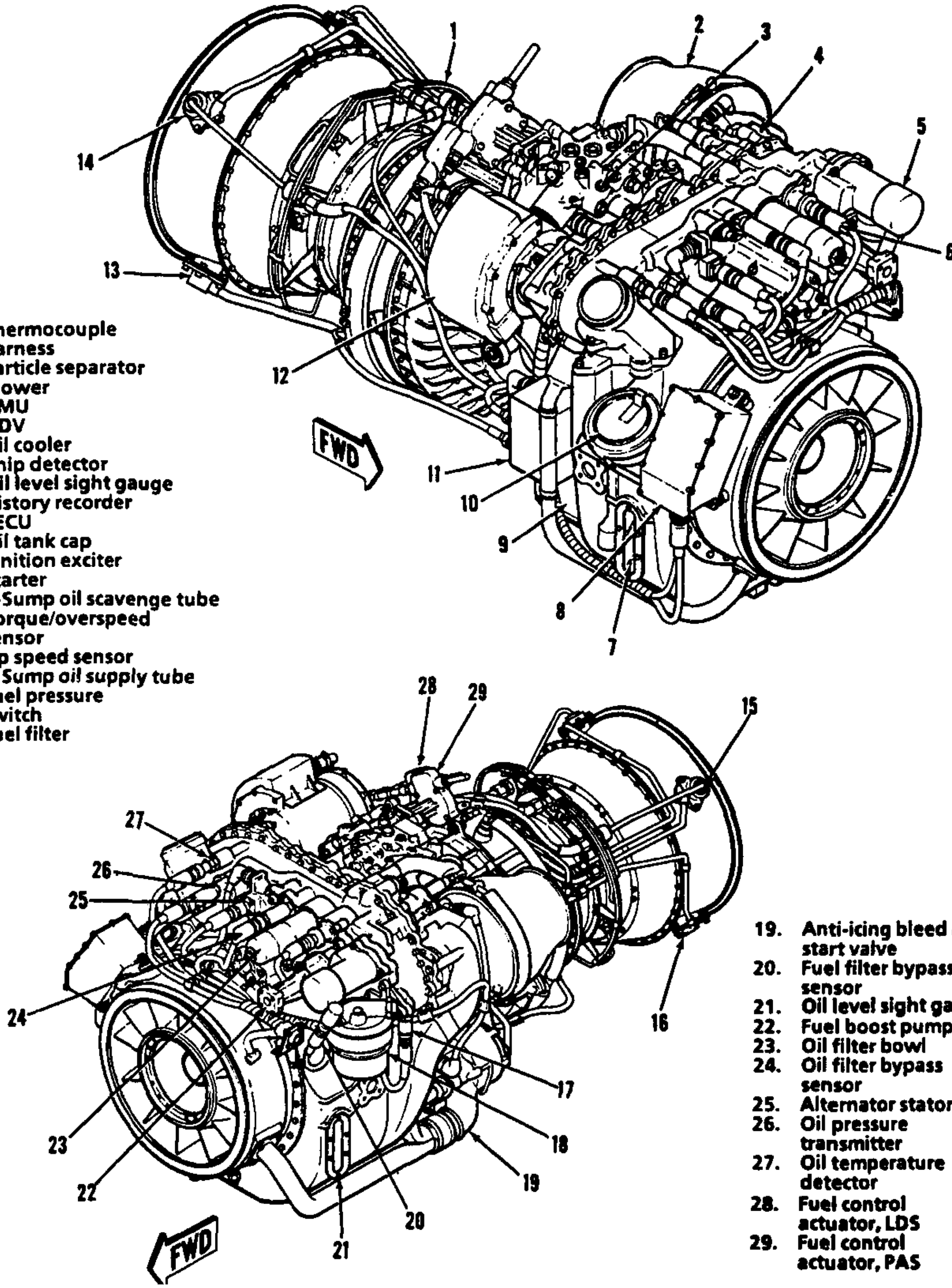
2.1.2 Engine Fuel Control System. The fuel system of the T700-GE-401 engine consists of the main fuel manifold, fuel injectors, suction fuel boost pump, HMU, and fuel filter. The fuel system operates in conjunction with the EECU to provide proper fuel flow to the engine during starting, acceleration, deceleration, and steady-state operation. This maintains constant power turbine speed (N_p) and provides loadsharing between engines. The HMU also has an actuator that positions the variable stator, inlet guide vanes, and the anti-icing bleed and start valve according to a predetermined schedule.

2.1.2.1 Engine Fuel System Flow. Fuel enters the engine at the low-pressure suction boost pump and then flows through passages in the accessory drive gearbox to the fuel filter. Filtered fuel then flows to the HMU.

Fuel from the HMU high-pressure pump passes through an external hose to the gearbox. From there it passes through the oil cooler and enters the ODV through passages in the gearbox.

The ODV sends fuel through the ODV manifold and the main fuel manifold to the fuel injectors for starting, acceleration, and all other engine operating conditions. The ODV also controls N_p overspeed. The N_p overspeed system receives an N_p signal from the torque and overspeed sensor. When N_p exceeds 25,000 rpm (125 percent), the EECU sends a signal to the ODV solenoid that shuts off fuel flow and reduces N_p. When N_p drops below 25,000 rpm, the EECU cuts the power to the ODV solenoid to restore fuel flow to the engine and the ignition system is activated for automatic relight.

2.1.2.2 Engine Fuel System Controls. Engine functioning is automatically controlled through the normal operating range by the EECU and HMU. Direct mechanical control inputs to the HMU are accomplished by the pilot and copilot/gunner using rotating throttles on the collective sticks. The PAS provides inputs to the HMU for setting permissible N_g speeds. An HMU LDS is mechanically connected to the collective stick. This spindle senses power requirements established by collective stick positioning and adjusts fuel flow through the HMU to reduce N_r transient droop when collective is increased. Transient droop compensation is further enhanced by a collective anticipator control motion transducer incorporated in the collective control system. The collective anticipator provides an electrical signal to the EECU that corresponds with the collective position. The EECU processes the signal to increase power based on the collective rate of change at low-power conditions (up to 9 percent indicated engine torque). This feature helps minimize rotor droop during rapid collective increases.



1. Thermocouple harness
2. Particle separator blower
3. HMU
4. ODV
5. Oil cooler
6. Chip detector
7. Oil level sight gauge
8. History recorder
9. EECU
10. Oil tank cap
11. Ignition exciter
12. Starter
13. C-Sump oil scavenge tube
14. Torque/overspeed sensor
15. Np speed sensor
16. C-Sump oil supply tube
17. Fuel pressure switch
18. Fuel filter
19. Anti-icing bleed and start valve
20. Fuel filter bypass sensor
21. Oil level sight gauge
22. Fuel boost pump
23. Oil filter bowl
24. Oil filter bypass sensor
25. Alternator stator
26. Oil pressure transmitter
27. Oil temperature detector
28. Fuel control actuator, LDS
29. Fuel control actuator, PAS

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Figure 2-1. Engine Assembly

Note

A shear pin is incorporated in the LDS linkage connection to the collective linkage. In case of a bind in the LDS linkage, the pin can be sheared to prevent binding of the collective control.

2.1.2.3 Engine Electrical Control Unit Lockout. An EECU lockout feature is incorporated in the fuel control system to enable the pilot to disable the EECU and manually control engine N_P with the throttle. EECU lockout is achieved by selecting ENG 1 or ENG 2 with the IDLE-STOP-REL switch and rotating the throttle past the normal full-open position to the mechanical linkage stop momentarily, and then rapidly retarding it to establish desired torque, MGT, or N_P.

2.1.2.4 Engine Governor Control. The pilot engine governor control panel (Figure 2-2) contains two rotating-wheel-type switches for adjusting engine N_P to be maintained by the EECU. The ENGINE RPM wheel selects the governor setting for both engines simultaneously in the range of 97 ±0.5 to 103 ±0.5 percent. The ENG 2 TRIM wheel provides a secondary governor adjustment for the No. 2 engine to facilitate manual adjustment of loadsharing. This enables the pilot to synchronize engine torque when the EECU torque sharing tolerance permits a torque split.

2.1.3 Air Induction System. Air enters the engine compartment through intake ducts located on each side of the transmission cowling. Bellmouth assemblies connect the engines to the intake ducts. Air enters the engine from the bellmouth through the engine swirl frame. Swirl vanes create a rotating or swirling motion of the incoming air. This action separates foreign particles from the incoming air by centrifugal action. These particles are then drawn by a blower and exhausted through a discharge duct. The clean air that remains after particle separation is carried to the deswirl vanes, which straighten the flow of air before it enters the compressor.

2.1.4 Engine Anti-Ice System. The anti-icing system prevents ice formation in the flowpath of engine inlet air. Engine anti-icing is provided by an electrically heated bellmouth, installed between each engine and the intake ducts, and hot axial compressor discharge bleed air flowing through the swirl and inlet guide vanes. In addition, hot scavenge oil flowing through internal passages in the scroll vanes provides continuous engine anti-icing. Control for the heated bellmouth and engine anti-ice bleed air valve is provided by the ANTI-ICE ENG 1 and ENG 2 switches on the pilot engine control panel (Figure 2-2). A 6-second time delay relay is incorporated in the ANTI-ICE ENG 2 switching circuit to prevent engine oscillations that occur when the anti-ice bleed air valves open simultaneously. Two advisory lights (Figure 2-3) labeled ANTI-ICE ON illuminate when the ANTI-ICE switch is set to ON and the bleed air valve has opened. Two caution lights labeled INLET ANTI-ICE illuminate if a malfunction occurs in the heated bellmouth system (inlet heater selected but not heating properly). Circuit protection is provided by the ENG No. 1 and ENG No. 2 ANTI-ICE and INLET HTR CONT/PWR dc circuit breakers (Figure 2-2).

Note

The anti-ice bleed air valve is electrically held in the closed position when the ANTI-ICE switch is set to OFF; therefore, if 28-vdc power is lost or the ANTI-ICE circuit breakers are pulled/popped out, engine anti-icing bleed air heat will be on.

2.1.5 Engine Start System. The engine starting system consists of one starter for each engine, two batteries, and a three-position engine start switch located on the pilot collective switch box. The switch (Figure 2-2) is labeled START ENG 1 and ENG 2. When set to either position, the starter and ignition circuits for the respective engine are activated. However, the ignition circuit will not be activated unless the ENGINE WASH switch is in the NORMAL start position (cover down) and the respective engine ENG FUEL switch is ON. The START switch is magnetically held in the desired position and automatically resets to the center position upon completion of the start cycle. With the START switch engaged, the battery start time-delay relay connects the batteries in series after 6 seconds to provide 48 volts to the selected engine starter. After the starter drops out or the START switch is disengaged, the circuit reverts to parallel. Power to the switch is supplied by the 28-vdc bus, and circuit protection is provided by the ENG NO. 1 and ENG NO. 2 START circuit breakers.

The engine wash switch (Figure 2-2) is used to disable fuel and ignition electrical circuits during engine wash cycles. In WASH position these circuits are disabled so wash procedures are efficient and damage to engine components will not occur.

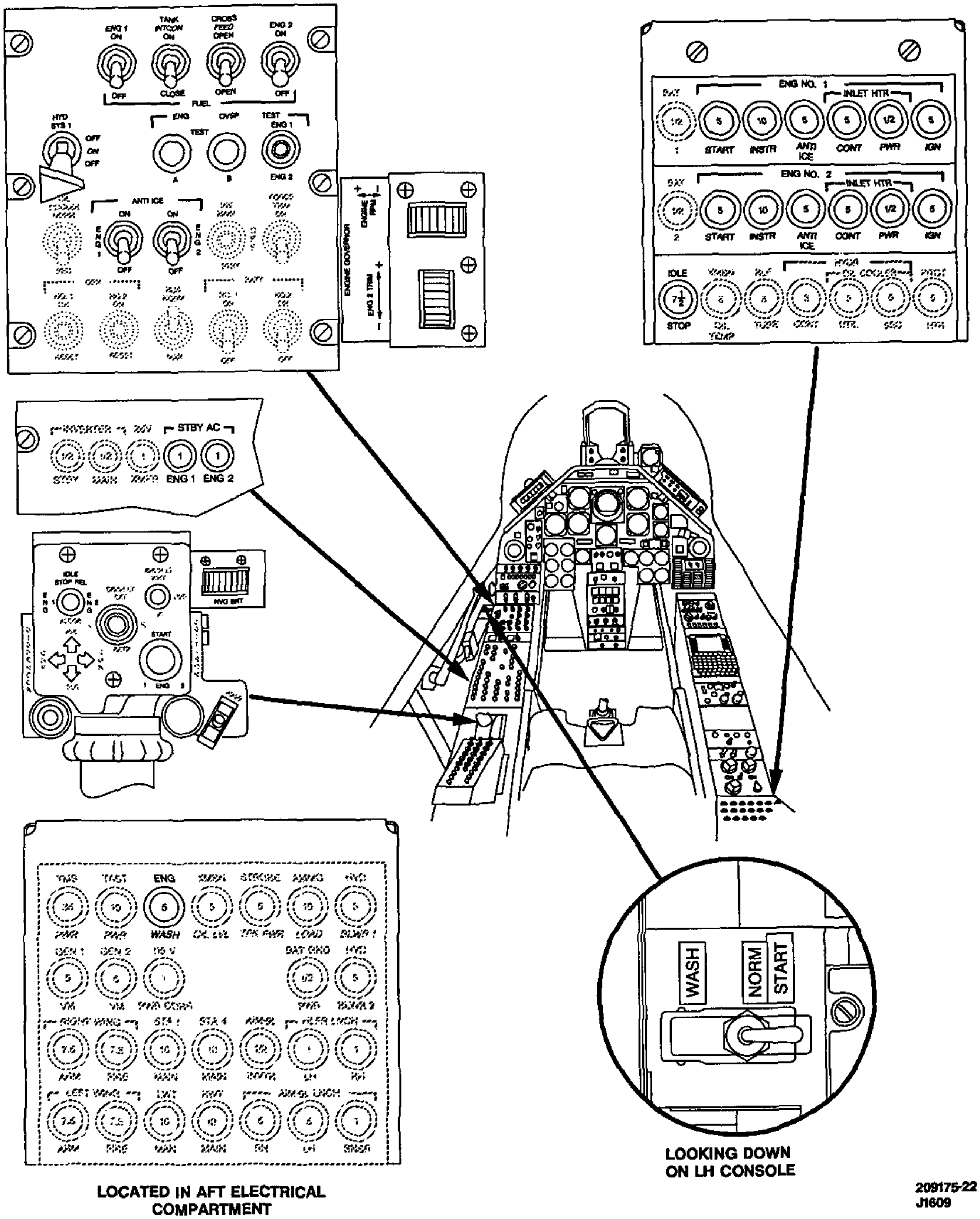

Figure 2-2. Engine Controls

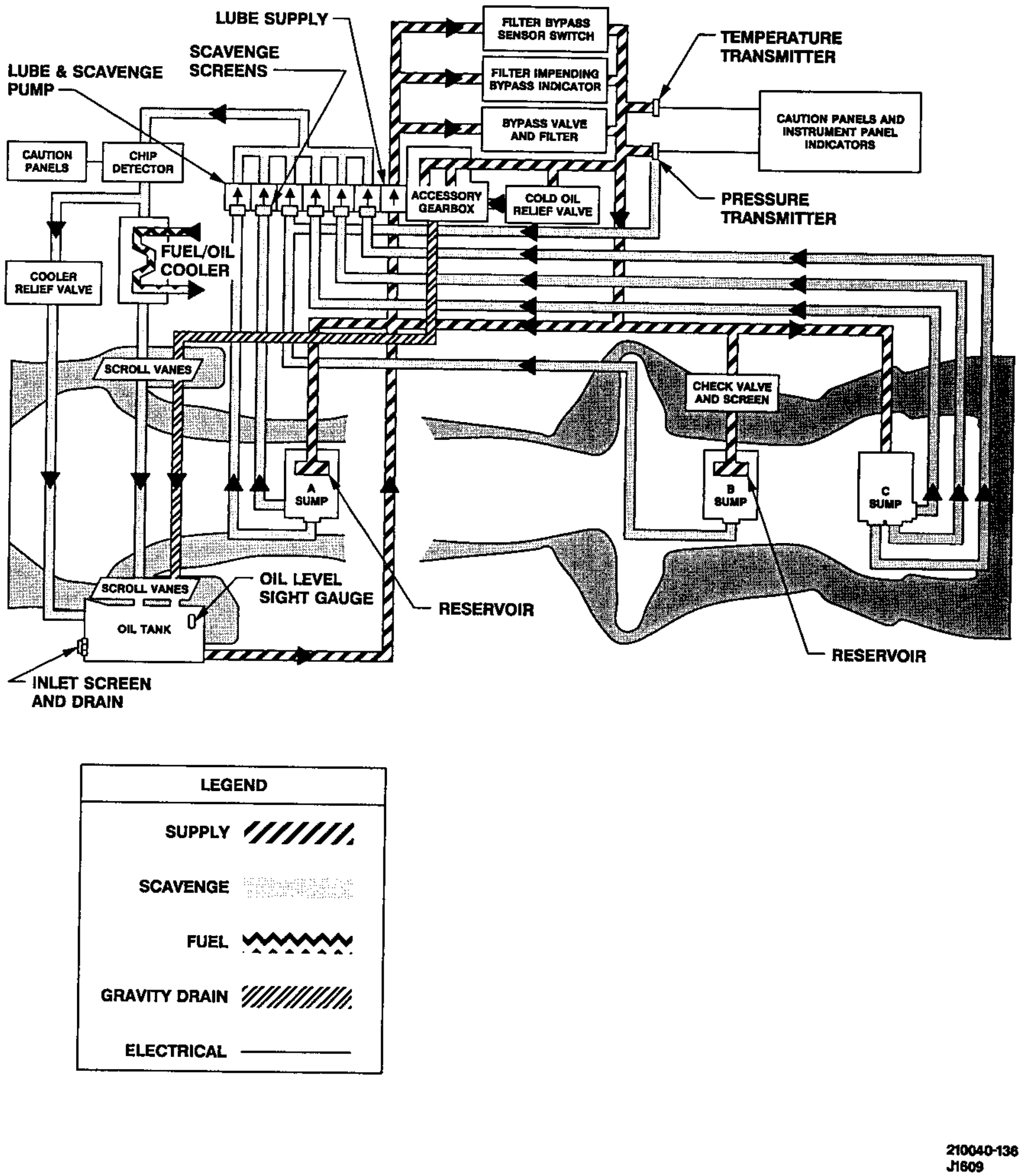

Figure 2-3. Engine Oil

NORM START is the position for engine start or run.

Note

Ignition circuit will not be activated unless the engine WASH switch is in the NORM START position.

2.1.6 Engine Ignition System. The ignition system is an ac-powered, capacitor-discharge system. The system includes a dual exciter unit, mounted on the right side, and two igniter plugs. During start, the ignition circuit is interfaced with the starting system and deenergized at the starter dropout speed.

2.1.7 Overspeed Protection System. The overspeed protection system protects the power turbine from destructive overspeed. The system includes a manual test feature. This feature allows the pilot to check system operation.

A solenoid operated ODV, two EECU overspeed sensors, and an automatic relight feature for each engine provides overspeed protection. The sensors trip between 123.75 and 126.25 percent N_p. When N_p exceeds the trip setting on both sensors, the ODV will stop fuel to the engine. Fuel flow will occur when N_p decreases below the sensor trip setting.

Note

The overspeed protection system will cycle around the trip setting until N_p is brought under control.

The overspeed test feature has an engine select switch and two test switches. The switches are located on the engine control panel (Figure 2-2). The test switches are used to perform sensing circuit check and overspeed system check.

Occasionally during the N_p overspeed test, an engine may not relight immediately and the N_g rolls back to a sub-idle (less than 67 percent) condition. If the engine then relights, recovery back to the pretest N_g speed will be slower because of lack of starter assist. In the event the engine does not relight or relights below normal ground idle speed, an engine shutdown may be necessary to prevent exceeding MGT limits. If this action is required, restart the engine and continue operational checks. It is not necessary to repeat the overspeed test.

2.1.7.1 Sensing Circuit Check. The sensing circuit check tests the operation of individual sensing circuits on the selected engine. Pressing TEST A and TEST B switches separately with N_p at 100 percent enables this check. A decrease in N_g when either TEST A or TEST B switch is pressed indicates a malfunction in the opposite sensing circuit.

CAUTION

When a circuit malfunctions during a check, it simulates an engine overspeed condition and activates the ODV. Release the test switch immediately and shut down the engine.

2.1.7.2 Overspeed System Check. The overspeed system check tests the operation of the automatic relight feature on the selected engine. The test is performed by pressing TEST A and TEST B switches simultaneously with N_p at 100 percent. Pressing the switches reschedules the overspeed sensor trip settings between 94.75 and 97.25 percent N_p. Holding the switches for 1 second should be enough time to cause the ODV to stop fuel flow to the selected engine. A properly operating overspeed protection system is indicated by a decrease in N_g.

CAUTION

Holding the test switches in longer than necessary to observe an N_g decrease can cause an overtemperature condition during relight.

Fuel flow should resume and automatic relight should occur when one or both switches are released. A failure to relight indicates a malfunction of the automatic relight feature.

CAUTION

A rapidly decreasing N_g during relight may result in an overtemperature condition. If an overtemperature condition appears possible, shut down the engine and restart it.

2.1.8 Engine Oil System. Lubrication of the engine is accomplished through a self-contained, recirculating, dry sump system (Figure 2-3). The integral oil tank is serviced on the right side of the engine. An oil-level sight gauge is located on both sides of the oil tank. The oil is circulated through the system by a gerotor type pump. The oil from the pump is passed through a 3-micron filter that contains an impending bypass indicator button and an electrical bypass sensor to provide cockpit indication of filter bypass. An oil scavenge system removes oil from the sumps and returns it to the oil tank. The fuel-oil cooler and a chip detector are located in the oil return flow path. The fuel-oil cooler is a tube-in-shell heat exchanger attached adjacent to the fuel boost pump on the forward side of the accessory gearbox. Fuel is used as the oil coolant. Inside the cooler, fuel flows through tubes while oil flows over the tubes. Additional air cooling of the oil occurs as oil flows through the scroll vanes en route to the oil tank. The chip detector installed in the accessory gearbox magnetically attracts ferrous materials in the returning oil. When sufficient material has been attracted to bridge the conductor, an electrical circuit is completed and the applicable caution light (ENG 1 CHIP or ENG 2 CHIP) is illuminated. Oil temperature and pressure sensing devices provide indications to the ENG OIL gauge and the caution advisory panel.

2.1.9 Engine Electrical System. Electrical power to all engine electrical components is supplied by an alternator installed on the forward face, right side, of the accessory gearbox. This alternator supplies primary ac power to the ignition system, EECU, and engine history recorder. In the event of alternator failure, the helicopter inverter automatically supplies electrical power to provide N_p overspeed protection only (all other electrical functions are inoperative). This system is protected by circuit breakers in the pilot ac circuit breaker panel (Figure 2-2) labeled A/C ENG 1 and ENG 2. The EECU is a solid-state device that processes inputs from the alternator, MGT thermocouples, N_p and torque sensors, collective anticipator, N_r sensor, and the HMU. Outputs from the EECU provide signals to the MGT engine rpm (N_p) and engine torque instruments and indicators; provide temperature limiting by controlling fuel flow; accomplish engine loadsharing and torque limiting; and permit variation of N_p rpm between 97 ±0.5 and 103 ±0.5 percent. The EECU limits steady-state MGT between 902.5 and 917.5 °C and steady-state engine torque between 102 and 108 percent. The nominal setting is 910 °C and 105 percent, respectively. Additionally, the EECU provides signals to the history recorder for maintenance purposes.

2.1.10 Engine Instruments and Indicators.

2.1.10.1 Torquemeter. The torquemeter (Figure 2-4) indicates the percentage of torque that each engine is providing and the amount of combined torque being supplied to the transmission. The gauge is powered by the 28-vdc essential bus, and the circuit is protected by the ENG NO. 1 and ENG NO. 2 INSTR circuit breakers.

2.1.10.2 Measured Gas Temperature Indicators. An MGT gauge (Figure 2-4) is supplied for each engine. The gauge indicates the temperature in degrees Celsius (°C) of gas entering the power turbine. Power for the gauges is supplied by the 28-vdc essential bus, and circuit protection is provided by the ENG NO. 1 and ENG NO. 2 INSTR circuit breakers.

2.1.10.3 Engine and Rotor Tachometer. The engine and rotor triple tachometer (Figure 2-4) has two pointers on the outer scale (one for each engine) to indicate percent of N_p (ENG RPM) and a single pointer on the inner scale to indicate percent of rotor (RTR) rpm (N_r). Normal operation is indicated when all three pointers are in synchronization. Power for the indicators is provided by the 28-vdc essential bus, and the circuit is protected by the ENG NO. 1 and ENG NO. 2 INSTR circuit breakers.

2.1.10.4 Gas Producer Tachometer. Two gas producer (NG) tachometers (Figure 2-4) are installed in the pilot instrument panel and labeled ENG 1 and ENG 2 GAS PROD. The instruments receive N_g speed signals from the engine alternators. The tachometer indicates percent of gas producer (N_g) rpm. The NG tachometers are powered by the 28-vdc essential bus and protected by the ENG NO. 1 and ENG NO. 2 INSTR circuit breakers.

Note

The No. 1 and 2 GAS PROD instruments are no longer installed in the copilot/gunner instrument panel on CM helicopters.

2.1.10.5 Engine Oil Temperature and Pressure Indicators. Two engine oil temperature and pressure indicators (Figure 2-4) are installed in the pilot instrument panel. These indicators are labeled ENG OIL. There is a dual instrument for each engine. The pressure indicators (P) receive signals from pressure transmitters located on the front face of each engine accessory gearbox. The temperature indicators (T) receive signals from a temperature sensor also located on the front face of each engine accessory gearbox. The pressure is indicated in psi and temperature is indicated in °C.

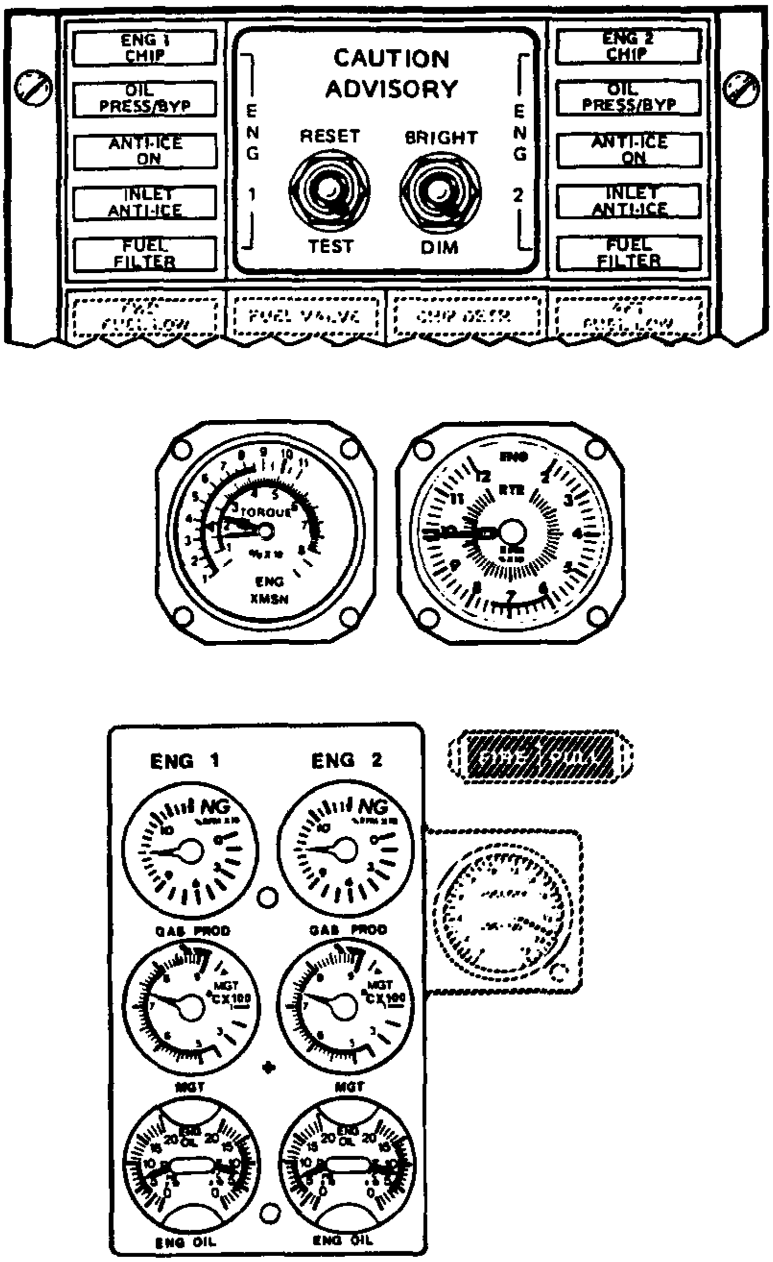

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Figure 2-4. Engine Instruments and Indicators

The pressure indicators are powered by 26 vac and protected by the OIL PRESS ENG circuit breaker. The temperature indicators are powered by the 28-vdc essential bus and protected by the ENG NO. 1 and ENG NO. 2 INSTR circuit breakers.

2.1.10.6 History Recorder. An engine history recorder (Figure 2-1) is attached to the right side of each engine. The recorders display four digital counters. Counter LCF 1 displays the number of times engine components have experienced high mechanical stress. When the engine exceeds 95 percent N_g, a count is recorded. An additional count will not be recorded until N_g drops below 40 percent and then increases to exceed 95 percent. Counter LCF 2 records the number of times the engine experiences high thermal stress. This counter advances by one increment each time N_g exceeds 95 percent. The counter will not advance again until N_g drops below 86 percent then rises to exceed 95 percent. The INDEX counter advances when MGT reaches approximately 90 percent of maximum continuous power. The index number is a function of time and temperature. As temperature increases, the counter advances more rapidly. The HOURS indicator displays engine running time. Running time is not accumulated until engine speed exceeds 50 percent N_g. Accumulation stops when speed drops below 40 percent N_g.

2.2 ROTOR SYSTEM

2.2.1 Main Rotor. The main rotor is a two-bladed, semi-rigid, seesaw-type rotor (Figure 2-5). It is preconed and underslung to optimize dynamic stability. The main rotor hub and blade assembly consists of a blade attached to each grip and spindle assembly. The grip and spindle assembly is attached to a common yoke assembly.

The grip and spindle assembly is the pitch change element and consists of oil lubricated roller bearings, elastomeric oil seals, tension torsion straps, strap pins and fittings, spindle, grip, drag brace, and pitch horn.

The yoke assembly consists of a flex beam yoke with a trunnion and elastomeric bearings mounted in the center section to form the flapping axis 90° to the pitch change axis.

A coning restraint assembly mounted on the underside of the main rotor hub restrains excessive flapping during low rotor rpm and static conditions. The assembly is passive during normal operation.

The main rotor control system consists of a swashplate mounted on a spherical surface for cyclic input, a sleeve for collective input, and scissor levers mounted on the sleeve assembly hub for mixing these motions. Pitch change links are attached between each scissor lever and rotor pitch horn for collective and cyclic control.

2.2.2 Rotor Brake. The rotor brake (Figure 2-5) is provided for stopping rotation of the main rotor after engine shutdown and preventing the rotor from turning during single-engine start. The rotor brake system consists of a rotor brake handle, connecting cable, rotor brake control unit, hydraulic lines, pucks, brake disc, pressure switch, and warning light. The rotor brake handle is located left of the pilot collective stick. The rotor brake control unit mounted forward of the transmission is controlled by a cable from the rotor brake handle. A brake disc and pucks are on each side of the main transmission. Hydraulic pressure to actuate the rotor brake is supplied from the No. 2 hydraulic system. If the No. 2 hydraulic system is not pressurized, the rotor brake may be pressurized by the hand pump.

To apply the brake with the No. 2 hydraulic system pressurized, push the detent plunger to release the handle from the downlock position and release the detent plunger and pull back on the rotor brake handle until the desired stopping rate is obtained. The ROTOR BRAKE light will illuminate to indicate pressure is being applied to the rotor brake system. When the rotor has slowed to approximately 10 percent N_r, release the rotor brake.

CAUTION

Do not move the rotor brake handle beyond the upper detent to stop a turning rotor.

Note

Brake pressure may be varied by returning the handle to the full off position and reapplying. The maximum braking pressure available decreases with a decrease in hydraulic pressure. Small rotor brake handle movements around an intermediate setting may result in erratic rotor brake response.

To apply the rotor brake for rotor hold during engine start, push the detent plunger and raise the handle above the upper detent, then release the

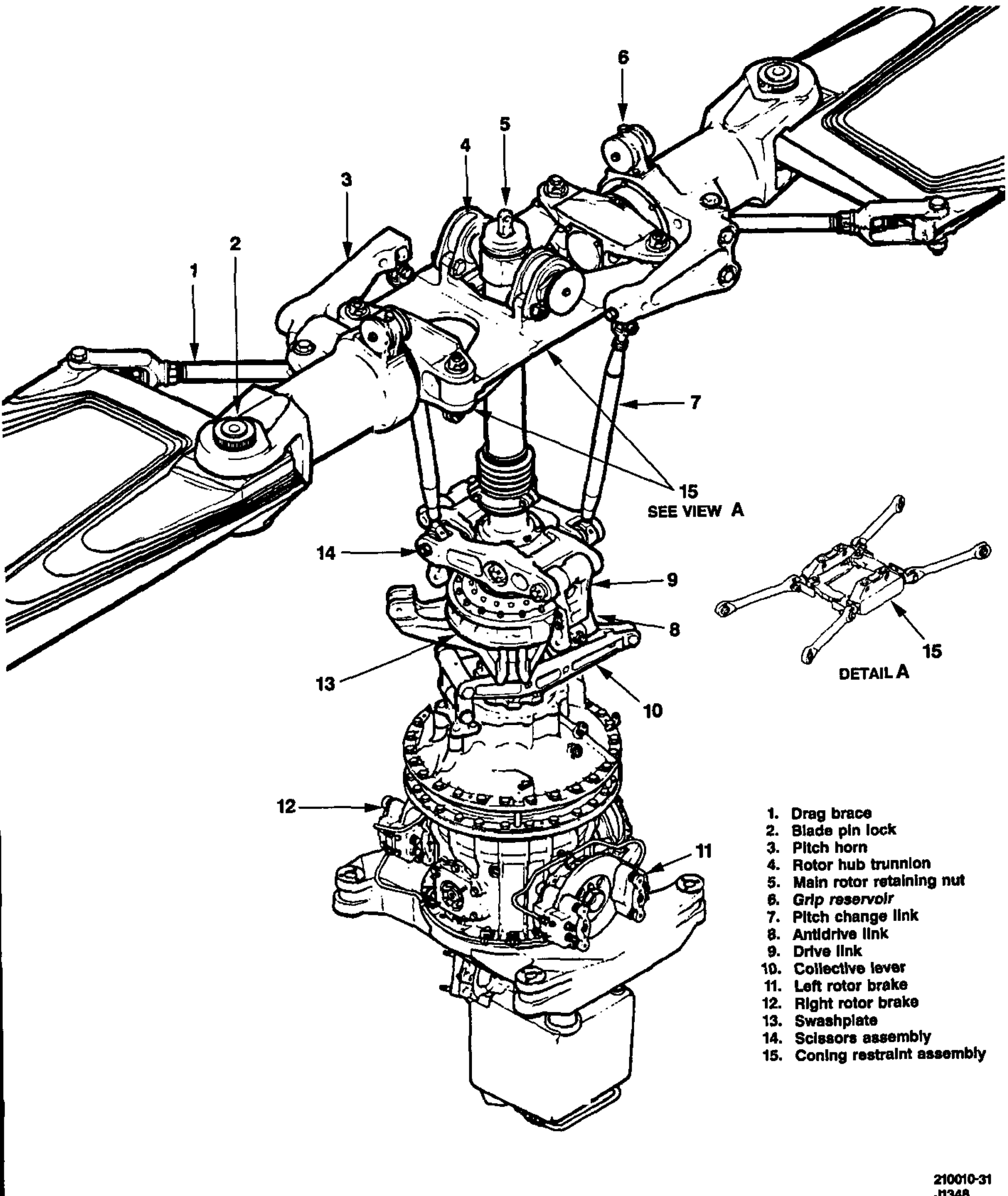

Figure 2-5. Main Rotor System

detent plunger. Pump the handle to obtain rotor brake pressure. The ROTOR BRAKE light will illuminate to indicate that pressure is being applied to the rotor brake system. Continue pumping after the light is illuminated until the handle pressure becomes stiff to ensure adequate pressure is obtained. Refer to paragraph 4.9, ROTOR BRAKE LIMITATIONS.

To release the rotor brake, push the detent plunger and place the handle against the lower stop. The rotor is free to start turning when the handle is moved slightly below the upper detent.

2.2.3 Tail Rotor. The tail rotor hub and blade assembly is a two-bladed, semi-rigid rotor with a skewed flapping axis. It is preconed and underslung to optimize dynamic stability.

The tail rotor hub and blade assembly consists of blades attached to grip plates by bolts. The grip plates are mounted on a common flex beam yoke by spherical pitch change bearings. A split trunnion is mounted on the yoke center section by needle flapping bearings.

The tail rotor controls mounted on the tail rotor gearbox and gearbox output shaft transfer pedal movement to the tail rotor blades to vary the pitch. The control tube extends through the tail rotor gearbox and is attached to the crosshead. Pitch change links connect the crosshead and pitch horns for pitch changes resulting from pedal movement. An active counterbalance system provides the ability to fly with hydraulic boost off if the requirement should occur.

2.2.4 Rotor System Instruments and Indicators.

2.2.4.1 Rotor Tachometer. The rotor tachometer (Figure 2-6) is the inner scale of the triple tachometer. A single pointer (RTR RPM) on the inner scale indicates percent of rotor rpm (N_r). Power for the rotor tachometer is provided by the 28-vdc essential bus.

2.2.4.2 Rotor Warning System. The main rotor and rotor brake are monitored by switches and sensors that interface with the warning and caution system. Warning lights and audio signals are activated when rotor rpm is high (voice only) or low (voice and tone), or the rotor brake system is pressurized (Figure 2-6).

2.2.4.2.1 RPM Warning Light. The RPM warning light located on the pilot glareshield illuminates when rotor rpm increases to 105 ±1 percent or decreases to 96 ±1 percent. The light also illuminates when the N_g of either engine decreases to 53 ±1 percent.

2.2.4.2.2 ROTOR BRAKE Warning Light. The ROTOR BRAKE warning light (Figure 2-6) illuminates when the rotor brake system is pressurized.

2.2.4.2.3 RPM and Rotor Brake Audio Warning System. The AAU provides a verbal message to the headset when the RPM or ROTOR BRAKE warning lights illuminate. The same signal that energizes the warning lights also activates the AAU. Audio may be muted by resetting either MASTER CAUTION light.

2.3 TRANSMISSION SYSTEM

The transmission system transmits power from the engines to the main rotor, tail rotor, and accessories. The system includes the main rotor transmission system; a combining gearbox; tail rotor transmission system; accessory drive pads; speed, temperature, and pressure sensors; and associated lubrication systems (Figure 2-7).

2.3.1 Main Rotor Transmission System. This system consists of main transmission, mast assembly, and main input driveshaft (Figure 2-7). The main transmission is driven by the combining gearbox through the main driveshaft. The transmission translates this power to the main rotor and tail rotor through the main rotor mast and tail rotor driveshaft, respectively. The main transmission incorporates drivepads for hydraulic systems No. 1 and No. 2 pumps, rotor brake discs, and the monopole tachometer sensor.

2.3.1.1 Main Transmission Oil System. The transmission oil system is a wet-sump type consisting of a pressure pump, oil cooler, automatic emergency oil cooler bypass valve, pressure relief and regulating valves, chip detectors, oil level sight gauge, and oil filters. Transmission oil pressure and oil temperature are displayed on the XMSN OIL gauge and monitored by the XMSN TEMP/PRESS caution light. The oil cooler bypass valve monitors the rate of oil flow to and from the oil cooler circuit. When the bypass valve detects a flow rate differential greater than 1.2 gallons per minute, the bypass valve closes and stops oil flow to the oil

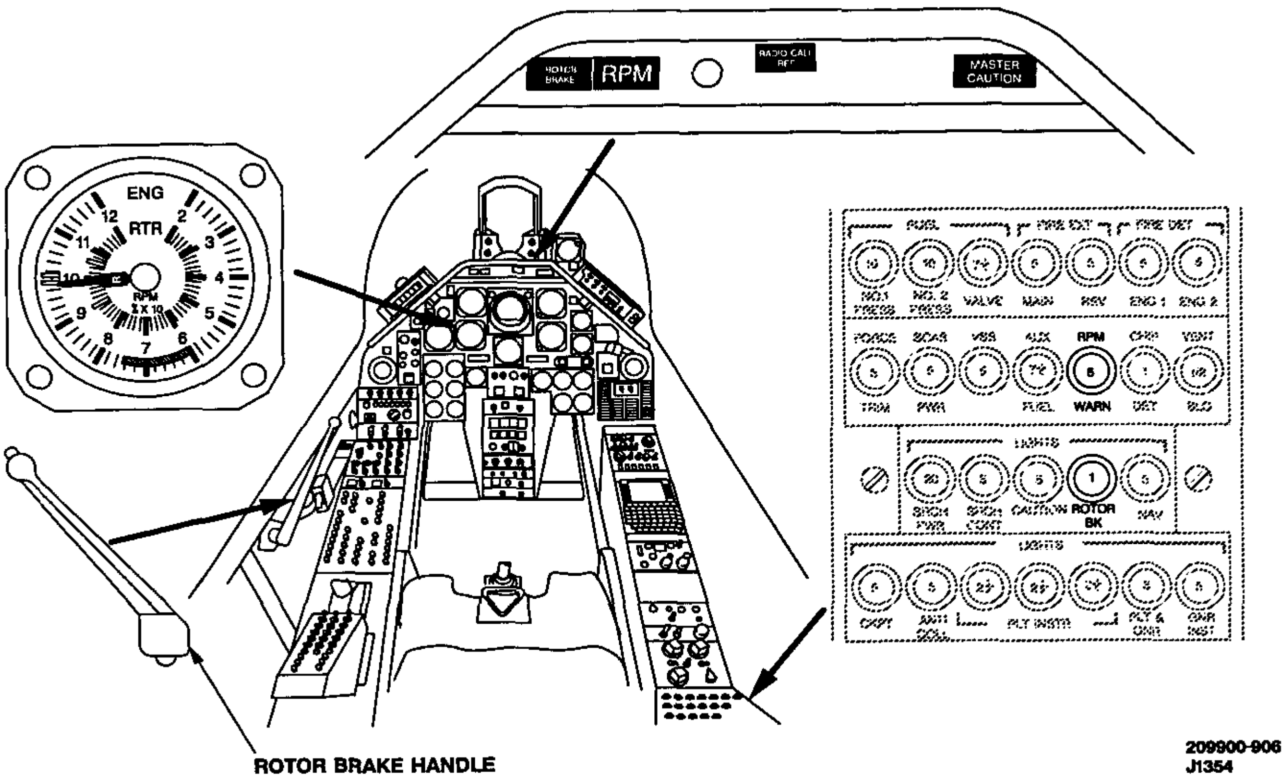

Figure 2-6. Rotor System Instruments and Indicators

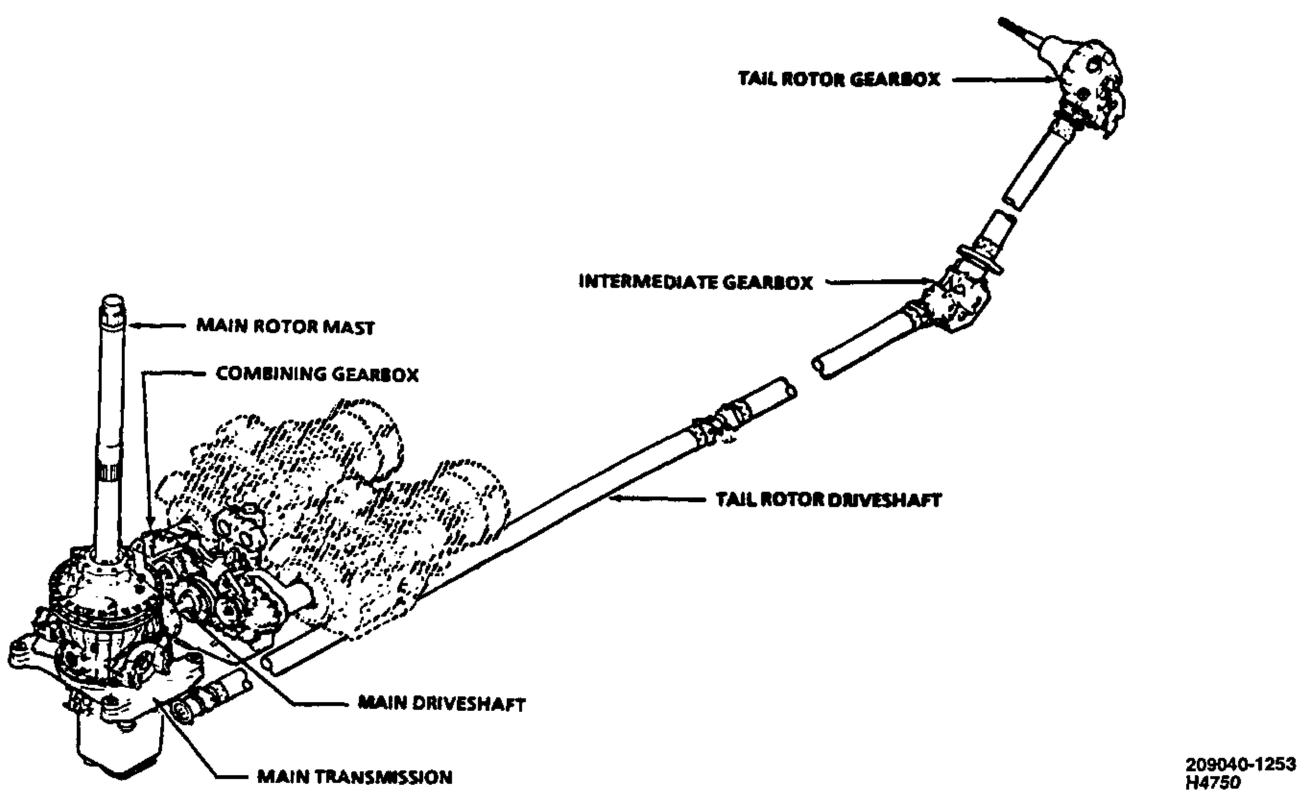

Figure 2-7. Transmission System

cooler circuit. The difference in flow rates indicates a loss of oil from the oil cooler circuit. When the bypass valve is closed, the remaining oil is recirculated within the transmission for flight to a safe landing area.

Note

If air is introduced in the oil cooler circuit when servicing or performing maintenance on the lubrication system, oil cooler bypass can occur upon initial helicopter runup. Shut down the helicopter (stop the rotor) to clear the bypass condition and perform another start.

Oil cooler bypass valve actuation is indicated by the XMSN OIL BYP caution light. Five magnetic electric chip detectors monitor oil in the system. If chips are present, the CHIP DETR caution light and XMSN segment on the GEARBOX CHIP indicator assembly will illuminate. The chip detectors are the burnoff type that are activated by pressing the illuminated XMSN segment on the GEARBOX CHIP indicator. A remote chip counter assembly records each chip detector closure as an aid to maintenance and drive system diagnostic operations. The chip counter assembly uses three separate counters to record chip detection events of the five chip detectors (i.e., one for the mast bearing chip detector, one for the two sump chip detectors, and one for the two planetary or midsection chip detectors).

Note

Burnoff chip detectors receive an electrical pulse when the illuminated XMSN segment on the GEARBOX CHIP indicator assembly is pressed. A delay of 2 seconds is required to allow recharge of the capacitor for full electrical output before subsequent burnoff attempts.

2.3.1.2 Transmission and Combining Gearbox Oil Cooler. The oil cooler consists of two heat exchangers. Both heat exchangers share cooling air supplied by a hydraulic motor-driven fan. The fan utilizes two redundant hydraulic motors coupled to the fan impeller via electromagnetic clutches. During normal operation, the primary fan motor is powered by the utility hydraulic system. If the utility hydraulic system, primary motor, or clutch is disabled, the secondary hydraulic motor, powered by hydraulic system No. 2, can be actuated to drive the fan. The oil cooler fan motor selection is controlled by the OIL COOLER switch on the engine control panel.

2.3.1.3 Oil Cooler Switch. The OIL COOLER switch is located on the engine control panel (Figure 2-8). This switch selects and controls the oil cooler fan hydraulic motors; however, the function of the switch is inactive until hydraulic pressure is present in at least one of the hydraulic systems. The NORM switch position selects the utility hydraulic system and engages the clutch of the primary hydraulic motor on the cooling fan. The SEC switch position shuts off the primary hydraulic motor by disengaging the primary clutch and activates the secondary hydraulic motor by engaging the secondary clutch. The secondary motor is powered by hydraulic system No. 2, and the VSS is disabled when the SEC position is selected. The switch circuit is protected by HYDR OIL COOLER UTIL and SEC circuit breakers.

2.3.2 Combining Gearbox. The combining gearbox is connected to the output driveshafts of the engines. Freewheeling units installed in each input drive train allow the combining gearbox to accept power from either engine or both engines. The combined power of both engines is transmitted to the main driveshaft through the combining gearbox at desired rotational speed. The gearbox drives two dc generators and the utility hydraulic system pump.

Three burnoff type chip detectors are installed. The chip detectors are monitored by the 1, 2, and SUMP segments of the GEARBOX CHIP indicator and CHIP DETR caution light on the caution advisory panel. A remote chip counter assembly records each chip detector closure as an aid to maintenance and drive system diagnostic operations.

The oil supply is contained in the gearbox sump and a sight gauge is used to check the level. Oil is circulated under pressure from the gear-driven pump through internal passages and an internal screen to oil jets. Oil from the gearbox passes through an external filter (40 micron) and external lines routed to an oil cooler below the engine deck. (Refer to paragraph 2.3.1.2, Transmission and Combining Gearbox Oil Cooler.) Oil returns from the cooler through a second external filter (3 micron) to an oil port on top of the gearbox.

During starts in cool ambient temperatures, a thermostat (bypass) valve will open to bypass the cooler until oil warms, then will close for normal flow. The oil manifold is equipped with a pressure

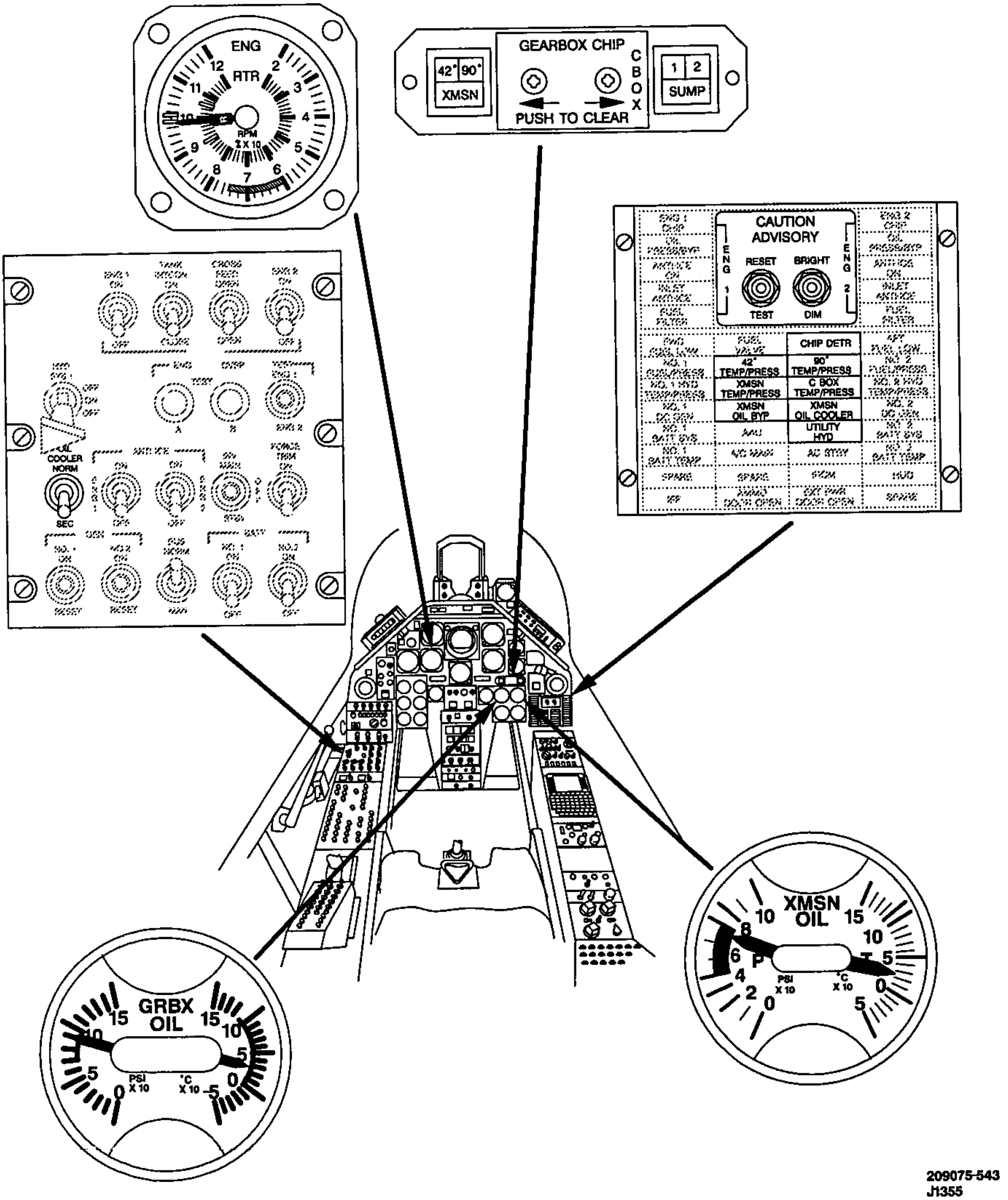

Figure 2-8. Transmission System Controls and Indicators

regulating valve and distributes oil through tubes, internal passages, and jets to lubricate bearings and gears inside the gearbox.

Oil temperature and pressure sensing is provided by a temperature bulb and a pressure transmitter. A temperature switch and a pressure switch will light the C BOX TEMP/PRESS segment on the caution advisory panel if limits are exceeded. Oil pressure and temperature indications are provided by the GRBX OIL gauge.

2.3.3 Tail Rotor Transmission System. The tail rotor transmission system consists of shaft assemblies, hanger bearing assemblies, flexible couplings, and gearboxes. Hanger bearings are installed to support the shaft sections. Grease-packed couplings are used at the main transmission output drive and on the forward side of the first hanger bearing to accommodate pylon motion and on the intermediate gearbox output drive to accommodate fin deflection. Flexible disc couplings are installed at the remaining hanger bearings, the intermediate gearbox input quill, and the tail rotor gearbox input quill to accommodate tailboom deflections. A fan is mounted on the intermediate gearbox output coupling to provide cooling for the gearbox.

2.3.3.1 Intermediate Gearbox (42°). The intermediate gearbox located at the base of the vertical fin (Figure 2-7) provides a 42° change of direction of the tail rotor driveshaft. The gearbox has a self-contained wet sump oil system. An oil level sight gauge, filler cap, magnetic electric chip detector (burnoff type), and temperature/pressure sensors are provided.

2.3.3.2 Tail Rotor Gearbox (90°). The tail rotor gearbox located at the top of the vertical fin (Figure 2-7) provides a 90° change of direction of the tail rotor driveshaft and reduces the driveshaft input speed of 4452 rpm to 1460 tail rotor rpm. The gearbox has a self-contained wet sump oil system. An oil level sight gauge, filler cap, magnetic electric chip detector (burnoff type), and temperature/ pressure sensors are provided.

2.3.4 Transmission System Instruments and Indicators. (Figure 2-8.)

2.3.4.1 Warning, Caution, and Advisory Lights. Refer to paragraph 2.11, WARNING, CAUTION, AND ADVISORY SYSTEMS.

2.3.4.2 Transmission Oil Temperature and Pressure Indicator. The transmission oil temperature and oil pressure indicator (Figure 2-8) is a dual indicator, registering temperature in degrees Celsius (°C) and pressure in psi. The indicator is located in the pilot instrument panel and marked XMSN OIL P/T. The oil pressure indicator is powered by the 26-vac essential bus and protected by the OIL PRESS TRANS circuit breaker. An electrical thermobulb transmits the oil temperature to the indicator. The temperature indicator is powered by the XMSN OIL TEMP circuit breaker. If oil pressure drops below safe limits or temperature limits are exceeded, the XMSN TEMP/PRESS caution segment illuminates.

2.3.4.3 Combining Gearbox Oil Temperature and Pressure Indicator. The combining gearbox oil temperature and pressure indicator (Figure 2-8) is a dual indicator, registering temperature in degrees Celsius and pressure in psi. The indicator is located on the pilot instrument panel and marked GRBX OIL P/T. The temperature portion receives indications from an electrical resistance bulb and the pressure portion receives its signal from the pressure transmitter. The temperature portion is powered by the 28-vdc essential bus and protected by the ENG NO. 2 INSTR circuit breaker. The pressure portion is powered by the 28-vdc essential bus and protected by the ENG NO. 1 INSTR circuit breaker. If oil pressure drops below safe limits or temperature limits are exceeded, the C BOX TEMP/PRESS caution segment illuminates.

2.4 FUEL SYSTEM

The fuel system consists of two interconnected, self-sealing, crashworthy, rubber fuel cells that provide up to .50-caliber ballistic protection, and the potential of containing fuel during a severe but survivable crash impact to reduce the possibility of fire. Each cell has a sump, drain valve, and a submerged fuel boost pump. The fuel boost pumps are controlled by the FUEL CROSS FEED switch and are automatically activated when the low fuel level switch is closed. In addition, the system has engine-driven suction pumps, fuel shutoff valves, crossfeed valves, boost pump pressure switches, fuel quantity transmitters and indicator, filters, fuel tank interconnect valve, fittings, and connecting lines. The crossfeed valve allows both engines to operate from either or both fuel cells. The fuel system is equipped for gravity and pressure refueling (Figure 2-9).

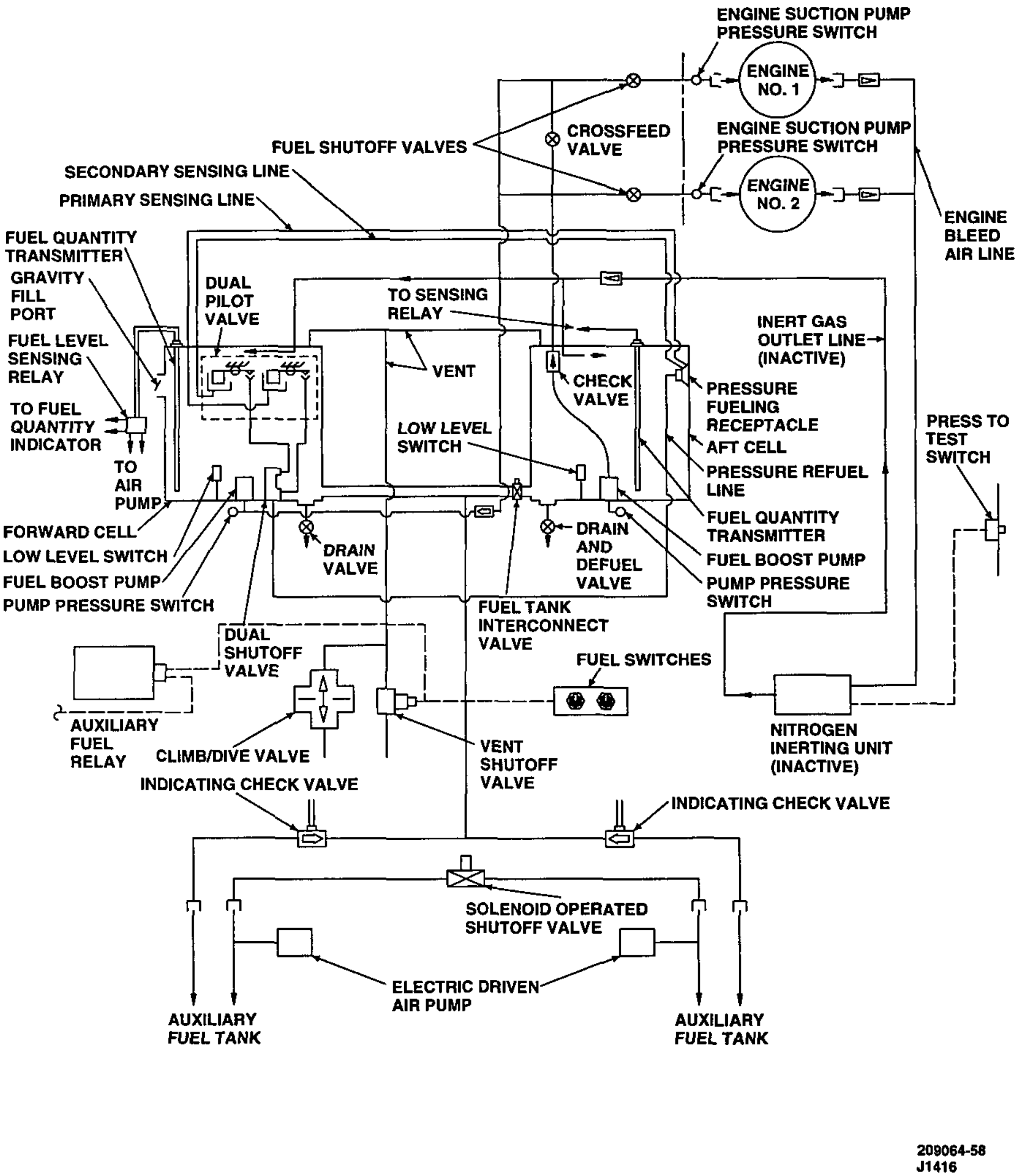

Figure 2-9. Fuel System

2.4.1 Fuel System Controls. Controls for fuel system operation are located on the pilot engine panel (Figure 2-10).

2.4.1.1 Fuel Shutoff Valve Switches. The two-position ENG 1 and ENG 2 FUEL switches control the engine fuel shutoff valves that are located on the front side of the respective engine forward firewall. The ON position opens the fuel valve and enables the engine start relay and ignition system. The fuel valve circuits are powered by the 28-vdc essential bus and protected by the FUEL VALVE circuit breaker.

2.4.1.2 Fuel Tank Interconnect Valve Switch. The FUEL TANK INTCON switch controls the valve in the fuel interconnect line between the aft and forward fuel cells. The normal position of this valve is OPEN during refueling and flight operations. The fuel interconnect valve circuits are powered by the 28-vdc essential bus and protected by the FUEL VALVE circuit breaker.

Note

- Ensure that the fuel tank interconnect valve is open during refueling. If the valve is closed, the aft fuel cell will not be serviced regardless of which fuel filler port is used.
- The interconnect valve is opened when either AUX FUEL switch is in the PUMP position, regardless of the FUEL TANK INTCON switch position.

2.4.1.3 Fuel Crossfeed Valve and Boost Pump Switch. The FUEL CROSS FEED switch controls operation of the fuel crossfeed valve and fuel cell boost pumps and opens the crossfeed valve to supply fuel from either fuel cell to both engines. The AUTO position shuts off boost pumps and closes the crossfeed valve during normal operating conditions. Fuel is then supplied by the engine-driven suction fuel pumps. The forward fuel cell supplies engine 1 and the aft cell supplies engine 2 when the crossfeed valve is closed. However, when a FUEL LOW caution light illuminates, the crossfeed valve opens and the fuel cell boost pumps are activated automatically. Refer to paragraph 2.4.2.5 for description of automatic switching feature. The crossfeed valve and boost pump circuits are powered by the 28-vdc essential bus. The crossfeed valve is protected by the FUEL VALVE circuit breaker, and the boost pump circuits are protected by FUEL NO. 1 PRESS and FUEL NO. 2 PRESS circuit breakers.

WARNING

In the event the fuel system suffers battle or crash damage with the crossfeed switch in the open position, the potential for fire increases, as the boost pumps are energized and continue to pump fuel through the system.

2.4.1.4 Fuel Filter. A fuel filter is provided for each engine and mounted on the left front side of the engine accessory gearbox. The main parts of the filter are a disposable filter element, and impending bypass indicator button, a bypass relief valve, and a differential pressure switch. Refer to paragraph 2.4.2.3 for a description of filter operation.

2.4.2 Fuel System Instrument and Indicators.

2.4.2.1 Fuel Quantity Indicator. The FUEL QTY indicator (Figure 2-10) is on the pilot instrument panel. This instrument indicates the quantity of fuel in both internal cells in pounds and is connected to fuel quantity transmitters in the forward and aft cells. Power is supplied by the 115-vac essential bus and is protected by the FUEL QTY circuit breaker.

2.4.2.2 Fuel Gauge Test Switch. A FUEL GA TEST switch is located on the pilot instrument panel (Figure 2-10). The switch provides a means of testing the fuel quantity indicator and circuit for operation. When the switch is pressed and held in, the fuel quantity indicator pointer moves from the actual quantity reading toward a lower quantity reading. Upon release of the test switch, the indicator needle will return to the actual reading.

2.4.2.3 Fuel Filter Caution Lights. Caution lights for ENG 1 FUEL FILTER and ENG 2 FUEL FILTER are located in the pilot and copilot/gunner caution advisory panel. When the fuel filter is clogged, a predetermined differential pressure across the filter is sensed by the bypass indicator. This pressure makes the indicator button pop up and opens the bypass relief valve to allow unfettered fuel to bypass the filter element. When the bypass relief valve opens, it closes a switch in the bypass sensor that turns on the respective FUEL FILTER caution

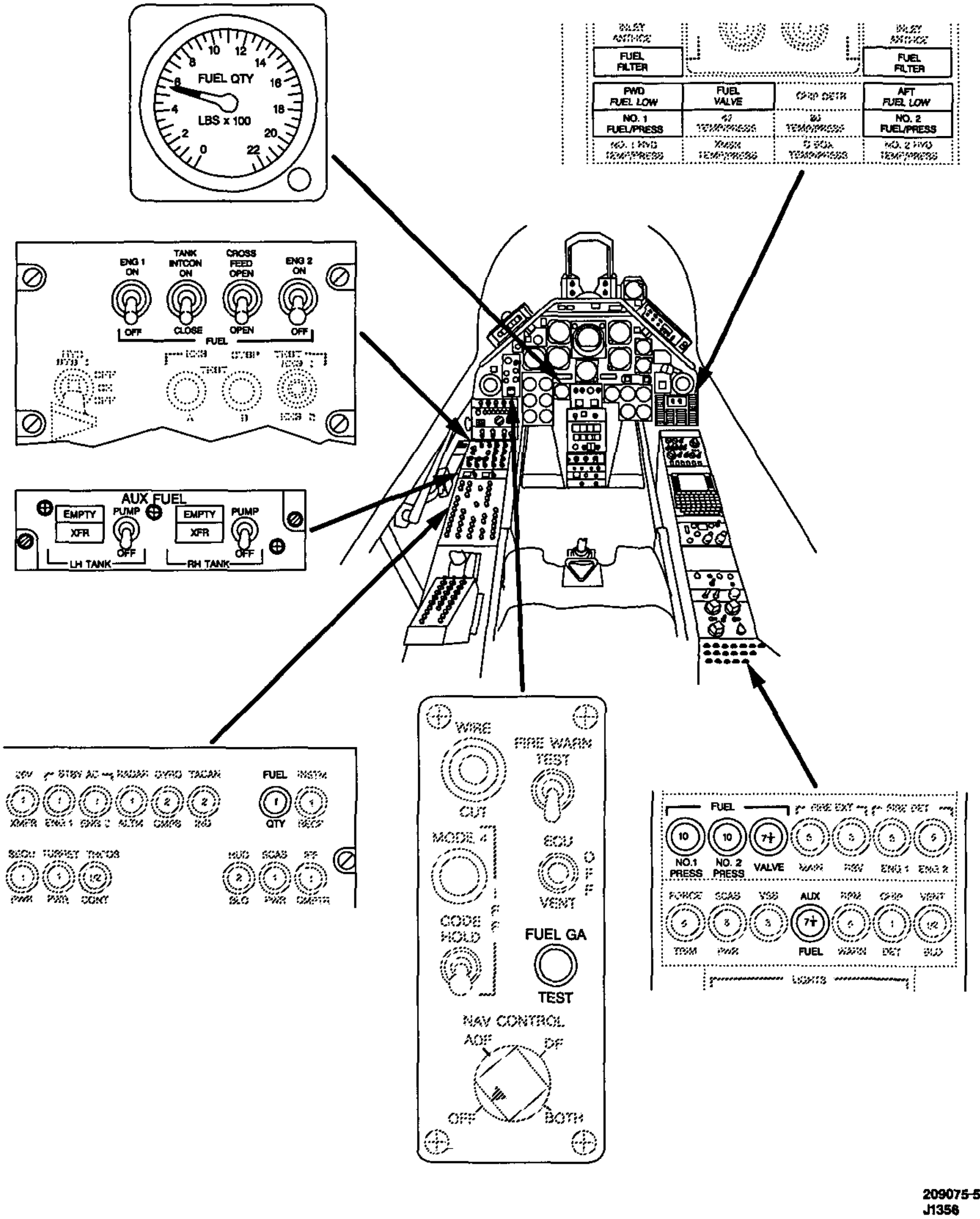

Figure 2-10. Fuel System Controls and Indicators

light. When the bypass indicator button pops up, the filter element should be changed and the button reset.

2.4.2.4 Fuel Pressure Caution Lights. Two caution lights marked NO. 1 FUEL PRESS and NO. 2 FUEL PRESS are located on the pilot caution advisory panel. If fuel pressure to an engine falls below the preset value of the fuel pump pressure switch, the applicable FUEL PRESS caution light will illuminate. The selection of fuel pressure monitoring for the fuel cell boost pumps or engine-driven suction pumps is made by the FUEL CROSS FEED switch. In the OPEN position, the NO. 1 FUEL PRESS light and NO. 2 FUEL PRESS light will monitor the forward and aft fuel cell boost pumps, respectively. In the AUTO position, the NO. 1 FUEL PRESS light and the NO. 2 FUEL PRESS light monitor the respective engine-driven suction pump unless a FUEL LOW caution light is on.

2.4.2.5 Forward and Aft Fuel Low Caution Lights. Both pilot and copilot and copilot/gunner caution advisory panels have FWD FUEL LOW and AFT FUEL LOW caution lights. Both fuel cells have a low-level switch that will illuminate the respective caution light, open the fuel crossfeed valve, and activate fuel cell boost pumps automatically when fuel in the cell reaches a low level. The quantity of fuel in each cell at the time a low-level light illuminates depends on the flight attitude. Avoid nosedown attitudes if fuel is low. At 9° nosedown (cruise) attitude with the fuel cell interconnect valve open, the AFT FUEL LOW light illuminates when 680 pounds of fuel remain and the FWD FUEL LOW light illuminates when 95 pounds remain.

WARNING

- Avoid nosedown attitudes in excess of 9° anytime the FWD FUEL LOW light illuminates to preclude the possibility of flameout.
- If AFT FUEL LOW warning light does not come on by 500 lbs. indicated, the FUEL CROSS FEED switch should be manually positioned to OPEN to prevent possible No. 2 engine flameout.

Note

- Nosedown attitudes of greater than 9° will result in an AFT FUEL LOW light at higher total fuel remaining indication.
- When fuel quantity is at or below the low fuel caution level, the boost pumps will be activated and the fuel crossfeed valve will open or remain open regardless of FUEL CROSS FEED switch position.

2.4.2.6 FUEL VALVE Caution Light. The FUEL VALVE caution light, located on the pilot caution advisory panel, monitors repositioning of the crossfeed valve and engine feed shutoff valves. When the FUEL CROSS FEED switch or FUEL ENG 1/ENG 2 switches are moved to select a different valve position (e.g., AUTO to OPEN or OFF to ON), the FUEL VALVE light illuminates momentarily as the valve is energized and changes position. The light will also illuminate momentarily when the crossfeed valve is opened automatically by the low fuel level switch or an engine feed shutoff valve closes upon pulling out a FIRE PULL handle.

2.4.3 Auxiliary Fuel System. There are two types of external auxiliary fuel tanks that may be installed at the wing stores stations: a 100-gallon capacity tank and a 77-gallon capacity tank. Empty weights of the tanks are 83 and 75 pounds, respectively. The 100-gallon tank is restricted to the outboard position of each wing. The 77-gallon tank may be loaded on the outboard, inboard, or both store positions of each wing. Refer to NWP 3.22.5-AH1 for authorized loading of wing stores.

These tanks, along with associated accessory equipment mounted on the parent rack, are used in conjunction with the controls, fuel cells (tanks), advisory lights, and fuel and air distribution valves inside the helicopter. An automatic level sensing relay in the helicopter operates the air pumps (mounted on the pylon assembly) that force fuel out of the auxiliary tanks and into the forward fuel cell (Figure 2-11).

Attaching brackets and hardware, fuel and air hoses, electrical cables, air pumps, check valves, and pressure regulators are provided to adapt the two different tanks to the parent ejector racks. The auxiliary fuel system is provisioned so that it is possible to use an air pump and a 77- or 100-gallon tank at the time of initial installation. The system is

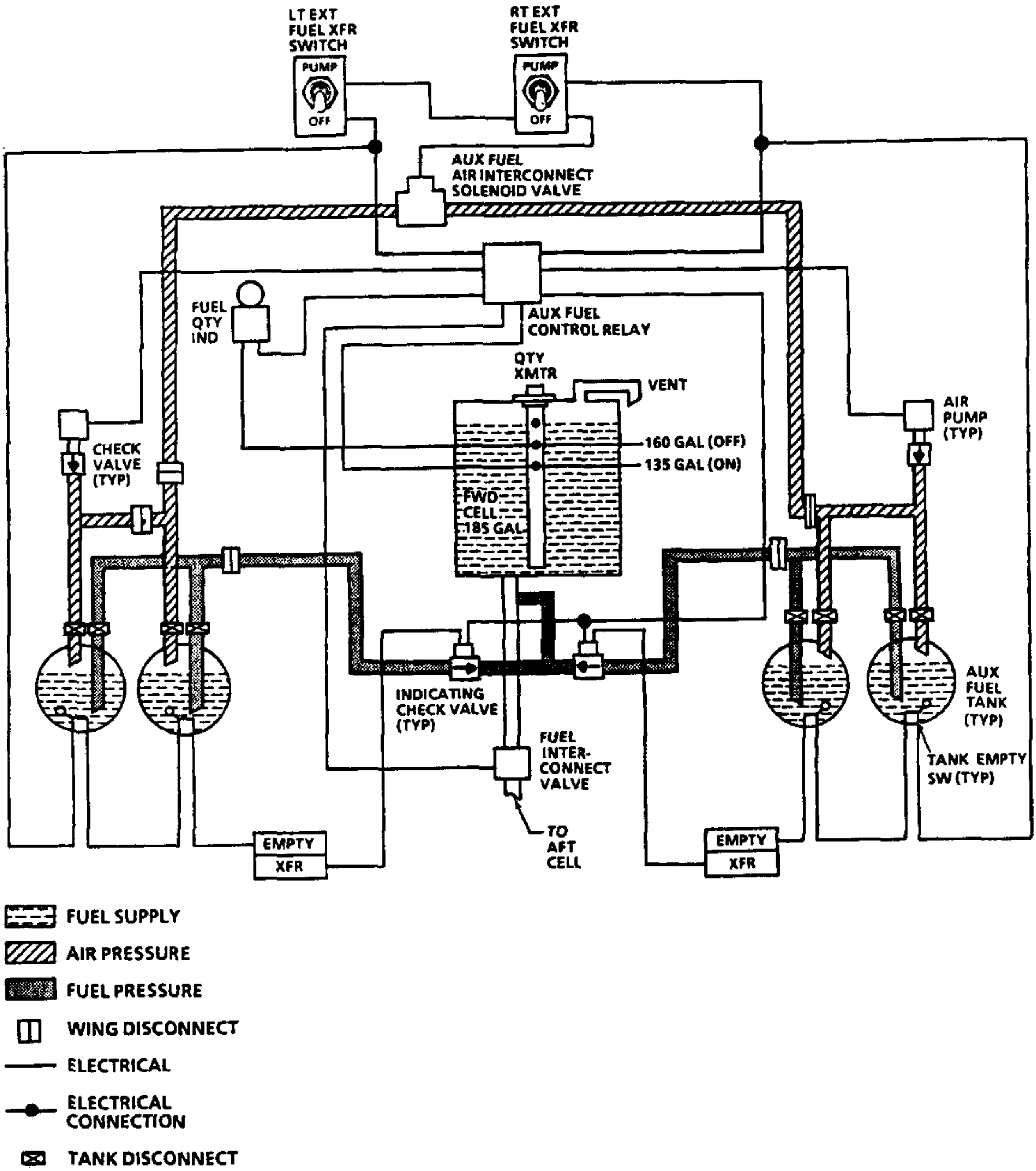

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Figure 2-11. Auxiliary Fuel System

powered by the 28-vdc essential bus, and circuit protection is provided by the AUX FUEL circuit breaker.

Auxiliary fuel tanks may be electrically jettisoned simultaneously or independently from the cockpit. Tank jettisoning is accomplished by setting the EMERGENCY JETTISON SELECT switches to 1 or 4 and pressing the JETTISON button on the collective stick. Also, the tanks are jettisoned first if wing stores at station 2 or 3 are selected to be jettisoned. The pilot or gunner may jettison tanks. A manual release lever located on the outboard side of the stores ejector rack is provided for ground operation.

A cockpit mounted AUX FUEL PUMP/OFF switch is provided for each side. The level sensing relay will energize when the AUX FUEL switch is set to PUMP and the forward fuel cell quantity is 50 gallons (340 pounds) below full (approximately 1700 pounds indicated by the FUEL QTY indicator). Auxiliary fuel will transfer from the side selected (or both when selected) to the forward fuselage fuel cell. Fuel transfer is automatically shut off when the level sensing relay deenergizes, and the forward fuel cell is 25 gallons (170 pounds) below full (approximately 1900 pounds indicated by the FUEL QTY indicator).

Note

Auxiliary fuel pumps may energize at a fuel level less than 1700 pounds.

A crossfeed system is provided in the air pressurization system so that one air pump can pressurize both sides if a failure of one pump occurs. A solenoid valve installed in the air feed line controls crossfeed. The solenoid valve opens for air crossfeed when both AUX FUEL switches are in the PUMP position.

The XFR advisory lights illuminate when fuel is flowing through an indicating check valve into the main fuel cells. EMPTY caution lights indicate when each side is empty.

2.4.3.1 TOW Activate Switch. The TOW ACTIVATE SW is a two-position (On/Off) switch located in the lower right turret area adjacent to the Ammo Boost switch. This switch will allow the helicopter to simultaneously carry and use weapons with auxiliary fuel tanks loaded on the outboard pylons of the wings.

TOW ACTIVATE SW (ON) enables the outer wing weapon pylons to articulate normally when the targeting system is active.

TOW ACTIVATE SW (OFF) disables hydraulics to the outer wing weapon pylons. This prevents any movement of the weapon pylons when the targeting system is active with auxiliary fuel tanks installed.

2.5 ELECTRICAL POWER SUPPLY SYSTEM

FO-5, FO-6, and FO-7 are schematics of the dc and ac power distribution system. Dc power is supplied by two generators, two batteries, or external power source through the external power receptacle. Ac power is supplied by the main and standby inverters, reference transformer, and the 26-vac transformer. A static inverter (dedicated to AIM-9) supplies ac power for the AIM-9 missile system.

2.5.1 Dc Power Supply System. Primary electrical power is provided through a dual-bus, 28-vdc, single-wire, negative ground arrangement. Power is supplied by two 30-volt, 400-ampere generators driven by the output section gearing of the combining gearbox. Backup electrical power and power for starting is supplied to the electrical system by two 24-volt, 34.5 ampere-hour batteries.

During normal operation, the helicopter essential and nonessential buses are powered by both generators. The system is so designed that in the event of failure of one generator, the remaining generator will supply the existing power requirements. The dual bus power distribution system allows nonessential loads to be automatically deenergized in the event both generators fail. The batteries then supply essential bus loads. The pilot may reclaim nonessential bus loads by placing the BUS switch to the MAN position. Battery charging is provided by two charger/monitors. The charger/monitors monitor battery voltage and illuminate the NO. 1 BATT SYS or NO. 2 BATT SYS caution light if cell voltage differential is sensed to be 0.5-volt (cell imbalance), battery temperature has reached 145 °F, or the charger/monitor has reached an overtemperature condition. Should any of these conditions exist, battery charging will be inhibited. When APU or generator power is sensed by the charger/monitors, the batteries are isolated from the essential bus and, depending upon state, are charged accordingly.

2.5.1.1 Dc Power Control. Dc power is controlled by switches mounted in the engine control panel (Figure 2-12). The panel contains the NO. 1 and NO. 2 GEN switches, BUS switch, and NO. 1 and NO. 2 BATT switches. Panel illumination is controlled by a rheostat switch in the lights panel. An ELEC PWR switch on the copilot/gunner miscellaneous control panel provides a means of deenergizing the complete electrical system in the event of an emergency.

WARNING

Total loss of electrical power will disable the transmission and gearbox oil cooler blower and will cause the loss of all engine, transmission, rotor, and component instruments and indicators. The gearbox oil temperature will rise very *rapidly (approximately 28 °C per minute),* and no cockpit indications will be available.

2.5.1.2 Battery. Two 24-volt, 34.5 ampere-hour batteries are installed. Each battery contains 20 individual nickel-cadmium cells that are capable of providing three start attempts without recharge. Currently the 20-cell battery is being replaced by a 19-cell, 24-volt, 35-ampere battery. The cells are enclosed in a vented, polyamide plastic case that is designed to contain the effects of battery explosion. A temperature sensor is installed in each battery case to detect battery overtemperature. Refer to paragraph 2.5.1.2.2.

2.5.1.2.1 Battery Switches. BATT NO. 1 and NO. 2 switches (Figure 2-12) are two-position (ON/OFF) switches installed in the engine control panel. Battery power is supplied to the electrical system when one or both BATT switches are in the ON position and neither generator nor external power is on line. Both switches must be ON for engine start. When the START switch is activated, the batteries initially act in parallel, then in series to provide up to 48 volts (6 seconds parallel, then series) for starting. When the starter drops off line at engine idle or the START switch is disengaged, the batteries revert to parallel operation.

2.5.1.2.2 Battery Caution Lights. The caution advisory panels (Figure 2-12) contain segments NO. 1 BATT SYS, NO. 1 BATT TEMP, NO. 2 BATT SYS, and NO. 2 BATT TEMP. The BATT SYS segments illuminate when the battery charging system has malfunctioned or a 0.5-volt differential between battery cells has been sensed. The BATT TEMP segments illuminate when an overtemperature condition occurs.

2.5.1.3 Generators. Two 30-volt, 400-ampere generators are installed on and driven by the combining gearbox. The generators share the load demand on the 28-vdc essential bus. The generators are controlled by respective switches (Figure 2-12) in the pilot engine control panel. The switches are labeled GEN NO. 1 and NO. 2. If a fault is detected in a generator, the appropriate caution light will illuminate. If the fault is corrected, the generator may be reclaimed by placing the switch to RESET and then ON. With both generators operational, the generators will operate in parallel with the batteries during the first 6 seconds of engine cross-start sending 28 volts to the start bus. After 6 seconds, battery input is removed from the start bus. A signal is sent to the generator voltage regulators allowing the generators to produce up to 40 volts. The generators will produce 40 volts until the start circuit is deenergized.

2.5.1.3.1 DCVM Switch and VOLTS DC Gauge. A DCVM switch is installed on the pilot instrument panel (Figure 2-12). This six-position, rotary switch enables the pilot to select either GEN 1, GEN 2, BATT 1, or BATT 2 output to be displayed on the VOLTS DC gauge or display of the voltage being applied to the essential or nonessential buses. Depending on the selected position of DCVM switch (ESNTL, NON ESNTL, BATT 1, BATT 2, GEN 1 or GEN 2), the VOLTS DC gauge is protected by DCVM, NON ESNTL VM, BATT 1 VM, BATT 2 VM, GEN 1 VM, or GEN 2 VM circuit breakers, respectively. During normal operation with selection of ESNTL or NON ESNTL, the VOLTS DC gauge will display 24 to 26 volts when batteries are supplying power. Selecting GEN 1 or GEN 2 will display 28 to 29 volts during normal operation and up to 40 volts during cross-starting. Selecting BATT 1 or BATT 2 will display 24 to 26 volts with generators off and no external power applied and 27 to 35 volts charge when generator or external power is applied. During battery start, selecting BATT 1 will display battery 1 voltage of 10 to 26 volts and selecting BATT 2 will display start bus voltage of 15 to 40 volts.

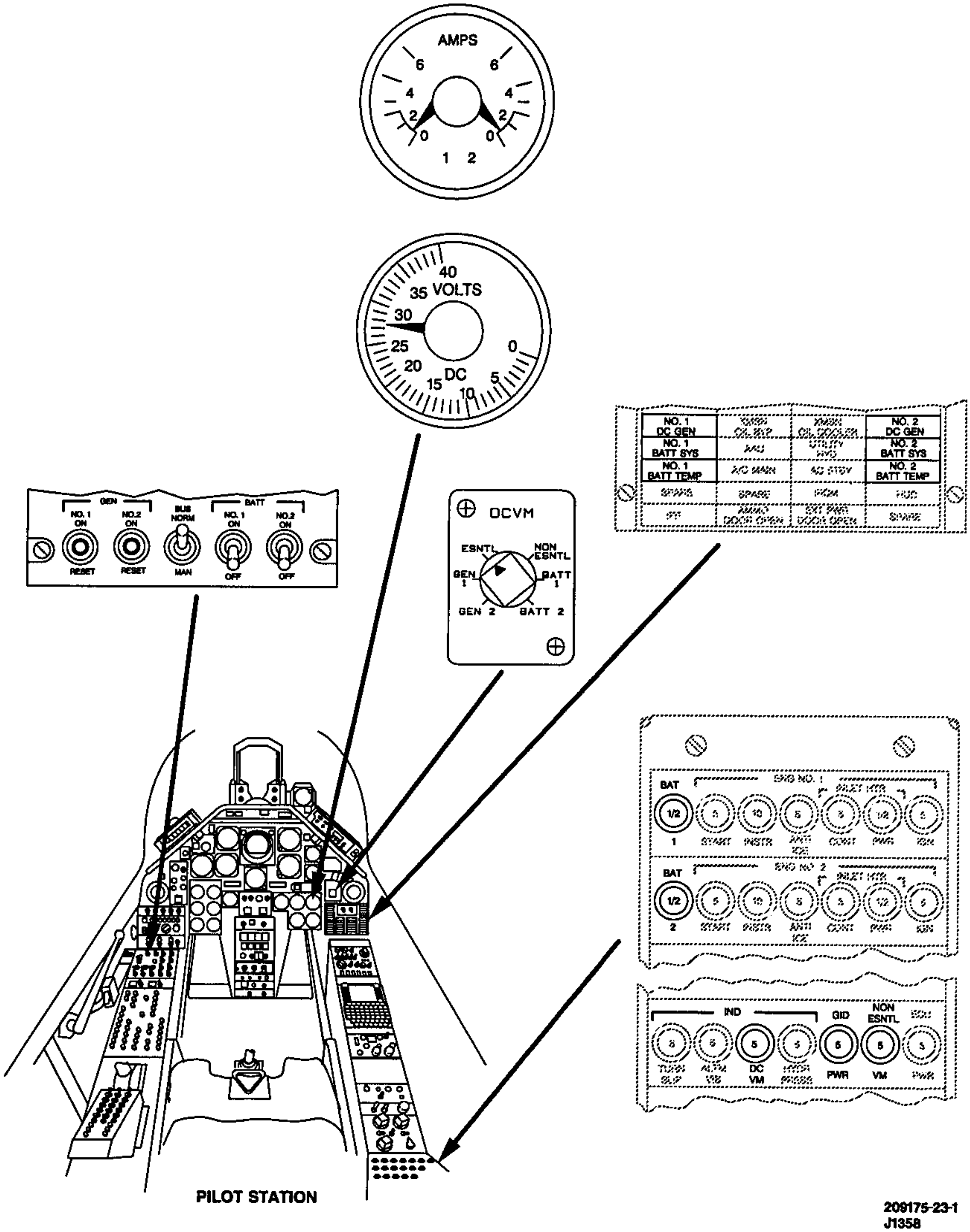


Figure 2-12. Dc Power Supply (Sheet 1 of 2)

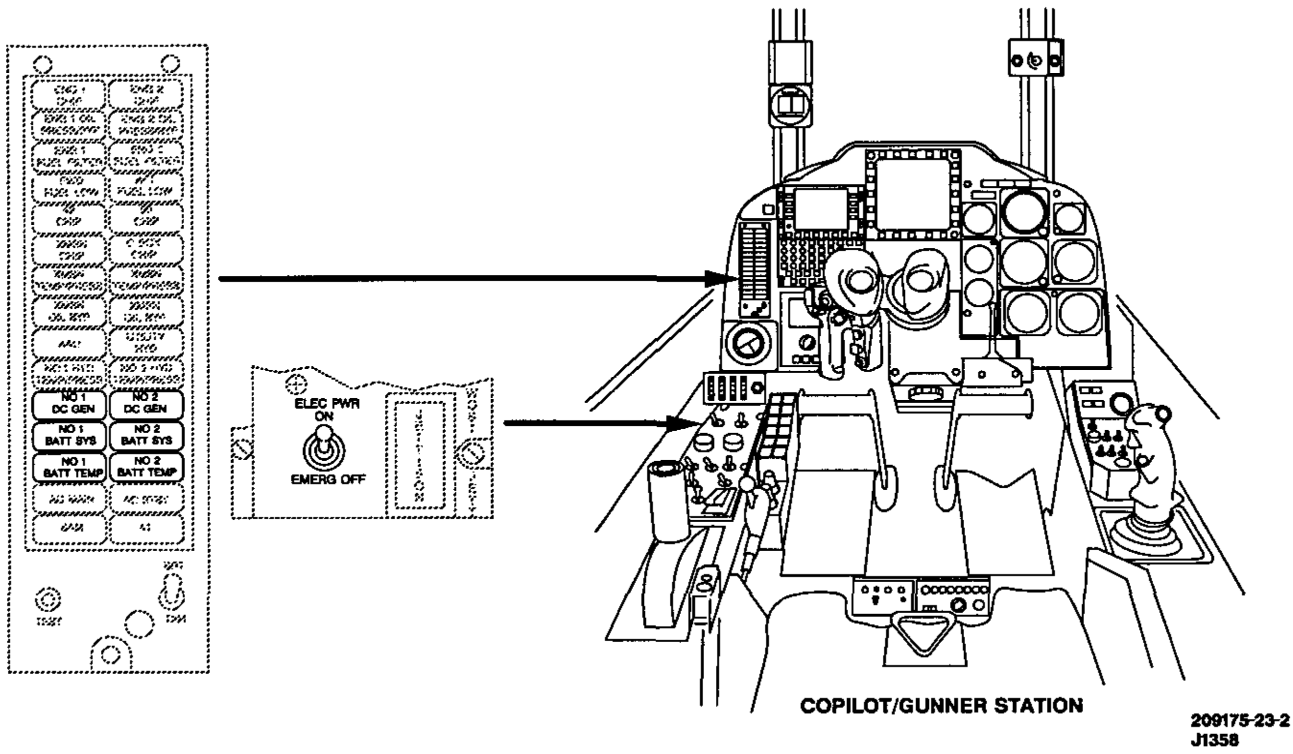


Figure 2-12. Dc Power Supply (Sheet 2 of 2)

Note

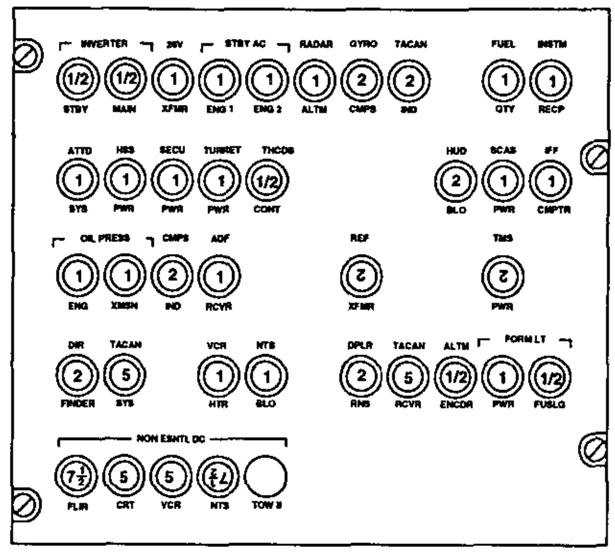
The VOLTS DC gauge will indicate battery voltage when the DCVM switch is in the BATT 1 or BATT 2 position with the battery switches ON or OFF.

2.5.1.3.2 Generator Switches NO. 1 and NO. 2. These switches are located on the pilot engine control panel (Figure 2-12). The switches are labeled GEN NO. 1 and NO. 2. During normal operations, both switches are in the ON position. The RESET position is spring-loaded to return the switch to the OFF position when released. In the event of generator failure, the respective GEN switch may be held in the RESET position momentarily and then moved to the ON position in an attempt to reclaim generator output.

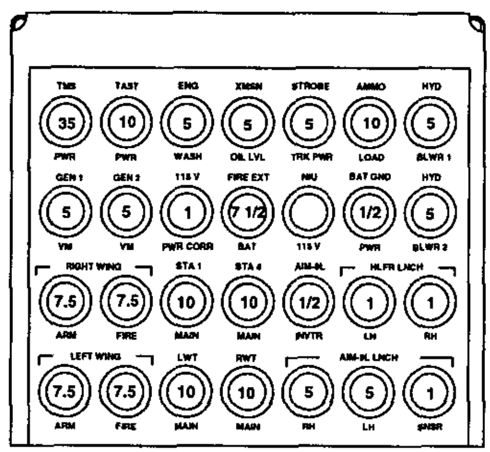
2.5.1.3.3 Generator Caution Lights. The NO. 1 DC GEN and NO. 2 GEN caution lights are located on the pilot and copilot/gunner caution advisory panels. The lights are operated by the line control relay for each generator. In the event of generator failure, the respective caution light will illuminate.

2.5.1.4 BUS Switch. The BUS switch (Figure 2-12) is located on the engine control panel. When the switch is in the NORM position, power is supplied to the 28-vdc nonessential bus provided at least one generator is operating. In the event of a dual generator failure, the nonessential bus can be reclaimed by placing the switch to the MAN position. During normal flight operations, the switch shall be in the NORM position.

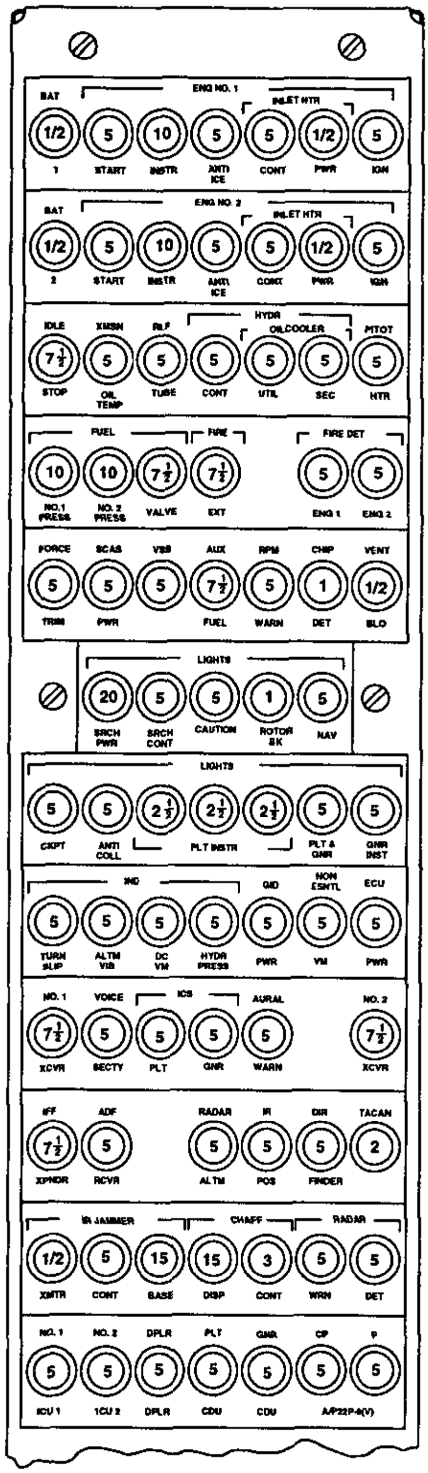
2.5.1.5 Dc Circuit Breaker Panel. The dc circuit breaker panel is located in the pilot cockpit, aft of the right console (Figure 2-13). (See FO-5, FO-6, and FO-7.) In the event a circuit is overloaded, the circuit breaker will extend, opening the circuit. The circuit is restored by pushing in the circuit breaker. In some cases, circuit breakers will protect additional circuits (items) other than as placarded.



AC PANEL



AFT ELECTRICAL COMPARTMENT
CIRCUIT BREAKER INSTALLATION



DC PANEL

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Figure 2-13. Circuit Breaker Panels

2.5.1.6 Dc Electrical System Indicators. The electrical system indicators consist of a dual ammeter and a voltmeter. The dual scale ammeter indicates amperage load on each dc generator. The voltmeter indicates voltage being supplied by the batteries or generators, and voltage being supplied to the essential or nonessential bus as selected by the DCVM switch.

2.5.1.7 Aft Electrical Compartment Circuit Breaker Installation. The aft electrical compartment circuit breaker installation is located in the aft electrical compartment (Figure 2-13). (See FO-5, FO-6, and FO-7.) Circuit breakers of the push-pull type are pushed in to energize and pulled out to deenergize the related circuits. In the event a circuit is overloaded, its circuit breaker will extend, opening the circuit. The circuit is restored by pushing in the circuit breaker. In some cases, circuit breakers will protect additional circuits (items) other than as placarded.

2.5.2 Ac Power Supply System. Ac power is provided from three sources: main inverter, standby inverter, and AIM-9 inverter. With both main and standby inverters installed and operational, two ac transformers, a reference transformer and a stepdown transformer, are fully operational to power armament, avionics, and instruments. With failure of either main or standby inverter, the reference transformer and step down transformer are automatically disconnected from nonessential ac circuits. The main inverter provides 115-vac, 1000 volt-ampere, single-phase, 400-Hz power for operating instruments and avionics equipment. The standby inverter provides 115-vac, 750 volt-ampere, three-phase, 400-Hz power for TOW and HELLFIRE missile system operation and emergency (standby) ac power.

Power from the inverters is distributed by a dual bus system so that nonessential ac loads are automatically dropped in the event of main inverter failure, and essential bus loads are transferred to one phase of the standby inverter. Overload protection is provided by the INVERTER MAIN/STBY circuit breakers located in the ac circuit breaker panel (Figure 2-14). (See FO-5, FO-6, and FO-7.)

The reference transformer converts or steps down 115-vac essential bus power to ac voltage settings required for operation of armament systems, the helmet sight subsystem, and the attitude indicators. Circuit protection is provided by the REF XFMR circuit breaker.

The 26-vac transformer steps down 115-vac essential bus power to 26-vac power that is supplied to the 26-vac essential and nonessential bus. Circuit protection is provided by the 26V XFMR circuit breaker.

Ac power for the AIM-9 missile system is provided by an AIM-9 inverter and protected by the AIM-9 circuit breaker. (Refer to Chapter 20.)

2.5.2.1 Inverters Switch. The three-position INV switch labeled MAIN/OFF/STBY is located on the pilot engine control panel (Figure 2-14). (See FO-5, FO-6, and FO-7.) In the MAIN position, the main inverter is on if electrical power is being supplied to the essential bus. In the OFF position, both inverters are off. In the STBY position, the standby inverter is on. Under normal conditions the switch is in MAIN. The standby inverter is also operational with the INV switch in MAIN when the MASTER ARM switch is in STBY or ARM position. When the main inverter is not operating, the 26-vac nonessential bus and the 115-vac nonessential bus are deenergized.

2.5.2.2 Inverter Caution Lights. The caution lights AC MAIN and AC STBY are located on the pilot and copilot/gunner caution advisory panels. The appropriate caution light illuminates when ac power from an inverter to the ac essential bus is lost.

2.5.2.3 Ac Circuit Breaker Panel. The ac circuit breaker panel is located on the pilot left console (Figure 2-14). (See FO-5, FO-6, and FO-7.) Circuit breakers of the push-pull type are pushed in to energize and pulled out to deenergize the related circuits. In the event of a current overload, the related system circuit breaker will be forced up (open).

2.5.3 External Power Receptacle. The external power receptacle (Figure 1-1) is located on the left side of the fuselage. When a 28-vdc APU is connected to the receptacle, the external power relay in the electrical power is supplied to the primary bus. When the external door is opened, the EXT PWR DOOR OPEN caution light will illuminate on the pilot caution advisory panel. A voltage sensor is provided in the electrical compartment that prevents the external power from being supplied to the helicopter bus if the APU is not set within the limits of 26 to 29 vdc. The sensor will automatically disconnect the helicopter bus from APU if voltage moves out of limits or excessive transients are present.

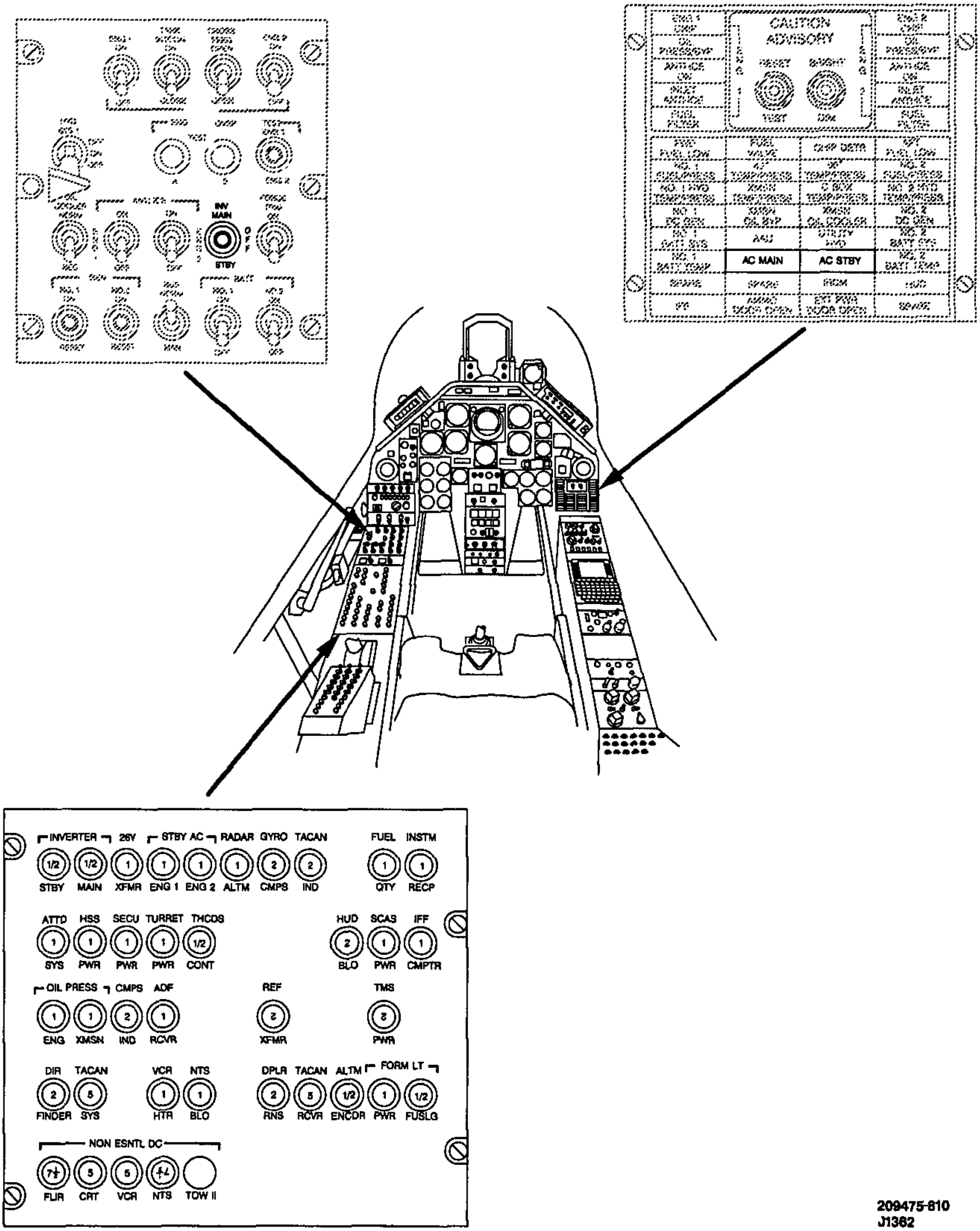

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Figure 2-14. Ac Power Supply

2.5.4 Exterior Lights.

2.5.4.1 Navigation Lights. The navigation lights (Figure 2-15) are controlled from the lights control panel (Figure 2-16). Two switches marked FLASH-OFF-STEADY and BRT-DIM are provided for control of the navigation lights. Power is supplied by the 28-vdc essential bus and protected by the LIGHTS NAV circuit breaker.

Note

Navigation light controls are located at both crew stations and will override either station selection as required. However, copilot/gunner cannot secure lights when pilot has selected FLASH/STEADY.

2.5.4.1.1 Infrared Position Lights. Four white infrared (IR) NVG compatible position lights (Figure 2-15) are mounted on the helicopter. One light is mounted on each wing pylon aft of the NAV light. Another light is mounted on top of each fairing located on either side of the aft tailboom. The IR position lights are protected by the IR POS circuit breaker located on the dc circuit breaker panel. The IR position lights are operated by an IR POSITION rotary switch located on the LIGHTS control panel (Figure 2-16) in the pilot right console. When the knob is rotated from OFF, required light brightness is selected by numbers from 1 to 5 increasing light intensity as larger numbers are selected. Number 5 is the brightest position. The IR position lights are powered by 28-vdc essential bus and are protected by the IR POS circuit breaker.

2.5.4.1.2 Infrared Light Beacon Ring. The IR light beacon ring assembly (Figure 2-15) consists of 10 infrared light emitting diode illuminators located beneath the top anticollision light. The IR light beacon ring is powered by an electronics unit located in the aft transmission area below the anticollision light. Control of the IR light beacon ring is accomplished by the six-position IR POSITION rotary switch (OFF-1-2-3-4-5) located on the pilot LIGHTS control panel (Figure 2-16) in the pilot right console. Selection from OFF to 1 through 5 will illuminate the IR light beacon ring simultaneously with the IR position lights from dim to bright, position 5 being the brightest. The IR light beacon ring system is powered by essential bus 28-vdc through the IR POS circuit breaker. When selected ON (position 1 through 5) the IR light beacon ring will flash at approximately 50 cycles per minute.

2.5.4.2 Anticollision Light. An anticollision light is mounted on top of the engine cowl (Figure 2-15). The light is controlled by the pilot ANTI-COLL LT switch and/or copilot/gunner ANTI COLL LT switch (Figure 2-16). The switches are electrically latched in the ON position one at a time, such that energizing either switch deenergizes the other. For example, if the pilot switch is positioned to ON, the light will operate, but if the gunner wishes to turn the system off, he must position the gunner switch to ON then OFF. When the gunner positions his switch to ON, the pilot switch will automatically return to OFF. Electrical power for the light and switches is supplied from the 28-vdc essential bus and protected by the LIGHTS ANTI COLL circuit breaker.

2.5.4.3 Fuselage Formation Lights. The fuselage formation lights (Figure 2-15) consist of seven green lights. Lights are located on the tail rotor gearbox, pylon fairing, and on the top of each wing tip fairing. Additionally, a self-powered rotor tip light is located on the top surface of each main rotor blade tip assembly. The rotor tip lights are not controllable; however, covers are provided for masking the light if required.

Note

The rotor tip lights contain a gaseous radioisotope, tritium (H_3). Care shall be exercised when handling these self-powered devices to minimize the possibility of cracking or breaking the container.

The lights (except rotor tip) are controlled from the lights panel (Figure 2-16). The FUSELAGE FORMATION switch provides for turning the formation lights on and varying the brightness from OFF to BRT. Power is supplied by the 115-vac nonessential bus and protected by the FORM LT PWR and FUS circuit breakers.

2.5.4.4 Searchlight. The controllable searchlight is located in the bottom fuselage section beneath the copilot/gunner station. Control switches are provided for the pilot and copilot/gunner. The pilot control switches are located on the collective stick switch box (Figure 2-16). The switches are marked SRCH LT-EXT/RET/L/R and SRCH LT-ON/OFF/STOW.

The copilot/gunner switches are located on the miscellaneous control panel. The switches are marked SRCH LT, ON-OFF and EXT-RETR. The copilot/gunner does not have the capability to rotate the light right or left. Power is supplied by the 28-vdc essential bus and protected by the LIGHTS SRCH PWR and SRCH CONT circuit breakers.

An IR filter may be installed over the searchlight lamp by maintenance personnel before a night vision goggle flight. The IR filter can only be installed or removed by groundcrew.

2.5.4.5 Dual Light Searchlight. The dual light searchlight is located in the bottom fuselage section beneath the copilot/gunner station. The searchlight is a controllable, dual light assembly with a white light on one side and IR light on the other. Control switches are provided for the pilot and copilot/gunner. The pilot control switches are located on the collective stick switch box (Figure 2-16). One switch is a three-position switch marked SRCHLT-WHT/OFF/IR and controls illumination in either IR or white light. The other switch is a four-position switch marked SRCHLT, EXT/R/L/RETR and controls right and left direction of the searchlight beam and extends or retracts the light assembly.

CAUTION

Do not illuminate the IR light with the light assembly fully retracted.

The copilot/gunner searchlight switches are located on the miscellaneous control panel (Figure 2-16). A two-position switch marked SRCHLT-ON/OFF turns the searchlight on or off. A second two-position switch marked EXT/RETR-STOW extends or retracts the light assembly. The copilot/gunner does not have the capability to rotate the light right or left or to operate the IR light. Power is supplied by the 28-vdc essential bus and protected by the LIGHTS SRCH PWR and SRCH CONT circuit breakers.

2.5.5 Interior Lights.

2.5.5.1 Map Lights. The pilot and copilot/gunner map lights are located on the side armored seat panels (Figure 2-16). Rheostat operating switches for the lights are mounted on the light assembly body. Brightness is controlled by operation of the rheostat. The rheostat is also the ON-OFF switch for the light assembly. Power is supplied by the 28-vdc essential bus and protected by the LIGHTS CKPT circuit breaker.

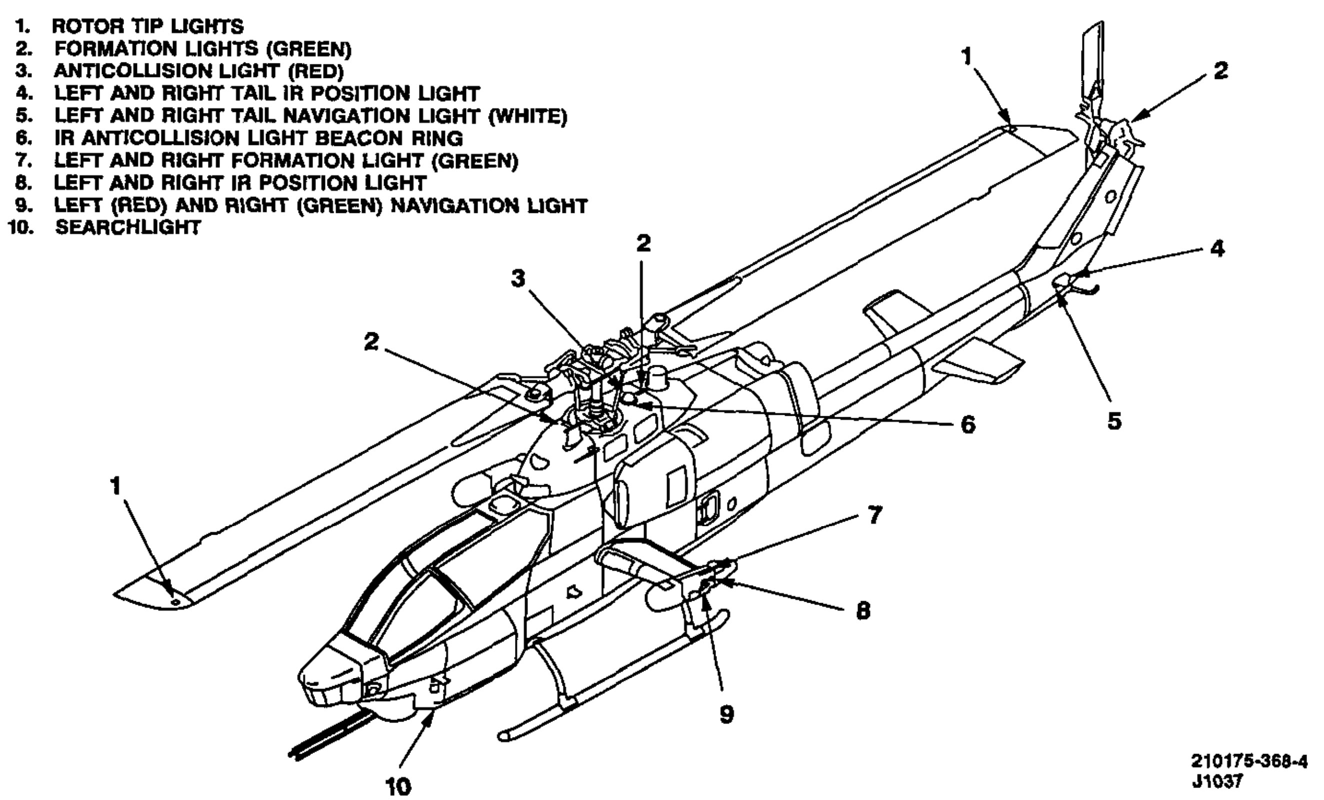

Figure 2-15. Exterior Lights

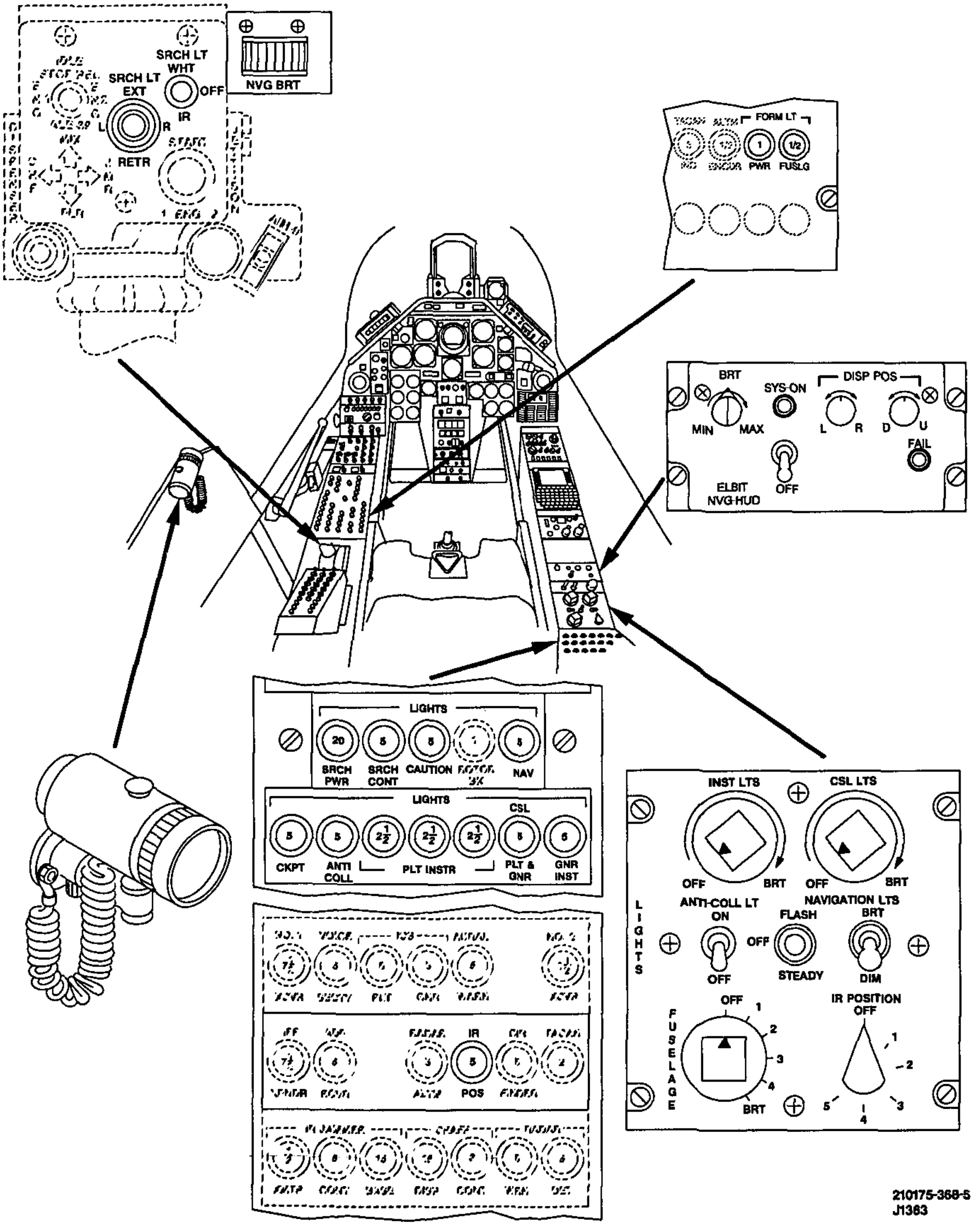

Figure 2-16. Exterior and Interior Light Controls (Sheet 1 of 2)

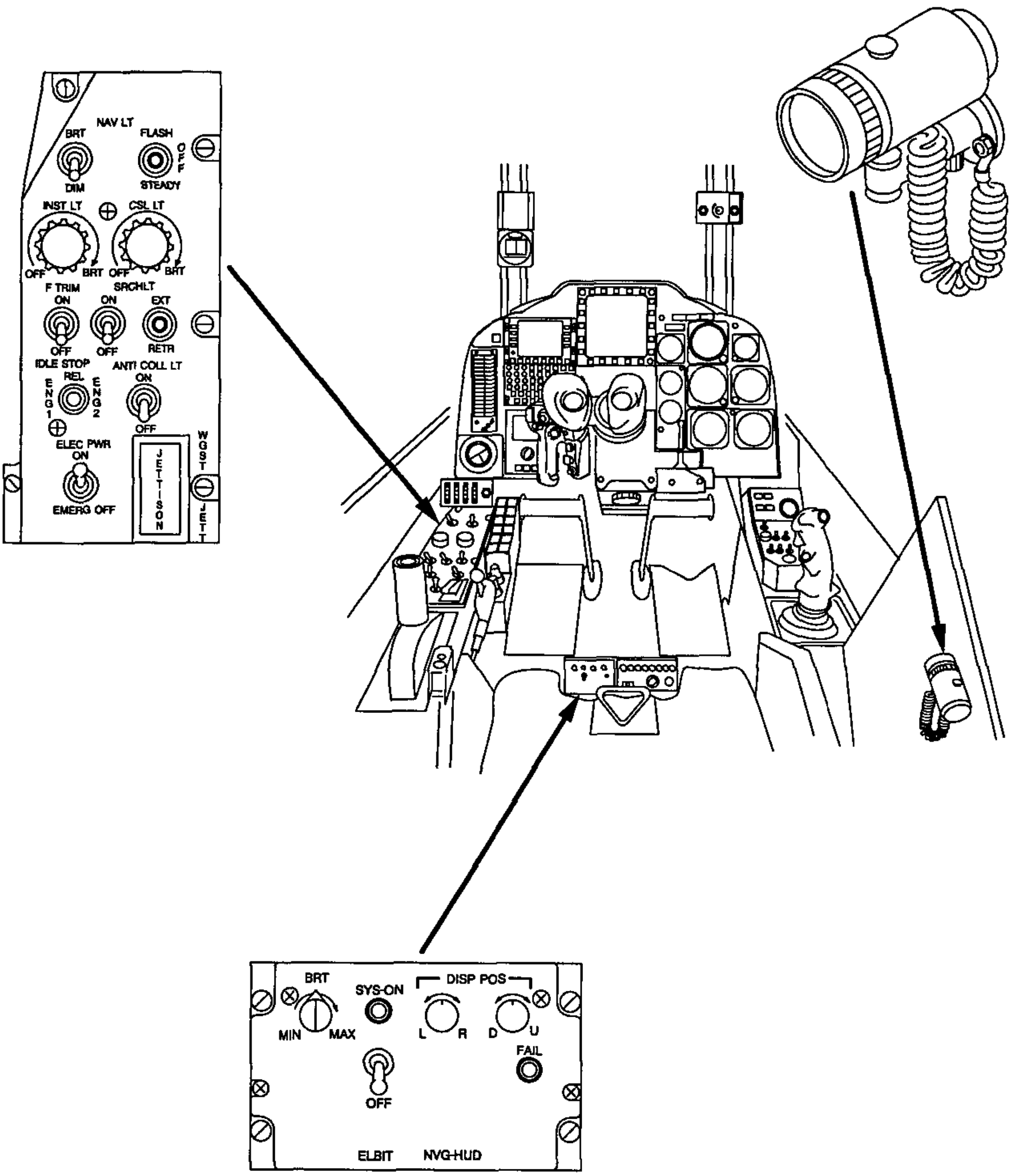

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Figure 2-16. Exterior and Interior Light Controls (Sheet 2 of 2)

2.5.5.2 Pilot and Copilot/Gunner Instrument Lights. Lighting for the pilot and copilot/gunner instruments is provided by individual bezels around each instrument. A pilot rheostat marked INST is located on the lights panel (Figure 2-16). A copilot/gunner rheostat marked INST LT is located on the miscellaneous control panel. Power is supplied by four 5-vdc instrument lighting power supplies (one for the copilot/gunner by the 28-vdc essential bus). Circuit protection is provided by the LIGHTS PLT INSTR GNR circuit breakers.

2.5.5.3 Pilot and Copilot/Gunner Console Lights. Lighting for the pilot and copilot/gunner console includes internal lighting and floodlights for panel lighting. A rheostat marked CSL is located on the pilot lights panel (Figure 2-16). The copilot/gunner miscellaneous control panel has a rheostat marked CSL LT. Power is supplied by the 28-vdc essential bus and protected by the LIGHTS CSL PLT & GNR circuit breakers.

2.6 HYDRAULIC POWER SUPPLY SYSTEM

The hydraulic system consists of three completely independent systems, comprised of hydraulic systems No. 1 and No. 2 and the utility hydraulic system.

2.6.1 Hydraulic Systems No. 1 and No. 2. Hydraulic systems No. 1 and No. 2 are powered by two transmission-driven hydraulic pumps. Components peculiar to both systems include reservoirs, pumps, and filter modules (FO-8). Systems No. 1 and No. 2 provide dual power boost for the main rotor controls through three dual hydraulic actuators (two for cyclic control and one for collective). The dual actuators are designed so that no single hydraulic leak or single pump failure will cause the loss of more than one hydraulic system. In addition to the main rotor controls, systems No. 1 and No. 2 provide hydraulic power for the following:

1. Hydraulic System No. 1
   a. Directional controls
   b. Directional (yaw) SCAS actuator.
2. Hydraulic System No. 2
   a. Rotor brake control unit
   b. TOW pylon actuators
   c. Fore and aft SCAS actuator
   d. Lateral SCAS actuator
   e. Vibration suppression system
   f. Oil cooler fan (when OIL COOLER switch is positioned to SEC).

2.6.2 Utility Hydraulic System. This system incorporates components similar to hydraulic systems No. 1 and No. 2. Hydraulic pressure is provided by a pump mounted on the combining gearbox. The utility hydraulic system powers a hydraulic motor-driven fan on the transmission/combining gearbox oil cooler during normal operation (Figure 2-17).

2.6.3 Hydraulic System Controls and Indicators. The hydraulic system controls, consisting of the HYD switch and OIL COOLER switch, are located on the pilot engine control panel. The HYD switch has a triangle shaped switch head. Hydraulic system indicators consist of the hydraulic caution lights, pressure gauge, fluid level sight gauges, and hydraulic filter bypass indicators (Figure 2-18).

2.6.3.1 Hydraulic Systems No. 1 and No. 2 Control Switch. The HYD SYS 1/SYS 2 switch (Figure 2-18) is a center-lock-type switch. The switch applies power to the system No. 1 or system No. 2 hydraulic control relays that actuate a bypass solenoid in the manifold to stop hydraulic pressure flow to the selected system. Set the switch to the SYS 1 position to disable system No. 1 or the SYS 2 position to disable system No. 2. Systems No. 1 and No. 2 are both operational with the switch in the center (ON) position.

Note

The hydraulic control relays are interfaced with the caution system to prevent the good (functional) system from being turned off in the event the other system fails (i.e., system No. 2 cannot be turned off if the No. 1 HYDR TEMP/PRESS caution light is on, and vice versa). Bypass solenoids are electrically held in event of a power low to the solenoid, and the variable pressure will flow to that system.

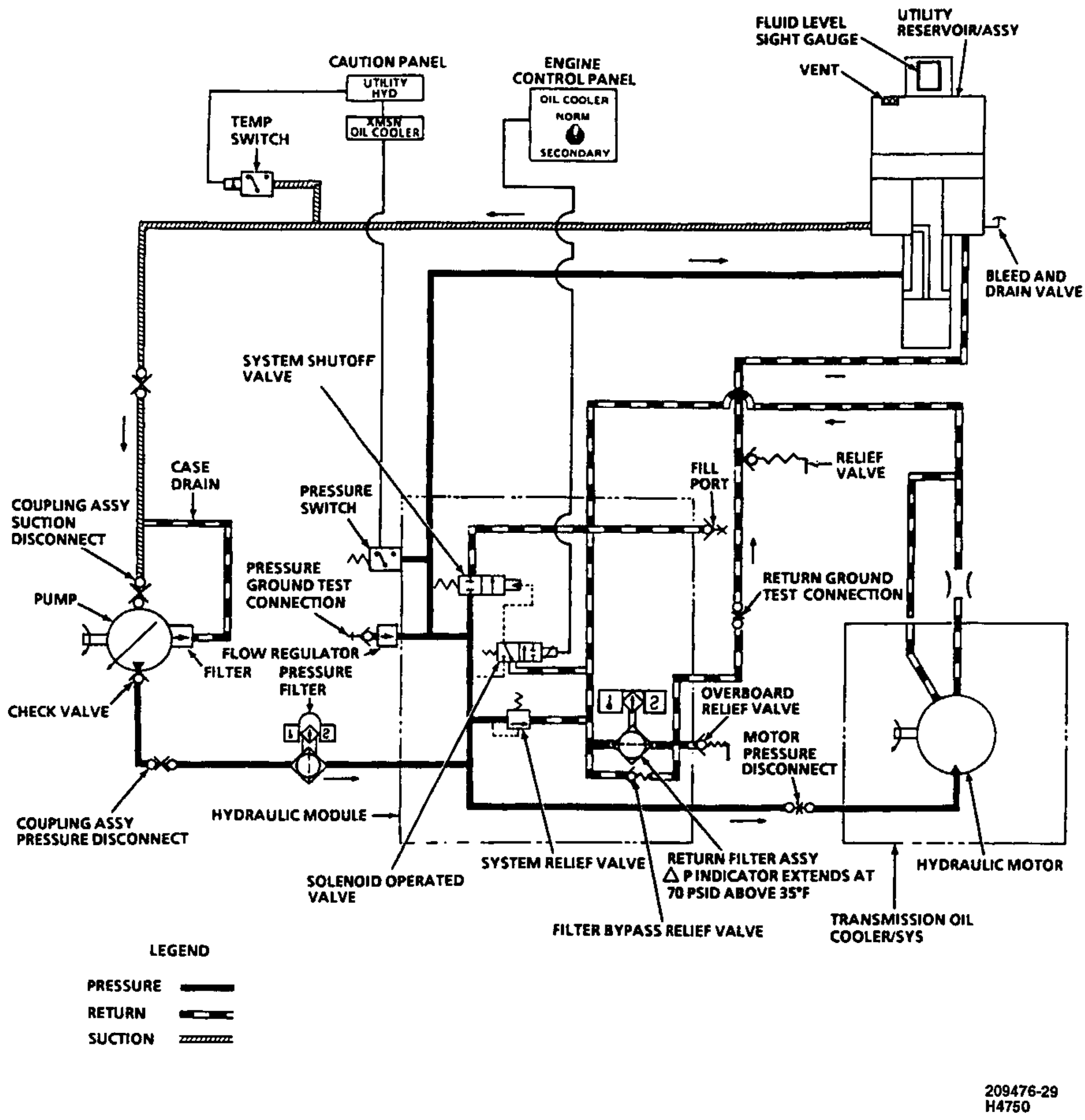

Figure 2-17. Utility Hydraulic System

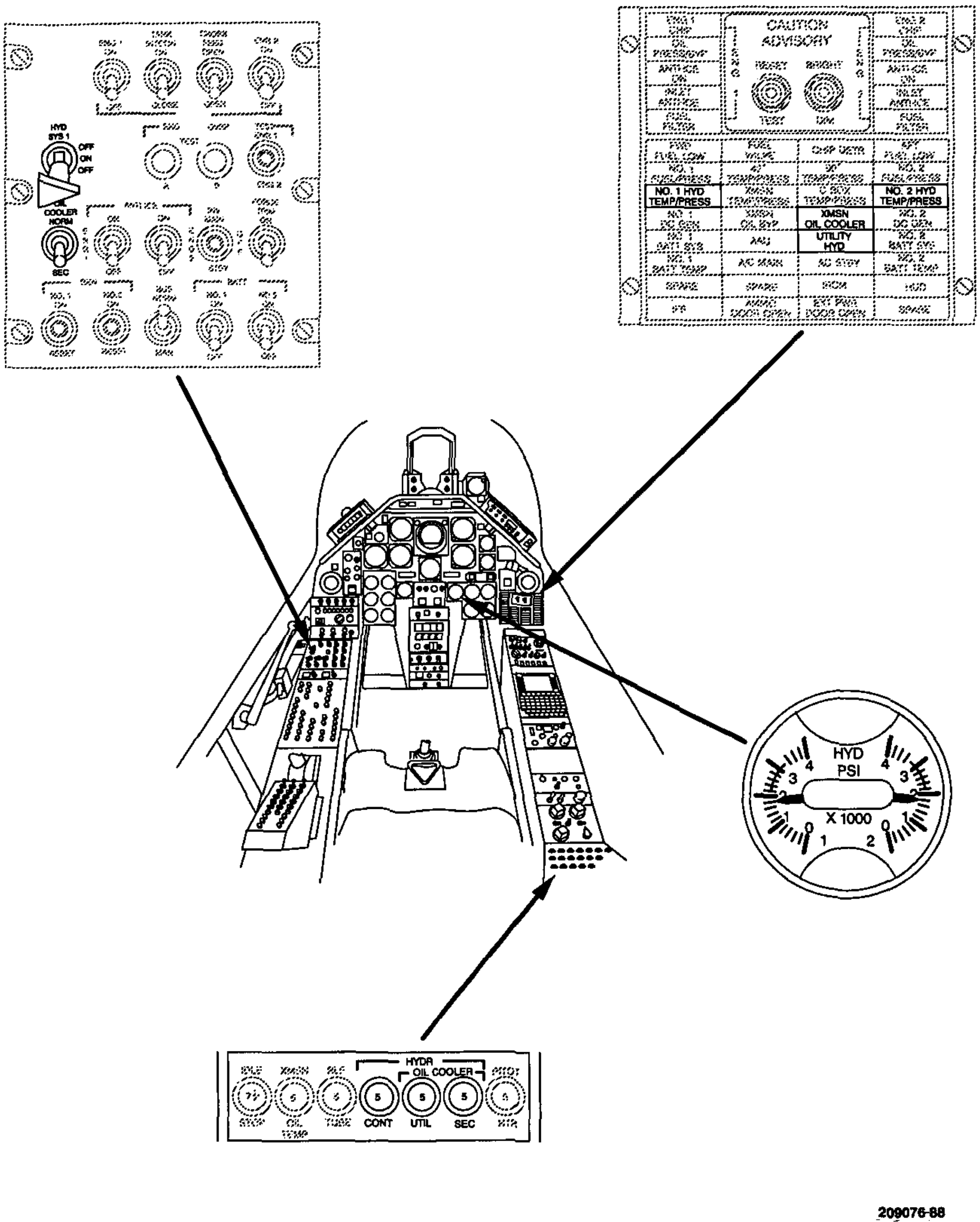

Figure 2-18. Hydraulic System Controls and Indicators

2.6.3.2 Utility Hydraulic System Control Switch. The OIL COOLER switch is a two-position switch (Figure 2-18). In the NORM position, the utility hydraulic system powers the primary hydraulic motor on the transmission/combining gearbox oil cooler fan. Setting the switch to the SEC position disables the utility hydraulic system and VSS system and selects a secondary hydraulic motor to power the oil cooler fan. The secondary motor (when selected) is powered by the No. 2 hydraulic system.

2.6.3.3 Hydraulic System Caution Lights. The hydraulic system caution lights (NO. 1 HYD TEMP/PRESS, NO. 2 HYD TEMP/PRESS, UTILITY HYD and XMSN OIL COOLER) are located on the caution advisory panel (Figure 2-18). Refer to paragraph 2.11, WARNING, CAUTION, AND ADVISORY SYSTEMS.

2.6.3.4 Hydraulic Pressure Gauge. The hydraulic pressure gauge (Figure 2-18) is marked HYD PSI and is on the pilot instrument panel. No. 1 and No. 2 hydraulic system pressures in psi are indicated on the gauge. See figure 4-5 for system pressure ranges and operating limits. Power is supplied by the 28-vdc essential bus and protected by the IND HYDR PRESS circuit breaker.

2.6.3.5 Hydraulic Fluid Level Sight Gauges. Each hydraulic system reservoir incorporates a fluid level sight gauge. The sight gauge indicates by a sight line if the reservoir requires servicing. See Figure 3-1 for location of system reservoirs.

2.6.3.6 Hydraulic Filter Bypass Indicators. The filter assembly incorporates a red indicator that extends when the differential pressure across the filter element exceeds 70 psi. Once extended, the indicator will remain so until manually reset. When the indicator is in the retracted (reset) position, it is hidden from view. See Figure 3-1 for the location of the filter bypass indicators.

2.6.4 Hydraulic System Cooling. Two 28-vdc blowers provide cooling air for the hydraulic system No. 2 compartment area to prevent overheating of the hydraulic fluid. The blowers are operational whenever 28-vdc power is applied to the nonessential bus. Circuit protection is provided by the HYD BLWR 1 and HYD BLWR 2 circuit breakers located in the aft electrical compartment.

2.7 FLIGHT CONTROLS

The flight control system is a positive mechanical type that is actuated by cyclic, collective, and tail rotor pedal controls. Complete controls are provided for both pilot and copilot/gunner. The copilot/gunner controls are slaved to the pilot controls (Figure 2-19). The system includes a cyclic system, collective system, tail rotor system, force trim system, and a stability and control augmentation system.

2.7.1 Cyclic Control System. The system is operated by the cyclic stick movement. Moving the stick in any direction will produce a corresponding movement of the helicopter that is the result of a change in the plane of rotation of the main motor. The stick fore and aft movement also changes the synchronized elevator attitude to assist controllability and lengthen cg range. The cyclic system has built-in operating friction and control feel provided by the force system.

2.7.2 Collective Control System. The pilot and copilot/gunner collective controls are located on the left side of each respective cockpit and control the power for flight. The collective assembly consists of the collective stick with adjustable friction (pilot only), dual twist grip throttles, and a switch box assembly on the pilot collective (Figure 2-19). A hold-down strap is provided for the pilot collective. Moving the collective stick up or down changes the angle of attack and lift developed by the main rotor. In addition, mechanical and electrical inputs to engine fuel controls are provided to reduce N_r transient droop. Refer to paragraph 2.1.2.2.

2.7.3 Throttle Control System. Dual twist grip throttles are located on both pilot and copilot/gunner collective controls. The throttles control fuel flow to the engines via mechanical inputs through the fuel control actuators mounted on the HMU. Each throttle is operated independently. Pilot throttles are equipped with a friction adjusting nut. The forward throttle controls engine No. 1, and the aft throttle controls engine No. 2. An electrical solenoid is incorporated in the throttle linkage to provide an idle stop and EECU lockout stop. The idle stop prevents inadvertent throttle closure. The EECU lockout stop prevents inadvertent advancement of the throttles beyond the normal full-open position, at which point the automatic fuel control function of the EECU is disabled and engine speed must be manually controlled with the throttle. The solenoid is actuated by the IDLE-STOP-REL switch on the collective switch box (pilot) and the miscellaneous control

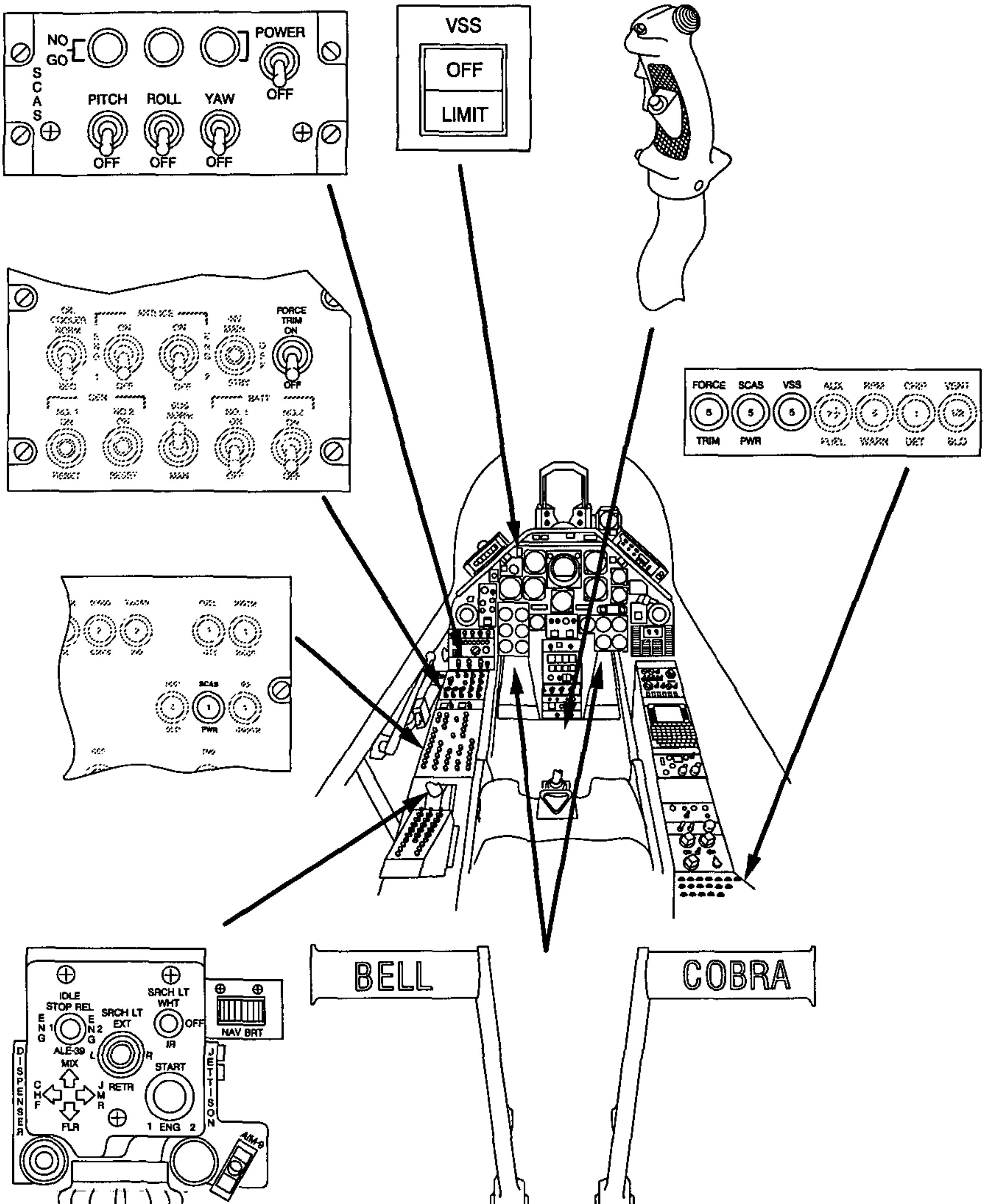

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Figure 2-19. Flight Controls (Sheet 1 of 2)

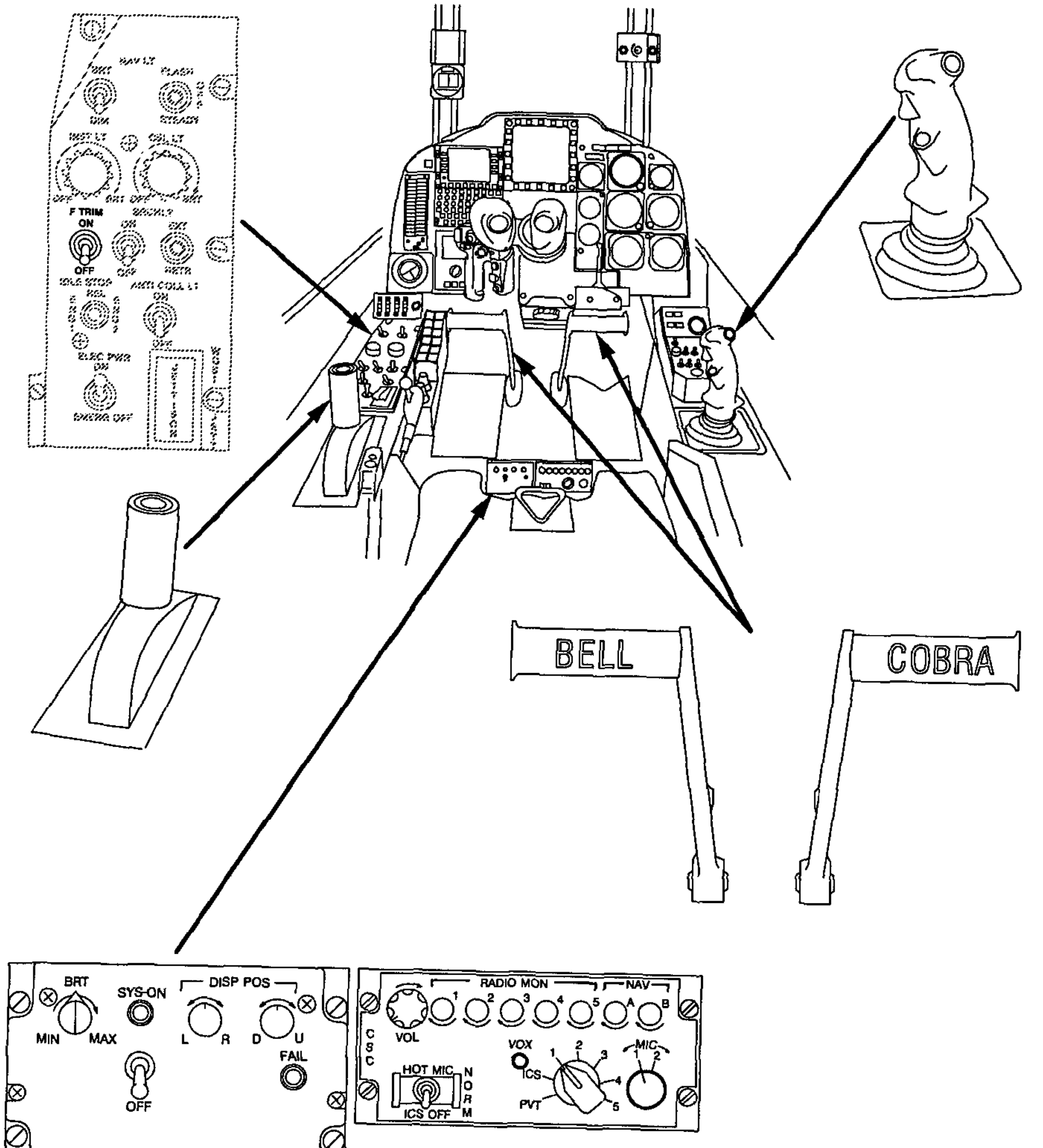

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Figure 2-19. Flight Controls (Sheet 2 of 2) panel (copilot/gunner). The switch receives power from the 28-vdc essential bus and is protected by the IDLE STOP circuit breaker.

Note

The idle stop/EECU lockout stop solenoid plunger remains retracted for 5 seconds after the IDLE-STOP-REL switch is pressed, allowing single-handed operation of throttles through the stop positions.

2.7.4 Tail Rotor Control System. The tail rotor control system is operated by the pedals. Pushing a pedal changes the pitch of the tail rotor resulting in directional control and may be used to pivot the helicopter about its vertical axis. A pedal adjuster is provided to adjust the pedal distance for individual comfort. Heel rests are provided for the copilot/gunner to prevent inadvertent pedal operation.

2.7.5 Synchronized Elevator. The synchronized elevator is located near the aft end of the tailboom and is connected by control tubes and mechanical linkage to the fore and aft cyclic hydraulic servo. Fore and aft movement of the cyclic stick produces a change in the synchronized elevator attitude, thus increasing controllability and cg range.

2.7.6 Force Trim System. The system incorporates magnetic brakes and force gradient springs in the cyclic and directional control systems to provide artificial feel in the systems. Depressing the cyclic stick TRIM REL switch will cause the magnetic brake and force gradient to be repositioned to correspond to the positions of the cyclic stick and pedals, thus providing trim. FORCE TRIM (pilot) and F TRIM (copilot/gunner) switches are provided. The pilot switch is located on the pilot engine control panel and the copilot/gunner switch is located on the copilot/gunner miscellaneous control panel. Both switches must be ON to actuate the system. The OFF position of either switch deactivates the system. Power is supplied by the 28-vdc essential bus and protected by the FORCE TRIM circuit breaker.

2.7.7 Stability and Control Augmentation System. The SCAS is a three-axis, limited authority, stability and control augmentation system. The SCAS was designed to reduce the pilot workload by standardizing the helicopter rate of displacement to control inputs and by reducing airframe oscillations through electronically controlled damping. Standardizing helicopter rate of displacement to control inputs is achieved by electrically measuring the amount of physical movement of the pilot control from one position to another position. This signal, when received by the amplifier, is interpreted as a pilot rate command, the magnitude being proportional to the amount of control displacement. The sensor amplifier compares the pilot rate command signal with a signal from the SCAS rate gyro. The rate gyro senses and reports the actual rate of displacement of the helicopter. If the pilot rate command is different from the rate reported by the gyro, the sensor amplifier sends a signal to the electrohydraulic actuator that will correct for the difference. The electrohydraulic actuator extends or retracts the flight control system to adjust the aircraft system rate to the rate selected by the pilot. Sensor amplifier circuitry limits the length of the SCAS memory so that only the most recent control position is used as a reference for the pilot rate command.

Reducing airframe oscillations through electronically controlled damping is accomplished by designing the sensor amplifier circuitry logic to recognize that airframe displacement rates not commanded by the pilot are undesirable. The sensor amplifier will then provide a control motion signal to the undesirable airframe rate. All three channels operate in a similar manner.

2.7.7.1 SCAS Control Panel. The SCAS control panel (Figure 2-19) contains a POWER switch for applying 28-vdc (essential bus) and 115-vac (essential bus) operating voltages to the system. The circuits are protected by the SCAS PWR dc and SCAS PWR ac circuit breakers. The panel also contains three magnetically held channel engage switches that energize electric solenoid valves controlling hydraulic pressure to the system. The panel has three NO-GO lights, one each associated with PITCH, ROLL, and YAW channel engage switches. These lights illuminate during the warmup to indicate the presence of current in each associated actuator channel. The warmup period allows the rate gyros to attain operating speeds and the system to obtain a nulled condition. Should an engagement be attempted prior to obtaining a null condition (i.e., with the NO-GO lights illuminated), the actuator will make an abrupt input to the flight controls at the moment of engagement. When engagement is made, the NO-GO lights are locked out of the circuit and do not operate as malfunction indicators. Disengaging a channel, however, restores the associated light to operation. The NO-GO lights have a built-in press-to-test feature for ensuring that the indicator is operational, but this feature works only prior to channel engagement.

2.7.7.2 SCAS Release Switch. The SCAS REL switch is mounted on each cyclic grip (Figure 2-19) and is used to disengage the pitch, roll, and yaw channels simultaneously. The channels are reengaged by the PITCH, ROLL, and YAW switches on the SCAS control panel.

2.7.7.3 Recoil Compensation System. When the weapon is fired, three-axis turret position signals are applied to the recoil compensation system that provide weapon recoil damping of helicopter movement. The recoil compensation system electrically interfaces the turret system with the SCAS. Turret position signals are applied to the recoil compensation system and, when the M197 gun is fired, output signals are applied to the SCAS servoactuators providing recoil damping. The recoil compensation system receives power from the RECOIL COMP switch (Figure 21-36) located on the pilot armament control panel. The magnitude of the recoil compensation system output signals can be set to LO-MED-HI by using the RECOIL COMP selector switch located on the pilot instrument panel.

2.8 VIBRATION SUPPRESSION SYSTEM

The VSS is an electronically controlled, hydraulically powered system that automatically senses and suppresses the apparent effect of rotor inducted vibrations. The system consists of four components: accelerometer, magnetic pickup, electronic control unit, and vibration suppressor assembly.

The accelerometer is located near the copilot/gunner pedals and measures the vibration. The system is synchronized by a magnetic pickup located on the rotor system that senses main rotor frequency (rpm). This information is then fed to the electronic control unit, which generates a control signal to the vibration suppressor assembly. The vibration suppressor assembly is mounted below the floor of the copilot/gunner cockpit. A 51-pound weight slides up and down on a piston in a sinusoidal manner at the appropriate two-per-revolution frequency to compensate for the main rotor induced vibrations.

The VSS is powered by hydraulic system No. 2 (FO-8). A nitrogen-charged accumulator (FO-8) absorbs pressure line surges and maintains even pressure on the vibration suppressor assembly.

The VSS is electronically controlled by the VSS switch located on the pilot instrument panel (Figure 2-19). The circuit is powered by the 28-vdc essential bus and protected by the VSS circuit breaker. The system is activated by pressing the VSS switch. Pressing the switch a second time will turn the system off (OFF light illuminates). The bottom switch segment illuminates (LIMIT) when VSS weight stroke exceeds 95 percent of electrical travel. This indicates to the pilot that the maximum amount of two-per-revolution vibrations are being dampened by the system. The light will extinguish when the weight stroke falls below 85 percent of allowable travel. The VSS will suppress two-per-revolution vibrations only between 90 and 110 percent rotor rpm when pressure is above 2000 psi on hydraulic system No. 2.

Note

VSS is disabled under the following conditions:

1. The OIL COOLER switch is positioned to SEC

2. Hydraulic system No. 2 is disabled

3. Rotor rpm not within operating limits. The OFF segment of the VSS switch will illuminate.

2.9 LANDING GEAR

The skid landing gear consists of two arched crosstubes and fairings secured to the fuselage structure and two skid tubes secured to the crosstubes. Each crosstube is secured to the fuselage by a rubber pad fitting assembly. The skid tubes consist of an aluminum tube with steel skid shoes, mounting fixtures to attach ground handling wheels, and a tow ring on the forward end for towing the helicopter.

A tail skid is attached to the lower aft section of the tailboom assembly. The tail skid reduces the possibility of damage to the tailboom and tail rotor and acts as an indicator to the pilot in case of a tail-low landing.

2.10 FLIGHT INSTRUMENTS

The flight instruments, navigation instruments, miscellaneous instruments, and indicators are described in the following paragraphs. For heads-up display and other flight data, refer to Chapter 20.

The description of engine instruments, transmission instruments, and rotor instruments will be found with the respective descriptions of the engine, transmission, and rotor. (See Figure 2-20.)

2.10.1 Airspeed Indicator. The airspeed indicators are calibrated in knots and provide an indication of forward airspeed. The system measures the difference between impact air pressure from the pitot tube and static air pressure from the static ports. The pitot tube is mounted on the left side of the pylon fairing (Figure 1-1), and the static ports are located in the side cabin skins near the bottom edge of the canopy and just aft of the copilot/gunner station. A pitot heater is provided for removal of ice or snow from the pitot tube.

2.10.2 Vertical Speed Indicator. The vertical speed indicator displays the rate of altitude change in fpm. The instrument is actuated by the rate of atmospheric pressure change and is vented to the static air system.

2.10.3 Pilot Altitude Encoder/Pneumatic Altimeter AAU-32/A. The AAU-32/A pneumatic counter-drum-pointer altimeter is a self-contained unit that consists of a precision pressure altimeter combined with an ac-powered altitude encoder (Figure 2-20). The altimeter also incorporates a 28-vdc internal vibrator to minimize instrument lag. Altitude is displayed by drum-type counters (100 to 50,000 feet) and a pointer that indicates hundreds of feet on a circular scale. Stripes are displayed in lieu of the number 0 on the 10,000-foot counter when at altitudes below 10,000 feet. A barometric pressure setting knob is provided to insert the desired altimeter setting in inches of Hg. The altimeter indicates pneumatic altitude in reference to the barometric pressure level selected by the pilot. If the altimeter reading fails to agree with the field elevation by more than 70 feet when proper barometric pressure is set, the altimeter requires zeroing or has failed internally.

Note

Abnormal force shall not be used when adjusting the barometric setting, as this may cause internal gear failure resulting in altitude errors. If the knob binds, settings can sometimes be made by backing off and turning at a slower rate.

The altitude encoder provides mode C altitude readings to the transponder set for reporting to ground stations. If ac power is lost or the altitude encoder fails, a CODE OFF flag appears on the upper left portion of the instrument face. The CODE OFF flag monitors only the encoder function of the altimeter. Therefore, altitude reporting may be inoperative when the flag is not showing if the transponder fails or is improperly set.

If the dc powered vibrator in the altimeter becomes inoperative because of internal failure or dc power failure, the pointer and drum may momentarily hang up when passing from 9 through 0 (climbing) or from 0 through 9 (descending). This hangup will cause lag, the magnitude of which will depend on the vertical speed of the helicopter and the friction in the altimeter. Pilots should be especially watchful of this type failure when the minimum approach altitude lies within the 8 to 1 part of the scale (800 to 1100, 1800 to 2100, etc.).

The altitude encoder ac power is controlled by the ALT ENCDR circuit breaker, and dc power for the vibrator is controlled by the IND ALTM VIB circuit breaker.

2.10.4 Copilot/Gunner Counter-Pointer Pressure Altimeter. The altimeter displays a pressure altitude range of minus 1000 to plus 20,000 feet. The altitude display is provided by a single pointer and two drum counters. The pointer indicates hundreds of feet on a circular scale, with 50-foot center markings. The four-digit counter indicates 1000-foot levels, and the single-digit counter provides 10,000-foot levels. The combined readings of two counters and the pointer indicate the pressure altitude in thousands and hundreds of feet. A striped window on the 10,000-foot counter is displayed in lieu of the 0 number (altitude below 10,000 feet). A barometric setting knob and a four-digit barometric scale counter are provided. The setting knob permits the altimeter to be set to indicate zero altitude at any ground level pressure throughout a range of 28.10 to 31.00 inches Hg. The altimeter scale is adjusted by turning the knob clockwise to increase scale values. Positive stops prevent the setting of ground level pressures outside the range of 28.10 to 31.00 inches Hg. A dc-powered vibrator operates inside the altimeter to decrease friction in the mechanism. If the vibrator becomes inoperative or loses dc power, the pointer and counter drums may momentarily hang up when passing from 9 through 0 (climbing) or from 0 through 9 (descending). This hangup will cause lag with the magnitude depending on vertical

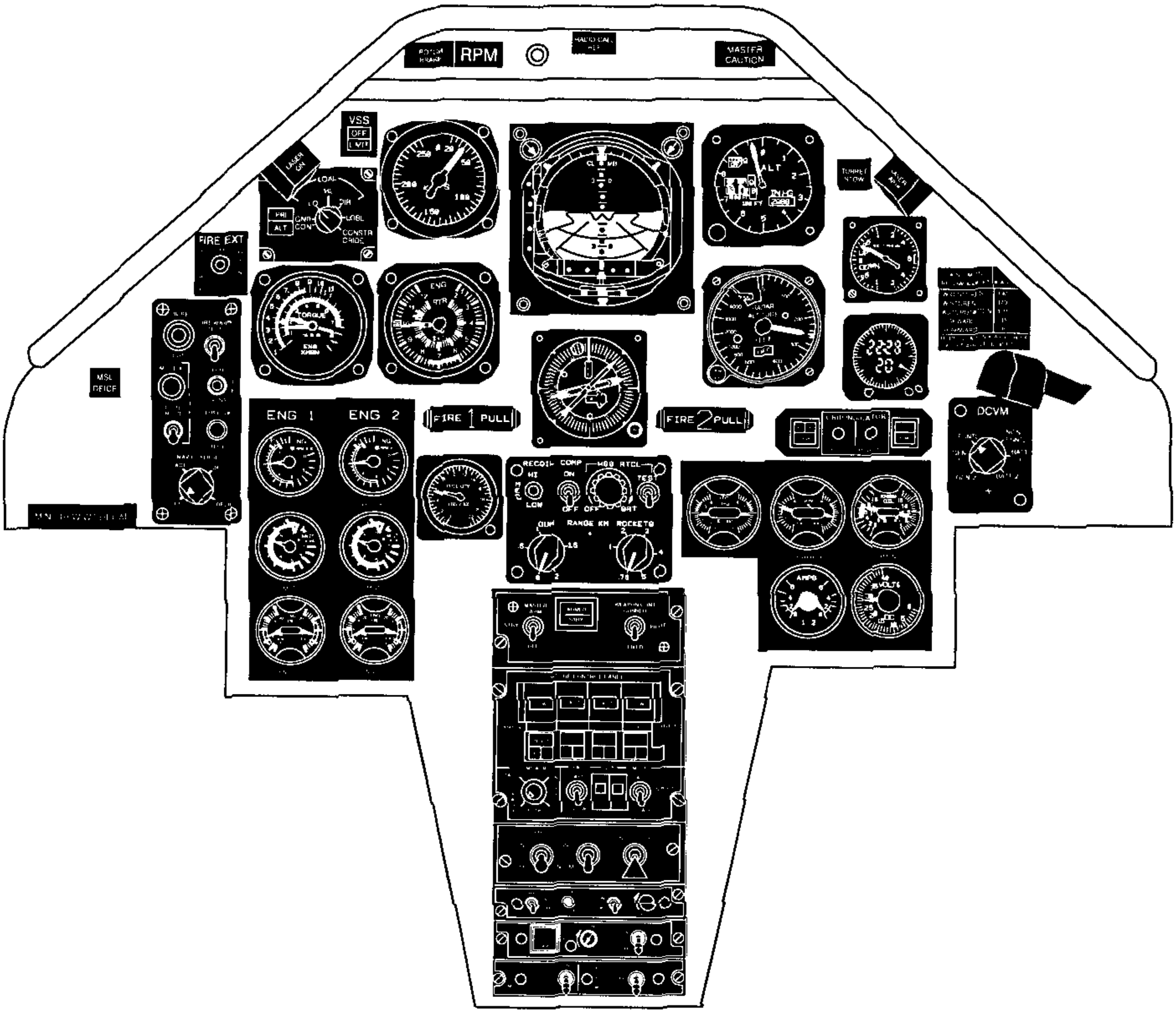

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Figure 2-20. Pilot and Copilot/Gunner Instrument Panel (Sheet 1 of 2)

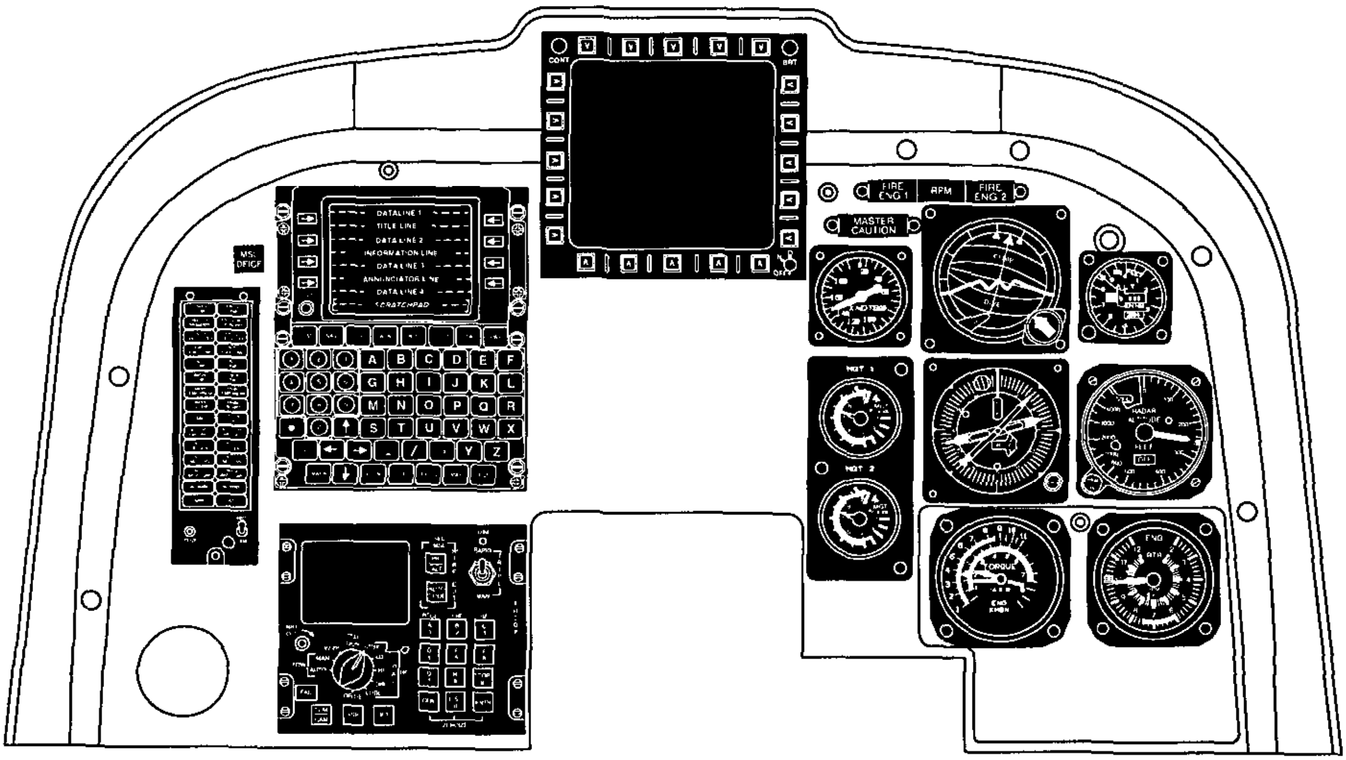

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Figure 2-20. Pilot and Copilot/Gunner Instrument Panel (Sheet 2 of 2) speed and friction in the altimeter. Vibrator power is controlled by the ALTM VIB circuit breaker.

2.10.5 Pilot Attitude Indicator. The pilot attitude indicator (Figure 2-21) provides the pilot with a visual indication of the pitch and roll of the helicopter in relation to the earth's horizontal plane. Pitch attitude is indicated by motion of the sphere in relation to the miniature aircraft. Roll attitude is indicated by motion of the roll pointer with respect to the fixed roll scale located at the top of the display. The indicator sphere can be adjusted to zero indication by the pitch and roll trim knobs located on the face of the instrument. The turn-and-slip portion of the pilot attitude indicator consists of a rate of turn pointer and an inclinometer (ball) that operate independently. The electrically operated rate of turn pointer is controlled by the dc powered rate gyro and indicates the direction and the rate of turn. The inclinometer indicates when the helicopter is in balanced flight. If the helicopter is yawing or slipping, the ball will be off center. Above the ball at the 6 o'clock position is a scale and a horizontal deviation pointer that will deviate toward the FM station when the NAV CONTROL panel selector switch is in the ADF or BOTH position and the tactical radio is tuned to an FM station and receiving a usable signal. When the pointer is centered in this situation, the helicopter is on a relative heading to or from the FM station.

The horizontal deviation pointer also indicates TACAN course deviation when the NAV CONTROL panel switch is in the DF or OFF position and there is a usable TACAN signal being received by the TACAN receiver. In this situation, the pointer will indicate 5° deviation from the selected TACAN radial for each dot of pointer deflection from center. When the pointer is centered, the helicopter is on the selected TACAN radial. The horizontal deviation flag for this pointer is at the 3 o'clock position and will appear when the instrument is not receiving a usable signal in the selected mode (TACAN). As the helicopter approaches the station, the pointer will move toward the center of the scale.

The power OFF flag appears in the lower left quadrant when electrical power to the instrument is off. Power is supplied by the 115-vac reference transformer and protected by the ATT SYS circuit breaker. Power for the bezel lighting is received from the 5-vdc lighting power supply.

2.10.6 Copilot/Gunner Attitude Indicator. The attitude indicator (Figure 2-20) is located on the copilot/gunner instrument panel. The instrument repeats the information presented on the pilot attitude indicator. TACAN functions are not connected and are not functional on the copilot/gunner attitude indicator. No turn needle or roll trim knob is provided. Power is supplied by the 115-vac reference transformer and protected by the ATT SYS circuit breaker. The bezel lighting receives power from the 5-vdc lighting power supply.

2.10.7 Pitot-Static System. The pitot system consists of an electrically heated pitot tube connected to the airspeed indicators (Figure 2-22).

The static system consists of static ports and the tubing necessary to connect them to the airspeed indicator(s), altimeter(s), and vertical speed indicator (Figure 2-22). The static ports are located on either side of the helicopter forward of the pilot compartment.

2.10.8 Standby Compass. A standard magnetic-type compass is mounted on the left windshield support and is bezel lighted.

2.10.9 Free Air Temperature Indicator. The free air temperature indicator is located on the left side of the pilot compartment. The indicator provides a direct reading of the outside air temperature.

2.10.10 Clock, Analog. The analog clock (Figure 2-23) is an eight-day clock with a stopwatch feature for elapsed time utilization. A sweep-second pointer is incorporated, along with a minute totalizer pointer, to indicate elapsed time up to one hour. The winding and setting knob, located in the lower left corner of the clock case, winds the mainspring of the clock when turned in a clockwise direction and engages the setting gear for the hour and minute hands of the clock when pulled out into the setting position. The knob is free to turn counterclockwise with a ratchet gear. The elapsed time knob, located on the upper right corner of the clock case, starts and stops the elapsed time function of the clock at will to take time out (up to 60 minutes and repeating). Three pushes of the knob completes the elapsed time functions, causing the elapsed time and sweep second hands to start, stop, or fly back. The fly-back position of the sweep second hand and the elapsed time hand will be 60 as indicated on the dial. The elapsed time function does not interfere with the hour and minute time hands.

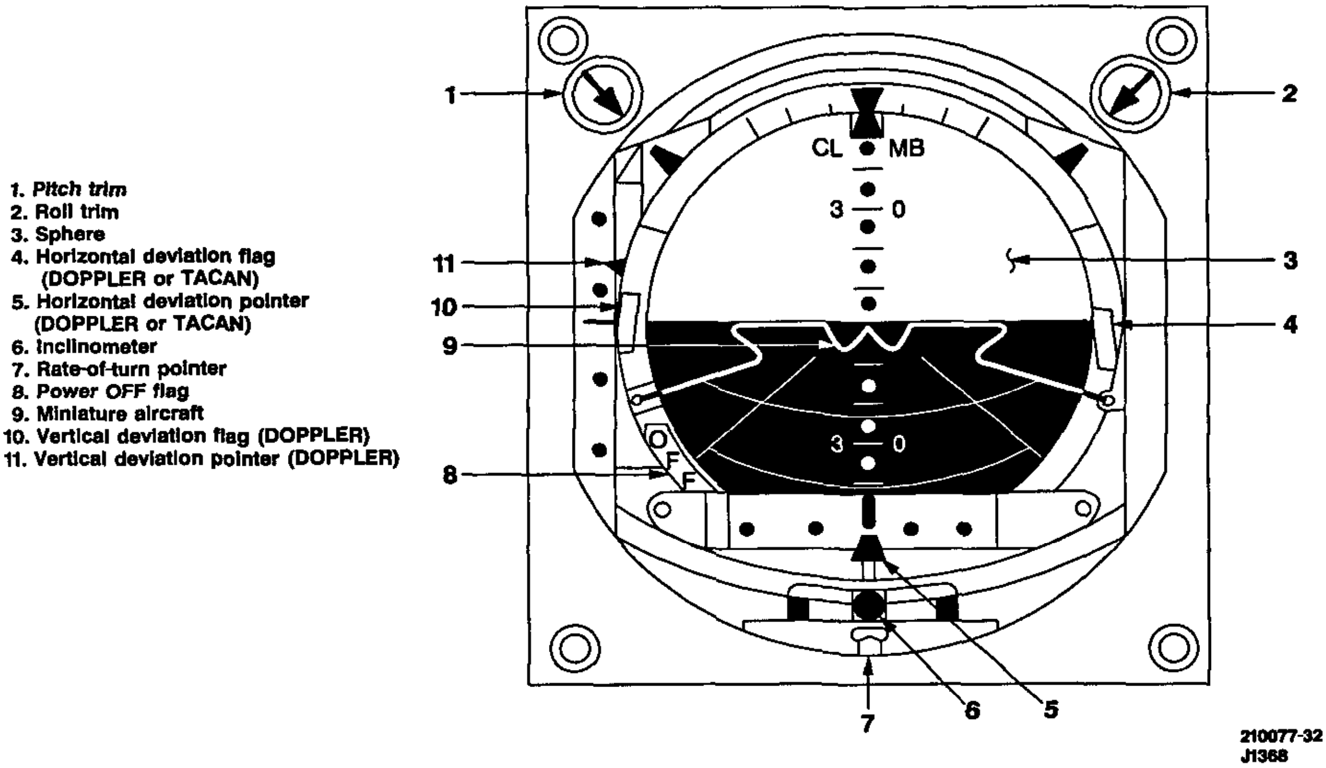

Figure 2-21. Pilot Attitude Indicator

2.10.11 Clock, Digital. The digital clock (Figure 2-23) is a quartz time-base, electronic, aircraft clock that digitally indicates hours, minutes, and seconds, and it contains a stopwatch feature for elapsed digital time utilization. The time is displayed in a 6-digit, 24-hour numeric display with hours and minutes on the top line and seconds underneath. When in the clock mode, a **C** will display on the bottom of the display. An **ET** will display on the bottom indicating elapsed time mode. An analog sweep-second pointer is incorporated. The display is green liquid crystal that is night vision compatible. The display is illuminated by the instrument lights control switch on the pilot LIGHTS control panel. The clock has a keep-alive battery system utilizing a 1/2 AA size battery to keep the timing circuits operating for a minimum of one year when the helicopter 28-vdc power is not applied. Power is 28-vdc essential bus supplied through the ENG NO. 1 INSTR circuit breaker. The digital clock requires no corrective or preventive maintenance while installed in the helicopter.

2.10.11.1 Clock Modes. The digital clock display has two modes: clock time mode and elapsed time mode. Pressing the SEL pushbutton will toggle between clock time mode and elapsed time mode. When the helicopter is powered up, the digital clock will illuminate all segments of the light emitting diode (LED) during the first 5 seconds then default to clock time. Switching back and forth between clock time and elapsed time will not affect the performance of either mode.

2.10.11.2 Set Clock Time. With the digital clock in the clock mode, press the SEL pushbutton and CTRL pushbutton simultaneously. The first digit will flash; momentarily press the CTRL pushbutton. Each depression of the CTRL pushbutton will increase the digit by one. Press the SEL pushbutton to set the next digit flashing. All digits are set in this same manner.

2.10.11.3 Set Elapsed Time. With the digital clock in the elapsed time mode, momentarily press the CTRL pushbutton to start the elapsed timer counter counting upward. The second, third, and fourth depressions of the CTRL pushbutton will stop, zero, and start the timer. The analog sweep-second pointer shall be synchronized with the elapsed timer.

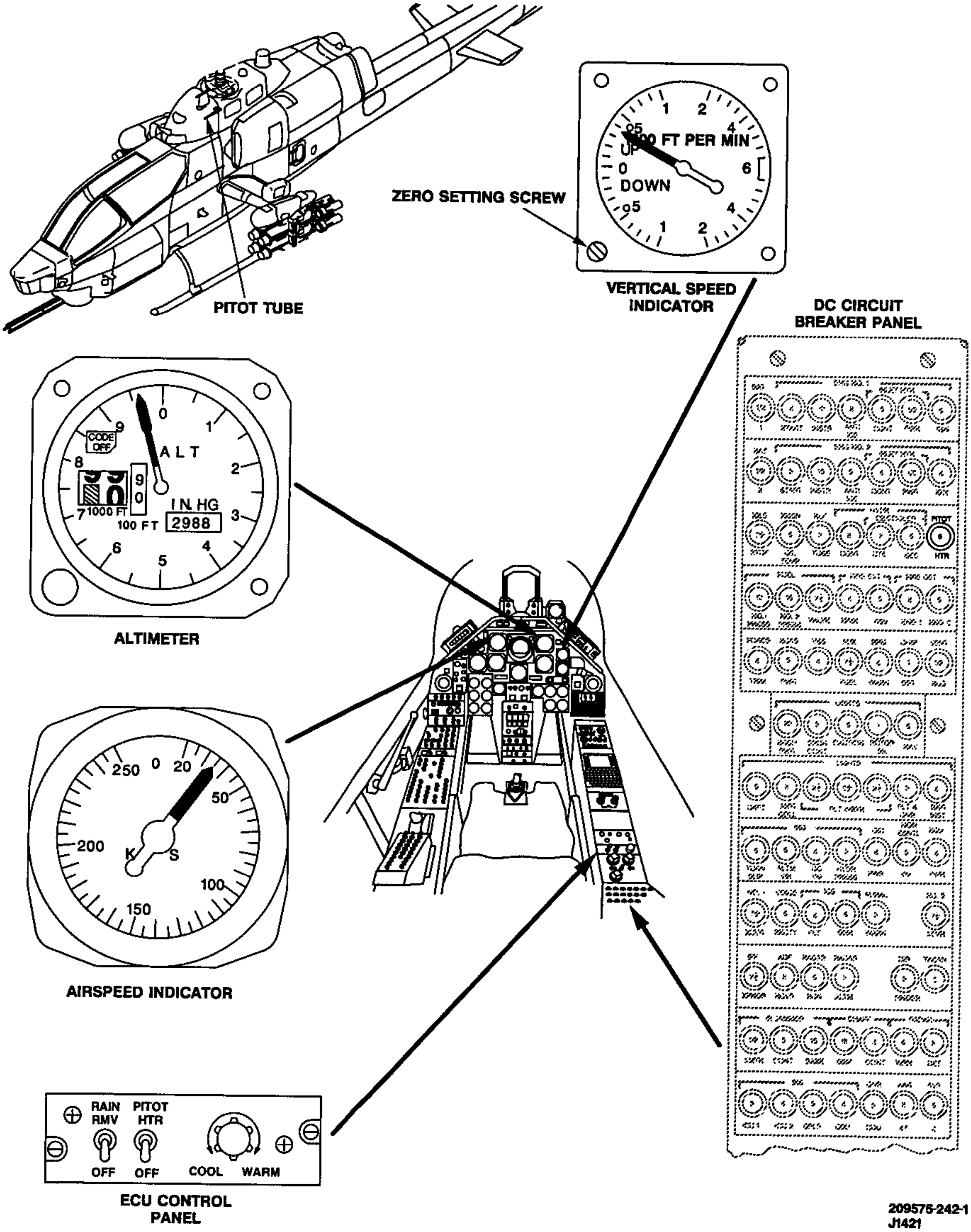

Figure 2-22. Static System

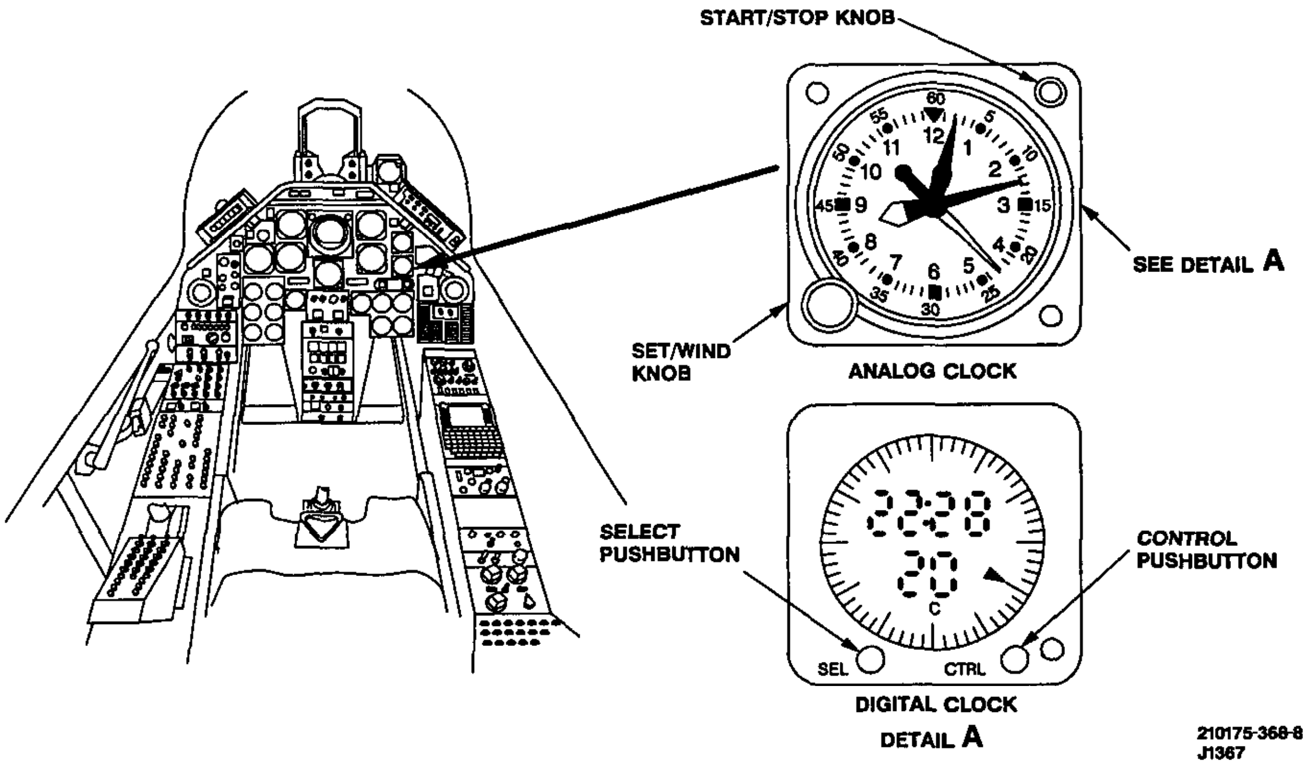

Figure 2-23. Clocks

2.11 WARNING, CAUTION, AND ADVISORY SYSTEMS

Warning indicators and caution advisory panels are provided for the pilot and copilot/gunner (Figure 2-24). In addition to the lights, an AAU provides audio signals (voice and tones) over the ICS for abnormal system conditions. See Figure 2-25 for a listing of warning, caution, and advisory light segments; aural signals; and action required when a light illuminates. Power is supplied by the 28-vdc essential bus, and the system is protected by the CAUTION LIGHTS and AURAL WARN circuit breakers.

2.11.1 Pilot Master Caution System. The pilot master caution system consists of a caution advisory panel and a remote MASTER CAUTION light.

2.11.1.1 MASTER CAUTION Light. The pilot MASTER CAUTION light is located just under the glareshield at the top of the instrument panel. When the light illuminates, the pilot is alerted to check the caution panel for the malfunction. Pressing the MASTER CAUTION light extinguishes and resets the MASTER CAUTION light and silences the AAU signals for subsequent caution indications.

2.11.1.2 Pilot Caution Advisory Panel. The caution advisory panel is located in the right section of the instrument panel. Illumination of any of the worded segments in the caution advisory panel alerts the pilot to malfunctions. The panel is equipped with a RESET TEST switch, a BRIGHT DIM switch, and two edge lights for illuminating the switches.

The BRIGHT DIM switch permits the pilot to select a bright or dim condition for all caution advisory panel lights, MASTER CAUTION light, ROTOR BRAKE light, RPM light, pilot armament control panel lights, STORE CONTROL PANEL lights, TURRET STOW light, and fire warning lights in the FIRE PULL handles. After each initial application of power, the lamps illuminate in the bright mode. Momentarily setting the switch to the BRIGHT or DIM position selects the desired intensity.

Note

The DIM function is operational only when the pilot instrument lights are illuminated.

Setting the RESET TEST switch to TEST will illuminate the pilot MASTER CAUTION light and warning/caution/advisory lights. Additionally, it will

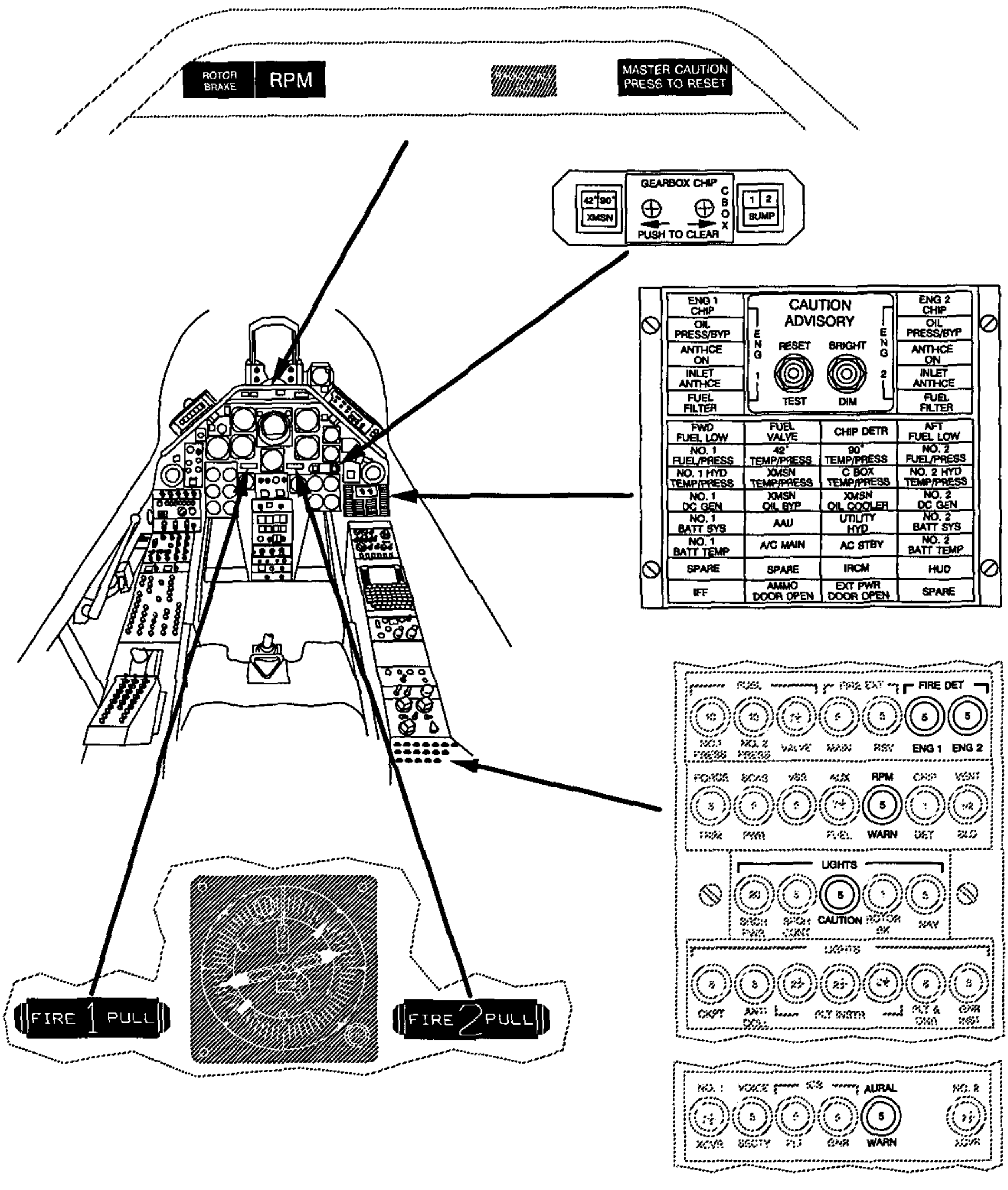

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Figure 2-24. Warning, Caution, and Advisory Lights (Sheet 1 of 2)

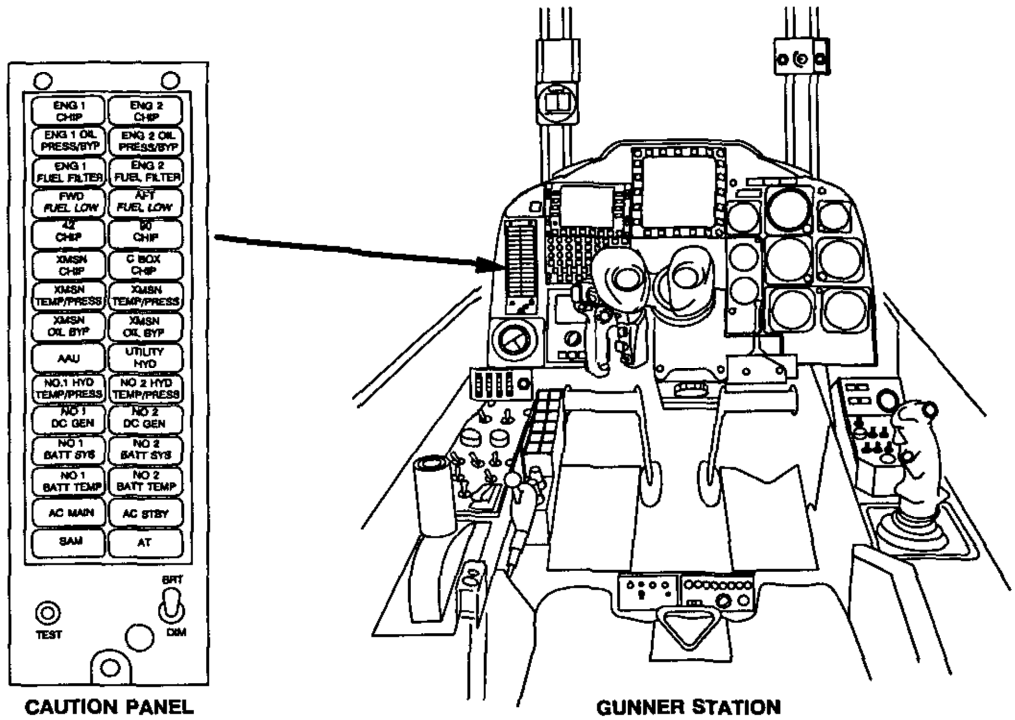


Figure 2-24. Warning, Caution, and Advisory Lights (Sheet 2 of 2)

light the copilot MASTER CAUTION light and the XMSN CHIP, C BOX CHIP, 42° CHIP, and 90° CHIP warning segments on the copilot caution panel. Lights illuminated when the RESET-TEST switch is activated will extinguish when the switch is released. The AAU will complete BIT and sequentially deliver voice and tone messages. BIT failure or loss of power to the AAU is indicated by illumination of the AAU light on the caution advisory panel. Testing the system will not change any malfunction indication existing prior to testing. The RESET position extinguishes the MASTER CAUTION light in both cockpits and silences AAU signals in preparation for subsequent malfunctions.

2.11.2 Copilot/Gunner Master Caution System. The copilot/gunner MASTER CAUTION light and caution panel (Figure 2-24) are located on the left side of the instrument panel (Figure 2-20). This is a repeater-type system; however, the panel does not contain all the light segments presented on the pilot panel. The BRIGHT DIM switch enables the copilot/gunner to select a bright or dim condition for all caution panel lights, MASTER CAUTION light, FIRE warning lights, RPM light, the copilot armament control panel, and the TURRET STOW light.

Note

The DIM function will operate only when the copilot/gunner instrument lights are on.

The TEST position of the TEST switch illuminates the entire copilot/gunner caution panel. Testing the system will not change any malfunction indication existing prior to testing.

2.11.3 Aural Alerting Unit. The AAU is a self-contained unit that delivers voice warning messages and nonverbal tones for cautions and advisories via the ICS. The AAU is activated in conjunction with the existing warning and caution light indicators. The signals that turn the caution and warning lights on and operate the RPM warning system activate the AAU. The AAU is controlled by the AURAL WARN circuit breaker and monitored by the AAU advisory light. AAU volume is slaved to the ICS volume setting. The AAU generates voice warning messages and two separate, discernible tones (one for cautions and one for advisories) for the helicopter systems as indicated in Figure 2-6.

The AAU delivers an 1100 Hz caution tone when the MASTER CAUTION light illuminates and a burst of three short 800 Hz advisory tones when an

Segment/Aural Signal	Condition	Action Required
MASTER CAUTION AAU: 1100 Hz tone.	Segment in CAUTION ADVISORY PANEL is illuminated.	Observe CAUTION ADVISORY panel. Reset MASTER CAUTION.
* ROTOR BRAKE AAU: "ROTOR BRAKE."	1. Rotor brake engaged. 2. Pressure applied. **Note** VSS and cyclic SCAS automatically disengage when hydraulic system No. 2 is shut off.	Place rotor brake handle down. If light remains illuminated, shut off hydraulic system No. 2. Monitor rotor rpm and land as soon as practicable. If light remains illuminated, land as soon as possible.
RPM AAU: "ROTOR RPM." If rotor rpm is low, a swept tone (whoop) is heard simultaneously.	Rotor rpm high or low. Engine rpm low or engine out (no AAU). **Note** VSS will automatically shut off when rotor rpm is not within operating limits.	Observe triple tach. Adjust rpm as required. Check engine instruments. Refer to ENGINE FAILURE. Land as soon as practicable.
* FIRE 1 PULL ** FIRE ENG 1 AAU: "NUMBER ONE ENGINE FIRE."	Fire in engine 1 area.	Collective — ADJUST. Throttle (No. 1 engine) — CLOSE. Wing stores — JETTISON (as appropriate). FIRE 1 PULL handle — PULL. FIRE EXT switch — MAIN. ENG 1 FUEL switch — OFF. FUEL CROSS FEED switch — AUTO. FUEL TANK INTCON switch — OPEN. MASTER CAUTION light — RESET. MAYDAY — BROADCAST. LAND AS SOON AS POSSIBLE. If fire persists — LAND IMMEDIATELY.

* — Pilot only
** — Copilot/gunner only

(TABLE I.D. 922040-1)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 1 of 9)

Segment/Aural Signal	Condition	Action Required
* FIRE 2 PULL ** FIRE ENG 2 AAU: "NUMBER TWO ENGINE FIRE."	Fire in engine 2 area.	Collective — ADJUST. Throttle (No. 2 engine) — CLOSE. Wing stores — JETTISON (as appropriate). FIRE 2 PULL handle — PULL. FIRE EXT switch — MAIN. Engine 2 FUEL switch — OFF. FUEL CROSS FEED switch — AUTO. FUEL TANK INTCON switch — OPEN. MASTER CAUTION light — RESET. MAYDAY — BROADCAST. LAND AS SOON AS POSSIBLE. If fire persists — LAND IMMEDIATELY.
* FIRE 1 PULL and FIRE 2 PULL ** FIRE ENG 1 and FIRE ENG 2 AAU: "DUAL ENGINE FIRE."	Fire in both engine areas.	Enter autorotation and close both throttles. FIRE 1 PULL handle — PULL. FIRE EXT switch — MAIN. ENG FUEL switches — OFF. FIRE 1 PULL handle — IN. FIRE 2 PULL handle — PULL. FIRE EXT switch — RESERVE. Broadcast MAYDAY.
* VSS LIMIT AAU: None.	VSS weight stroke exceeding 95% of electrical travel.	None. Light will extinguish when weight stroke is less than 85%.
ENG 1 CHIP or ENG 2 CHIP AAU: 1100 Hz tone.	Metal particles in oil of respective engine.	Reduce throttle on affected engine to idle. Land as soon as practicable. If secondary indications exist, execute single engine procedures.
OIL PRESS/BYP (ENG 1/ENG 2) AAU: 1100 Hz tone.	Engine oil pressure low. or Engine oil bypassing filter.	Check ENG OIL pressure. If oil pressure is in operating range or greater, reset MASTER CAUTION, monitor ENG OIL pressure, and land as soon as practicable. If oil pressure is below 30 psi, shut down affected engine and execute single engine procedures.

* — Pilot only
** — Copilot/gunner only

(TABLE I.D. 922040-2)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 2 of 9)

Segment/Aural Signal	Condition	Action Required
* ANTI-ICE ON (ENG 1/ENG 2) (Advisory light on when selected) AAU: Three 800 Hz tones.	Engine anti-icing system activated.	Verify engine anti-ice switch is in desired position. If system cannot be deactivated, observe N_g limits with anti-ice on. Check ANTI-ICE circuit breaker.
* INLET ANTI-ICE (ENG 1/ENG 2) AAU: 1100 Hz tone.	Engine inlet anti-icing system activated and inlet temp below 43 °F.	Check ENG INLET HTR PWR and CONT circuit breakers.
FUEL FILTER (ENG 1/ENG 2) AAU: 1100 Hz tone.	Engine fuel filter clogged.	Land as soon as practicable.
FWD FUEL LOW AAU: 1100 Hz tone.	Forward fuel cell fuel level low. **Note** When light is illuminated the crossfeed valve opens and fuel cell boost pumps are activated automatically.	FUEL TANK INTCON switch — OPEN. Land as soon as possible.
* FUEL VALVE AAU: 1100 Hz tone.	Fuel valves or crossfeed valve in transit or not in selected position.	Check ENG 1/ENG 2 FUEL and FUEL CROSS FEED switches for desired position. Check FUEL VALVE circuit breaker. Prepare for single-engine operation.
* CHIP DETR ** 90° CHIP 90° (GEARBOX CHIP indicator).	Metal particles in tail rotor gearbox oil.	Press PUSH TO CLEAR 42°/90° XMSN indicator a maximum of three times to clear first chip indication (minimum 2-second pause between presses). MASTER CAUTION — RESET. If light extinguishes, continue flight. If light does not extinguish or illuminates again, reduce power and reset MASTER CAUTION. Land as soon as practicable. If accompanied by 90° TEMP/PRESS caution light, be prepared to execute loss of tail rotor procedures. Land as soon as possible.

* — Pilot only
** — Copilot/gunner only

(TABLE I.D. 922040-3)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 3 of 9)

Segment/Aural Signal	Condition	Action Required
* CHIP DETR ** 42° CHIP 42° (GEARBOX CHIP indicator)	Metal particles in tail rotor gearbox oil.	Press PUSH TO CLEAR 42°/90° XMSN indicator a maximum of three times to clear first chip indication (minimum 2-second pause between presses). MASTER CAUTION — RESET. If light extinguishes, continue flight. If light does not extinguish or iluminates again, reduce power and reset MASTER CAUTION. Land as soon as practicable. If accompanied by 42° TEMP/PRESS caution light, be prepared to execute loss of tail rotor procedures. Land as soon as possible.
* CHIP DETR ** XMSN CHIP XMSN (GEARBOX CHIP indicator)	Metal particles in mast bearing oil, transmission oil, or transmission sump oil.	Press PUSH TO CLEAR 42°/90° XMSN indicator a maximum of three times to clear first chip indication (minimum 2-second pause between presses). MASTER CAUTION — RESET. If light extinguishes, continue flight. If light does not extinguish or illuminates again, land as soon as possible. If accompanied by XMSN TEMP/PRESS caution light, land immediately.
CHIP DETR C BOX CHIP 1, 2, SUMP (GEARBOX CHIP indicator)	Metal particles in engine 1 or 2 side, sump of combining gearbox, or throughout gearbox.	Press PUSH TO CLEAR 1, 2, SUMP indicator a maximum of three times to clear first chip indication (minimum 2-second pause between presses). MASTER CAUTION — RESET. If light extinguishes, continue flight. If light does not extinguish or illuminates during remainder of flight, land as soon as possible. If accompanied by C BOX TEMP/PRESS caution light, land immediately.
AFT FUEL LOW AAU: 1100 Hz tone.	Aft fuel cell fuel level low. **Note** When light is illuminated, the crossfeed valve opens and fuel cell boost pumps are activated automatically.	FUEL TANK INTCON switch — OPEN. Land as soon as practicable.

* — Pilot only
** — Copilot/gunner only

(TABLE I.D. 922040-4)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 4 of 9)

Segment/Aural Signal	Condition	Action Required
* NO. 1 FUEL PRESS or * NO. 2 FUEL PRESS AAU: 1100 Hz tone. **Note** FUEL PRESS lights monitor fuel cell boost pump pressure when the crossfeed valve is open. Engine-driven suction pump pressure is monitored when the crossfeed valve is closed.	1. Engine-driven suction fuel pump malfunction if crossfeed valve is closed.	1. FUEL CROSS FEED switch — OPEN. Verify FUEL TANK INTCON switch — OPEN. Verify affected engine FUEL PRESS light extinguished. Do not make rapid collective movements. Flight above 10,000 feet shall not be attempted. Land as soon as practicable. If affected engine has flamed out, follow procedures for single engine operations.
	2. Fuel cell boost pump malfunction if crossfeed valve is open.	2. Verify FUEL TANK INTCON switch — OPEN. Verify FUEL CROSS FEED switch — OPEN. FUEL PRESS circuit breaker (affected boost pump) — RESET IF OUT. If light does not extinguish, descend below 10,000 feet and land as soon as practicable.
* 42° TEMP/PRESS AAU: 1100 Hz tone.	42° gearbox oil temperature high and/or pressure low.	Establish and maintain forward airspeed. If indication persists, land as soon as possible.
* 90° TEMP/PRESS AAU: 1100 Hz tone.	Tail rotor gearbox oil temperature high and/or pressure low.	Establish and maintain forward airspeed. If indication persists, land as soon as possible.
NO. 1 HYD TEMP/PRESS or NO. 2 HYD TEMP/PRESS AAU: 1100 Hz tone.	No. 1 or No. 2 hydraulic system hydraulic fluid temperature high and/or pressure low.	Verify HYD PRESS. Affected system — OFF. HYDR CONT circuit breaker — IN. If SYS 2 failure, switch VSS to OFF and monitor XMSN and GRBX OIL temperature if OIL COOLER switch in SEC. Land as soon as possible. If XMSN or C BOX TEMP/PRESS caution light illuminates, land immediately.

* — Pilot only

(TABLE I. D. 922040-5)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 5 of 9)

Segment/Aural Signal	Condition	Action Required
XMSN TEMP/PRESS AAU: 1100 Hz tone.	Transmission oil temperature high and/or pressure low.	Verify condition on XMSN OIL gauge. If problem is temperature, check GRBX OIL temperature. If GRBX OIL temperature is also high, position OIL COOLER switch to SEC and land as soon as practicable. (In SEC position the VSS will automatically shut off.) If XMSN OIL temperature remains above limit or pressure is below limit, land as soon as possible. If XMSN OIL pressure is zero, be prepared to execute impending transmission failure procedures.
C BOX TEMP/PRESS AAU: 1100 Hz tone.	Combining gearbox oil temperature high and/or pressure low.	Verify condition on GRBX OIL TEMP/PRESS gauge. If problem is temperature, position OIL COOLER switch to SEC. (In SEC position, the VSS will automatically shut off). Land as soon as practicable. If temperature does not return to normal operating limits or if oil pressure is below limit, land as soon as possible. If oil pressure is zero, be prepared to execute impending transmission failure procedures.
NO. 1 DC GEN AAU: 1100 Hz tone.	No. 1 Dc generator failed.	Check AMPS gauge. If generator not operating, GEN NO. 1 — RESET then ON. If output not restored, GEN NO. 1 switch — OFF. Land as soon as practicable.
XMSN OIL BYP AAU: 1100 Hz tone.	Transmission oil bypassing oil cooler.	Monitor XMSN OIL temperature. Reduce power as required to maintain temperature within limits. Reset MASTER CAUTION and land as soon as practicable. If oil temperature is above limit, land as soon as possible.

(TABLE I.D. 922040-6)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 6 of 9)

Segment/Aural Signal	Condition	Action Required
XMSN OIL COOLER AAU: 1100 Hz tone. **CAUTION** If oil cooler blower is inoperative, GRBX OIL temperature will rise rapidly (approximately 28 °C/MIN) even if power is reduced.	Loss of utility hydraulic system pressure to primary oil cooler blower motor if OIL COOLER switch in NORM. Hydraulic system No. 2 pressure lost to secondary oil cooler blower motor if OIL COOLER switch positioned to SEC.	If OIL COOLER switch in NORM, position OIL COOLER switch to SEC. Reset MASTER CAUTION. Monitor XMSN and GRBX OIL temperature and land as soon as practicable. If XMSN or C BOX TEMP/PRESS caution light illuminates, land as soon as possible. If OIL COOLER switch in SEC, monitor XMSN and GRBX OIL temperature and land as soon as possible. If XMSN or C BOX TEMP/PRESS caution light illuminates, land immediately.
NO. 2 DC GEN AAU: 1100 Hz tone.	No. 2 Dc generator failed.	Check AMPS gauge. If generator not operating, GEN NO. 2 — RESET then ON. If output not restored, GEN NO. 2 — OFF. Land as soon as practicable.
NO. 1 BATT SYS or NO. 2 BATT SYS AAU: 1100 Hz tone.	No. 1 or No. 2 battery failed. Cell imbalance in battery. Defective charger/monitor. Battery temp above 145 °F.	Reset MASTER CAUTION. If light does not extinguish within 5 minutes, affected BATT switch — OFF. Land as soon as practicable.
AAU AAU: None.	Aural alerting unit has a BIT failure or loss of power to the AAU.	AURAL WARN circuit breaker — IN. If output not restored, circuit breaker OUT.
UTILITY HYD AAU: 1100 Hz tone.	Utility hydraulic system pressure low and/or temperature high or utility hydraulic system has failed. (Refer to caution in XMSN OIL COOLER light.)	Position OIL COOLER switch to SEC and reset MASTER CAUTION. Monitor XMSN and GRBX temperature. Land as soon as practicable. If XMSN or C BOX TEMP/PRESS caution light illuminates, land as soon as possible.

(TABLE I.D. 922040-7)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 7 of 9)

Segment/Aural Signal	Condition	Action Required
NO. 1 BATT TEMP or NO. 2 BATT TEMP AAU: 1100 Hz tone.	No. 1 battery temperature high. No. 2 battery temperature high.	BATTERY NO. 1 or NO. 2 — OFF. If light does not extinguish, land as soon as possible. Shut down helicopter.
AC MAIN AAU: 1100 Hz tone.	Main inverter failed.	INVERTER MAIN circuit breaker — IN. If light remains illuminated, INVERTER MAIN circuit breaker — OUT. INV switch — STBY. MASTER CAUTION — RESET. Land as soon as practicable.
AC STBY AAU: 1100 Hz tone.	Standby inverter failed.	INVERTER STBY circuit breaker — IN. If light remains illuminated, INVERTER STBY circuit breaker — OUT.
SAM APR-44 audio tone.	SAM threat radar signal detected by radar warning system.	Appropriate countermeasures.
AI (APR-44 provisions only)	Airborne threat radar signal detected by radar warning system.	Appropriate countermeasures.
* IRCM AAU: 1100 Hz tone.	AN/ALQ-144 countermeasures system inoperative.	Position IRCM control panel switch to OFF.
* HUD AAU: 1100 Hz tone.	HUD inoperative.	Check HUD PWR circuit breaker. Run BIT a second time. Check HUD light extinguished.
* IFF AAU: 1100 Hz tone.	Mode 4 IFF inoperative (or not properly keyed).	Select alternate code on IFF control panel.

* — Pilot only

(TABLE I.D. 922040-8)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 8 of 9)

Segment/Aural Signal	Condition	Action Required
* AMMO DOOR OPEN AAU: 1100 Hz tone.	Ammo bay or external door(s) open.	Secure appropriate door(s).
* EXT PWR DOOR OPEN AAU: 1100 Hz tone.	External power door not secured.	Secure door.

* — Pilot only

(TABLE I.D. 922040-9)

Figure 2-25. Warning, Caution, and Advisory Panel Segments (Sheet 9 of 9)

advisory segment illuminates. When a BIT check of the AAU is initiated with the RESET TEST switch on the pilot caution advisory panel, the voice warning messages are delivered in the following sequence: dual engine fire, No. 1 engine fire, No. 2 engine fire, rotor brake, rotor rpm, followed by two discernible tones (1100 Hz and 800 Hz). AAU voice messages can be silenced by pressing either MASTER CAUTION light. AAU tones can be silenced by pressing either MASTER CAUTION light or positioning the pilot RESET switch on the caution panel to RESET. The AAU is powered by the 28-vdc essential bus and protected by the AURAL WARN circuit breaker.

2.12 FIRE DETECTION SYSTEM

Each engine compartment is equipped with a heat sensing loop for fire detection. An overheat condition in an engine compartment causes the appropriate engine fire warning light (FIRE 1 PULL/ FIRE 2 PULL) to illuminate (Figure 2-26). A FIRE WARN TEST switch allows testing of the sensor loops. The AAU also provides a voice warning message on the ICS when an overheat condition is present in the engine compartment.

2.12.1 Fire Warning System. Fire warning lights are located in the FIRE 1 PULL and FIRE 2 PULL handles on the pilot instrument panel (Figure 2-26). Two lights are located in the copilot/gunner panel and indicate FIRE ENG 1 and FIRE ENG 2 when illuminated. The pilot and copilot/gunner lights are connected in parallel, and both sets of lights illuminate when energized. A FIRE WARN TEST switch is located on the miscellaneous control panel mounted on the pilot instrument panel. The switch is spring-loaded to the off position. The TEST position causes all four fire warning lights to illuminate, indicating the system is operational. The detector elements are heat sensing wire loops connected to the fire detector control unit. These elements have high electrical resistance at normal ambient temperatures. However, their resistance drops rapidly when heated. The fire detector control unit senses the low resistance from any overheat condition and illuminates the appropriate fire warning light. If the overheat condition is corrected without damage to the detector elements, the fire warning lights will extinguish when the elements cool down and their resistance increases. Power is

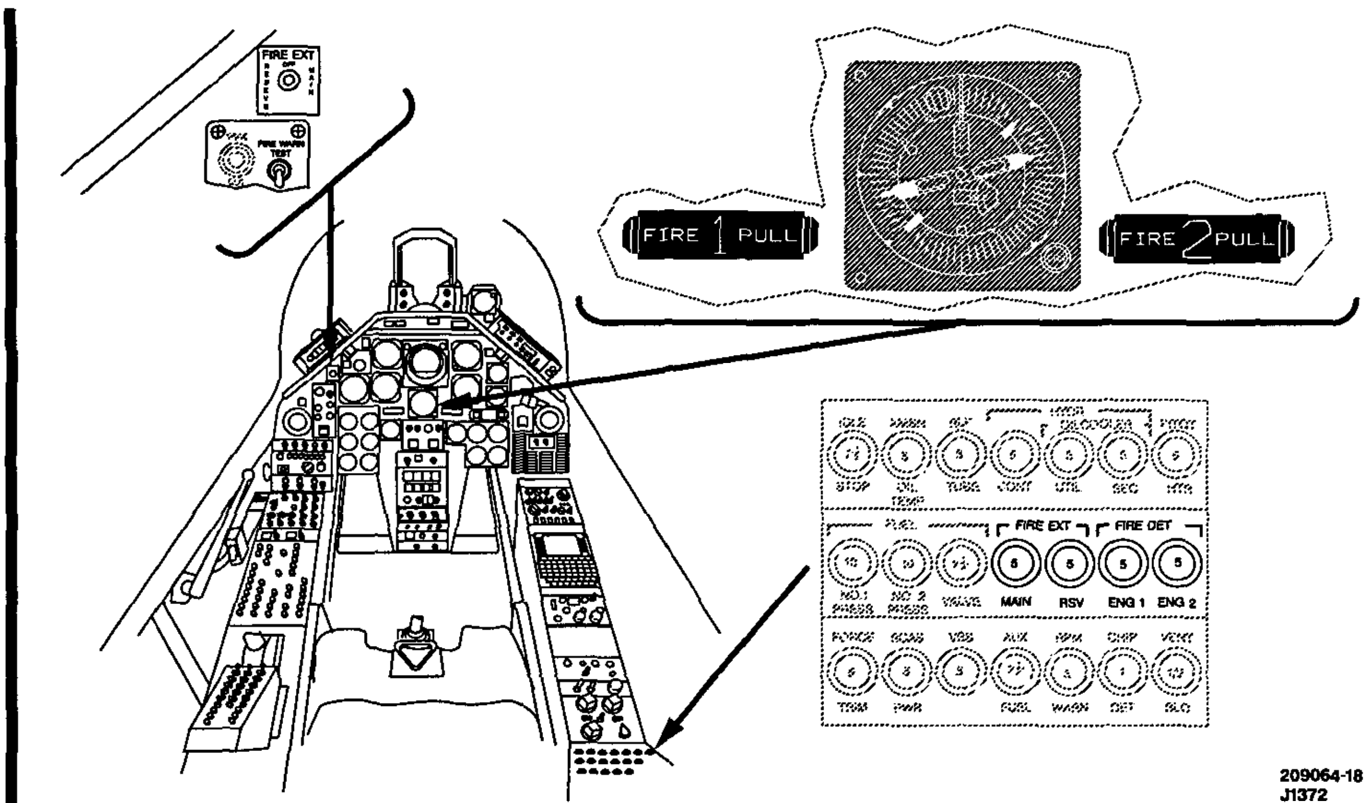


Figure 2-26. Fire Detection and Extinguishing System

supplied by the 28-vdc essential bus and protected by FIRE DET ENG 1 and FIRE DET ENG 2 circuit breakers.

CAUTION

Do not actuate the FIRE WARN TEST switch more than 15 seconds. Prolonged use will overheat the detector elements.

2.12.2 Engine Fire Extinguishing System.

Two fire extinguisher bottles are mounted in the oil cooler compartment for extinguishing engine compartment fires. Plumbing, from the bottles to outlet nozzles, and electrical actuating systems are designed to permit using either or both bottles to extinguish a fire in either engine compartment.

Illumination of either FIRE PULL warning light indicates excessive heat in the respective engine compartment (Figure 2-26). Pulling the FIRE PULL handle will shut off fuel to the affected engine, deactivate the ECU and rain removal circuits, and arm both fire extinguisher bottles. Setting the FIRE EXT switch to either MAIN or RESERVE will discharge the selected bottle into the affected engine compartment. The main fire extinguishing bottle should be selected first. To use the reserve bottle lift and move the FIRE EXT switch to the RESERVE position. FIRE PULL light illumination is not required to discharge the extinguishers.

The 28-vdc essential bus supplies power. The FIRE EXT circuit breaker provides circuit protection.

CAUTION

Pulling a FIRE PULL handle and setting the FIRE EXT switch to MAIN will result in that bottle being discharged into the selected engine compartment. However, when both FIRE PULL handles are pulled out and the FIRE EXT switch is set to the MAIN position, the bottle will not discharge. If the switch is then set to the RESERVE position, only one bottle will discharge. The discharged extinguishing agent will be routed to both engine areas and could be ineffective in either engine area.

2.13 INGRESS/EGRESS SYSTEM

2.13.1 Crew Compartment Doors.

Pilot and copilot/gunner access (Figures 2-27 and 2-28) is provided by canopy doors that are hinged at the top and swing outward and up. The pilot canopy door opening is on the right side and the copilot/gunner canopy door is on the left side.

Both doors are opened or closed manually with an assist from a pneumatic strut from inside or outside. To open either door from the closed position, turn the door handle and raise the door; it will automatically extend to the full-open position. To close the canopy door, pull the door shut and turn the door handle to the closed position. The doors may only be placed in the full-open or closed position.

CAUTION

Crew compartment doors may depart the helicopter if opened in flight.

2.13.2 Canopy Removal System. The canopy removal system (CRS) provides for rapid crew egress in emergency situations (Figures 2-27 and 2-28). The system consists of a linear explosive system used to cut the side windows from the canopy support structure, three arm/fire mechanisms, and the interconnecting lines of flexible, confined, detonating cord. The arm/fire mechanisms are manually activated, percussion-type detonators. When fired, all four window cutting assemblies will be immediately detonated to blow the four side windows outward in fragments, leaving an empty frame for egress or ingress.

2.13.2.1 Nose Mounted CRS Ring. The external, nose mounted CRS mechanism is equipped with a canopy removal system ring for external activation of the CRS system. To actuate the system, ROTATE THE RING 90° COUNTERCLOCKWISE AND PULL.

2.13.2.2 Cockpit CRS Handles. The cockpit, yellow-striped canopy removal system handles are installed in the arm/fire mechanisms as shown in Figures 2-27 and 2-28. The system can be actuated by either of the handles or the nose mounted ring. The CRS handles have a safety pin with streamer (REMOVE BEFORE FLIGHT) to prevent accidental firing of the system. The pins must be pulled before the system can be actuated. To actuate the system from the CM cockpit, PULL THE HANDLE COMPLETELY OUT OF THE ARM/FIRE MECHANISM. To actuate the system from the B cockpit, ROTATE THE HANDLE 90° COUNTERCLOCKWISE AND PULL.

WARNING

- Helmet visors shall be down prior to activation of the CRS to preclude possible eye injury.
- When the system is actuated, debris may be expelled 50 feet outward from the helicopter.
- The CRS handle/ring must be pulled completely out of the arm/fire mechanism or the CRS may not detonate.
- The CRS handle must be pulled straight out of the arm/fire mechanism without bending the initiator or extreme force will be required to remove the initiator and actuate the system.
- Activation of the CRS when combustible fuel and/or vapors are present may result in an explosion/fire. The canopy breakout knife or survival knife can be used as an alternate means of egress when combustible fuel and/or vapors are present.
- Simultaneous or near simultaneous pulling of both pilot and copilot/gunner arm/fire mechanism handles may result in injury to one or both crew members. The pilot and copilot/gunner must coordinate prior to firing the system.

2.14 ENVIRONMENTAL CONTROL SYSTEM

2.14.1 Environmental Control Unit. The ECU is located in the hydraulic compartment. Air for the ECU is bled from the engine compressors. Conditioned air from the ECU is supplied through the air distribution system. The ECU is subject to automatic shutoff because of priority demand for engine bleed air in the event engine oil pressure is 15 psig or below or a FIRE PULL handle is pulled. The automatic control function of the ECU energizes the ventilation blower, providing a backup ventilating function for the system.

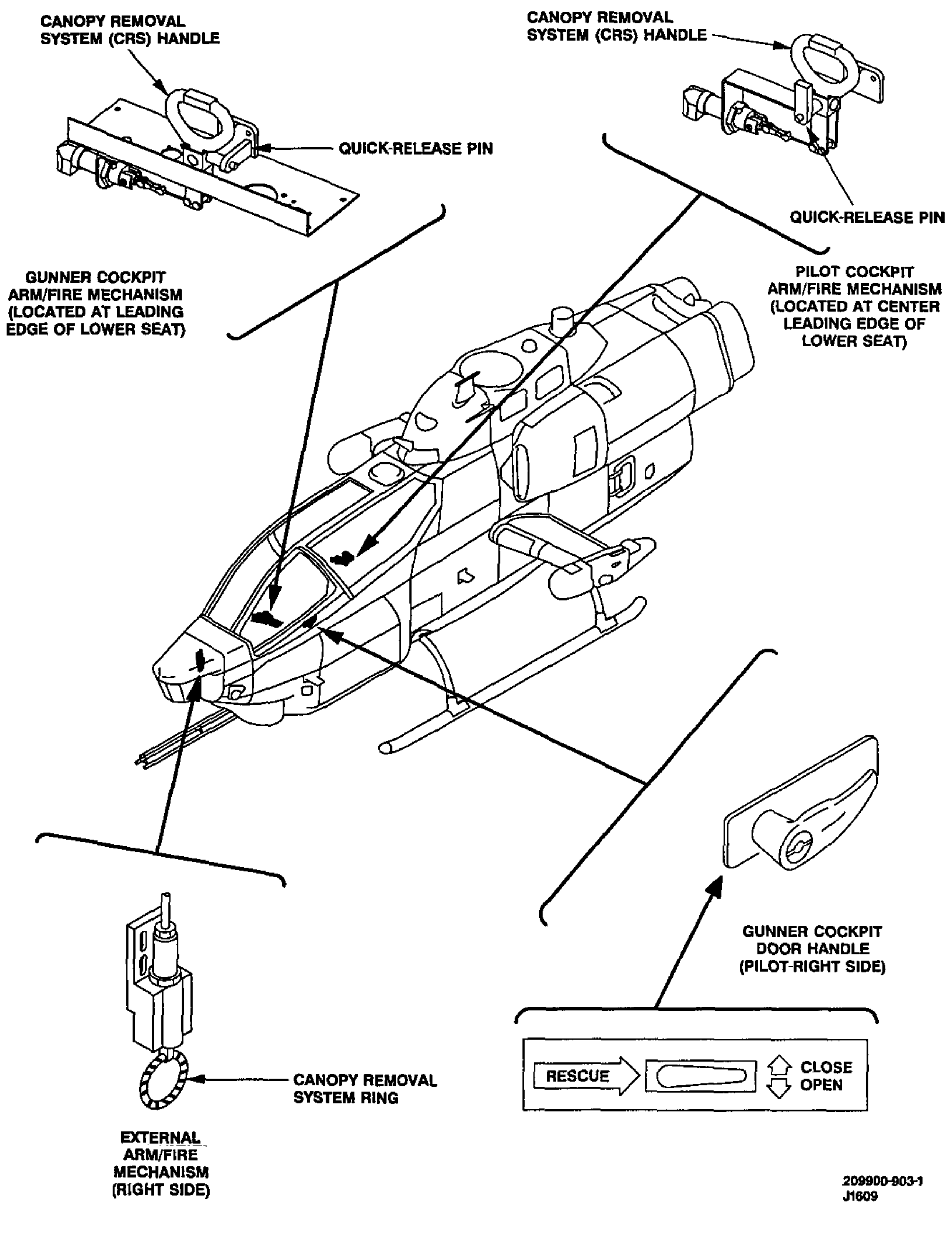


Figure 2-27. CM Ingress/Egress Systems

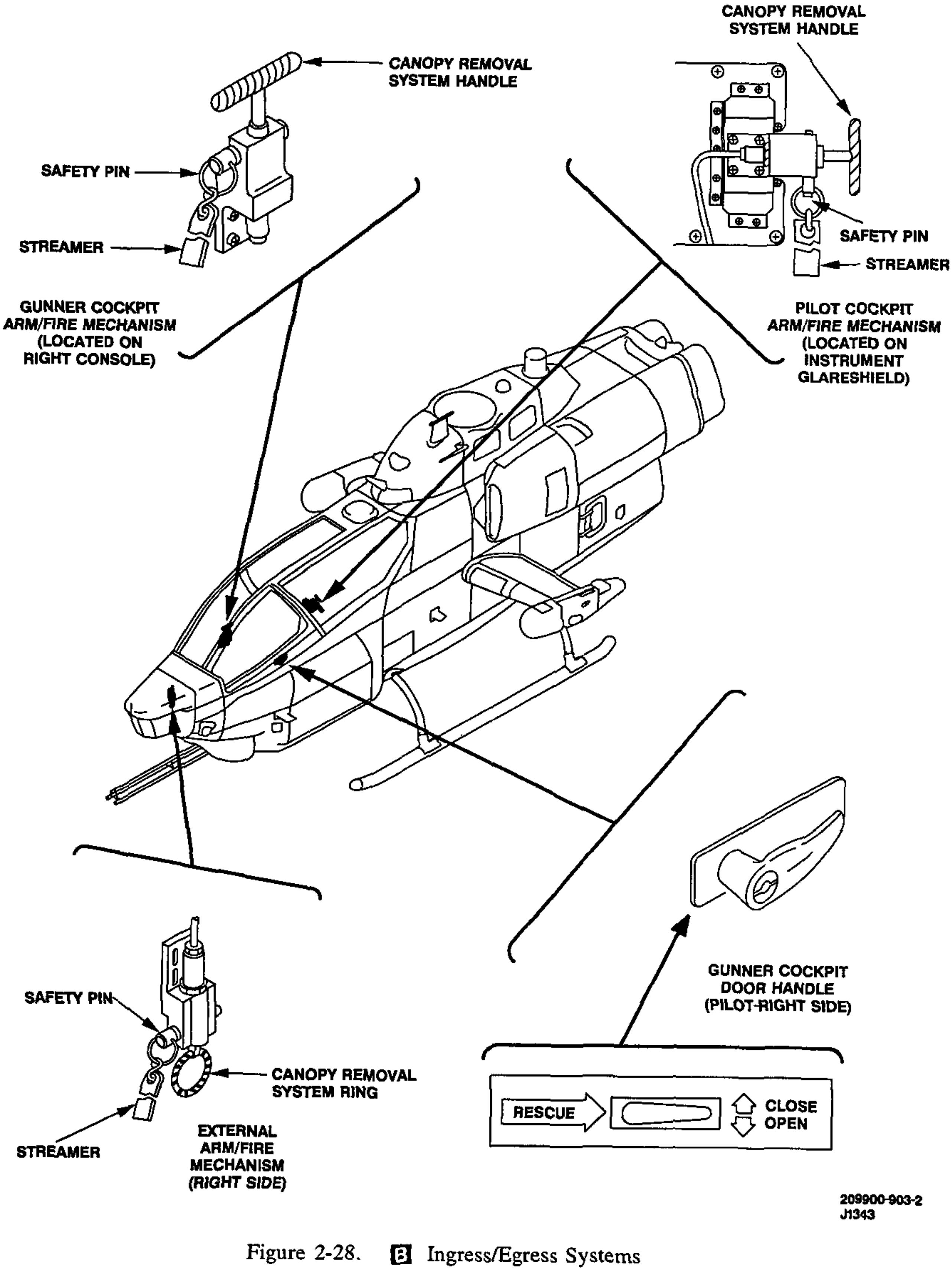


Figure 2-28. B Ingress/Egress Systems

Setting the ECU/VENT switch (Figure 2-29) to the ECU position actuates the unit. The COOL/ WARM knob, located on the control panel in the pilot right console, regulates the temperature of the outlet air.

Power is supplied by the 28-vdc essential bus and protected by the ECU PWR circuit breaker. The RAIN REM and ECU switches should be in the OFF or VENT position during flight conditions requiring maximum engine performance because of reduction in engine power available.

2.14.2 Ventilating System. Ventilating air is supplied through air inlets located on the leading edge of the pylon fairings. An electrical blower provides forced air throughout the distribution system. Setting the ECU/VENT switch (Figure 2-29) to VENT actuates the system. The pilot has an adjustable outlet on each side of the instrument panel and one between the tail rotor control pedals. The copilot/gunner has one outlet on the left side of the instrument panel, or by the right side armament panel, and one between the tail rotor control pedals. Airflow volume is regulated by the butterfly valve in the outlets.

Ventilating air is also routed through the pilot and copilot/gunner seat and back cushions. Power is supplied by the 28-vdc essential bus and protected by the VENT BLO circuit breaker.

WARNING

Should the bleed air valve fail in the OPEN position with the temperature control in the COOL position and the cockpit air inlets partially or fully closed, the ECS duct system can expand causing cyclic control interference or binding. Increased force required to move the cyclic may not overcome this condition.

2.14.3 Defrosting/Defogging. The ECU provides heated air for defrosting and defogging. The outlets on the pilot instrument panel shroud provide air for defrosting and defogging the side canopy areas.

2.15 AVIONIC EQUIPMENT COOLING

The avionics and TOW compartments are cooled by two blowers located under the ammunition bay floor. The TOW blowers are powered by the 28-vdc essential bus and controlled by the TOW SYS BLWR circuit breaker.

2.16 RAIN AND ICE REMOVAL SYSTEM

Removal of rain or ice from the forward window panel is accomplished by setting the RAIN REM switch to RAIN REM (Figure 2-29). The switch is located in the ECU panel on the pilot right console. When the RAIN REM switch is actuated, a bleed air valve opens and bleed air mixed with outside air is directed to the base of the forward windshield. Power is supplied by the 28-vdc nonessential bus and protected by the ECU PWR circuit breaker.

CAUTION

The rain removal system should be turned off as soon as cleared vision will permit. Heat may melt the windshield if operated for a prolonged period on a dry windshield.

Note

A decrease in power available can be expected when operating the ECU and/or the rain removal system.

2.17 PERSONNEL EQUIPMENT

2.17.1 Pilot Seat. The pilot seat is a vertically adjustable, nonreclining type, installed at a reclined angle of 15°. The vertical height adjustment is on the left side of the seat. The back, bottom, and side panels are made of ceramic and fiberglass composite armor.

Additional protection is provided by side shoulder panels that can be installed on or removed from the basic seat. The seat is equipped with seat and back cushions, lap safety belt, and inertia reel shoulder harness.

2.17.2 Copilot/Gunner Seat. The copilot/gunner seat is a fixed seat installed at a reclined angle of 15°. The seat is made of ceramic and fiberglass composite armor. The seat is equipped with a lap safety belt, inertia reel shoulder harness, and seat and back cushions. Arm rests are provided for each side of the seat.

2.17.3 Seatbelts and Harnesses. Seatbelts, inertia reels, and shoulder harnesses are installed on the pilot and copilot/gunner seats. Each seat incorporates a manual lock-unlock control handle. When the control handle is in the unlocked position, the inertia reel cable will extend to allow the occupant to lean forward. However, the reel will automatically lock when the helicopter encounters an impact force in excess of a 2g deceleration. Locking of the reel can be accomplished with the harness at any position, and the reel will automatically take up the slack in the harness. To release the lock, it is necessary to lean back slightly to release tension on the lock and move the control handle to the lock and then unlock position. It is possible to have pressure against the seat whereby no additional movement can be accomplished and the lock cannot be released. If this condition occurs, it will be necessary to loosen the shoulder harness. The reel should be manually locked for takeoff and landing.

2.18 EMERGENCY EQUIPMENT

2.18.1 First-Aid Kit. An aeronautical-type first-aid kit is located on the aft bulkhead of the pilot compartment.

2.18.2 Handheld Fire Extinguisher. A portable fire extinguisher is located on the bulkhead to the left of the copilot/gunner seat.

WARNING

When using the handheld CF_3Br Halon 1301 extinguishers for aircraft in-flight fires, asphyxiation or degraded human motor capabilities will occur with inadequate ventilation.

2.19 MISCELLANEOUS EQUIPMENT

2.19.1 Data Case. The data case is mounted on the left armor panel in the pilot compartment.

2.19.2 Rear-View Mirror. A rear-view mirror is located in the copilot/gunner compartment above the UHF EMER switch.

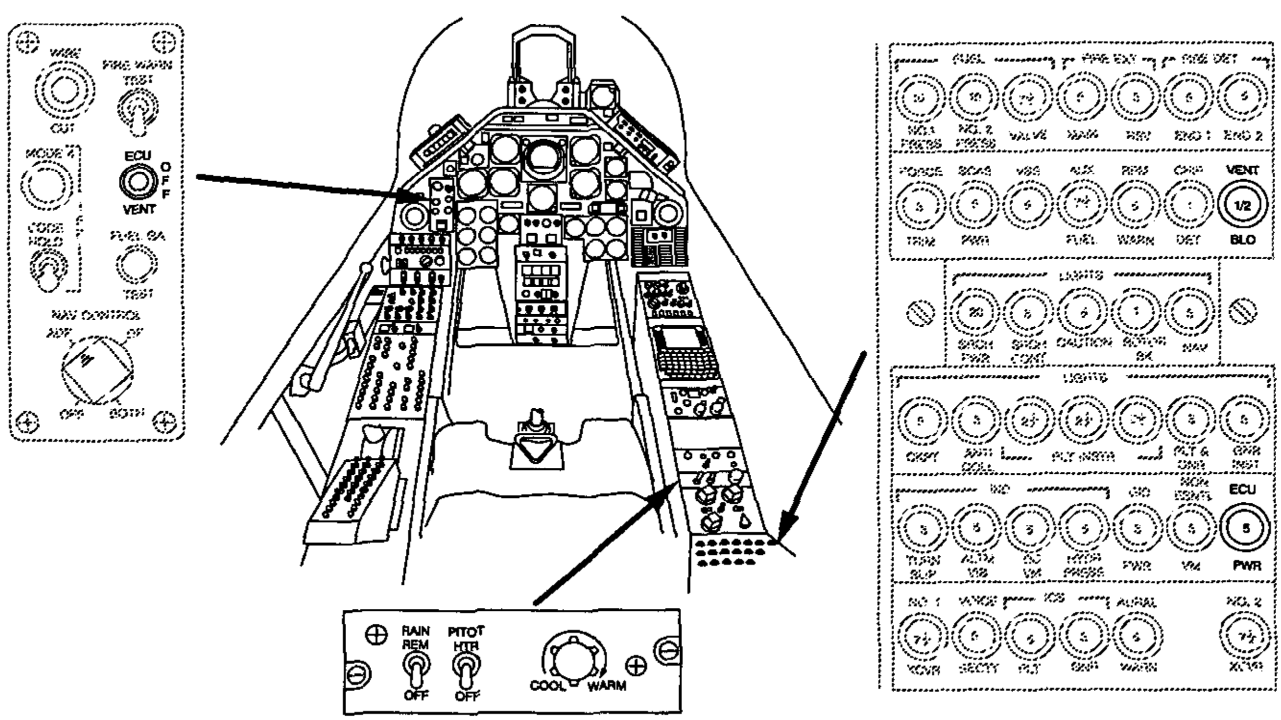


Figure 2-29. Environmental System Controls

2.19.3 Relief Tubes. The relief tubes are located in the pilot and copilot/gunner compartments. The system is vented overboard on the underside of the helicopter and provided with three strip heaters to prevent freezeup. The heating strips are designed to energize at temperatures below 40 ±5 °F and not to exceed an operating temperature of 70 ±5 °F. Power is supplied by the 28-vdc essential bus. Control and protection of the circuit is provided by the RLF TUBE circuit breaker.

2.19.4 Engine Inlet Screens. Engine inlet screens are provided for both engine inlets. The screens are removable and shall be installed when flight into possible icing conditions or unusual FOD danger areas (such as low level/hover maneuvers in an area of cut, long-bladed grass or loose gravel) is expected. The screens are not required for normal operation.

2.20 WIRE STRIKE PROTECTION

The wire strike protection consists of deflectors and three cutters installed on the upper and lower portions of the forward fuselage. The deflectors and cutters are designed to guide wire toward the base area where the cutting edge is located (Figure 1-1).

CHAPTER 3
Service and Handling

3.1 SERVICING DATA

The servicing data is presented by systems and components. Figure 3-1 illustrates servicing points and sight gauges for replenishment of nitrogen charge, hydraulic fluid, oil, and fuel. If necessary, refer to Figures 2-1 and 2-5 for a better definition of servicing points and sight gauges for the respective components. Figure 3-2 provides detailed illustrations of the main transmission and gearboxes for identification of the related chip detectors. Fuel, oil, hydraulic fluid, and nitrogen specifications for the helicopter are shown in Figure 3-3. System capacities are shown in Figure 3-4.

3.2 ENGINE WASH PROCEDURES

There are two types of engine wash procedures: the engine performance recovery/gas path cleaning wash and the engine desalinization rinse.

The ENG WASH switch is located on top of the pilot left console outboard of the engine control panel.

Only personnel designated by commanding officers shall be authorized to conduct engine motoring wash procedures.

3.2.1 Engine Performance Recovery/Gas Path Cleaning Wash.

CAUTION

Engine MGT shall be 125 °C or less before water or cleaning solution is sprayed into the engine. If necessary, the starter may be motored to reduce MGT. Starter limitations shall be observed. If an APU is used as the electrical power source for engine wash/rinse procedures, the APU current limiter shall be set at 750 amps when motoring the engine during wash/rinse cycles.

1. Armament — OFF/SAFE.
2. Water wash tank — Connect to engine wash connector on engine to be washed.
3. Rotor brake — As Required.
4. BATT NO. 1 and NO. 2 switches — ON.
5. MASTER CAUTION circuit breaker — PULL.
6. APU — CONNECT (set 26 to 29 vdc).
7. ENG WASH switch — WASH.
8. ENG START switch — ON. Simultaneously turn on cleaning solution supply system and motor engine for 15 seconds.
9. ENG START switch — OFF. Continue applying cleaning solution for 15 seconds during coastdown.
10. Cleaning solution supply — OFF.
11. Allow solution to soak in engine and starter to cool for 10 minutes.
12. Repeat steps 7 through 11.
13. Cleaning solution supply — Disconnect.
14. Rinsing solution supply — Connect and pressurize tank.
15. Accomplish steps 7 through 11 with rinsing solution.
16. Rinsing solution supply — Disconnect.
17. ENG WASH switch — Normal Start.

Note

During the cooldown period, allow residual water to drain from wash manifold and prepare for an engine run. The time required to obtain engine light-off will be several seconds longer than with a fully dried engine.

18. Perform a normal engine start (Refer to paragraphs 7.9 and 7.10.)
19. ANTI-ICE ENG 1/ENG 2 — ON.

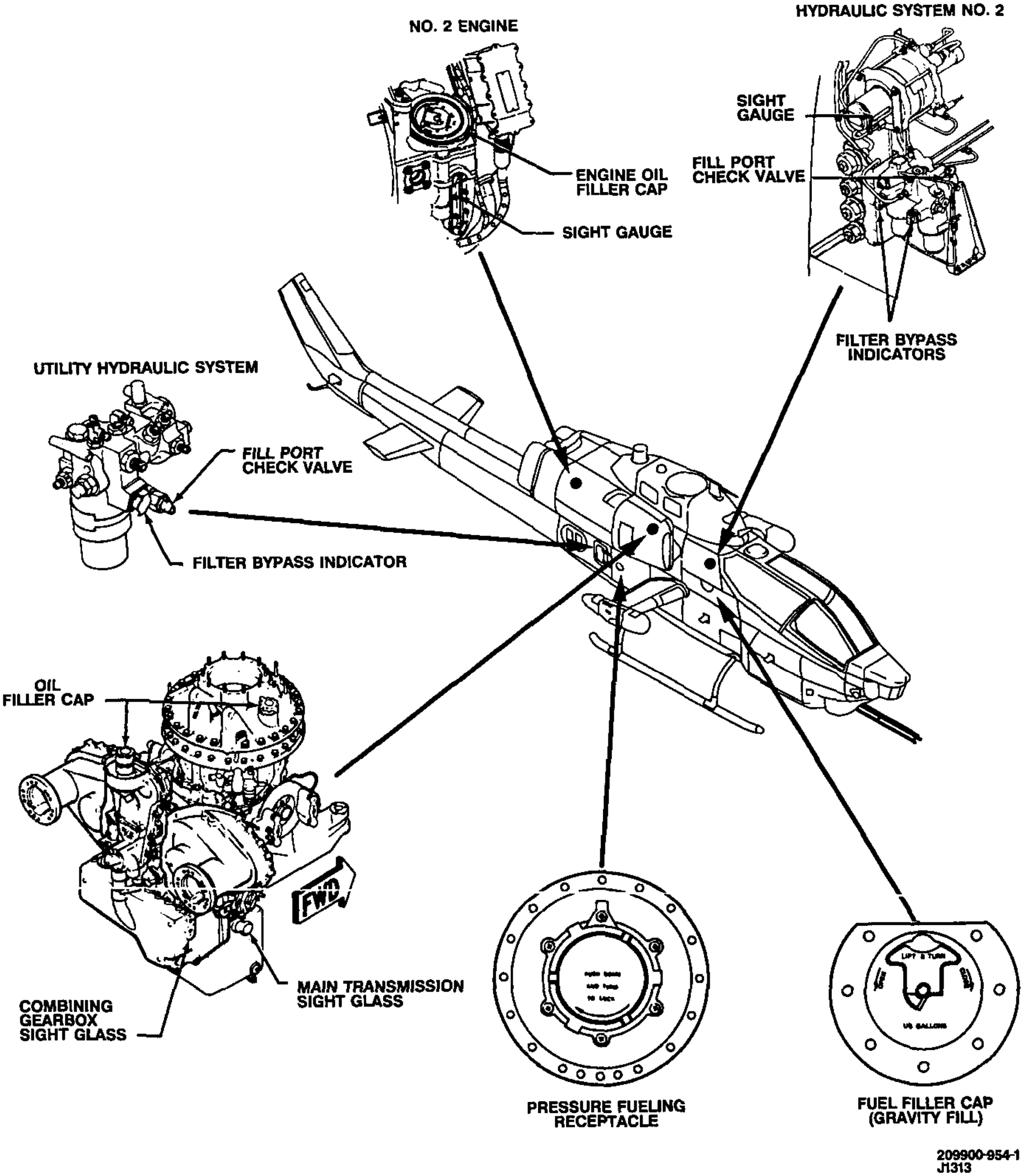


Figure 3-1. Servicing Diagram (Sheet 1 of 2)

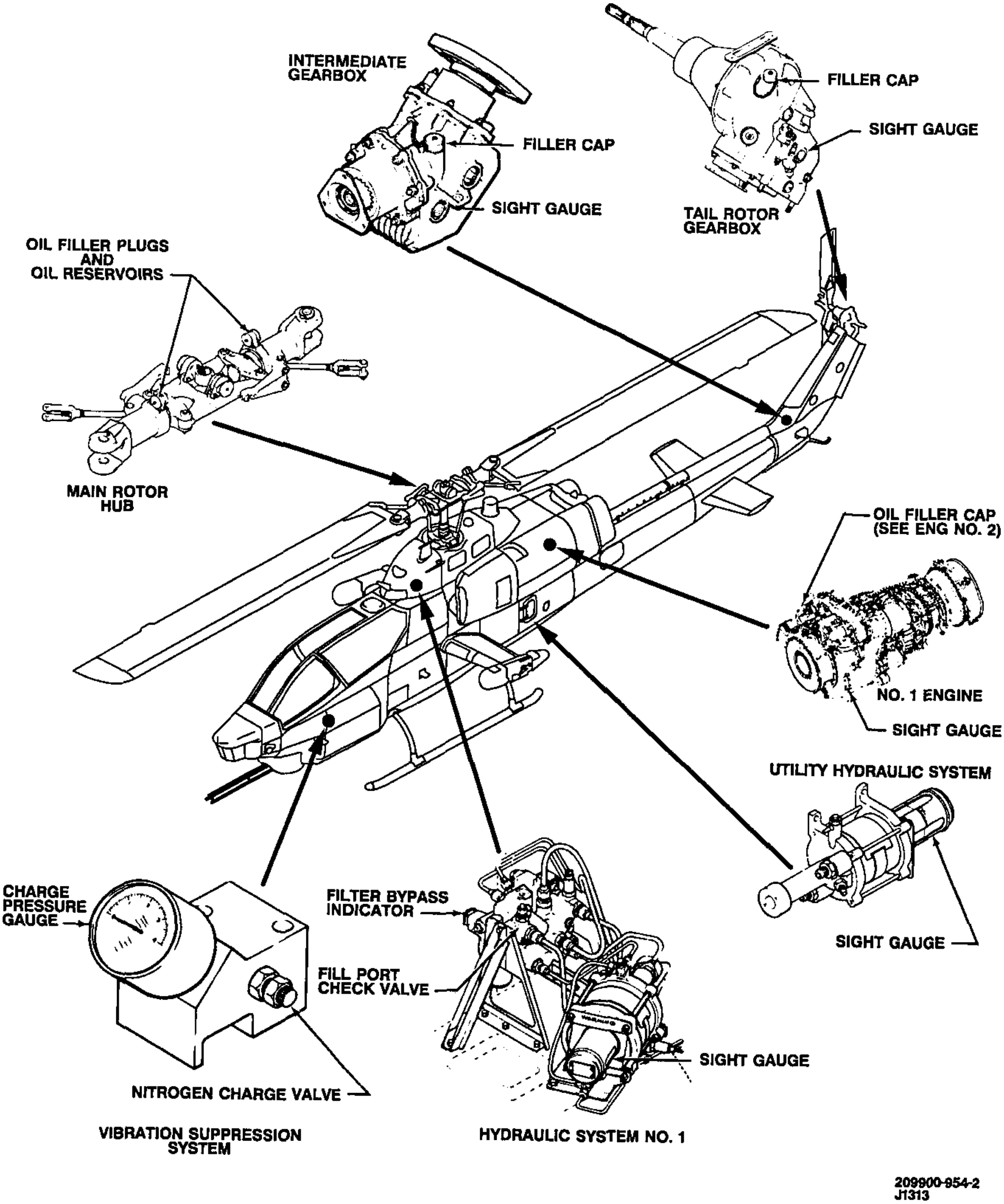
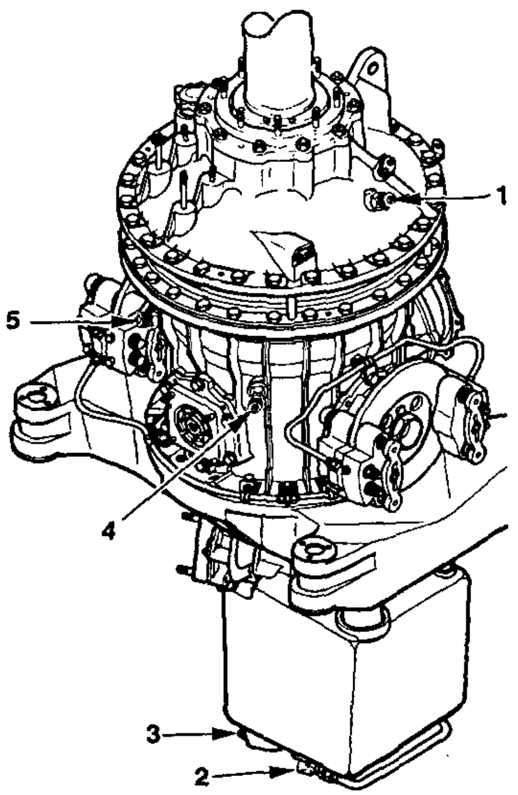
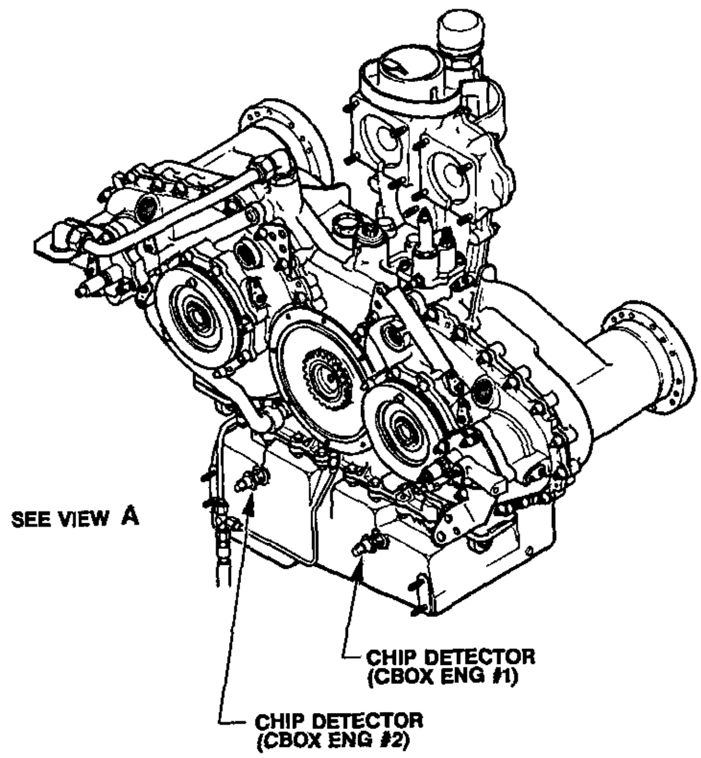


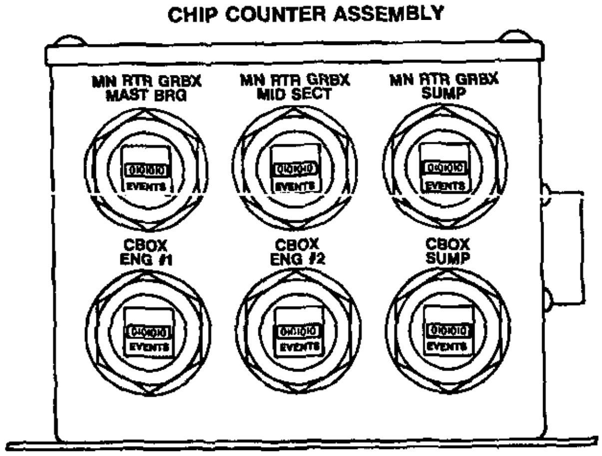
Figure 3-1. Servicing Diagram (Sheet 2 of 2)



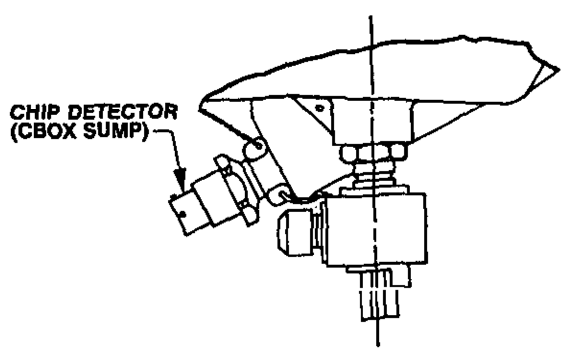
1. MAST BEARING CHIP DETECTOR
2. LEFT SIDE SUMP CHIP DETECTOR
3. RIGHT SIDE SUMP CHIP DETECTOR
4. LEFT SIDE PLANETARY CHIP DETECTOR
5. RIGHT SIDE PLANETARY CHIP DETECTOR



CHIP COUNTER ASSEMBLY



LOCATED ON ECU COMPARTMENT
AFT BULKHEAD, LEFT SIDE



VIEW A
LOOKING AFT

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Figure 3-2. Transmission/Gearbox Chip Detector Locations (Sheet 1 of 2)

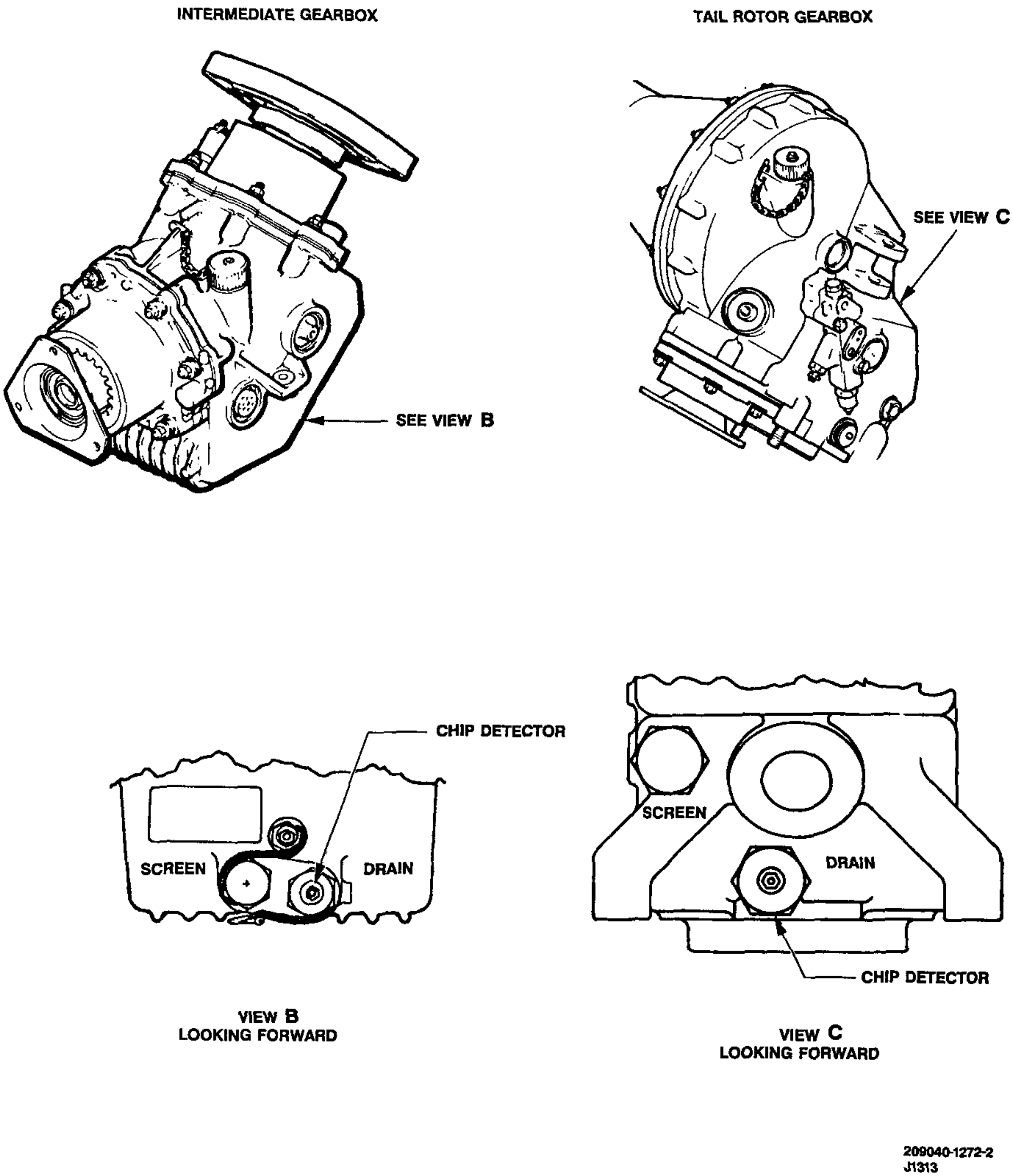

Figure 3-2. Transmission/Gearbox Chip Detector Locations (Sheet 2 of 2)

SYSTEM	SPECIFICATION		
	STANDARD	ALTERNATE	
FUEL	JP-5 (MIL-T-5624) JP-4 (MIL-T-5624) JP-8 (MIL-T-83133)	ASTM D-1655 JET A JET A-1 JET B	
OIL			NATO SYMBOL
Engines	MIL-L-23699	MIL-L-7808	O-156 O-148
Combining gearbox Transmission Intermediate gearbox Tail rotor gearbox	DOD-L-85734 (AS)	AEROSHELL 555 ROYCO 555 EXXON ETO25 MIL-L-7808 * MIL-L-23699 •	—— O-148 O-156
Main rotor hub grips	MIL-L-46152	Any high detergent 10W 30 oil	——
HYDRAULIC FLUID			
Flight control and utility systems	MIL-H-83282	MIL-H-5606	H-537 H-515
VSS ACCUMULATOR NITROGEN	BB-N-411C Type 1 Grade B Class 2		——

* Use for operation at sustained ground temperature below -40 °C.
• *Emergency use only. Avoid excessive dilution of Aeroshell or Royco 555 oils.*

* NATO SYMBOL	U.S. MILITARY SPEC MIL-T-5624 GRADES	U.S. COMMERCIAL SPEC ASTM D-1655-62T GRADES	U.K. GRADES
F-44	*** JP-5	**** JET A	AVCAT/48
F-40	JP-4	** JET B	AVTAG
F-34	JP-8	JET A-1	AVTUR/50

* *The NATO symbols denote general types of fuels as manufactured under* several national military and commercial specifications, and can be applied to products meeting a general category. Fuels having the same NATO symbol are interchangeable for use by military aircraft.

** *Equivalent to JP-4 except that freezing point is -50 °C vice -58 °C.*

*** F-44 approved fuel afloat.

**** Equivalent to JET A-1 except freezing point is -40 °C vice -50 °C.

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Figure 3-3. Specification Sheet

SYSTEM	CAPACITY (US)		
	USABLE	UNUSABLE	TOTAL
FUEL			
TOTAL (INTERNAL)	298 GAL	6 GAL	304 GAL
OIL			TOTAL
ENGINE NO. 1	3.8 QUARTS	3.5 QUARTS	7.3 QUARTS
ENGINE NO. 2	3.8 QUARTS	3.5 QUARTS	7.3 QUARTS
COMBINING GEARBOX INCLUDING COOLER	14 QUARTS	6 QUARTS	20 QUARTS
TRANSMISSION INCLUDING COOLER	16 QUARTS	4 QUARTS	20 QUARTS
INTERMEDIATE GEARBOX	3.5 PINTS	—	3.5 PINTS
TAIL ROTOR GEARBOX	4.5 PINTS	—	4.5 PINTS
MAIN ROTOR HUB GRIP NO. 1	2.5 PINTS	—	2.5 PINTS
MAIN ROTOR HUB GRIP NO. 2	2.5 PINTS	—	2.5 PINTS
HYDRAULIC			
SYSTEM NO. 1	9 PINTS	—	9 PINTS
SYSTEM NO. 2	15 PINTS	—	15 PINTS
UTILITY SYSTEM	3 PINTS	—	3 PINTS
VSS ACCUMULATOR	2000 ± 100 PSI (HYDRAULIC SYSTEM OFF)	—	—

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Figure 3-4. System Capabilities

20. Run engine at 100-percent engine rpm (N_p) for a minimum of 5 minutes.

Note

Ensure engine anti-icing operates for the last 3 minutes to dry out piping.

21. ANTI-ICE ENG 1/ENG 2 — OFF.
22. Shut down engine. (Refer to paragraph 7.35)
23. Repeat procedures for remaining engine.

Note

The remaining engine wash may be accomplished during the soaking period of the first engine. Engine drying runs may be done at the same time.

3.2.2 Engine Desalinization Rinse. An engine desalinization rinse is performed to remove internal salt accumulations from the engine. The rinse is recommended when the helicopter is deployed aboard ship, when operating from bases within 2 miles of salt water, or after flights below 500 feet over salt water. There are four methods of rinsing the engine. The preferred method is after engine shutdown following the last flight of the day. The other methods in order of preference are as follows:

1. Method 2 — Prior to engine start preceding the first flight of the day.
2. Method 3 — Prior to engine shutdown following the last flight of the day.
3. Method 4 — After engine start prior to the first flight of the day.

3.2.2.1 Preferred Method.

CAUTION

Engine MGT shall be 125 °C or below before accomplishing rinse. If necessary, the engine may be motored to reduce MGT. Starter limitations shall be observed. If an APU is used as the electrical power source for engine wash/ rinse procedures, the APU current limiter shall be set at 750 amps when motoring the engine during wash/rinse cycles.

1. Armament — OFF/SAFE.
2. Wash cart — Connect to engine to be rinsed.
3. Rotor brake — As Required.
4. BATT NO. 1 and NO. 2 switches — ON.
5. MASTER CAUTION circuit breaker — Pull.
6. APU — Connect (set 26 to 29 vdc).
7. ECU and RAIN RMV switches — OFF.
8. ENG WASH switch — WASH.
9. ENG START switch — ON. Simultaneously turn on rinsing solution supply system and motor engine for 15 seconds.
10. ENG START switch — OFF. Continue applying rinsing solution for 15 seconds during coastdown.
11. Rinsing solution supply — OFF.
12. Allow starter to cool 10 minutes.
13. Repeat steps 8 through 11.
14. Accomplish steps 2 through 13 for the remaining engine.
15. Disconnect rinsing solution supply.
16. ENG WASH switch — Normal Start.

Note

The time required to obtain engine light-off will be several seconds longer than with a fully dried engine.

17. Accomplish a normal engine start on both engines. (Refer to paragraphs 7.9 and 7.10.)
18. ANTI-ICE ENG 1/ENG 2 — ON.
19. Operate engines at 100-percent engine rpm (N_p) for a minimum of 5 minutes.

Note

Ensure engine anti-icing operates for the last 3 minutes to dry out piping.

20. ANTI-ICE ENG 1/ENG 2 — OFF.
21. Shut down engines. (Refer to paragraph 7.35.)

3.2.2.2 Method 2. The procedure is the same as the preferred method except it is accomplished before the first flight of the day.

3.2.2.3 Method 3.

Note

Methods 3 and 4 are provided for use when required by operational necessity. These methods are not as effective as the preferred method and with prolonged use will result in a significant degradation in engine performance.

1. Engine running at flight idle.
2. Armament — OFF/SAFE.
3. Wash cart — Connect to engine to be rinsed.
4. ECU and RAIN RMV switches — OFF.
5. ANTI-ICE ENG 1/ENG 2 (engine being rinsed) — ON.
6. Inject 5 gallons of water into engine (do not exceed 2.5 gpm).
7. Run engine for 3 to 5 minutes.
8. Accomplish steps 1 through 7 for the remaining engine.
9. ANTI-ICE ENG 1/ENG 2 — OFF.
10. Shut down engine. (Refer to paragraph 7.35)

3.2.2.4 Method 4. This procedure is the same as Method 3 except it is accomplished before the first flight of the day.

3.3 FUELING

WARNING

The helicopter shall not be located in the vicinity of possible sources of ignition, such as blasting, drilling, or welding operations. During field operations, a minimum of 50 feet should be maintained from other aircraft and 75 feet from any operating radar set.

Only authorized and qualified personnel shall operate fueling equipment. The plane captain shall be responsible for fueling the helicopter after each flight. He will make a visual check to ensure the proper fuel is used. The helicopter shall be fueled with the grades of fuel listed in Figure 3-3. Helicopter servicing vehicles will be positioned parallel to the helicopter during any servicing operation.

Prior to fueling, grounding devices on the helicopter and on trucks shall be inspected by fueling personnel for a proper ground. Turn off all switches and electrical equipment in the helicopter (unless hot refueling procedures are being accomplished). Check that no electrical apparatus supplied by outside power (electrical cords, drop lights, floodlights, etc.) is in or near the helicopter. For night fueling, safety flashlights shall be used. Before using a fuel hose, the hose nozzle shall be brought in contact with some metal part of the helicopter, remote from the fuel cells, to eliminate any static differential that may exist. This procedure should reduce the chance of a static spark at the fuel cell filler port.

Before removing the cell filler caps, the hose nozzle ground attachment shall be connected to a metal part of the helicopter at a safe distance from filler openings and cell vents. During fueling, a secondary operator or assistant plane captain will man a fire extinguisher with a second extinguisher readily available.

Note

Ensure the fuel tank interconnect valve is open prior to refueling. If the valve is closed, the aft fuel cell will not be serviced regardless of which fuel filler port is used.

3.3.1 Pressure Fueling. The pressure fueling system will accept the standard pressure fueling probe and is capable of receiving fuel at a rate of 45 gpm at 55 psi. The system consists of a receiver located in the right side of the aft fuel cell (Figure 3-1), a dual pilot valve in the forward cell, a dual shutoff valve, and two press-to-test precheck valves. The pilot valve senses a full tank and causes the shutoff valve to close, stopping the fueling operation. Proper operation of the pilot and shutoff valves is checked during filling by pressing the precheck valves which in turn actuate the pilot valve, causing the shutoff valve to close. Procedures for pressure fueling are as follows:

1. BATT NO. 1 and NO. 2 switches — ON.
2. FUEL TANK INTCON switch — OPEN.
3. BATT NO. 1 and NO. 2 switches — OFF.
4. Helicopter — Ground.

5. Fueling unit — Ground.

6. Fireguard — Post.

7. Filler cap — Remove.

8. Fuel probe — Connect to Receiver.

9. Fuel handle — ON.

10. Push and hold one of two PRECHECK REFUEL plungers on the rim of the fueling valve. Fuel flow should stop. Release the plunger to allow flow. Repeat with the other PRECHECK REFUEL plunger.

11. Fuel vent — Check for Airflow.

CAUTION

Pressure refueling shall be discontinued immediately when any of the following is observed: fuel flow does not stop on either precheck refuel check; no airflow out of vent; slow or no fuel flow; fuel out of vent; fuel seeping out around vent access panel; fuel quantity gauge shows no increase; or sound of structural deformation.

12. After satisfactory tests, complete fueling.

13. Fuel handle — OFF.

14. Fuel probe — Disconnect.

15. Filler cap — Install.

16. Grounds — Remove.

CAUTION

If the fuel quantity gauge shows below full quantity when pressure fueling automatic shutoff occurs, a malfunction or failure exists within the fuel system.

3.3.2 Gravity Fueling. The helicopter is gravity fueled through a filler cap on the right side, forward of the wing (Figure 3-1). Before fueling, accomplish the procedures in paragraph 3.3 and check that the tank interconnect valve is open.

3.3.3 Hot Refueling.

Note

Aircraft custodians are responsible for training personnel as nozzle operators and aircraft directors. Proper accounting data (DD form 1896/97 Jet Fuel/AV Fuel Identification card) shall be used for aircraft refueling and defueling as appropriate to the operation being performed.

1. Throttles — 100-Percent Engine RPM.
2. Copilot/gunner — Out (as required).
3. Copilot/gunner door — CLOSED.
4. Pilot door — CLOSED.
5. Helmet visor — Down.
6. FUEL TANK INTCON switch — Open.
7. FORCE TRIM — ON.
8. Fueling personnel shall proceed with steps 4 through 16 of the pressure fueling procedures (paragraph 3.3.1).

3.4 OIL SYSTEM SERVICING

Refer to Figure 3-3 for a list of approved oils.

WARNING

Lubricating oils MIL-L-23699 and MIL-L-7808 contain materials hazardous to health and can cause paralysis if swallowed. Prolonged contact may irritate the skin. Wash hands thoroughly after handling. It may burn if exposed to heat or flame. Use only with proper ventilation.

Lubricating oil MIL-L-23699 can withstand higher operating temperatures than lubricating oil MIL-L-7808 and has improved anticoking characteristics. Lubricating oil MIL-L-23699 has a higher viscosity than MIL-L-7808, which results in slightly higher oil pressures under similar engine speed and oil temperature conditions. Experience indicates this is approximately 5 to 10 psi. The minimum oil temperature for starting with lubricating oil MIL-L-23699 is –40 °C (–40 °F). The minimum oil temperature for starting with lubricating oil MIL-L-7808 is –54 °C (–65 °F). Therefore, MIL-L-7808 is the recommended engine oil when operating at sustained ground temperatures of −32 °C (−25 °F) or below.

3.4.1 Engine. Each engine has an integral oil system. A sight gauge is located on both sides of each engine. An oil fill port is located on the upper right side of each engine. Engine one has a funnel installed to facilitate servicing. Service to the level indicated on the sight gauge(s) (Figure 3-1).

Note

Ensure the funnel is clean prior to servicing. After servicing, ensure the funnel covers are reinstalled.

3.4.2 Main Rotor Hub. The oil filler plug is located on top of the reservoir sight gauge. Service to approximately half full.

3.4.3 Transmission. The transmission oil filler cap and neck assembly is located on top of the transmission. A sight gauge is located on the right side of the sump case. Service to the level indicated on the sight gauge (Figure 3-1).

3.4.4 Combining Gearbox. An oil filler cap is located on top of the gearbox. A sight gauge is located on the right side of the sump (Figure 3-1). Service to the level indicated on the sight gauge.

3.4.5 Intermediate Gearbox. An oil filler cap is located on the top left side of the gearbox. A sight gauge is located on the left side of the gearbox. Service to the level indicated on the sight gauge (Figure 3-1).

3.4.6 Tail Rotor Gearbox. An oil filler cap is located on the top center of the gearbox. A sight gauge is located below the oil filler cap (Figure 3-1). Service to the level indicated on the sight gauge.

3.5 HYDRAULIC SYSTEM SERVICING

Hydraulic fluids listed in Figure 3-3 are approved for use in the flight control systems and utility hydraulic system.

CAUTION

Do not contaminate hydraulic fluid MIL-H-83282 with any other fluid. A mixture containing only 5 percent hydraulic fluid, MIL-H-5606, will reduce the flame retardant characteristics of hydraulic fluid MIL-H-83282 by approximately one-third.

3.5.1 Hydraulic Systems No. 1 and No. 2. Service to the level indicated on the reservoir sight gauge (Figure 3-1). These are pressurized systems that cannot be serviced without a hydraulic service unit.

3.5.2 Utility Hydraulic System. Service to the level indicated on the reservoir sight gauge. Service in accordance with hydraulic systems No. 1 and No. 2.

3.6 HELICOPTER JACKING POINTS

Four jack fittings are provided. One fitting is installed under each wing, one under the forward fuselage, and one under the aft fuselage (Figure 3-5). Maximum jacking weights are 9660 pounds for ship-based procedures and 12,800 pounds for shore-based procedures.

CAUTION

Prior to jacking the helicopter, ensure the required structural panels and fasteners are installed on the helicopter. Refer to NAVAIR 01-H1AAC-2-1 WP 008 00.

3.7 EXTERNAL POWER REQUIREMENTS

The external power receptacle is located on the left side of the fuselage. When a 28-vdc APU plug is inserted into the receptacle, the external power relay in the electrical system is energized and 28-vdc electrical power is supplied to the primary bus. When the external power door is opened, the EXT PWR DOOR OPEN caution light will illuminate on the pilot caution advisory panel. A voltage sensor is provided in the electrical compartment; that prevents the external power from being supplied to the helicopter bus if the APU is not set within the limits of 26 to 29 vdc. The sensor will automatically disconnect the helicopter bus from the APU if

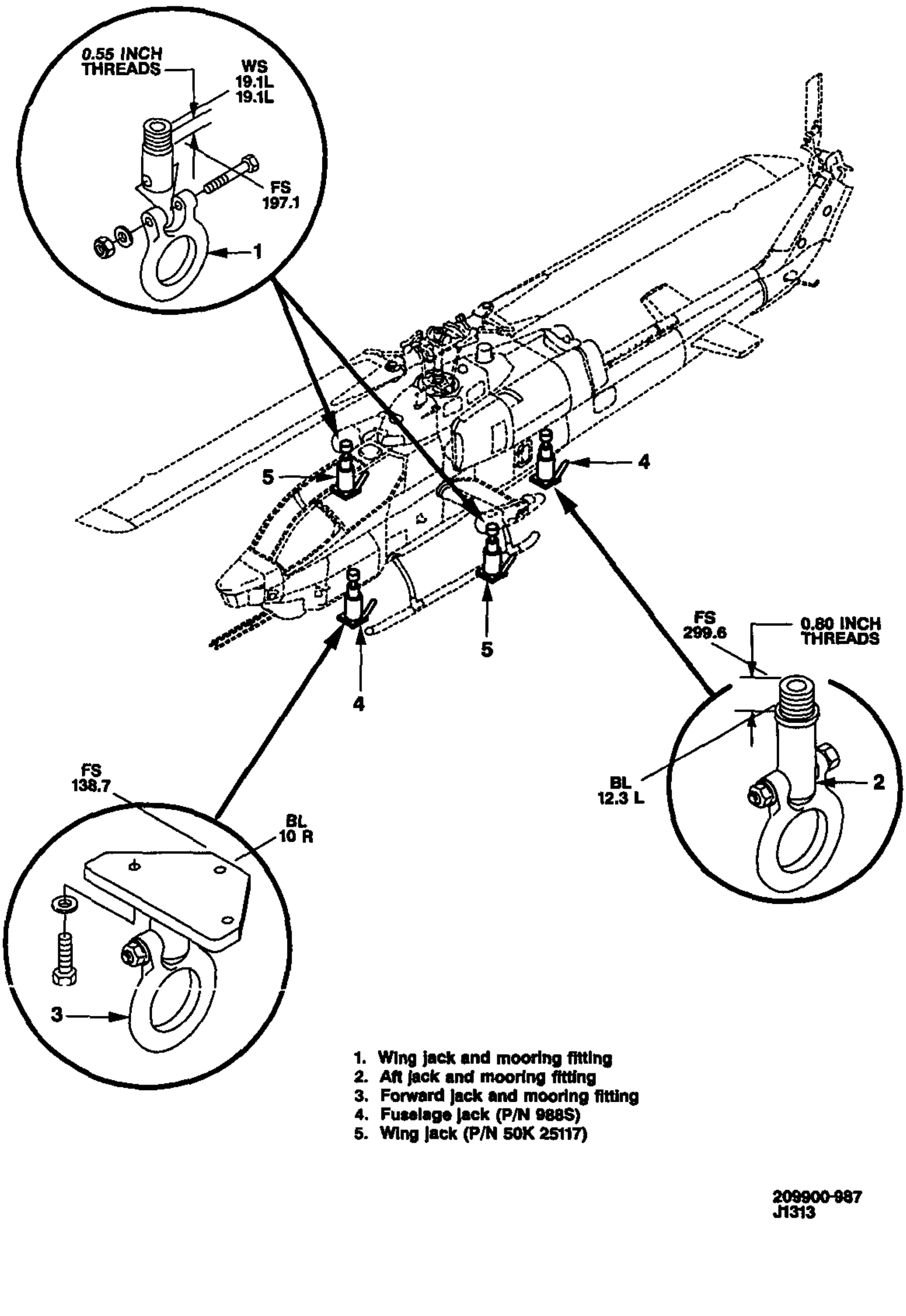


Figure 3-5. Jacking and Mooring Fitting Installation

voltage moves out of limits or excessive transients are present.

During an APU start, dc voltage does not increase to 48 volts as in a battery start. This causes a higher drain on the starter. Using an APU to charge the batteries is preferred to an APU start, and external power should be limited to ground troubleshooting and battery charging.

CAUTION

Failure to pull the MASTER CAUTION LIGHT circuit breaker prior to applying external power may result in damage to the master caution panel. Voltage should be confirmed steady at 26 to 29 vdc prior to placing the circuit breaker in. APU output limitations for starting the helicopter are 600 amps minimum and 1300 amps maximum.

3.8 DANGER AREAS

Figure 3-6 shows danger areas of engines, 20-mm gun, canopy jettison, intakes, exhaust, and wing stores armament.

3.9 TURNING RADIUS/GROUND CLEARANCE

Refer to Figure 3-7.

3.10 TOWING HELICOPTER

The maximum helicopter weight for towing operations is 13,560 pounds. Ground handling wheels are provided to facilitate movement of the helicopter (Figure 3-8). Eyebolt fittings for installing ground handling wheels are located at the forward and aft ends of the skids. Prior to movement of the helicopter, disconnect the static ground wire and secure all doors, panels, fairings, and loose parts.

CAUTION

Forward ground handling wheels should be used during a shipboard environment. The pitching and rolling of the ship may cause the helicopter to pitch forward and cause the forward skids to contact the deck while towing the helicopter without forward ground handling wheels. This contact may cause structural failure to the forward crosstube.

3.10.1 Ground Handling. If the helicopter is moved by hand, do not push on any part of the airframe that could result in damage to the helicopter (such as elevators, etc.). Towing the helicopter on rough ground surfaces or across hangar door tracks at gross weights in excess of 13,560 pounds may cause permanent set in the crosstubes.

Both the forward and aft mounted ground handling gear are required when moving the helicopter over rough terrain or hangar door tracks. Limited operation using only the aft mounted ground handling gear is allowed over smooth, level surfaces. The helicopter may be towed or pushed by hand. A qualified aircraft handler shall be positioned on the tail skid to take weight off the front skid tube and provide steerage. Two aircraft handlers may be required on the tail skid when wind and weight conditions warrant.

3.10.2 Towing Speed. Towing speed shall not exceed 5 miles per hour. Sudden stops and starts shall be avoided. Extreme caution shall be exercised when towing in a congested area.

3.10.3 Ground Handling Gear. Two types of ground handling gear are used for moving the helicopter: forward mounted and aft mounted with handbrakes.

1. Install all the ground handling gears in the eyebolts on the skid tubes.
2. Extend the aft ground handling wheel on one side only. Extend the forward gear on the same side. Extend the remaining aft ground handling gear. Extend the remaining forward-mounted ground handling gear. Lower in reverse order.

WARNING

Do not raise or lower the forward-mounted ground handling gear unless the aft ground handling gear is raised.

3. One handbrake is installed on each aft ground handling gear assembly. During actual movement of the helicopter, each handbrake shall be manned by a qualified aircraft handler. Handbrakes shall be applied immediately upon whistle or hand signal.

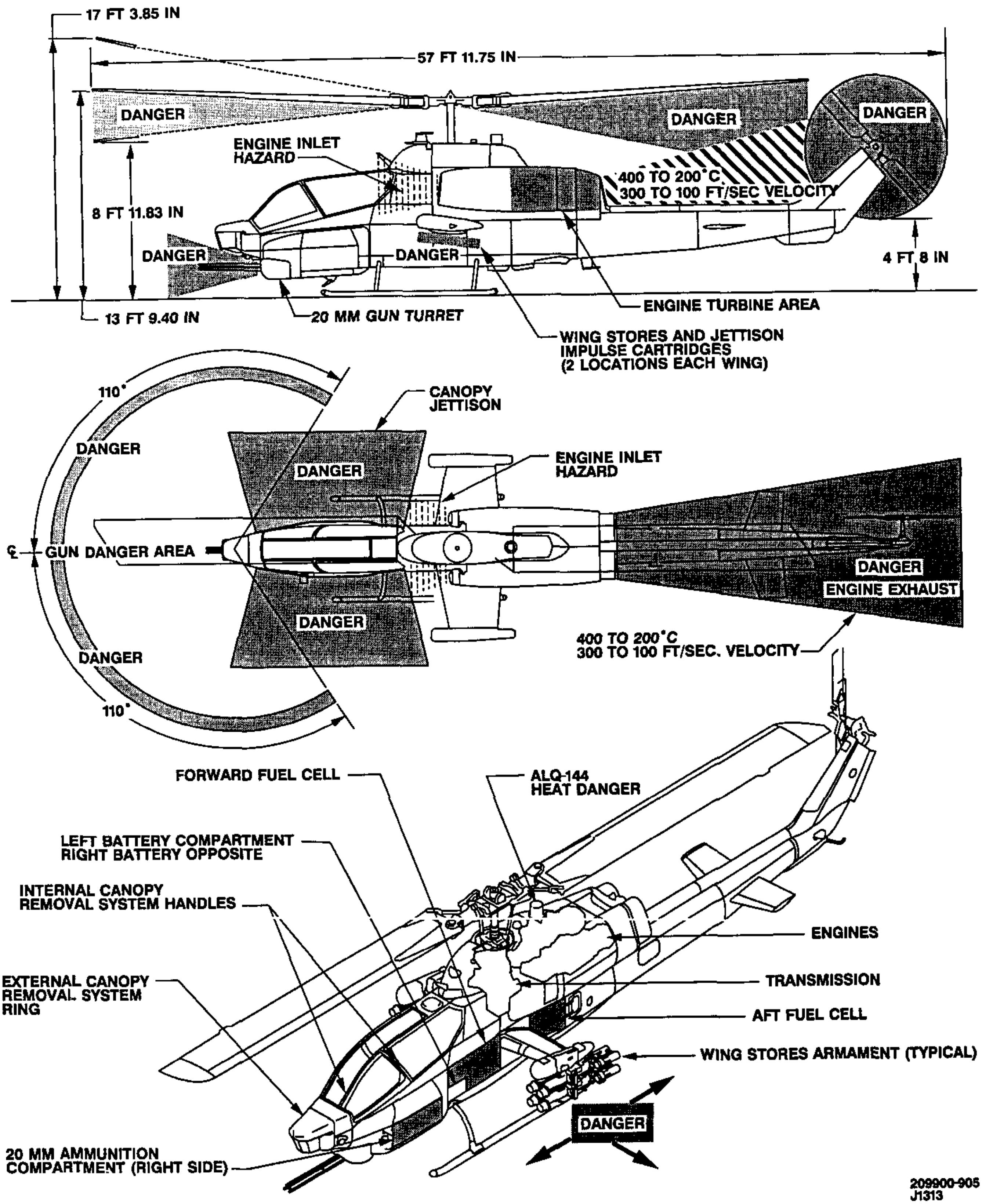
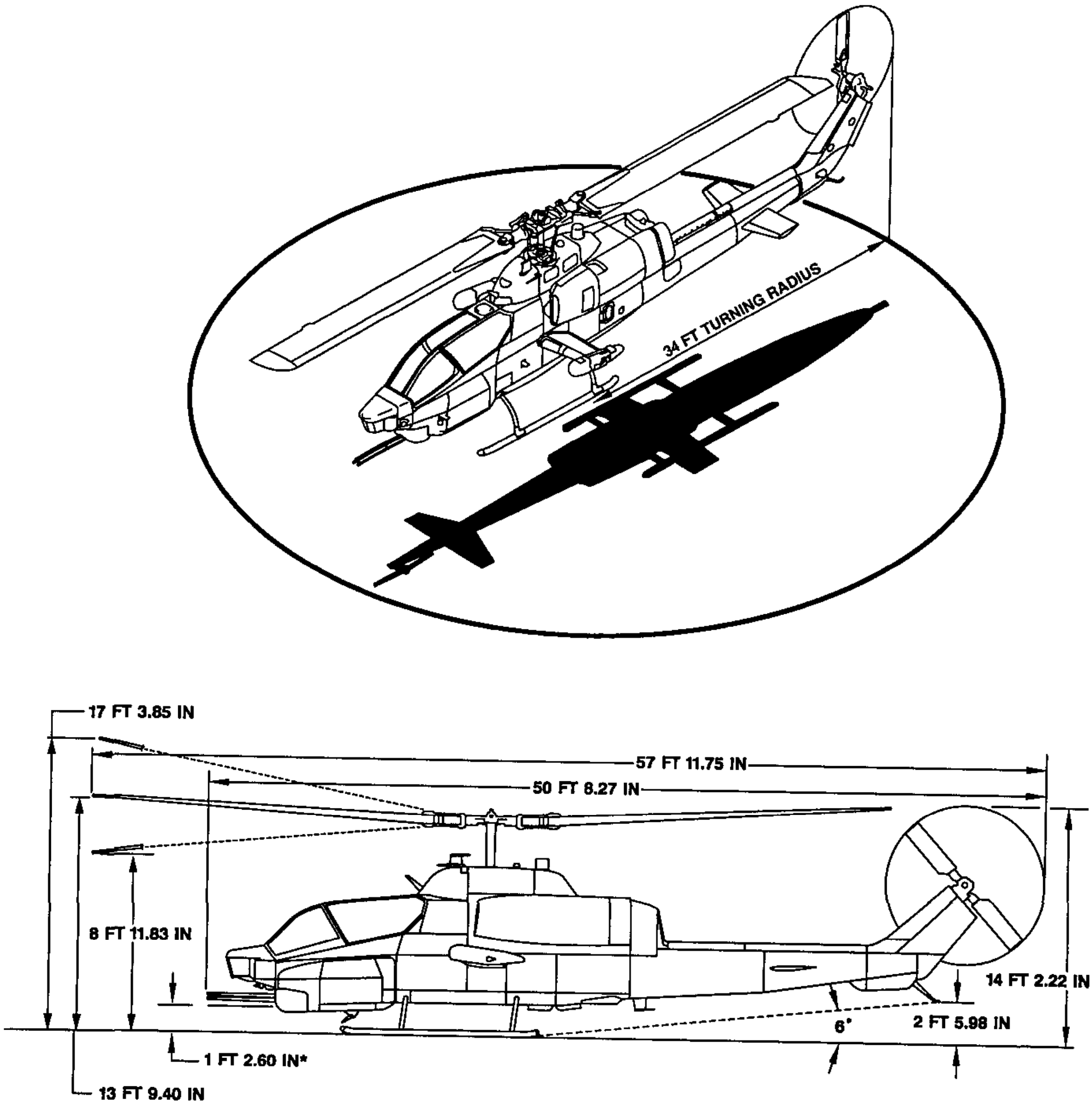


Figure 3-6. Helicopter Danger Areas (Typical)



* CHECK ANTENNAS AND WIRE STRIKE CUTTER WHICH PROTRUDE LOWER.

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Figure 3-7. Turning Radius and Ground Clearance

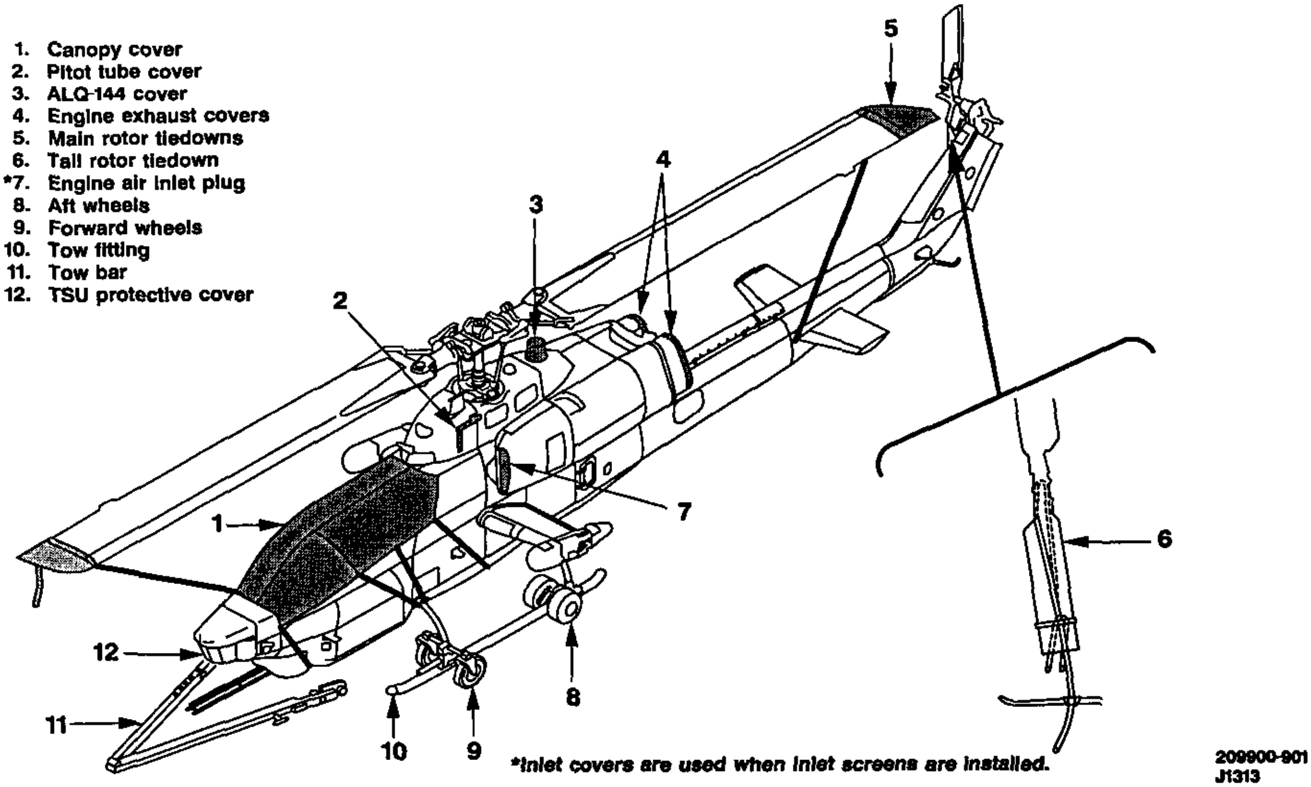


Figure 3-8. Ground Handling

4. Care should be exercised when lowering the helicopter. The helicopter should be lowered slowly after ensuring all personnel are well clear of the helicopter.

3.10.4 Wingwalker. When towing a helicopter, a wingwalker equipped with a whistle shall be stationed on each side of the helicopter to ensure adequate clearance. At night, the wingwalkers will carry a flashlight or luminous wand.

3.10.5 Movement. During all phases of helicopter movement, the main rotor blades shall be secured in accordance with paragraph 3.11.1.1, main rotor tiedown procedures (Figure 3-8).

3.10.6 Operation of Equipment. Only qualified personnel shall operate towing equipment. Towing couplings shall be inspected prior to towing. Only approved tow bars shall be used. Ground handling wheels shall be installed in eyebolts provided on each landing gear skid tube, located forward of the aft crosstube and forward of the forward crosstube. Reference the maintenance manual for proper ground handling gear installation and operation.

Care shall be taken to ensure that the ground handling pins are properly installed in eyebolts on the skid tube.

3.11 TIEDOWN/SECURING HELICOPTER

Position the helicopter on a level surface when possible. Covers for the canopy, TSU, ALQ-144, pitot tube, engine air inlet screens, and engine exhausts are provided along with tiedowns for tail rotor and main rotor blades (Figure 3-8).

If available, attach a static ground wire to the ground receptacle on the right side of the fuselage, forward of the fuel filler cap. Check that all switches are in the OFF position. Disconnect batteries for extended parking. Close and lock doors.

3.11.1 Parking Helicopter. When parking the helicopter, main rotor blade tiedowns shall be installed whenever any of the following conditions exist:

1. Thunderstorms are in the local area or forecasted.

2. Winds in excess of 20 knots or a gust spread of 15 knots exist or are forecasted.

3. The helicopter is parked within 150 feet of hovering or air taxiing helicopters that are in excess of the maximum gross weight of the AH-1W helicopter.

4. The helicopter is to be parked overnight.

3.11.1.1 Tiedown Main Rotor. The main rotor tiedown consists of two red nylon sock assemblies equipped with lines, straps, rings, and a keepered hook or quick-release pin for attachment to designated points on the helicopter. The lines and straps on each sock assembly are fixed in length; one for securing a blade over the nose of the helicopter and one for securing a blade over the helicopter tailboom (Figure 3-8). A red streamer stenciled in white letters REMOVE BEFORE FLIGHT is attached to the outboard end of each sock assembly. A separate tiedown-assist strap with handle and shotbag is provided for use in reaching and holding the blade down while installing the sock assembly. Install the main rotor tiedown as follows:

1. Turn main rotor until aligned fore and aft with tail rotor aligned with vertical fin.

2. Install sock assembly with keepered hook on forward blade and sock assembly with quick-release pin on aft blade.

3. Attach keepered hook on forward blade sock assembly to tow fitting on right skid tube.

4. Attach ring and quick-release pin on aft blade sock assembly to bracket on left side of tailboom, forward of the elevator.

CAUTION

Do not alter the length of the straps on the main rotor tiedown sock assemblies or cause the blades to be deflected downward more than 30 inches from horizontal in the secure position.

3.11.1.2 Tiedown Tail Rotor. The tail rotor tiedown is red in color and is stenciled in white letters REMOVE BEFORE FLIGHT. Secure the tail rotor to the tail skid or vertical fin with a tiedown strap after the main rotor blades have been tied down.

3.11.1.3 Engine Inlet Plugs. Engine inlet plugs are provided for left- and right-side installation. Two red streamers stenciled in white letters REMOVE BEFORE FLIGHT are attached to each cover.

3.11.1.4 Inlet Screen Covers. Inlet screen covers are provided when inlet screens are installed. Two red streamers stenciled in white letters REMOVE BEFORE FLIGHT are attached to each cover.

3.11.1.5 Engine Exhaust cover. A cover is provided for each engine exhaust ejector. The covers have a red streamer on each side stenciled in white letters REMOVE BEFORE FLIGHT and a nylon cord to secure them when installed.

3.11.1.6 Pitot Tube Cover. The pitot tube cover is provided with a nylon cord and a red streamer stenciled in white letters REMOVE BEFORE FLIGHT. Install the cover in the pitot tube and tie the cord to secure the cover to the pitot tube.

3.11.1.7 Canopy Cover. A canopy cover (Figure 3-9) is provided to protect the canopy from an abrasive environment, ultraviolet sun rays, and weather. The cover assembly consists of the following panels with Velcro fasteners, straps and buckles.

TSU panel

Copilot/gunner cockpit panel

Pilot cockpit panel

Turret assembly and M197 gun panel

Each cover protects a different portion of the forward fuselage. The inside liner that rests against the canopy or TSU glass is made of fine woven artificial silk bounded by a simulated fur trap. A feature of the canopy cover is that only an individual section needs to be removed to gain access to that portion of the canopy or cockpit.

3.11.1.7.1 Removal.

1. All straps and buckles — LOOSEN.

CAUTION

Use care not to bang strap buckles against helicopter during strap removal.

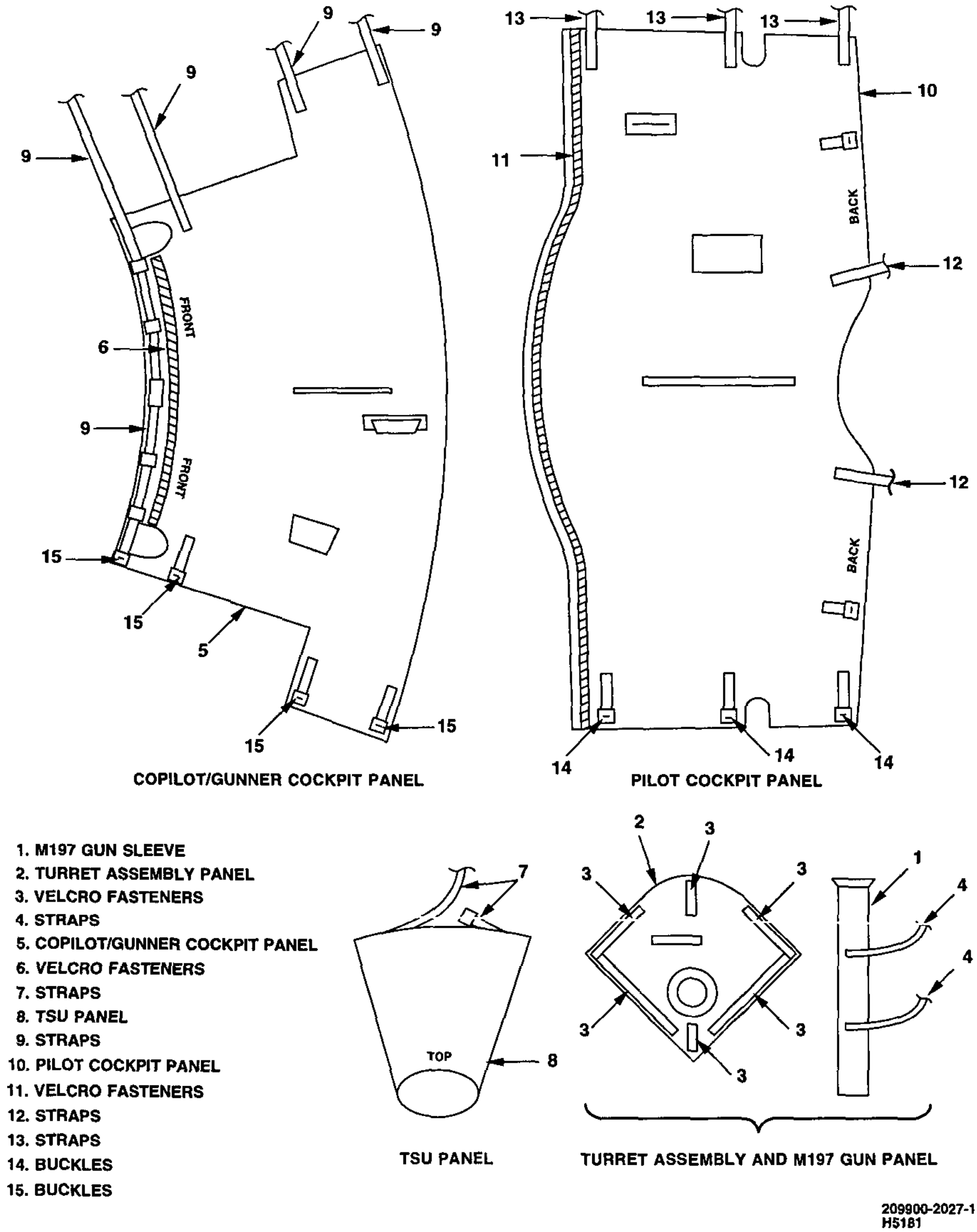


Figure 3-9. Canopy Cover (Sheet 1 of 2)

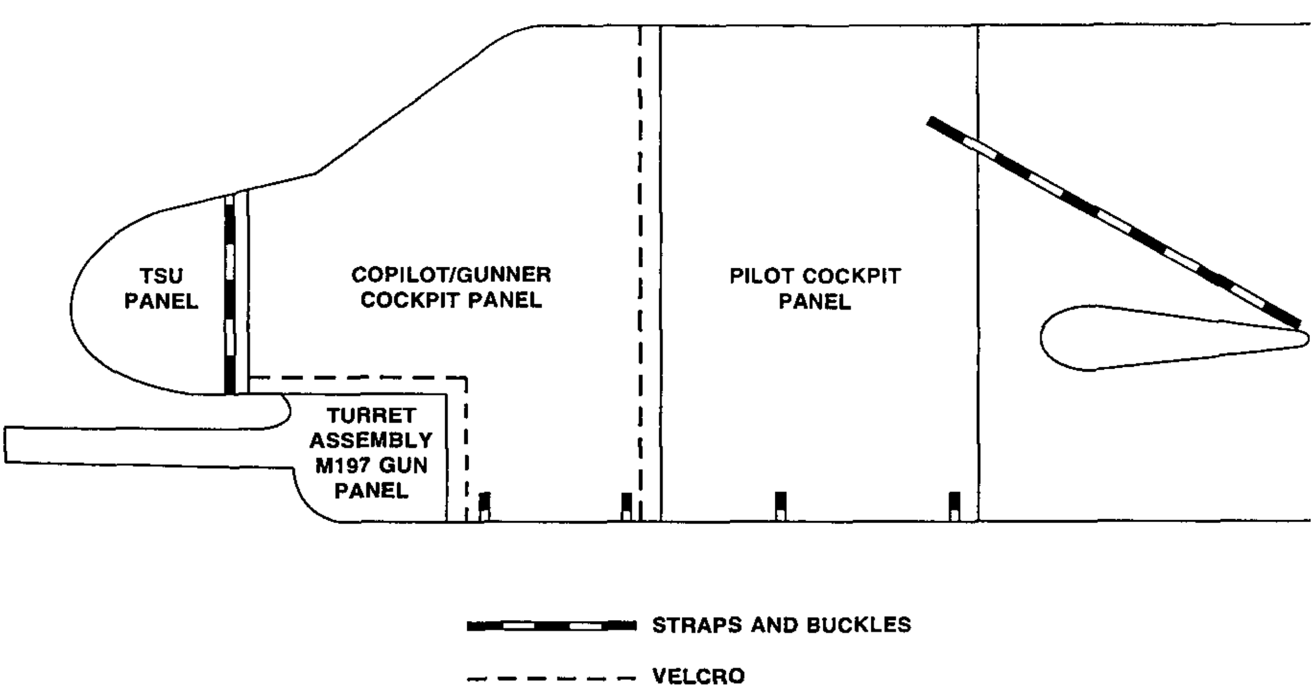


Figure 3-9. Canopy Cover (Sheet 2 of 2)

2. M197 gun sleeve and turret assembly panel Velcro fasteners and straps — UNFASTEN FROM COPILOT/GUNNER COCKPIT PANEL AND SLIDE SLEEVE AND PANEL OFF GUN.

Note

When removing canopy cover, assure exterior surface only comes in contact with the ground.

3. TSU Velcro fasteners at copilot/gunner cockpit panel — UNFASTEN AND REMOVE TSU PANEL.

4. Copilot/gunner cockpit panel Velcro fasteners and straps at pilot cockpit panel — UNFASTEN AND REMOVE PANEL.

Note

Use care to clear panel pockets and slots from door handles and steps before removing panel.

5. Pilot cockpit panel Velcro fasteners and straps — UNFASTEN AND REMOVE PANEL.

3.11.1.7.2 Installation.

Note

Canopy covers should be installed as soon as possible after landing to prevent canopy abrasions and to keep cockpit temperatures at a minimum.

1. Pilot and copilot/gunner canopy doors — CLOSE.

2. TSU and M197 gun — STOW.

3. Ammo and equipment bay doors — CLOSE.

4. Pilot cockpit panel — IDENTIFY AND POSITION ON HELICOPTER WITH CENTER TOP INDEX MARK ORIENTED ON FUSELAGE.

Note

Locate antenna, temperature probes, steps, and grab/door handles in appropriate slots in cover as required.

5. Rear straps — PASS OVER WING PYLON AND ENGAGE HOOKS AS REQUIRED. DO NOT TIGHTEN STRAPS.

6. Lower straps — PASS BENEATH FUSELAGE AND CONNECT BUCKLES. DO NOT TIGHTEN.

7. Copilot/gunner panel — IDENTIFY AND POSITION ON HELICOPTER WITH CENTER TOP INDEX MARK ORIENTED ON FUSELAGE.

WARNING

Care should be taken when using handles and steps when cover is being installed because cover may be slippery when wet.

Note

Locate steps and grab/door handles in appropriate slots in cover as required.

Velcro fasteners should overlap pilot cockpit panel by about two inches.

8. Lower straps — PASS BENEATH FUSELAGE AND CHIN SECTION AND CONNECT BUCKLES.

9. TSU panel — IDENTIFY AND POSITION OVER TSU LOCATING VELCRO SLIT AT BOTTOM.

Note

Velcro fasteners should overlap copilot/ gunner cockpit panel by two inches.

Pass TSU sighting rod carefully through aperture in panel.

10. Straps — CONNECT BENEATH CHIN SECTION OF HELICOPTER.

Note

TSU panel is manufactured to accommodate any parked TSU position; therefore, panel may appear to be too large. This design consideration should be ignored.

11. Turret assembly and M197 gun panel — IDENTIFY AND SLIDE GUN SLEEVE OVER BARREL.

12. TSU and copilot/gunner panel — LOOSEN LOWER STRAPS

13. Rear edge of TSU panel — PULL FORWARD SIX INCHES.

14. M197 gun panel — PULL AFT AND WEAVE EDGES BENEATH COPILOT/ GUNNER COCKPIT PANEL AND SECURE WITH VELCRO FASTENERS.

15. TSU panel — SECURE IN ORIGINAL POSITION AND TIGHTEN ALL STRAPS.

16. All Velcro fasteners and buckles — ASSURE THEY ARE FASTENED AND TIGHTENED. TIGHTEN WING PYLON STRAPS LAST.

WARNING

Assure adequate ventilation when occupying helicopter crewstations with remaining canopy cover installed.

CAUTION

Although the canopy cover is flameproof, avoid open flame or contact with engine exhaust.

3.11.2 Mooring Helicopter. Mooring is securing the parked helicopter in such a manner that it will not be damaged during periods of high winds or turbulent weather. The helicopter shall be moored if wind is expected to exceed 45 knots (52 mph). The helicopter should be sheltered or evacuated to a safe area when winds are forecast to exceed 65 knots (75 mph).

1. Park the helicopter over ground mooring points, headed toward the direction from which the highest winds are expected and comply with requirements for parking the helicopter.

2. Install forward and aft jack fittings with mooring shackles attached.

3. Attach mooring lines from ground mooring points to shackles on jack fittings and the mooring shackle under each wing. Ground mooring points should be 45° to the left and right of the fuselage fittings and 45° forward and aft of the wing fittings (Figure 3-10).

4. The helicopter may also be moored using outboard wing jack fittings. If required,

install wing jack fittings in outboard ejector rack adapter inserts. Attach mooring lines.

5. Fill fuel tanks to capacity if time permits.

6. Disconnect batteries.

7. Secure all loose equipment.

8. Moor ground support equipment a safe distance from the helicopter.

Note

Not applicable to shipboard operation.

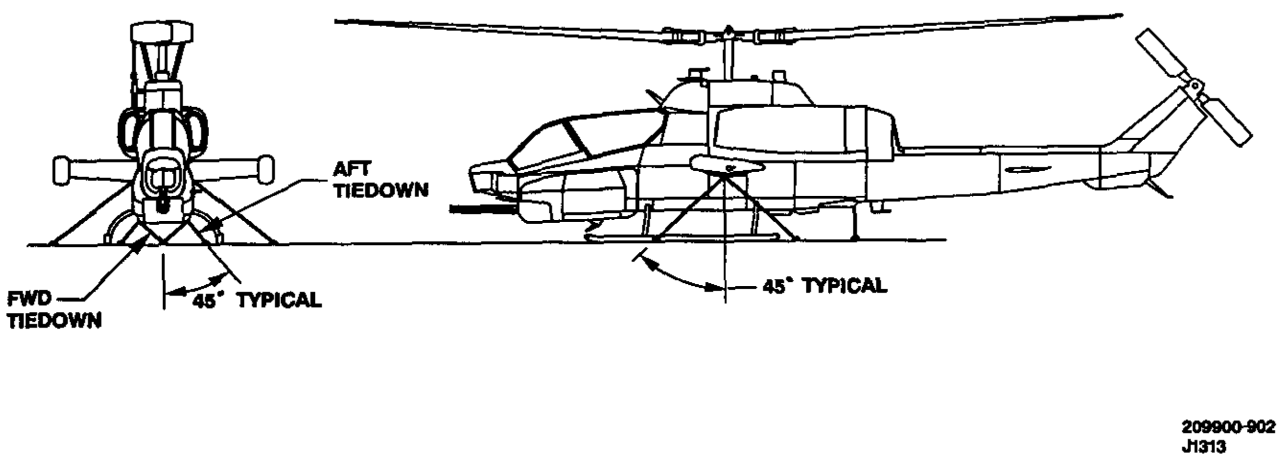


Figure 3-10. Mooring Diagram

CHAPTER 4

Operating Limitations

4.1 SCOPE

The operating limitations that shall be observed during normal operations are covered in this chapter.

It is a pilot responsibility to make proper notation any time operating limitations are exceeded.

CAUTION

If helicopter rotor or engine limitations are exceeded, record on a VIDS/MAF (OPNAV 4790/60). Further flight shall not be attempted until the helicopter is inspected and proper maintenance is accomplished by qualified maintenance personnel.

Note

Record all chip light indications on a VIDS/MAF (OPNAV 4790/60), including those followed by a successful chip burnoff.

4.2 ENGINE RATINGS

Engine ratings were not set up as limits that if exceeded would result in an engine failure. Overall engine life for a particular installation is first determined. This life is broken down into percentages that reflect the time used at different power settings. With this information, allowable limits are set. In normal engine life, when engine time is used up, the engine is ready for overhaul. A better understanding of engine ratings will bring into focus the real reason engine limits are set.

4.3 MEASURED GAS TEMPERATURE

Excessive temperature causes deformation of metal parts and, if allowed to persist, will result in sagging and/or creep and subsequent structural failure. Consequently, MGT is the most important factor in engine durability. This does not mean that MGT is to be used as a limit in place of a time at maximum power settings. However, always reduce a power setting to maintain MGT within limits.

MGT conveys information on how well the engine is performing at a desired power setting. Normally, MGT will be kept within limits by the fuel control. If MGT increases or stabilizes at too high a temperature, reduce power. Excessive temperatures should be noted for maximum reached and for the length of time above the limit. The temperature should be reported as a discrepancy for appropriate maintenance action.

4.4 MINIMUM CREW REQUIREMENTS

The minimum crew consists of one pilot.

WARNING

Solo flight shall require 180 lbs ballast properly secured in ammo bay to ensure aircraft remains within CG limits.

Note

- The view is restricted from the aft cockpit. With only one pilot in the helicopter, a slight sideslip may be required to see the landing area during final approach.
- Ballast, equipment, or baggage may be carried in the ammunition compartment if properly secured.

4.5 ENGINE LIMITATIONS

See Figure 4-5.

4.5.1 Engine Starter Limits. Starter use is limited as follows:

1. Sixty seconds — ON
2. Five minutes — OFF
3. Sixty seconds — ON

4. Thirty minutes — OFF.

The above cycle may then be repeated.

4.5.2 Engine Wash Starter Limits. With the ENG WASH switch in the WASH position, the duty cycle for the starter is as follows:

1. Fifteen seconds — ON
2. Ten minutes — OFF.

The cycle can be repeated three additional times (total four cycles) which may then be followed by an engine start.

4.5.3 Hot Start. The maximum MGT during starting shall not exceed 867 °C before starter cutout. Refer to paragraph 12.2.3.

4.6 TRANSMISSION AND COMBINING GEARBOX LIMITATIONS

See Figure 4-5.

4.7 HYDRAULIC SYSTEM LIMITATIONS

See Figure 4-5.

4.8 ROTOR LIMITATIONS

See Figure 4-5.

4.9 ROTOR BRAKE LIMITATIONS

1. Do not apply the rotor brake above 60 percent N_r.
2. Do not apply the rotor brake below 25 percent N_r.
3. When feasible, release the rotor brake at approximately 10 percent N_r to avoid sudden stoppage.
4. Do not move the handle above the detent while the rotor is turning.
5. During rotor brake start, release the brake within 25 seconds after 67 percent N_g is attained. Do not exceed idle rpm (67 ±3 percent) with the rotor brake on.

CAUTION

Do not attempt rotor brake start at an ambient temperature below −18 °C (0 °F). Increased engine torque at lower temperatures may exceed braking capability and result in slippage.

4.10 AIRSPEED LIMITS

Decrease airspeed 5 KIAS for each 1000 feet of density altitude above 4000 feet. Airspeed limits below 4000 feet of density altitude are as follows:

1. One hundred ninety KIAS without stores
2. One hundred seventy KIAS any configuration with stores/auxiliary fuel tanks
3. One hundred twenty KIAS steady state autorotation
4. Thirty-five-knot sideward flight
5. Thirty-knot rearward flight
6. Flight within the red area of the height velocity diagram should be avoided (Figure 4-1).

Note

The airspeed indicator is unreliable at airspeeds less than 40 knots.

4.10.1 Twin-Engine Height-Velocity Diagram. The diagram (Figure 4-1) presents the height-velocity limitations as a function of airspeed, height above ground, and gross weight. The “avoid continuous operation” portion represents a critical area of helicopter operation during takeoff and landing. In the event of twin-engine failure, the use of area A, B, or C curves, as defined in the height-velocity diagram, is determined by using the area obtained from the gross weight versus density altitude plot above the height-velocity diagram. If the helicopter is operating in area A of the density altitude versus gross weight chart, then the corresponding area A of the height-velocity diagram should be used to determine performance. If the helicopter can safely jettison stores to reduce weight, this is recommended because the rotor inertia and skid gear can better absorb the touchdown. The limitations as illustrated on the height-velocity diagram are for smooth, level, firm surfaces.

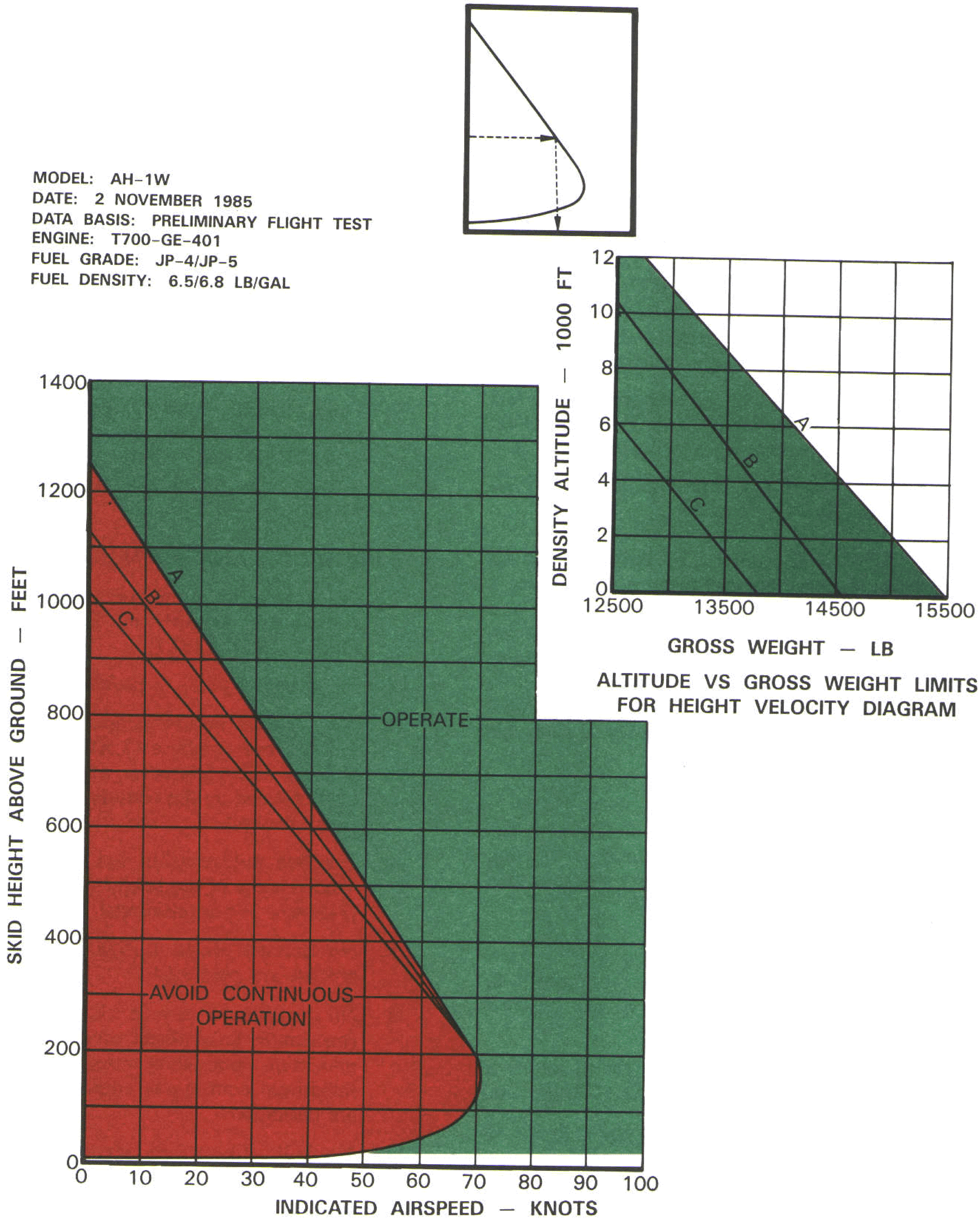


Figure 4-1. Height Velocity — Twin-Engine Failure — All Configurations — Calm Wind

EXAMPLE:

For a helicopter with a gross weight of 13,000 *pounds at a density altitude* of 6000 feet and a skid height above the ground of 500 feet, find the indicated airspeed required to be outside the AVOID region.

SOLUTION:

1. Enter the DENSITY ALTITUDE VS GROSS WEIGHT plot (upper right-hand area) at 13,000 pounds and move up to the 6000 foot DENSITY ALTITUDE line. This point falls below line B but above line C, so use line B of the height-velocity plot in determining the height-velocity limitations.
2. Enter the height-velocity diagram at 500 feet on the *SKID HEIGHT ABOVE GROUND* scale and project right to intersect line B.
3. Drop down and read an INDICATED AIRSPEED *of 48 knots*.

4.10.2 Single-Engine Height-Velocity Diagrams: These diagrams (Figure 4-2, sheets 1 and 2) illustrate graphically the hover height and airspeed limitations for safe landing after a single-engine failure. Sheet 2 gives the ratio of single-engine power available to the power required to hover out of ground effect (Q-ratio) for operational gross weights and pressure altitudes at four air temperatures.

EXAMPLE:

Find the minimum high hover height and the minimum airspeed for no height-velocity restriction of a 14,500 pound helicopter having a single-engine failure at 4000 feet and 15 °C OAT.

SOLUTION:

1. Enter the +15 °C portion of Figure 4-2, sheet 1 at 14,500 pounds on the GROSS WEIGHT scale.
2. Move horizontally to the right to intersect the 4000 foot PRESSURE ALTITUDE line.
3. Move downward and read 0.68 on the Q RATIO scale.
4. To establish the density altitude, use the upper right-hand portion of Figure 4-2, sheet 2. Enter the PRES ALT scale at 4000 feet.
5. Move up to the 15 °C line and project left and read a DENSITY ALT of 4900 feet.
6. Enter the lower left-hand portion of Figure 4-2, sheet 2 at 4900 feet on the DENSITY ALTITUDE scale.
7. Move up and interpolate for a Q ratio of 0.68, then move horizontally to the left and read 176 feet on the SKID HEIGHT ABOVE GROUND scale. This is the minimum high hover height for safe landing.
8. Move horizontally to the right and intersect the BASELINE. From this intersection, continue right following the trend of the curves to the point of contact with the MINIMUM SPEED FOR NO HEIGHT RESTRICTION line.
9. Drop vertically from this point and read an airspeed of 23 on the CALIBRATED AIRSPEED scale. This is the minimum airspeed for which no height restriction exists.

4.11 PROHIBITED MANEUVERS

1. No acrobatic maneuvers are permitted (acrobatic as defined in the current OPNAVINST 3710.7).
2. Flight below +0.5g is prohibited.
3. No practice autorotations to touchdown unless gross weight is 12,500 pounds or less and a qualified instructor, designated for full autorotations by the commanding officer, is in the cockpit.
4. Practice autorotation entries within the shaded areas of the height-velocity diagram (Figure 4-1) are prohibited.
5. No airstarts above a 15,000 foot pressure altitude are permitted.
6. No dual engine throttle chops above V_{MC} (maximum level flight speed attainable at maximum continuous transmission limit or maximum continuous engine power limit) are permitted.
7. No solo flights are permitted from the copilot/gunner cockpit.
8. Do not exceed 65 percent transmission torque at airspeeds above V_H while in a dive.
9. ACM/EVM flying and abrupt or extremely aggressive maneuvers are prohibited except

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: ESTIMATED DATA

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

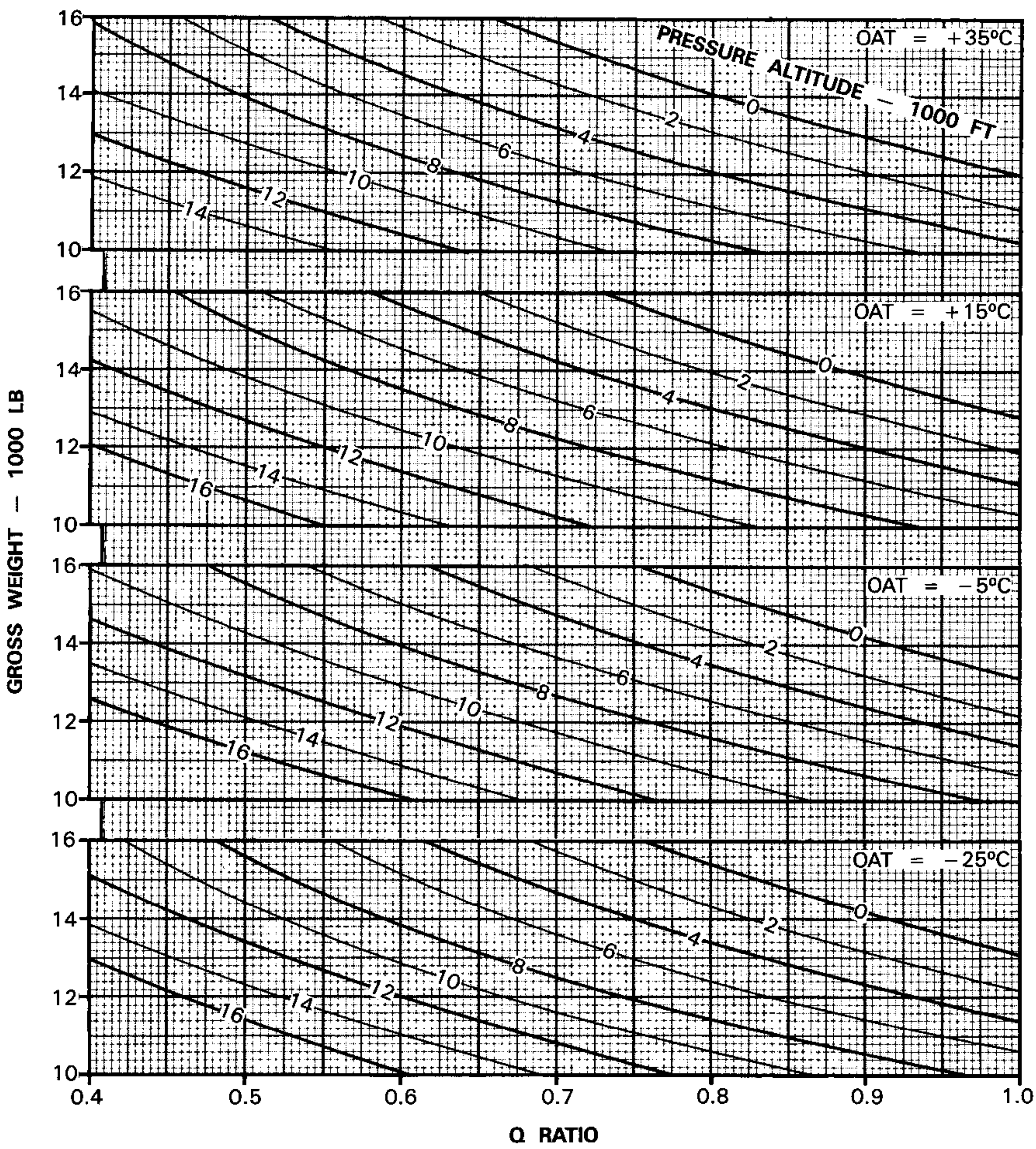


Figure 4-2. Single-Engine Height Velocity — 2.5-Minute Power — All Configurations — 100-Percent Engine RPM — Calm Wind (Sheet 1 of 2)

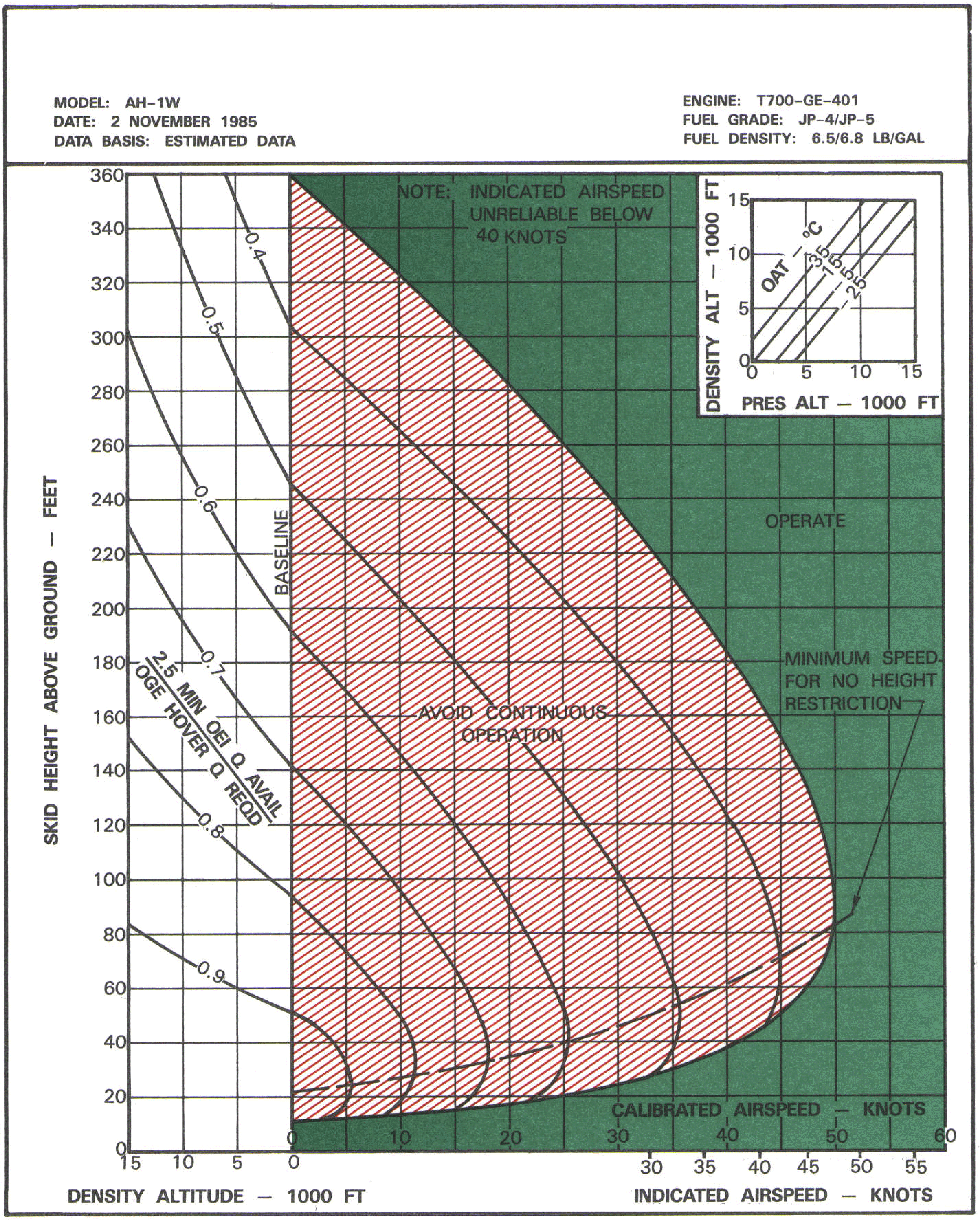


Figure 4-2. Single-Engine Height Velocity — 2.5-Minute Power — All Configurations — 100-Percent Engine RPM — Calm Wind (Sheet 2 of 2)

in emergency or actual combat conditions or specifically waived by CNO. For the purpose of weapon system training, airborne employment of the AIM-9 missile system is authorized.

4.12 ACCELERATION (G) LIMITATIONS

See Figure 4-3.

4.13 ALTITUDE LIMITATIONS

Ambient temperature/altitude combinations shall be limited as shown below when operating with JP-4 fuel and the FUEL CROSS FEED switch in the AUTO position (crossfeed valve closed and fuel cell boost pumps off). Flight above a pressure altitude of 10,000 feet requires fuel cell boost pumps operating (fuel crossfeed open, no low fuel lights) regardless of jet fuel type used.

PRESSURE ALTITUDE RANGE	MAXIMUM AMBIENT TEMPERATURE
Sea level to 2000 feet	+35 °C (+95 °F)
2000 to 10,000 feet	+30 °C (+86 °F)

4.14 WEIGHT AND BALANCE LIMITATIONS

Refer to NAVAIR 01-1B-40 for weight and balance information.

4.14.1 Longitudinal Center-of-Gravity Limits. See Figure 4-4 for longitudinal cg limits.

4.14.2 Lateral Center-of-Gravity Limits. Lateral cg limits are 6.0 inches left and right of the centerline. Within these limits, the helicopter may be flown with a single store on any station. Stores on both stations on the same side with the opposite side empty can possibly exceed the lateral limit (depending on the particular stores). Refer to NWP 3-22.5-AH1, Vol. I, for authorized station loading configuration.

Note

The most critical flight condition with the lateral cg at the right limit is level flight at full power. The most critical flight condition with the lateral cg at the left limit is 120 KIAS in autorotation. If the lateral cg limits are exceeded, there may not be sufficient lateral control margin to maintain balanced flight.

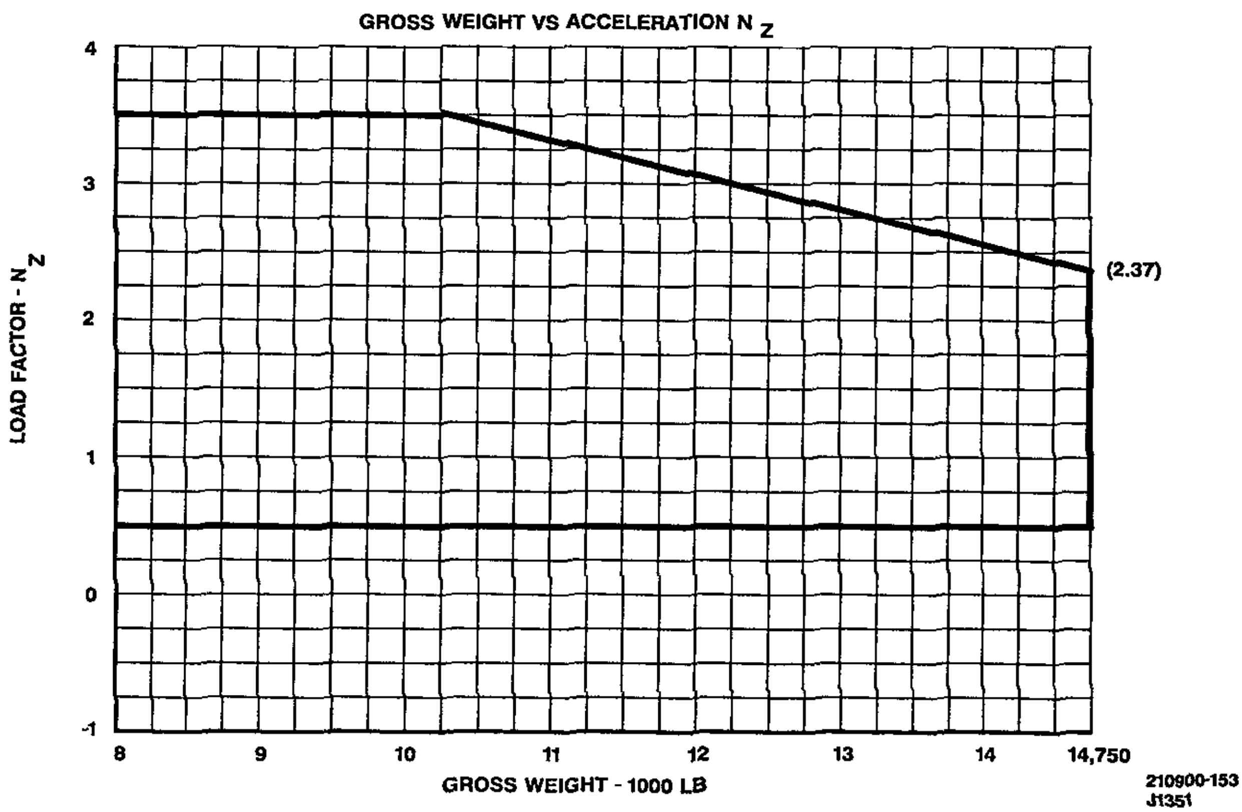


Figure 4-3. Gross Weight Versus Acceleration Nz

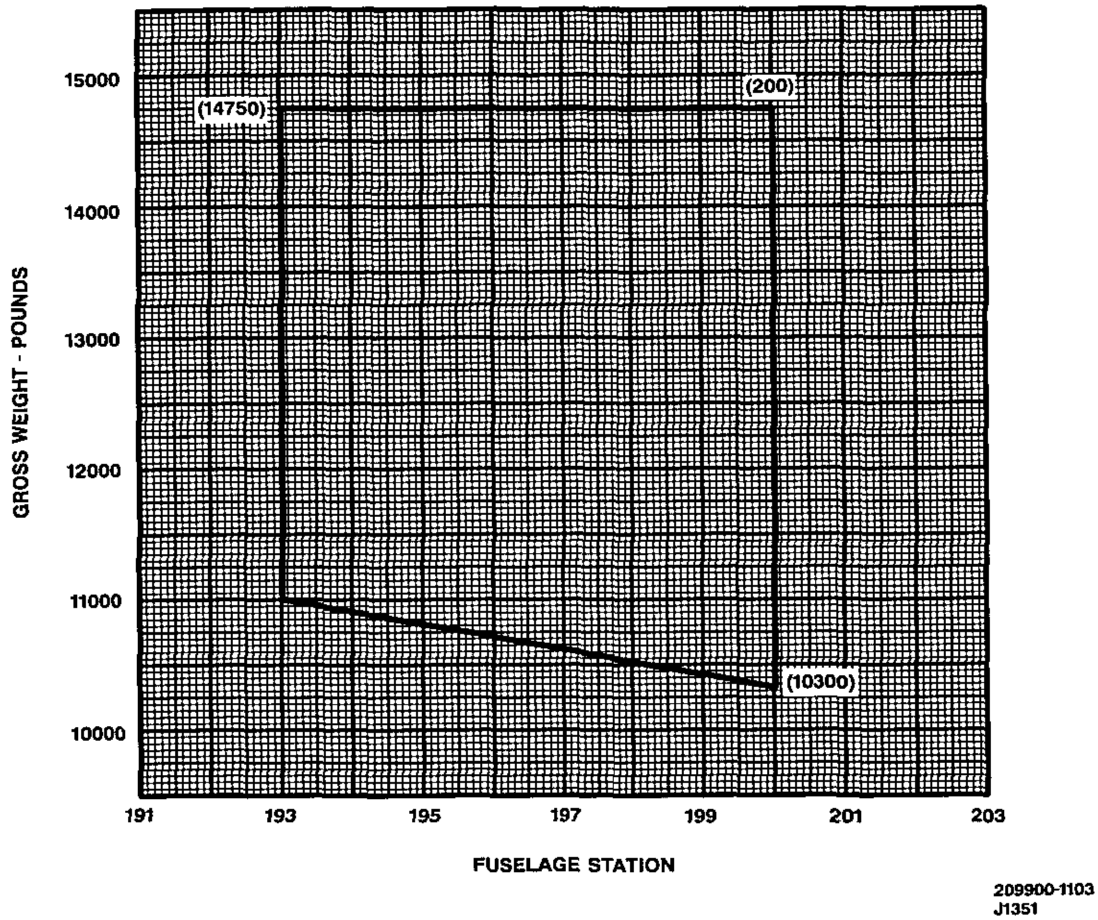


Figure 4-4. Center of Gravity

4.15 DUMMY TURRET AND DUMMY TSU LIMITATIONS

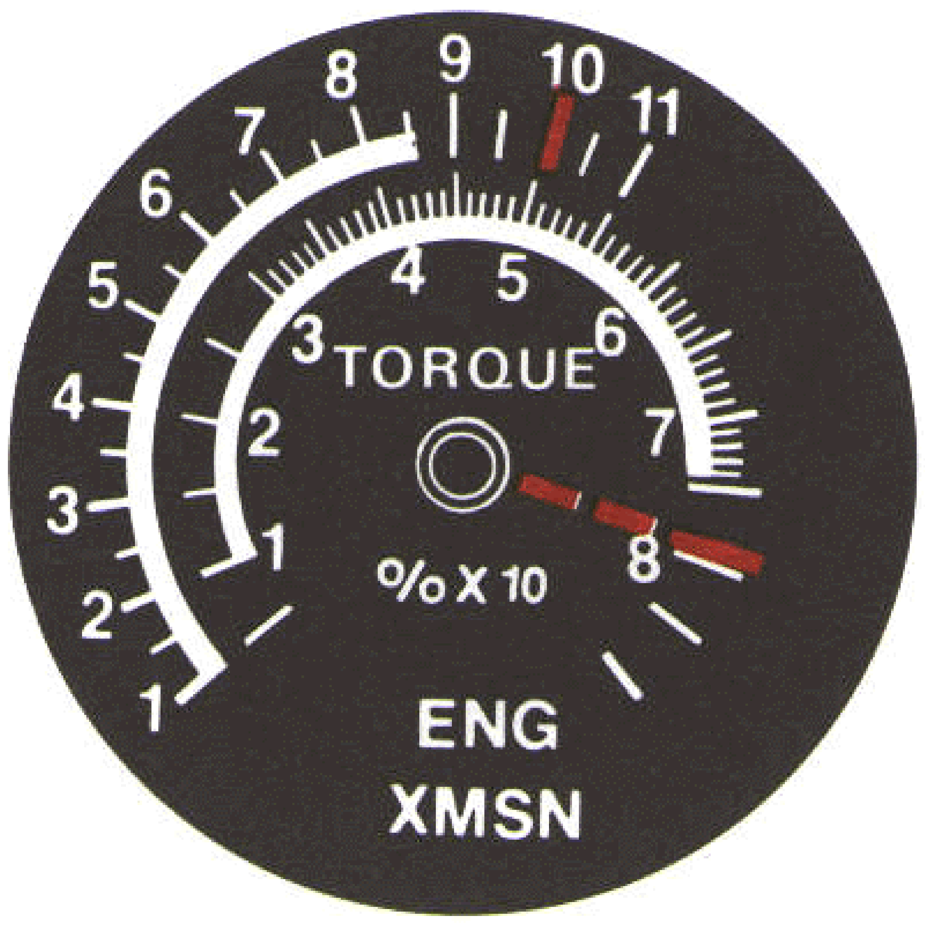
The dummy turret and the dummy TSU are authorized for flight to the limits of the basic airframe.

4.16 EXTERNAL STORES LIMITATIONS

Refer to paragraph 4.14 and Part XI. For additional limitations, refer to NWP 3-22.5-AH1, Vol. I.

4.17 INSTRUMENT MARKINGS

See Figure 4-5.



ENGINE TORQUE

(White) 10 to 74% Continuous Operation
75 TO 79% One Engine Inoperative Power Range (2 1/2 Minutes)

(Red) 79% One Engine Inoperative Maximum Power Limit

TRANSMISSION TORQUE

(White) 10 to 85% Normal Operation
85 TO 100% Takeoff/Intermediate Power (30 Minutes)

(Red) 100% Maximum

GAS PRODUCER TACHOMETER (Ng)

(Red) 102% Maximum Steady State

▼ 105% Transient (12 Seconds)

TRIPLE TACHOMETER (Np and Nr)

ENGINE

(White) 99 to 100% Normal Operation

(Red) 100% Maximum

(Red) 99% Minimum

(Red/White striped) 60 to 75% Avoid

NOTE

- Steady state operation of Np in the 60 to 75% range may result in shortened engine life
- Np may transiently follow Nr to 110%

ROTOR (POWER ON)

(White) 99 to 100% Normal Operation

(Red) 105% Maximum

NOTE

Transients to 110% for 10 seconds are permissible.

(Red) 91% Transient Minimum

ROTOR (POWER OFF)

84% Transient Minimum
91 to 105% Normal Operation
105 to 110% Transient Maximum (10 Seconds)

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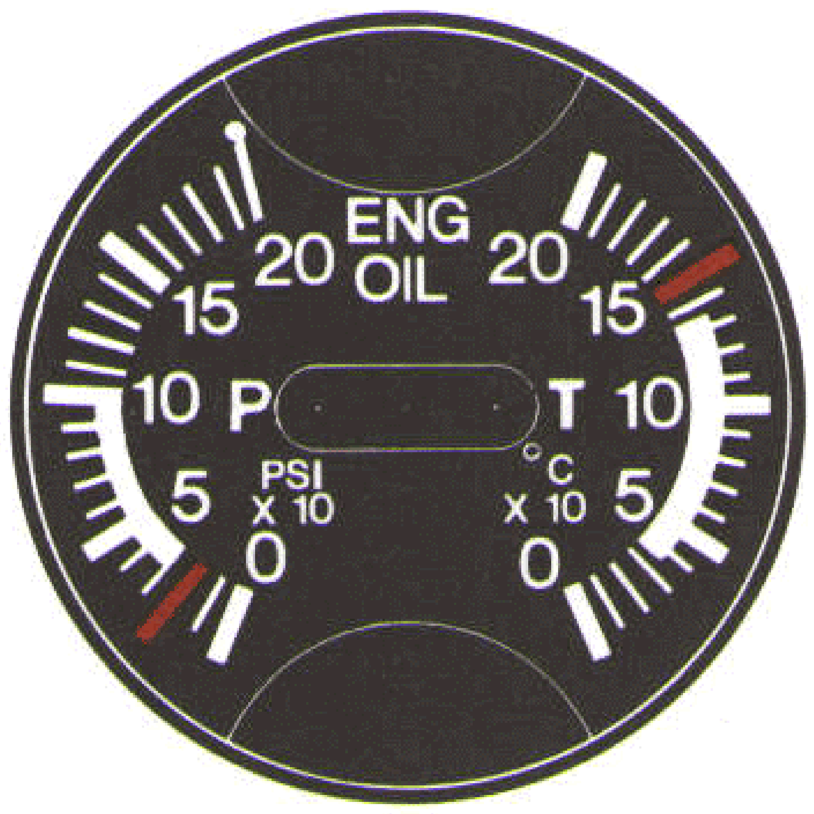
Figure 4-5. Operating Limits and Instrument Range Markings (Sheet 1 of 3)



ENGINE OIL TEMPERATURE

35 to 132 °C Normal Operation
132 to 150 °C 30 Minute Operation

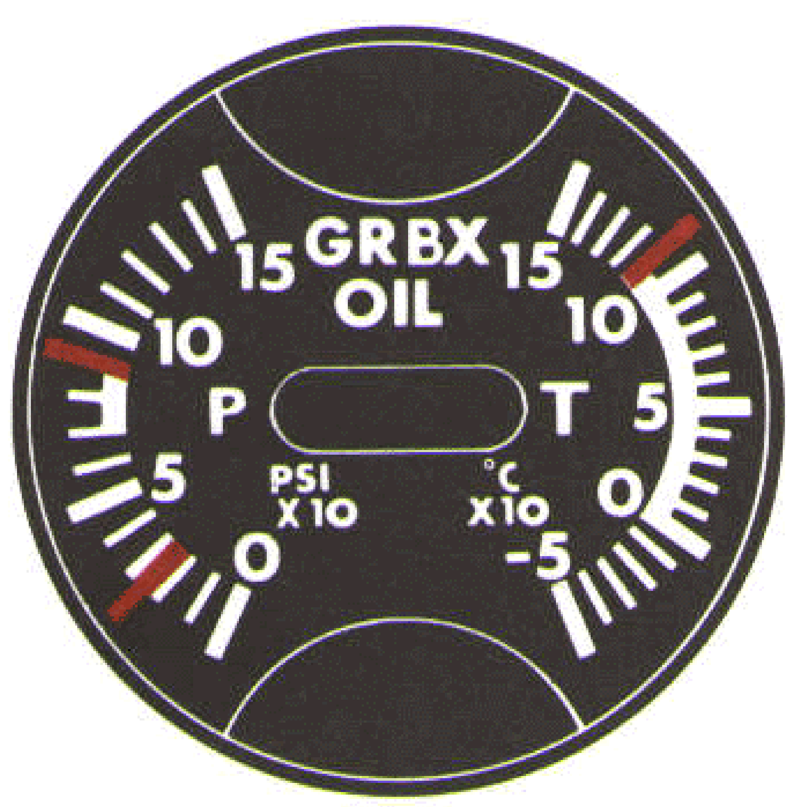
150 °C Maximum

ENGINE OIL PRESSURE

20 PSI Minimum Below 90% Ng

30 PSI to 100 PSI Normal Operation

200 PSI Cold Start Limit



COMBINING GEARBOX OIL TEMPERATURE

0 to 110 °C Normal Operation

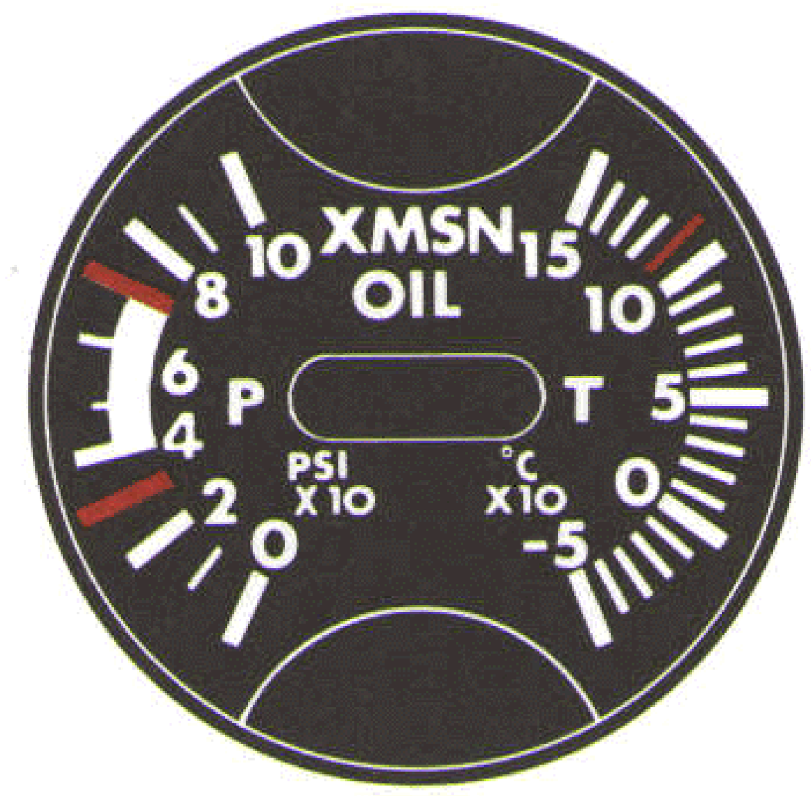
110 °C Maximum

COMBINING GEARBOX OIL PRESSURE

25 PSI Minimum

70 to 90 PSI Normal Operation

90 PSI Maximum



TRANSMISSION OIL TEMPERATURE

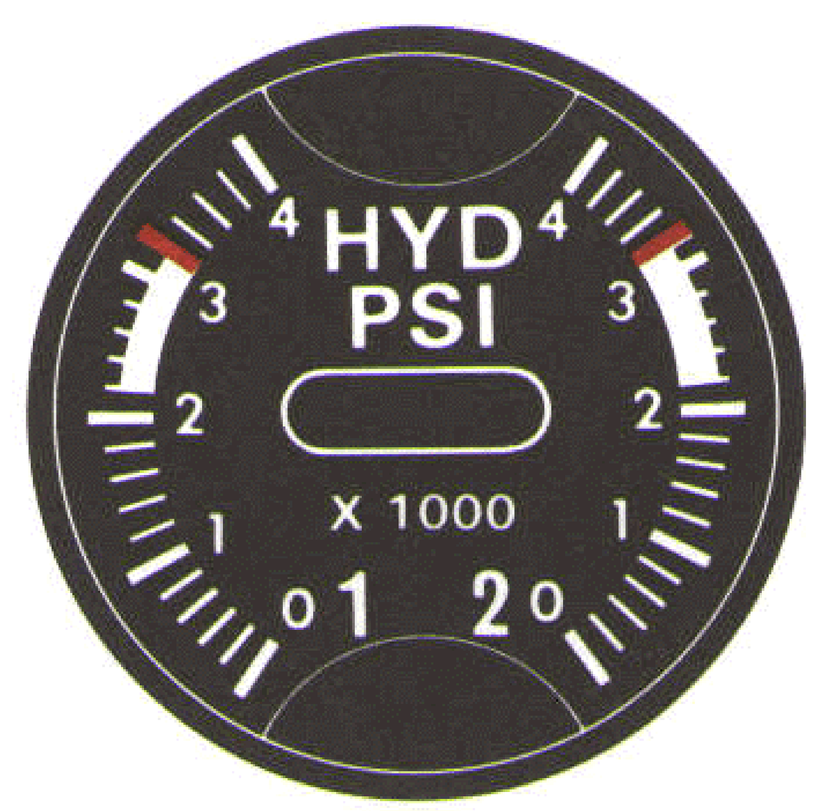
110 °C Maximum

TRANSMISSION OIL PRESSURE

30 PSI - Minimum

40-70 PSI - Normal Operation

70 PSI - Maximum



DUAL HYDRAULIC PRESSURE

2940 - 3060 PSI Normal Operation

2200-3200 PSI Operation Range
Limits are for gauge pressure variations with control or SCAS inputs. Steady LOW or HIGH pressure readings are an indication of hydraulic system malfunction.

3200 Maximum

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Figure 4-5. Operating Limits and Instrument Range Markings (Sheet 2 of 3)

MEASURED GAS TEMPERATURE

INFLIGHT

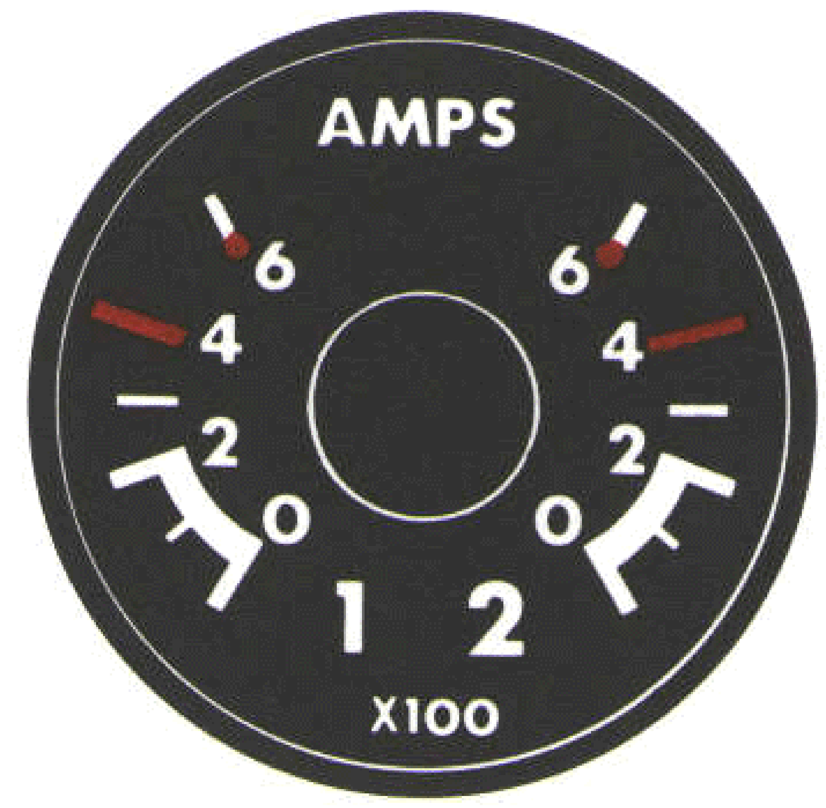
▭	400 to 801 °C	- Continuous Operation
	801 to 867 °C	- Intermediate Power (30 Minutes)

ONE ENGINE INOPERATIVE

(red/white striped)	867 to 917 °C	- Maximum Power Range (2 1/2 Minutes)
(red)	917 °C	- Maximum Power Limit (2 1/2 Minutes)
▲	965 °C	- Maximum Transient (12 Seconds)

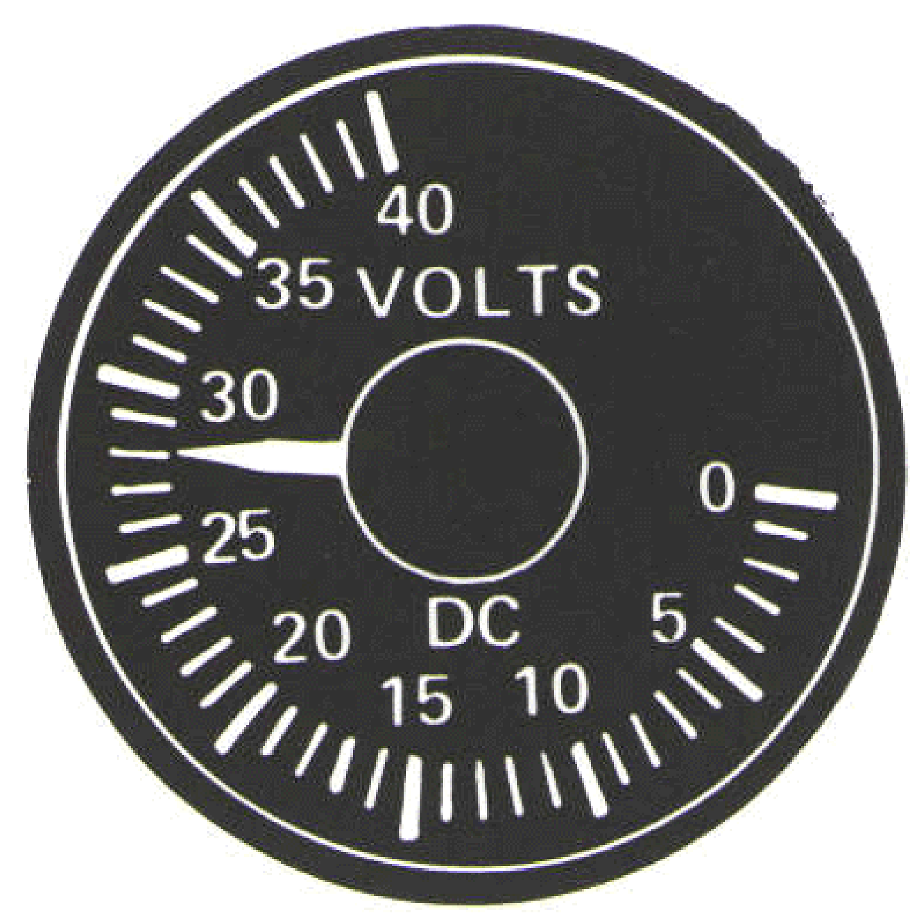
STARTING

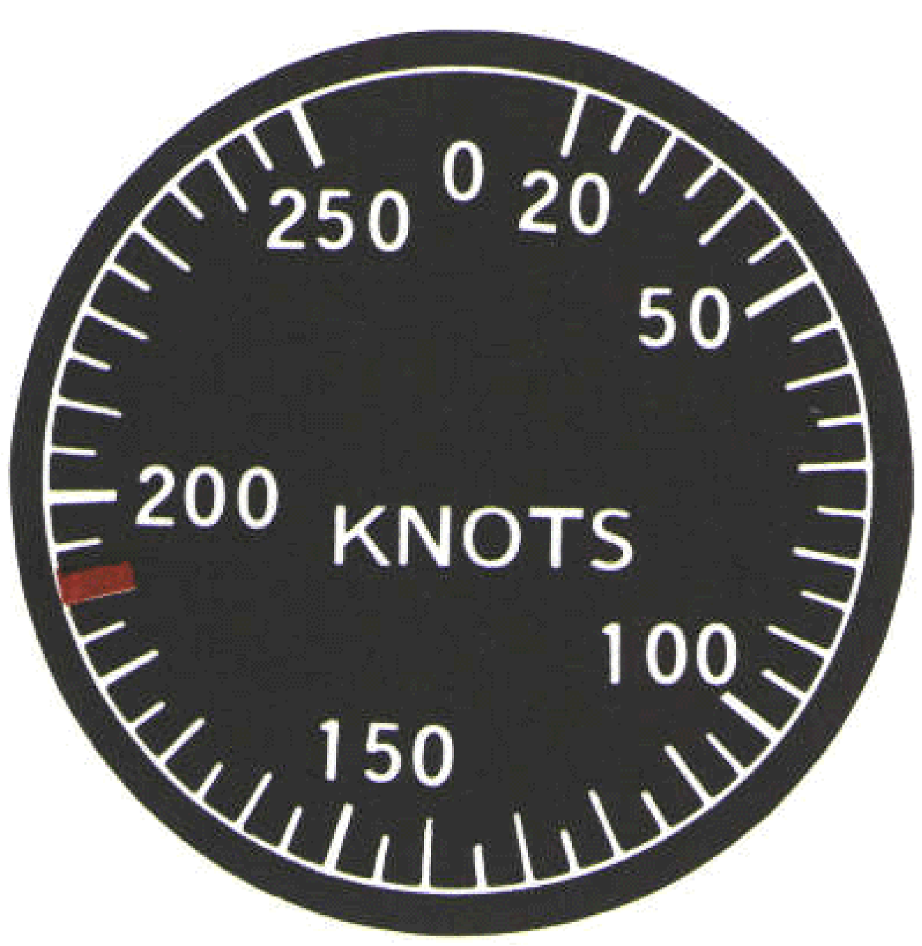
○	867 °C	-Maximum



DUAL AMMETER

▭	0 to 200 Normal Operation
(red)	400 Maximum Continuous
●	600 Maximum - Cross Starting





AIRSPEED

(red)	190 Maximum VNE

VOLTMETER

VOLTS	DCVM SELECT
24 to 26	ESNTL/NONESNTL (Battery Power)
28 to 29	ESNTL/NONESNTL (Generator Power)
28 to 29	GEN 1/2 (Normal)
28 to 40	GEN 1/2 (Cross Starting)
24 to 26	BATT 1/2 (Generator/External Power Off)
27 to 35	BATT 1/2 (Generator/External Power Applied)
10 to 20	BATT 1 (Battery Start)
10 to 40	BATT 2 (Battery Start)

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Figure 4-5. Operating Limits and Instrument Range Markings (Sheet 3 of 3)

PART II

Indoctrination

CHAPTER 5

Training Indoctrination

5.1 INTRODUCTION

The operating procedures contained in this manual will apply to the helicopter when performing assigned missions within its capabilities. The information contained herein is to clarify, amplify, and standardize those areas where there is room for variance of interpretation by individual commands. The procedures contained herein cannot possibly cover every conceivable situation but are intended to govern situations most frequently encountered. The safety and success of any mission are of paramount importance with precedence of actions depending upon the existing situation.

5.2 GROUND TRAINING SYLLABUS

A ground training program shall be established that will ensure thorough training and a high degree of readiness for all flight personnel. The ground training syllabus that follows is to be used as a guide. It represents the minimum requirements to be met prior to completing the familiarization stage in the flight training syllabus as set forth by the type commands.

5.3 PILOT GROUND TRAINING

Every pilot checking out in the helicopter will be required to complete a course of instruction. This course of instruction will vary from about 20 hours to the maximum of 40 hours depending upon pilot background.

A written examination will be given on the NATOPS flight manual and NWP series publications.

Instruction and examination must be completed on the following subjects prior to completion of the flight familiarization phase:

1. Helicopter operational performance
2. Weight and balance
3. Publications (FAA, tactical, technical)
4. Communications
5. Survival and first aid
6. Search and rescue
7. Flight planning, fuel management
8. Helicopter navigation
9. Flight safety
10. Emergency procedures.

5.4 PILOT FLIGHT TRAINING

A flight training syllabus shall be established by each command to accomplish maximum training for the mission and tasks assigned. The syllabus must be flexible and tailored to fit the situation and the varying nature of the tasks and commitments. The flight training syllabus will contain the following phases: familiarization, formation, instruments, navigation, night, shipboard, and special categories.

5.5 FLIGHTCREW DESIGNATION, QUALIFICATIONS, AND REQUIREMENTS

The flightcrew qualifications and requirements as set forth in the following paragraphs are minimums and are not to be interpreted as limiting in any way the establishment of higher requirements by proper authority.

5.5.1 Designation. A naval aviator or aviation pilot will be designated as qualified in model only after having previously been designated as a helicopter pilot under the provisions of the current OPNAVINST 3710.7. A pilot who has qualified in one of the helicopter classifications shall have a certificate thereof, signed by the qualifying authority. This certificate will state the model helicopter and modification thereto in which the aviator is qualified and shall be placed in the Aviators Flight Log Book or Officers Qualification Jacket, as appropriate.

5.5.2 Designating Authority. Commanding officers or higher authority in the chain of command are empowered to designate a pilot qualified in model and issue certification thereto. The immediate superior in command to the commanding officer or higher authority may assume the function. The authority assuming the function shall issue appropriate instructions.

5.5.3 Qualifications.

5.5.3.1 Pilot Qualified in Model. A PQM must have successfully completed the combat capable phase of the flight training syllabus, to include a NATOPS evaluation. The pilot must also meet the requirements as set forth in the current OPNAVINST 3710.7.

5.5.3.2 Attack Helicopter Commander. An AHC must be a PQM who has completed an advanced flight training syllabus (demonstrating comparable proficiency through the combat-qualified level) demonstrating the personal ability to command a helicopter under any assigned squadron task.

5.5.3.3 Mission Commander. A mission commander shall be a properly qualified naval aviator designated by appropriate authority. The mission commander may exercise command over single naval aircraft or formations of naval aircraft. The mission commander shall be responsible for all phases of the assigned mission except those aspects of safety of flight that fall under the prerogatives of individual pilots in command. Requirements for designation as mission commander will be outlined by appropriate authority.

5.5.3.4 Section Leader. A section leader must be a PQM. In addition, this pilot must be fully qualified to lead a section under all conditions in performance of any of the squadron tasks.

5.5.3.5 Division Leader. A division leader must be a PQM with no less than 600 total flight hours. Of this total, 200 hours must be in helicopters, of which 50 hours must be in squadron model.

5.5.3.6 Flight Leader. A flight leader must be a qualified division leader with no less than 750 total flight hours.

5.5.3.7 Copilot/Gunner. A copilot/gunner is a pilot who has completed the familiarization stage and all front cockpit ordnance requirements.

5.5.3.8 Functional Checkpilot. An FCP must have a minimum of 100 hours in model, be a PQM, and be designated in writing by the unit commanding officer.

5.5.3.9 Crew Requirements.

1. A pilot designated as PQM shall command the helicopter and occupy one of the control positions on all service and combat flights.
2. A transition pilot (pilot under instruction), rated safe for solo, may command the helicopter on all types of operational training missions within his capabilities and that, in the opinion of the commanding officer, are best suited to instill pilot confidence and helicopter command responsibilities.
3. On all flights, a qualified observer may occupy the forward seat to ensure adequate visual surveillance. A qualified observer is anyone who is thoroughly briefed in cockpit conduct and safety, to include intercom system operation and lookout responsibilities.
4. All instructional flights will be under the direct supervision of a designated PQM.

5.5.4 Currency.

5.5.4.1 Annual Flying and Currency Requirements. To ensure that the skill of naval aviators is maintained at an acceptable standard of readiness for fleet operations, the annual flying requirements as set forth in the current OPNAVINST 3710.7 must be adhered to by all active duty naval aviators.

5.5.4.2 NATOPS Evaluation. On assignment to another unit, a PQM will not be required to receive a NATOPS evaluation if the log book entry and pilots qualification jacket indicate successful completion of the check within the last 12 months.

5.5.4.3 Waivers. Unit commanders are authorized to waive in writing minimum flight and/or training requirements where recent experience in similar model helicopters warrants.

5.5.5 Crew Rest Requirements. Pilots should not be scheduled for more than 6-1/2 hours of normal flying per day. Eight hours for 1 day is permissible provided a minimum of 2 hours crew rest is taken between each 4-hour period of flight. The normal crew day for all aircrews will be 12 hours; however, in a situation requiring an aircrew to exceed their 12-hour limit to complete a mission, the commanding officer may authorize an extension of up to 6 hours if warranted by urgent or unusual operational requirements. The crew day begins upon reporting to work and ends with the termination of the last sortie.

5.6 PERSONAL FLYING EQUIPMENT

The latest available type of flight safety and survival equipment listed below shall be worn by all pilots and crewmembers on all flights unless a tactical combat environment or military exigency requires onsite deviations. See the current OPNAVINST 3710.7 for further details.

5.6.1 All Flights.

1. Protective helmet
2. Flight safety boots
3. Nomex gloves
4. Nomex flight suit
5. Identification tags
6. Survival knife and sheath
7. Personal survival kit
8. Signaling devices for all night flights and flights over water or sparsely populated areas.

5.6.2 Overwater Flights.

1. Life preservers shall be worn.
2. Antiexposure suits shall be provided for all personnel in accordance with the current OPNAVINST 3710.7.
3. The HEED, SRU-36/P, shall be carried in the pistol pocket of the SV-2 survival vest.

5.6.3 Night and Instrument Flights.

1. A flashlight shall be carried in the helicopter
2. Approach plates
3. Maps.

PART III

Normal Procedures

CHAPTER 6

Flight Preparation

6.1 MISSION PLANNING

6.1.1 Introduction. Adequate and thorough planning of the flight is necessary to ensure the successful completion of any mission.

6.1.2 Factors Affecting Helicopter Lift Capability.

6.1.2.1 Temperature. High OAT increases inlet air temperature, which has an adverse effect on the power output of gas turbine engines and decreases the lift capability of the rotor.

6.1.2.2 Humidity. The effect of humidity on gas turbine engines is negligible.

6.1.2.3 Altitude. Altitude has a marked effect on the performance of all helicopter engines. Air density and temperature decrease all altitude increases. As air density decreases, the mass flow of air through the gas turbine decreases; therefore, power output of the engine decreases. However, the gas turbine operates more efficiently at the lower temperatures encountered at high altitudes, resulting in reduced specific fuel consumption.

6.1.2.4 Wind. If a helicopter can take off and land into a steady wind, payloads can be increased because less power is required for the same flight performance with wind than without wind. Helicopters operating from the decks of ships underway are in an excellent position to take advantage of the relative wind generated by ship movement. However, an allowance for deck edge and elevator turbulence must be made. Consideration must be given to winds in the landing zone ashore when at maximum gross weight conditions.

6.1.2.5 Ground Effect. For hovering flight closer than one-half rotor diameter to the Earth, the lifting ability of a helicopter is increased by ground effect. Since the power required to hover increases with an increase in height above the ground, the helicopter can hover at heavier gross weights in ground effect than out of ground effect.

6.1.2.6 Engine Performance. Helicopter performance will be reduced with a deteriorated engine (see Figure 10-2). Performance will also be reduced when salt or dirt is allowed to build up in the engines.

6.1.3 Weight Limitations Applicable to Helicopters.

6.1.3.1 Aerodynamic Power-Weight Limit. Increases in ambient air temperature, humidity, and/or pressure altitude restrict lift capability of the helicopter because a decrease in air density will result in decreased power available from the engine and a loss of rotor efficiency. The relationship of lift capability to atmospheric conditions is found in the performance charts in Part XI. While flight operations based on HIGE limit will permit an increase of lift capability, HOGE weight computations will be used for normal training operations. Exceptions to this will be necessary when operational and service flights are made under favorable conditions that require carrying payloads at an altitude beyond the capability of the helicopter to HOGE. Sliding landings and takeoffs will further increase payloads but require a surface of sufficient length in an area free of obstacles. HOGE and HIGE should be computed prior to takeoff or landing. Operations based on these exceptions should be made only under carefully calculated requirements.

6.1.3.2 Weight and Balance. This helicopter is a class 1B aircraft for weight and balance purposes (the cg limits can be exceeded by some normal loads) and therefore needs loading control. The Manual for Weight and Balance, NA 01-1B-40, includes guidance and data for the specific serial number helicopter to ensure proper loading control. The maximum allowable gross weight for takeoff is 14,750 pounds and must not be exceeded. CG limits are shown in Figure 4-4. The lateral cg limit is 6.0 inches right or left of center.

Form 365F of NA 01-1B-40 is not normally required for each flight if a current form is on file. See the current OPNAVINST 3710.7 for further information. The pilot in command will ensure that the maximum allowable gross weight and longitudinal and lateral cg limits will not be exceeded during flight.

6.1.4 General Precautions. Special care will be exercised to avoid flying over populated areas, civilian airports, turkey and chicken farms, etc. In all cases, conformance with existing regulations is mandatory.

6.1.5 Requirements for Mission Planning. Mission planning has two requirements. The first requirement is for pilot and operations personnel to calculate normal and emergency helicopter operating capabilities concurrent with existing ambient conditions and mission requirements prior to every flight on a daily basis. The second requirement is preparation of planning documents for the future helicopter assault or support mission and is normally prepared from weather summaries and predicted weather in the area to be considered. Weather summaries suitable for preparation of such estimates can be prepared or obtained by any authorized weather facility with a forecasting capability. Fuel reserve for all flights shall be computed so as to land with no less than 10 percent or 20 minutes fuel remaining, whichever is greater.

6.1.6 Computation Card. The computation card for determining capabilities (Figure 6-1) shall be used for mission planning. Deviations and substitutions may be made with the standard form. Substituting HIGE or HOGE is an example. HOGE computations should be made for all mission requirements in order to have this information readily available during flight.

6.2 BRIEFING

The pilot is responsible for briefing the crew. This briefing shall ensure complete understanding of the mission. The pilot shall give specific instructions to cover special situations that may occur.

A briefing will be used. On training flights, the appropriate syllabus guide should be used. Each pilot will maintain a kneepad and a record of all flight numbers, call signs, and other data necessary to successfully assume the lead and complete the assigned mission. The briefing guide will include the following items.

6.2.1 Time Hack.

6.2.2 General.

1. Helicopter call signs, event
2. Lead/alternates
3. Fuel load, stores, gross weight
4. Start, taxi, takeoff times
5. Takeoff data, rendezvous.

6.2.3 Target or Destination.

1. Primary
2. Secondary
3. Operating area, targets
4. Control agency
5. Time on station or over target.

6.2.4 Navigation/Flight Planning.

1. Duty runway
2. Climb out
3. Operating/restricted areas
4. Obstacles to flight
5. Mission plan
6. Cockpit coordination
7. Bingo/low fuel
8. Holding
9. Approach/lighting
10. GCA/missed approach
11. Recovery
12. Divert/emergency fields.

6.2.5 Communications.

1. Frequencies
2. Agencies
3. Procedure/discipline
4. IFF
5. NAVAIDs
6. Signals.

6.2.6 Weapons.

1. Loading

1. A/C SIDE NO.	________	12. OAT	________
2. A/C BUREAU NO.	________	13. HIGE (AT AIRFIELD)	________
3. PILOT	________		
4. COPILOT	________	14. HIGE (AT HIGHEST MISSION ELEVATION)	________
5. BASIC WT.	________		
6. CREW WT.	________	15. HOGE (AT AIRFIELD)	________
7. FUEL WT.	________		
8. ARMAMENT WEIGHT:		16. HOGE (AT HIGHEST MISSION ELEVATION)	________
20 MM	________		
TOW	________	17. SINGLE ENGINE:	
HELLFIRE	________	MAX TORQUE (2-1/2 MINUTE LIMIT)	________
2.75 RKT	________		
5.00 RKT	________	FLY AWAY CLIMB A/S	________
FLARES	________	FLY AWAY CRUISE A/S	________
OTHER	________		
9. GROSS WT.	________	SERVICE CEILING	________
10. PRESS ALT.	________		
11. DENSITY ALT.	________		

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Figure 6-1. Computation Card

2. Arming
3. Hot ordnance routes
4. Pattern
5. Switches
6. Airspeeds
7. Minimums
8. G versus weight
9. Duds, hung ordnance, dearm, jettison
10. Safety
11. Crew coordination.

6.2.7 Weather.

1. Local, en route, destination forecast
2. Alternates
3. Winds.

6.2.8 Emergencies.

1. Aborts
2. Radio failures
3. NAVAIR failures
4. Loss of visual contact, VMC/IMC
5. Inadvertent IMC
6. Lost procedures
7. SAR
8. Helicopter/system failures
9. Crew coordination.

6.2.9 Special Instructions.

1. Intelligence
2. Safety
3. Reports/authentication.

6.3 DEBRIEFING

A proper debriefing conducted under tactical or training conditions can be the most important part of a flight. Mistakes can be discussed in an atmosphere free from distractions. Under tactical conditions, debriefing is a primary source of information leading to the location of targets, distribution of troops, and many other important considerations. An outline should be followed when debriefing a flight. This outline should contain all of the items for briefing plus the following:

1. All unusual circumstances encountered
2. Discrepancies noted
3. Constructive criticism can be conducted in such a manner that all concerned can participate and present their ideas on the conduct of the flight.

6.4 CREW COORDINATION BRIEF

1. Who is in front/back?
2. Checklist procedures. Challenge/Response.
3. Control changes. Positive three way.
4. Arming/Dearming procedures
5. Look-out procedures/responsibilities
6. Navigation procedures/responsibilities
7. Penetration procedures
8. Refuel procedures
9. Ordnance procedures:
   a. Weapons switchology/selection
   b. Sector of fire responsibilities
   c. Expendables responsibilities.
10. Supporting arms control:
    a. Artillery/Naval gunfire; who calls, who flies
    b. Offensive air support; who calls; who flies.
11. NVG procedures:
    a. Goggle/degoggle
    b. Crew responsibilities:
       (1) Aircraft lighting; changes-interior/exterior
       (2) Takeoff/landing; who flies, who monitors instruments
    c. Radar altimeter setting (all changes briefed intercockpit)
    d. Aircrew currency, proficiency, comfort level
    e. Weather/ambient light
    f. Shadows
    g. Illusions
    h. Moon angle (MR/MS)
    i. NVG emergencies (tube/battery failure)
    j. Aircraft emergencies
    k. Use of landing/IR light
    l. Ordnance effects.
12. Aircraft emergencies. Pilot/Copilot responsibilities.
    a. Engine failures. Dual/Single.
    b. Transmission or driveshaft failure
    c. Gearboxes
    d. Tail rotor failure
    e. Tail rotor malfunction (stuck pedal)
    f. Hydraulic failures
    g. Electrical
    h. Fires
    i. Bird/wire strike
    j. Ditching.
13. Load computation/gross weight
14. Weather/winds
15. Terrain
16. Obstacles
17. Inadvertent
18. Brownout/whiteout/vertigo.

CHAPTER 7
Shore-Based Procedures

7.1 INTRODUCTION

Shore-based procedures are discussed in this chapter to cover as many operational situations as possible.

7.2 SCHEDULING

The commanding officer or his designated representative is responsible for the promulgation of the flight schedule when based ashore. The flight schedule, when published, becomes an order of the commanding officer. The flight schedule will contain sufficient information to ensure all preparations relative to flight can be accomplished in a smooth and timely manner. The minimum essential items that shall be included on the flight schedule are found in the current OPNAVINST 3710.7.

7.3 GROUND OPERATIONS

7.3.1 Preflight Inspection. Prior to flight, the pilot and aircrewmen shall conduct a complete visual check of the helicopter, except in the case of crew hot seating. When crews hot seat, the new crew has the option of accepting the previous crew preflight.

7.3.2 Fireguard. Prior to starting engines, a qualified fireguard shall be positioned near the engines and remain in readiness with a fire bottle until the engines are operating.

WARNING

- The fireguard shall remain clear of the exhaust and compressor blade area.
- Ear protection and goggles that provide adequate peripheral vision shall be worn by flight line personnel.

7.3.3 Helicopter Acceptance. The pilot in command shall ensure, prior to acceptance, that the helicopter is satisfactory for safe flight and can accomplish the assigned mission. The pilot will review the completed VIDS/MAF (OPNAV 4790/60) discrepancies from the last 10 flights and all previous outstanding discrepancies. Prior to flight, the pilot and aircrewmen shall ensure a complete visual check of the helicopter is accomplished.

1. The pilot shall ensure that the plane captain has conducted a standard daily preflight as set forth in the NAVAIR 01-H1AAC-6 series and signed the OPNAV form 3760/2D, Part A prior to each flight.

2. The pilot shall ensure that the maintenance controller or designated representative has signed the OPNAV form 3760/2D, Part A, signifying the helicopter is safe for flight.

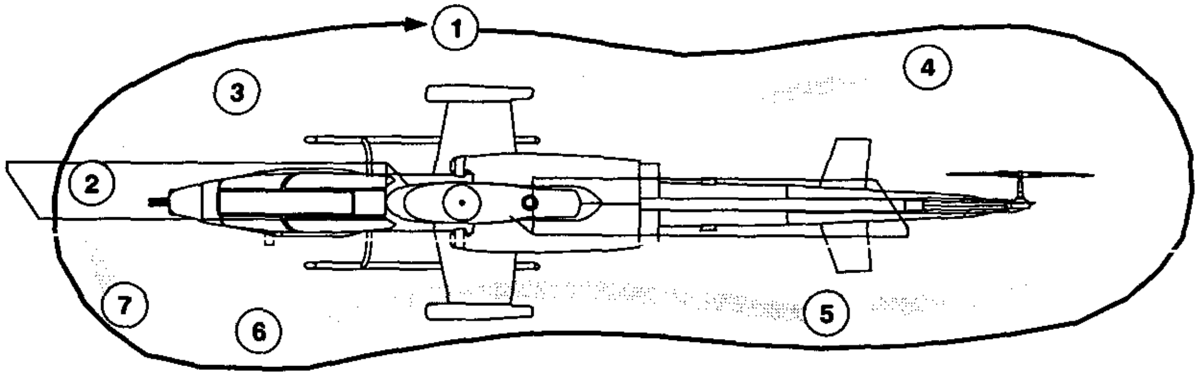
3. The pilot shall ensure a proper fuel sample has been taken.

7.4 DISCREPANCY REPORTING

Immediately following each flight, the pilot shall note all discrepancies in detail by completing the applicable items of the VIDS/MAF form in accordance with OPNAVINST 4790.2 series. To aid in discrepancy analysis, specific information such as position of controls, movement of controls and results, instrument readings, etc., should be recorded in flight, if practical, to be included on the VIDS/MAF (OPNAV 4790/60) form. Maintenance troubleshooters should be available for consultation. The pilot will ensure that he has conveyed his complete knowledge of the discrepancy orally and in writing.

7.5 EXTERIOR INSPECTION

Figure 7-1 represents minimum preflight inspection for all flights.



1. *All covers and tiedowns removed.*

2. Windshield.
Telescopic sight unit.
Wire strike cutter.
Vibration suppressor assembly.

3. Ammunition compartment.
Pitot-static system port.
Pilot canopy operation and latching.
Battery compartment.
Hydraulic fluid level and leaks (sys No. 2).
Fuel quantity and cap security.
Engine inlet screen (if installed).
Right skid tube and crosstubes.
Right wing.
Transmission oil level.
Engine No. 2 oil level.
Combining gearbox oil level.
Oil or fuel leaks in transmission, combining gearbox, and engine compartment.
All access doors and panels secured.
Oil cooler compartment for leaks/condition, utility hydraulics and engine fire extinguisher.
Aft electrical compartment.
Main rotor blades *from right side.*
Fuselage and tailboom.
Elevator for damage.
All accessible *portions of the* tail rotor driveshaft for condition/security.

4. Tail rotor.
Tail skid.
Vertical fin trailing edge.
Tail rotor gearbox oil level and leaks.
Intermediate gearbox oil level and leaks.

5. Elevator for damage.
Fuselage and tailboom.
All accessible portions of the tail rotor driveshaft for condition/security.
Avionics/baggage compartment.
Oil cooler compartment for leaks/condition, engine fire extinguisher and utility hydraulic fluid level.
Oil or fuel leaks in transmission, combining gearbox and engine compartment.
Engine No. 1 oil level.
Hydraulic fluid level and leaks (sys No. 1).
Main rotor, mast and head.
Engine inlet screen (if installed).
Wire strike cutter (top).
Pitot tube.
Battery compartment.
All access doors and panels secure.
Left skid tube and crosstubes.
Left wing.
Pitot-static system port.

6. Gunner canopy operation and latching.
VSS accumulator pressure.
Searchlight.
Wire strike cutter (bottom).
Avionics compartment.

7. Feeder and barrels.
Turret gun drive assembly.
Rear gun mount.
Declutcher-feeder cannon plug.
Elevation and azimuth brakes.
Turret cowling.
Muzzle and mid-barrel clamps.

WARNING

Gun chambers, feeder and bore shall be clear of ammunition prior to non-ordnance related *flights.* Feeder solenoid shall be engaged and barrels rotated a minimum of six cycles.

NOTE

- Visually check condition of externally mounted antennas during inspection (refer to figure 19-3).
- Verify all covers/tiedowns are removed (as appropriate prior to interior inspection).

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Figure 7-1. Exterior Inspection

7.6 PREENTRY INSPECTION

7.6.1 Normal Operation. The following list represents the minimum preentry inspection items for all flights:

Note

The pilot should adjust the butterfly valve in the air vent between the tail rotor control pedals prior to entering the cockpit, as it is difficult to reach when seated.

1. Canopy removal system (CRS) safety pins — INSTALLED.

Note

CRS safety pins should be installed prior to entering the cockpit.

2. Armament circuit breakers — UP/INBD (except HUD, AIM-9, and TURRET EL STOW).
3. Armament switches — OFF/SAFE.
4. FIRE PULL handles — IN.
5. FIRE EXT switch — OFF.
6. ENG WASH switch — OFF.
7. BATT NO. 1 and NO. 2 switches — ON.
8. BUS switch — MAN.
9. Hydraulic cooling fans — CHECK.
10. BUS switch — NORM.
11. INV switch — MAIN.
12. FUEL QTY — CHECK.
13. Auxiliary fuel tank check:
    a. AUX FUEL PUMP switches — UP (on).
    b. Check AUX FUEL XFR lights illuminate.
    c. AUX FUEL PUMP switches — OFF.

Note

- For auxiliary fuel tank functional checkflight, the FUEL QTY indicator should read approximately 1170 pounds.
- An APU is required to accomplish the auxiliary fuel check. A minimum of 20 minutes is required to pressurize tanks and illuminate AUX FUEL XFR lights.

14. INV switch — OFF.
15. BATT NO. 1 and NO. 2 switches — OFF.

7.6.2 Single-Pilot Operation. The following items shall be checked in the copilot/gunner cockpit when flight by a single pilot is to be conducted:

1. Safety belt/shoulder harness — SECURE.
2. Loose equipment — STOW/SECURE.
3. Canopy removal system (CRS) safety pins — INSTALLED.
4. UHF EMER switch — OFF, COVERED.
5. CSC panel — SET.
6. INST LT and CSL LT switches — OFF.
7. SRCH LT switch — OFF.
8. FORCE TRIM switch — ON.
9. ELEC PWR switch — ON.
10. WGST JETT switch — OFF, COVERED.
11. PILOT OVERRIDE switch — OFF.
12. Armament switches and controls — As required.
13. Canopy door — CLOSE and SECURE.

7.7 INTERIOR INSPECTION — COPILOT/ GUNNER

The following items represent minimum inspection for all flights:

Note

The copilot/gunner should adjust the butterfly valve in the air vent between the tail rotor control pedals prior to entering the cockpit as it is difficult to reach when seated.

1. Loose equipment — STOW/SECURE.
2. Pedals — ADJUST.
3. Safety belt/shoulder harness — ADJUST.
4. Inertia reel — CHECK.
5. HUD — CHECK (desiccant crystal/BIT indicator).

6. Map light — OFF.
7. Canopy removal system (CRS) safety pins — INSTALLED.
8. ANVIS HUD control panel — OFF.
9. CSC panel — SET.
10. PILOT OVERRIDE — OFF.
11. Armament switches and controls — As required:
    a. AIRSPEED COMP — As required.
    b. Turret depression limit — LIMIT.
    c. TSU track rate — As desired.
    d. Wing stores select — OFF.
12. NTS Laser min range — OFF / SET (as required).
13. NTS Laser FIRST/LAST/OFF — OFF.
14. UHF EMER — OFF, COVERED.
15. CM Radar altimeter — OFF.
16. Altimeter — SET.
17. ACQ/TRK/STOW — STOW.
18. CM NTS MFD — DAY / NIGHT (as required).
19. THCDP — OFF.
20. Instrument and console lights — As required.
21. Exterior lights — As required.
22. FORCE TRIM switch — ON.
23. SRCH LT switch — OFF.
24. Electrical power — ON.
25. Wing stores jettison — OFF, COVERED.
26. Inform pilot — Copilot/gunner checklist complete.

7.8 INTERIOR INSPECTION — PILOT

1. Loose equipment — STOW/SECURE.
2. Seat and pedals — ADJUST.
3. Safety belt/shoulder harness — ADJUST.
4. Inertial reel — CHECK.
5. DC circuit breakers — IN (except PLT and GNR CDU, and NO. 1 and NO. 2 ICU) (CHAFF DISP and CONT CBs — OUT (as required)).
6. Map light — OFF.
7. Lights — As required.
8. Pitot heater — OFF.
9. Rain removal — OFF.
10. ANVIS HUD control panel — OFF.
11. Compass (if installed) — SLAVED.
12. Radios/Nav equip/KYs/IFF — OFF.
13. ALE-39 ARM — OFF (down).
14. ALE-39 power — OFF.
15. Clock — SET and RUNNING.
16. Altimeter — SET.
17. Radar altimeter — OFF.
18. FIRE PULL handles — IN.
19. HPCP switch — GNR CONT.
20. MASTER ARM — OFF.
21. NARCADS panel — SET (as required).
22. GND/AIR/NORM — NORM (as desired).
23. ZEROIZE — FORWARD (off).
24. UHF emergency — OFF, COVERED.
25. APR-39 power — OFF.
26. APR-44 power — OFF.

27. ALQ-144 IRCM — OFF.
28. Canopy removal system (CRS) safety pins — INSTALLED.
29. AIM-9 ARM — OFF.
30. VSS — OFF.
31. FIRE EXT switch — OFF.
32. ECU/VENT — OFF.
33. IFF CODE HOLD — HOLD/HOLD.
34. Navigation control panel — OFF.
35. EMERGENCY JETTISON SELECT — OFF.
36. CSC panel — As desired.
37. SCAS power — OFF.
38. LAUNCHER ARM — OFF.
39. FUEL ENG 1 and ENG 2 — OFF.
40. FUEL CROSS FEED — OPEN.
41. FUEL TANK INTCON — OPEN.
42. Hydraulics — ON.
43. OIL COOLER — NORM.
44. ANTI-ICE ENG 1 and ENG 2 — OFF.
45. INV switch — OFF.
46. FORCE TRIM switch — ON.
47. GEN NO. 1 and NO. 2 — OFF.
48. BUS — NORMAL.
49. BATT NO. 1 and NO. 2 — OFF.
50. AUX FUEL PUMP — OFF.
51. AC circuit breakers — IN.
52. Searchlight — OFF.
53. UNCAGE/FIRE — GUARD DOWN.
54. Collective strap — OFF.
55. Armament circuit breakers — DOWN/OUTBOARD (except TURRET CNTRL, DR MTR, GUN MTR).
56. HUD — CHECK
    a. Dual combiner glass/optics — CLEAN.
    b. HUD brightness — BRIGHT.
    c. PWR — OFF.
    d. MODE — TEST.
57. Copilot/gunner checklist — COMPLETE.

7.8.1 Interior Inspection (Night Flights). In addition to interior inspection for all flights, the pilot shall inspect the following:

1. Flashlights — AVAILABLE.
2. Interior lights — CHECK operation.
3. Exterior lights — CHECK operation.

Note

IR NAV and IR light beacon ring operation must be checked with night vision goggles.

4. ANVIS HUDs — INSTALLED (if required).

7.9 PRESTART CHECKLIST

1. Helmet — ON.
2. BATT NO. 1 and NO. 2 — ON.
3. DCVM — BATT 1, BATT 2 (24 vdc minimum).

CAUTION

Do not attempt battery start with voltage below 24 volts to preclude possible damage to the battery or helicopter.

4. ANTI-COLL/POS lights — As required.

5. If the APU is required:

CAUTION

APU output limitations for starting the helicopter are 600 amps minimum and 1300 amps maximum.

Note

Using an APU to start will result in longer start times.

a. Master LIGHTS CAUTION circuit breaker — PULL.

CAUTION

Failure to pull master LIGHTS CAUTION circuit breaker prior to applying external power may result in damage to the master caution panel.

b. APU — CONNECT.

c. DCVM — ESNTL (26 to 29 vdc).

d. Master LIGHTS CAUTION circuit breaker — IN.

6. INV switch — STBY (AC STBY caution light out).

7. INV switch — MAIN (AC MAIN/STBY lights out).

8. Rotor brake — CHECK/ON (if required).

Note

If rotor brake is not used, ensure handle is fully stowed.

9. FIRE WARN — TEST.

Note

Do not hold test switch on for more than 15 seconds.

10. Fuel gauge — TEST.

11. MASTER CAUTION, CAUTION, ADVISORY, and AAU — TEST.

12. Throttles — OPEN, CHECK IDLE STOP, EECU LOCKOUT, CLOSE.

13. Throttles — SET FRICTION.

14. Main rotor — CLEAR.

7.10 START CHECKLIST

CAUTION

- Engine starts with tail winds in excess of 10 knots may result in smoke, tailpipe fire, and/or excessive MGT.
- If rotor brake slippage occurs after the starter is engaged and the decision is made to continue the start, release the rotor brake immediately. If slippage occurs in winds greater than 35 knots, abort the start. Refer to wind limitations in Chapter 8.
- If for any reason a starting attempt is to be aborted, rotate the appropriate throttle to OFF and motor the engine using the START switch for 20 seconds or until MGT is less than 150 °C. Observe starter limits. A starting attempt shall be aborted in the event one or more of the following conditions occurs:
  - N_g fails to reach 14 percent within 6 seconds.
  - MGT is not evident within 20 seconds after initial indication of N_g.
  - Oil pressure is not evident within 30 seconds after starter is engaged.
  - N_p is not present within 30 seconds after N_g has reached 67 ±3 percent.
  - MGT reaches 867 °C before starter disengagement (52 to 59 percent N_g).

Note

Failure to pull the NO. 1 ICU, NO. 2 ICU, and PLT CDU circuit breakers prior to engine start and generator engagement may result in random CDU zeroizing and random bit failures of ICUs.

1. FUEL CROSS FEED — OPEN.
2. FUEL TANK INTCON — OPEN.
3. FUEL ENG 1 and ENG 2 — As required.
4. Engine priming — As required.

Note

Engine starting may be difficult under hot ambient temperatures, 30 °C (86 °F) or above, and/or when using JP-4 because of fuel vaporization in the HMU. Aborted starts can be avoided by priming the engines.

   a. Throttles — OPEN to EECU LOCKOUT.
   b. Observe fuel coming out of the overboard drain.
   c. Throttles — CLOSE.
   d. Proceed with normal start.

5. START switch — ON (note MGT below 200 °C).

Note

Either engine may be started first.

6. Throttle — OPEN slowly to lower side of IDLE STOP.

Note

Observe an increase in BATT 2 voltage after 6 seconds when batteries switch from parallel to series.

7. NG, MGT, and ENG OIL pressure — MONITOR.

CAUTION

- If MGT reaches 867 °C before starter disengagement (52 to 59 percent N_g), abort the start.
- Ensure the collective is full down, cyclic is centered, and pedals are neutral (approximately three-fourths of an inch right) as soon as hydraulic pressure allows.

8. START switch — Verify OFF (52 to 59 percent N_g).

CAUTION

Avoid steady state N_p operation between 60 and 75 percent.

9. ENG OIL — 20 PSI or above at IDLE.
10. IDLE — CHECK 67 ±3 percent N_g.
11. Rotor brake — RELEASE.
12. Flight controls — As required.
13. XMSN, GRBX, and HYD temperature/pressure — CHECK.
14. Throttle — INCREASE (90 to 95 percent N_r/N_p).

Note

If engine is operated above 96 percent, EECU cross-signaling will cause N_r/N_p fluctuations of 1 to 2 percent when attempting start on the other engine.

15. APU (if used) — DISCONNECT.
16. GEN NO. 1 and NO. 2 — ON.
17. DCVM — GEN 1, GEN 2 (28 to 29 vdc).
18. ECU — VENT (as required).
19. Repeat steps 3 through 10 for remaining engine.

CAUTION

- To ensure that the second engine has engaged properly, the second engine throttle should be advanced slowly until both N_p and rotor needles are matched and torque rise is noted.
- A nonengaged engine is indicated by a higher N_p rpm than the engaged engine along with zero torque. If an engine does not engage, do not allow N_p to overshoot more than 2 to 3 percent. Immediately shut down the nonengaged engine. When the nonengaged engine has stopped, shut down the remaining engine.

Note

A restart may be attempted. On restart, start the engine that failed to engage first.

20. DC circuit breakers (PLT and GNR CDU, and NO. 1 and NO. 2 ICU) — IN.

21. HUD power — STBY.

22. HUD MODE — TEST.

23. MASTER ARM — STBY.

24. WEAPON CONTROL — GUNNER.

25. ACQ/TRK/STOW — STOW.

26. THCDP BRT — ON.

27. THCDP mode — STBY TOW or TSU/ GUN (observe BIT and verify TSU gimbals stabilize).

28. Radios/Nav equip/KYs/IFF — ON/STBY.

29. CNU EGI align — GCA (or as desired).

30. Navigation system — As required.

    a. START page — CHECK (datum/date/ time/position).

    b. TIMER page — CHECK (TOD/TMR selection).

    c. WPT list — BUILD.

    d. TGT list — BUILD.

    e. CONFIG page — CHECK (NTS/CDU 2 installed/not installed).

31. Remaining engine engagement — CHECK.

Note

The batteries may not receive a full charge during flights of 1 hour or less. This may result in an inability to start engines on subsequent flights. In these instances, the BAT 1 and BAT 2 circuit breakers may be pulled out at the start of the flight to bypass the battery charger monitors and allow a fast charge of the batteries. During this time, the NO. 1 BATT SYS or NO. 2 BATT SYS caution lights may illuminate temporarily. Within 6 to 10 minutes, push in BAT 1 and BAT 2 circuit breakers to reestablish the charger monitor functions necessary to fully charge the batteries. The NO. 1 BATT SYS or NO. 2 BATT SYS caution lights should remain extinguished.

32. Throttles — FULL OPEN.

CAUTION

Inadvertent EECU lockout may occur. Be prepared to reduce the throttle rapidly to control N_r/N_p.

33. FUEL CROSS FEED — As Required.

34. ENGINE RPM — ADJUST (100 percent N_r/N_p).

35. ENG 2 TRIM — ADJUST.

36. Warning/Caution advisory lights — CHECK.

37. ENG, XMSN, and GRBX OIL pressures — CHECK.

38. Flight controls — CHECK.

39. Force trim — CHECK.

40. Hydraulics system — CHECK.

7.11 POSTSTART CHECKLIST

1. SCAS POWER — ON.

2. Attitude gyro — SET.

3. Radar altimeters — ON/TEST/SET (100 ±15).

4. SCAS — NO GO LIGHTS OUT/ENGAGE.

Note

Use of anti-ice and the inlet heater is required when flying in or encountering visible moisture at ambient air temperatures of 4 °C (40 °F) or below.

5. Anti-ice — CHECK (as required).

    a. N_g — SET above 89 percent.

Note

Under most conditions, it will be necessary to roll the throttle of the engine not being checked to idle and add collective pitch to raise N_g above 89 percent.

b. ANTI-ICE ENG 1 switch — ON. Note rise in MGT and AMPS load; ENG 1 ANTI-ICE ON advisory light on.

c. ANTI-ICE ENG 1 switch — OFF. Note decrease in MGT and AMPS load.

d. Repeat steps a, b, and c for ENG 2.

6. Engine overspeed sensing circuit — CHECK.

CAUTION

The overspeed sensing circuit test shall not be performed during flight. A circuit malfunction may cause a flameout.

Note

A circuit malfunction may only cause an engine fluctuation and not a total flameout.

7. Oil cooler secondary hydraulic motor — CHECK.

8. HUD POWER — Verify TEST PASS/ON:

a. AUTO BRT — OFF.

b. HUD BRIGHTNESS — As desired.

c. MODE switch — STAD, then NORM.

d. NIGHT FILTER — As desired.

9. COMPASS — ALIGNED.

10. VSS — ON (light out).

11. CNU HaveQuick/SINCGARS — INITIALIZE (as required)

12. Armament preflight procedures — As required.

13. NTS NTS — CHECK.

a. DVO — FOCUS.

b. CCD — FOCUS.

c. MFD — ADJUST (BRT/CNT/SYM).

d. MFD — CHECK gray scale.

e. ORT — ADJUST (BRT/CNT/SYM).

f. BORESIGHT — PERFORM.

Note

Allow cool down of FLIR prior to BRST.

14. ANVIS HUDs — As desired.

7.12 SUBSEQUENT START CHECKLIST

Note

During missions requiring multiple starts, the Subsequent Start Checklist may be used.

7.12.1 Subsequent Prestart.

1. Helmet — ON.

2. BATT NO. 1 and NO. 2 — ON.

3. DCVM — BATT 1, BATT 2 (24 vdc minimum).

4. ANTI-COLL/POS lights — As required.

5. If APU is required:

a. Master LIGHTS CAUTION circuit breaker — PULL.

b. APU — CONNECT.

c. DCVM — ESNTL (26 to 29 vdc).

d. Master LIGHTS CAUTION circuit breaker — IN.

6. INV switch — MAIN (caution lights out).

7. Rotor brake — As required.

8. Throttles — CLOSED.

9. Main rotor — CLEAR.

7.12.2 Subsequent Start.

1. FUEL CROSS FEED — OPEN.

2. FUEL TANK INTCON — OPEN.

3. FUEL ENG 1 and ENG 2 — ON.

4. START switch — ON (note MGT below 200 °C).

5. Throttle — Open slowly to lower side of IDLE STOP.

6. N_g, MGT, and ENG OIL pressure — MONITOR.

7. START switch — Verify OFF (52 to 59 percent N_g).
8. Rotor brake — RELEASE.
9. XMSN, GRBX, and HYD temperatures/ pressures — CHECK.
10. Throttle — INCREASE (90 to 95 percent N_r/N_p).
11. GEN NO. 1 and NO. 2 — ON.
12. DCVM — GEN 1, GEN 2 (28 to 29 vdc).
13. ECU — VENT (as required).
14. Repeat steps 4 through 7 for remaining engine.
15. DC circuit breakers (PLT and GNR CDU, and NO. 1 and NO. 2 ICU) — IN.
16. HUD power — STBY.
17. HUD MODE — TEST.
18. MASTER ARM — STBY.
19. WEAPON CONTROL — GUNNER.
20. ACQ/TRK/STOW — STOW.
21. THCDP BRT — ON.
22. THCDP Mode — STBY TOW or TSU/ GUN (observe BIT and verify TSU gimbals stabilize).
23. Radios/Nav equip/KYs/IFF — ON.
24. CNU EGI align — GCA (or as desired).
25. Navigation system — As required.
26. Remaining engine engagement — CHECK.
27. Throttles — FULL OPEN.

WARNING

When engines operating on JP-4 are restarted within 2 hours of engine shutdown with ambient air temperature above 21 °C (70 °F), a minimum of 2 minutes of two-engine ground operation at 100 percent N_p is required prior to takeoff to purge the hot fuel from the engine nacelle area.

28. FUEL CROSS FEED — As required.

7.12.3 Subsequent Poststart.

1. SCAS power — ON.
2. Attitude gyro — SET.
3. Radar altimeters — ON/TEST (100 ±15)/ SET.
4. SCAS — NO GO lights OUT/ENGAGE.
5. Flight controls — ABBREVIATED CHECK.
6. HUD turn-on procedures — COMPLETE.
7. COMPASS — ALIGNED.
8. VSS — ON.
9. CNU HaveQuick/SINCGARS — INITIALIZE (as required).
10. Armament preflight procedures — As required.
11. NTS NTS — CHECK and BRST.

Note

Allow cool down of FLIR prior to BRST.

12. ANVIS HUD — ON (as required).

7.13 COCKING CHECKLIST

After preflight, the helicopter will be started, all normal NATOPS checklist items completed, and the Arming Checklist completed. The helicopter will then be shut down and cocked in accordance with the following procedures:

1. BATT NO. 1 and NO. 2 — ON (APU if required).
2. CNU EGI align — GCA.
3. INV switch — MAIN.
4. Rotor brake — As required.
5. Throttles — CLOSED.

6. FUEL ENG 1 and ENG 2 — ON.
7. FUEL CROSS FEED — OPEN.
8. FUEL TANK INTCON — OPEN.
9. FUEL QTY — CHECK.
10. Selected armament circuit breakers — DOWN/OUTBD (except TURRET CONTR, DR MTR, GUN MTR).
11. HUD MODE — TEST.
12. WEAPON CONTROL — GUNNER.
13. ACQ/TRK/STOW — STOW.
14. THCDP mode — STBY TOW or TSU/GUN.
15. BATT NO. 1 and NO. 2 — OFF.

7.13.1 Quick Start Checklist. After cocking upon receipt of an alert or call for assistance, the Quick Start Checklist shall be completed prior to launch.

1. Helmet — ON.
2. BATT NO. 1 and NO. 2 — ON (APU if required).
3. DCVM — BATT 1, BATT 2 (24 vdc minimum).
4. ANTI-COLL/POS lights — As required.
5. Main rotor — CLEAR.
6. START switch — ON (note MGT below 200 °C).
7. Throttle — OPEN slowly to lower side of IDLE STOP.
8. START switch — Verify OFF (52 to 59 percent N_g).
9. Rotor brake — RELEASE.
10. Throttle — INCREASE (90 to 95 percent N_p/N_r).
11. GEN NO. 1 and NO. 2 — ON.
12. DCVM — GEN 1, GEN 2 (28 to 29 vdc).
13. ECU — VENT (as required).
14. Repeat steps 6 through 8 and 10 for the remaining engine.
15. DC circuit breakers (PLT and GNR CDU, and NO. 1 and NO. 2 ICU) — IN.
16. HUD power — STBY.
17. MASTER ARM — STBY.
18. THCDP BRT — ON.
19. THCDP mode — STBY TOW or TSU/GUN (observe BIT and verify TSU gimbals stabilize).
20. Radios/Nav equip/KYs/IFF — ON/STBY.
21. CNU EGI align — SHA (or as required).
22. Navigation system — As required.
23. Remaining engine engagement — CHECK.
24. SCAS power — ON.
25. Throttles — INCREASE (100 percent N_r/N_p).
26. FUEL CROSS FEED — As required.
27. Flight controls — ABBREVIATED CHECK.
28. SCAS — ENGAGE.
29. Radar altimeters — ON/TEST (100 ±15)/SET.
30. HUD turn-on procedures — COMPLETE.
31. COMPASS — ALIGNED.
32. VSS — ON.
33. CNU HaveQuick/SINCGARS — INITIALIZE (as required).
34. NTS NTS — CHECK/BRST.

Note

Allow cool down of FLIR prior to BRST.

35. Armament preflight procedures — As required.
36. ANVIS HUDs — ON (as required).

7.14 PRETAKEOFF CHECKLIST

1. RPM — 100 percent N_r/N_p.
2. Caution and warning lights — CHECK.
3. TURRET STOW light — As desired.

Note

The TURRET STOW light will not be on after arming procedures contained in Chapter 21 are completed.

4. Instruments — CHECK.
5. FUEL QTY — CHECK.
6. SCAS — ENGAGED.
7. ECU/VENT — As desired.
8. Shoulder harness — LOCKED.
9. MASTER ARM — STBY.
10. JETTISON — As required.
11. GND/AIR/NORM — As desired.

Note

TNS The GND/AIR/NORM switch should be in the NORM position (AIR position for backup mode) prior to takeoff, and STBY NAV should delete from the CDU upon takeoff, indicating the helicopter is in flight and the Doppler is in the air navigation mode.

Note

TNS If the helicopter start point position is unknown but can be positioned to a known point, move the helicopter to a known point with the GND/AIR/NORM switch in the GND position until over the known point. Place the pilot GND/AIR/NORM switch to NORM when over the known point to initialize the Doppler navigation start point.

12. Area — CLEAR.
13. Canopy removal system (CRS) safety pins — OUT (as required).
14. VSS — ON.
15. Exterior lights — As desired.

7.15 AIR TAXIING

WARNING

Avoid low-level/hover flight maneuvers in areas with cut grass or other debris without inlet screens installed. Engine inlet blockage can occur causing engine performance loss.

Movement of the helicopter from one ground position to another can be accomplished by air taxiing at an altitude of 3 to 5 feet (skid tube above ground surface). From a hover, apply sufficient cyclic to establish a slow rate of movement over the ground in the desired direction. In confined areas, this rate of movement should be no faster than a person can walk.

Whenever possible, all air taxiing should be done by pointing the nose of the helicopter in the desired direction of movement. Sideward and rearward flight may be necessary for use in high winds and in confined areas. Because of increased rotor wash caused by air taxiing, caution should be exercised when in the vicinity of other aircraft. Particular attention should be directed to the increased rotor wash and its effects on loose objects and debris in the vicinity of the helicopter. Sufficient ground control personnel shall be available to provide for the safe taxiing of helicopters in the vicinity of obstructions or other aircraft. Only approved standard taxi signals will be used. Extreme caution should be exercised when taxiing at night.

1. AN/ASN-75 compass — CHECK.
2. Turn-and-slip indicator — CHECK.
3. ATTITUDE indicator — CHECK and SET.
4. Magnetic compass — CHECK.
5. Vertical velocity indicator — CHECK.
6. Exterior lights — As desired.

7.16 TYPES OF TAKEOFF

Conditions at the time of takeoff are the governing factors in the type of takeoff to be accomplished. The factors governing the type of takeoff to be accomplished are the gross weight of the helicopter, pressure altitude, outside air temperature, prevailing winds, the size of the takeoff area, and the tactical situation. There are many possible variations in takeoff procedures.

As the helicopter accelerates from hovering flight to flight in any direction, with engine power, rpm, and collective held constant in calm air, a momentary settling will occur. This momentary settling condition is a result of the helicopter moving from the ground cushion and the tilting of the tip-path plane of the main rotor.

Taking off into the wind or with a crosswind component will partially eliminate this settling because of the increased airflow over the main rotor. The higher the wind velocity, especially when taking off into the wind, the less pronounced this setting will be. Conversely, taking off with a tailwind component will aggravate this settling because of the decreased airflow over the main rotor as the helicopter groundspeed matches the velocity of the tailwind component.

7.16.1 Takeoff Performance. A normal takeoff can be accomplished whenever the helicopter is capable of hovering with the skids 5 to 10 feet above the ground. The hover charts in PART XI can be used to determine if the helicopter can hover out of ground effect and in ground effect.

7.16.2 Normal Takeoff to Hover. The vertical takeoff is the normal type of takeoff and should be used whenever possible. The helicopter is lifted from the ground vertically to a height of approximately 3 to 5 feet where the flight controls and engine may be checked for normal operation before continuing to climb. A normal vertical takeoff is made in the following manner. Begin with throttles full open, the collective pitch full down, and the cyclic control in a neutral position. Increase collective pitch control slowly and smoothly until hovering altitude of 3 to 5 feet is reached. Apply pedals to maintain heading as collective is increased. Make minor corrections with the cyclic to ensure vertical ascent and use the pedals to maintain heading.

7.16.3 Normal Takeoff From Hover. Hover briefly to determine if the engines and flight controls are operating properly. From a normal hover at a 3- to 5-foot altitude, apply forward cyclic to accelerate into effective translational lift; maintain hovering altitude with collective and maintain heading with pedals until translational lift is attained and the ascent has begun. In order to preclude sinking, a slight increase in power may be necessary. Just prior to translational lift, the pilot will note a slight decrease in N_g. As the helicopter is flown into translational lift, a slight reduction in power may be necessary to preclude ballooning. Adjust power and smoothly lower the nose of the helicopter to arrive at approximately 25 feet of altitude and 50 knots of airspeed. Maintain runway alignment until 50 feet of altitude has been reached, at which time establish a crab, if necessary, to trim the helicopter. Continue to accelerate and climb. Then smoothly lower the nose of the helicopter to an attitude that will result in an increase of airspeed to at least 70 knots. Adjust power as required to establish the desired rate of climb.

7.16.4 Normal Takeoff From the Ground. This takeoff is utilized for expeditious departure or where normal takeoff to a hover is undesirable, for example, over heavy sand or loose grass. With the helicopter on the ground, coordinate increased collective with simultaneous forward cyclic to takeoff and move smoothly into translational lift. Maintain normal takeoff attitudes until translational lift is attained, then proceed into normal climb.

7.16.5 Maximum Power Takeoff. Place the cyclic in the neutral position. With throttles full open, increase collective smoothly. As the helicopter leaves the ground, continue increasing power to maximum available (not to exceed limits) and assume an 80 knot attitude. As power is increased, maintain heading by smoothly coordinating pedals. When sufficient altitude for obstacle clearance is attained, smoothly increase airspeed and reduce power to establish a normal climb.

7.16.6 Confined Area Takeoff. This takeoff is utilized to depart an area over an obstacle where little or no forward motion is possible until the helicopter is above the height of the obstacle. Lift to a 4 foot hover, if possible, without exceeding limits. If within limits, smoothly increase collective to maximum allowable power and lift straight up. When the skids are above obstacle height, apply forward cyclic to accelerate into translational lift and proceed into normal climb.

7.16.7 Crosswind Takeoff. In the event a crosswind takeoff is required, there will be a definite tendency to drift downwind. This tendency can be corrected by applying cyclic into the wind a sufficient amount to prevent downwind drift. When a crosswind takeoff is accomplished, it is advisable to turn the helicopter into the wind for climb as soon as obstacles are cleared and terrain permits.

7.17 AFTER TAKEOFF

After the helicopter accelerates forward to 10 to 15 KIAS, less power is required to sustain flight because of an increase in aerodynamic efficiency as airspeed is increased to best climbing speed. Takeoff power should be maintained until a safe autorotative airspeed is attained, then power may be adjusted to establish the desired rate of climb.

7.18 CLIMB

The normal climb is made by adjusting nose attitude to maintain at least 70 KIAS. Refer to PART XI for optimum climb airspeeds. At approximately 100 feet prior to the desired cruising altitude, smoothly lower the nose and allow the helicopter to accelerate to cruise airspeed, while maintaining a slight rate of climb to reach cruising altitude. As the airspeed approaches cruise airspeed, adjust power to maintain the desired altitude and airspeed.

7.19 CRUISE

WARNING

Flight above certain ambient temperature/altitude combinations may result in engine flameout when operating with JP-4 and the FUEL CROSS FEED switch in the AUTO position (crossfeed valve closed and fuel cell boost pumps off).

Normal cruise will be conducted at a safe altitude and as dictated by weather, helicopter configuration and weight, terrain and obstacles, mission of flight, safety of the helicopter, and safety of persons and property on the ground Refer to PART XI for design cruise airspeeds and airspeed indicator corrections. Power and attitude should be adjusted to attain desired cruise airspeed.

7.20 DESCENT

A descent is performed at a normal cruise airspeed and collective pitch control as required for the desired rate of decent. At approximately 100 feet prior to the desired cruising altitude, adjust the nose attitude and power setting to level off at the desired altitude.

7.21 PRELANDING CHECK

1. Armament postfiring/before landing checklist — As required.
2. RPM — 100 percent.
3. Caution and warning lights — CHECK.
4. TURRET CNTRL Circuit Breaker — OFF.
5. TURRET STOW light — ON.
6. Instruments — CHECK.
7. FUEL QTY — CHECK.
8. SCAS — ENGAGED.
9. ECU/VENT — As desired.
10. RAIN REMOVAL — As desired.
11. Shoulder harnesses — LOCKED.
12. MASTER ARM — STBY/OFF.
13. Landing light — As required.

7.22 LANDING

7.22.1 Normal Approach and Landing. The downwind leg should be flown at 80 KIAS, 500 feet above the surface. Select the 180° position with reference to the existing wind. At the 180° position, commence a coordinated descending turn to arrive at the 90° position at 300 feet and 70 KIAS. Adjust the rate of turn and rate of descent so as to intercept the landing line with approximately 1000 feet of straightaway and about 125 feet of altitude. At this point, adjust the nose attitude smoothly to slow the airspeed and decrease the rate of descent. Start the gas producer accelerating by slightly increasing collective while the helicopter is still in translational lift. Maintain heading with the pedals. The objective of a normal approach is to simultaneously arrive over the point of intended landing with zero groundspeed and approximately 3 to 5 feet of altitude. This should be accomplished without an extreme flare and/or abrupt power change.

Once the helicopter is established in a hover, lower the collective to establish a slow, controlled rate of descent to a gentle touchdown, making corrections with the pedals and cyclic to maintain a level attitude, vertical descent, and constant heading. Upon contact with the ground, continue to lower the collective smoothly and steadily until the entire weight of the helicopter is resting on the ground and the collective if full down.

7.22.2 Slope Landing. Make the slope landing by heading the helicopter generally cross-slope. (Slope landings should be made cross-slope with skid-type gear.) Descend slowly, placing the upslope skid on the ground first. Coordinate reduction of collective pitch with lateral cyclic (into the slope) until the downslope skid touches the ground. Continue coordinating reduction of collective and application of cyclic into the slope until all the weight of the helicopter is resting firmly on the slope. If the cyclic control contacts the stop before the downslope skid is resting firmly on the ground, return to hover and select a position where the degree of slope is not so great. After completion of a slope landing and after determining that the helicopter will maintain its position on the slope, place the cyclic in the neutral position.

WARNING

After the upslope skid contacts the deck, a roll rate must be established for the downslope skid to contact the deck. Angular momentum can build to the point where dynamic rollover can ensue regardless of helicopter angle of bank. If mast bumping occurs, reposition the cyclic toward center, keep the control inputs and helicopter roll rate small to avoid dynamic rollover, then reestablish a hover.

7.22.3 Crosswind Landing. Crosswind landings can generally be avoided in helicopter operations. Occasionally, plowed, furrowed or eroded fields, and narrow mountain ridges may require that crosswind landings be made. The crosswind landing in such instances is utilized to prevent landing at a high tipping angle or dangerous tail-low altitude.

A crosswind landing may also be accomplished on smooth terrain when deemed advisable by the pilot. The following procedures should be observed in accomplishing a crosswind landing.

1. Accomplish Prelanding Checklist.
2. Hover helicopter crosswind.
3. Hold the cyclic control stick into the wind to prevent side drift throughout the landing.
4. Proceed as in a normal landing.

7.22.4 Steep Approach and Landing. The steep approach is a precision, power-controlled approach used to clear obstacles and to accomplish a landing in confined areas. Slightly past the normal 180° position, commence a coordinated descending turn to arrive at the 90° position with 300 feet of altitude and 70 KIAS. Continue to decelerate and turn to arrive on the wind line with approximately 1000 feet of straightaway and 300 feet above the ground or 100 feet of altitude above the highest obstacle. Airspeed should be smoothly reduced to 45 KIAS as the approach angle is reached. Reduce collective and adjust the cyclic to commence a descent on the desired approach angle. Keep the point of intended landing in sight through the windshield. The airspeed is controlled by nose attitude, and the rate of descent is controlled by the collective. Power requirements are governed by the gross weight, wind velocity, density altitude, and approach angle. Slow the rate of descent with the collective, simultaneously reducing airspeed with the cyclic so as to arrive over the point of intended landing with 3 to 5 feet of altitude and zero airspeed. This should be effected with little or no flare. The landing from a hover is standard.

WARNING

During steep approaches at less than 40 knots, avoid descent rates exceeding 800 fpm. Refer to POWER SETTLING, paragraph 11.9.

7.22.5 High-Speed Approach and Landing. The high-speed approach is employed to accelerate the transition from flight to landing. Airspeed is maintained in excess of 100 KIAS to an altitude of 100 feet, at which point the quick-stop technique is employed to transition to a landing. Rotor rpm will tend to overspeed during the approach and quick stop. Adjust collective as necessary to maintain rotor/engine rpm within limits. Arrive at 45 KIAS and level attitude in order to transition from a steep approach to a landing.

7.22.6 Maximum Gross Weight Landing (No Hover Landing). Maximum gross weight landings should be practiced to simulate landing without hovering at high gross weights and high density altitudes. This type of landing may be employed where a transition to a hover is not possible or a sliding landing is not feasible. The helicopter is flown as in a normal approach with a straightaway of approximately 1000 feet, 70 KIAS, and 125 feet of altitude. At this point, raise the nose attitude to slow airspeed and adjust collective to slow the rate of descent. As the airspeed decreases, continue to adjust the collective to maintain a slow, controlled rate of descent. As translational lift is lost, level the helicopter and assume the landing attitude. Continue to increase the collective to maximum power available to prevent a hard landing. Touchdown should be at less than 5 knots groundspeed. Once the helicopter is firmly on the ground, smoothly lower the collective to the bottom to complete the landing. No-hover landings should be made, whenever possible, when operating in sandy or dusty areas to minimize wear on engines and rotor blades.

7.22.7 Sliding Landing. Sliding landings should be practiced to simulate conditions where HIGE is not possible. They have value in that they acquaint the pilot with the characteristics of skid-type landing gear on various landing surfaces and they afford the opportunity to evaluate possible landing sites in case of engine failure. If an emergency autorotative approach is necessary, a sliding landing has the advantage of greater helicopter controllability during touchdown. It affords a safer landing with heavy gross weights as well.

To practice a sliding landing, select a firm, smooth surface of sufficient length and free of obstructions. The helicopter is flown as in a normal approach until just prior to touchdown. Maintain sufficient forward speed to retain translational lift and smoothly and slowly lower the helicopter to the ground with the collective. Maintain heading with the pedals. Do not land the helicopter in a crab. Compensate for any crosswind with the wing-down method. The landing attitude should be skids level to prevent any pitching of the helicopter at touchdown. Do not lower the collective abruptly during the slide. Once the helicopter is on the ground, gradually lower the collective and allow the helicopter to slide to a stop. When the helicopter has stopped, lower the collective to the bottom.

WARNING

Sliding landings on soft surfaces such as mud, loose sand, and plowed fields may cause the lower wire cutter or the skids to dig in. This could result in an abrupt stopping of the helicopter, possible causing severe structural damage or a nose-over crash.

7.23 AUTOROTATION PRACTICE

Full autorotation landings shall not be attempted as a practice measure except by pilots specifically authorized by the squadron commanding officer. Practice autorotations with power recoveries are permitted; however, recovery shall be initiated with sufficient altitude to permit full recovery at an altitude of 3 to 5 feet above the surface. From this point, a waveoff shall be accomplished straight ahead as in a normal takeoff.

Practice autorotations shall always be made into the wind and shall be performed at approved landing areas or airfields. Always plan an autorotation to an area that will permit a safe landing in an actual emergency, preferably a hard, flat, smooth surface, clear of approach and rollout obstructions. Practice autorotations should not be attempted in conditions of critical cg loadings. Caution should be exercised when practicing autorotations under conditions of high gross weight because angle of descent is steeper and rotor rpm has a tendency to build up and is harder to control. The minimum entry altitude should be 500 feet above the ground and airspeed not less than 70 KIAS for straight-in autorotations. The minimum entry altitudes should be 750 feet AGL for 90° autorotations and 1000 feet AGL for 180° autorotations. To initiate the maneuver, roll off the throttles to idle, simultaneously reducing the collective to the full-down position. Maintain heading and/or balanced flight with the pedals. During advanced phases of training, minimum altitude and speed will be at pilot discretion but shall not be less than 100 feet and 70 KIAS.

Note

If the helicopter is only slightly out of balanced flight, the rate of descent will be increased by about 500 fpm. An acutely unbalanced condition can result in an extremely high rate of descent.

Adjust collective as necessary to maintain rotor/engine rpm within limits.

Basic autorotation descents are performed at a constant 80 KIAS and in balanced flight. At approximately 75 to 100 feet AGL, commence a smooth flare sufficient to slow the airspeed and rate of descent. The rate and degree of flare necessary will vary with airspeed, gross weight, height above the ground, wind conditions, and the desired groundspeed for landing. Adjust the collective as necessary to keep the rpm within limits. Roll throttles open enough to join ENG RPM (N_P)

needles with the RTR RPM (N_r) needle at 100 percent and increase the collective slightly. Check the GAS PROD gauges to ensure that gas producers are accelerating normally. Throughout the flare, smoothly roll both throttles toward the OPEN position. When the groundspeed has been slowed to a safe sliding landing speed, smoothly and positively lower the nose of the helicopter to achieve a skids-level attitude by 20 feet. At approximately 15 feet of altitude, smoothly increase the collective to stop the descent at 3 to 5 feet AGL and roll both throttles to the full-open position while maintaining RTR RPM (N_r) and ENG RPM (N_p) within limits. Practice autorotations may be terminated to a hover or with forward groundspeed below 15 knots.

WARNING

An excessively nose-high attitude in the flare at too low an altitude will result in dragging the tail skid. This can cause serious structural damage to the tail pylon, possible tail rotor failure, and uncontrolled flight.

At average gross weights, the best glide airspeed is approximately 99 KIAS and the minimum rate of descent airspeed is approximately 66 KIAS. Skidding/slipping the helicopter or reducing airspeed will increase the rate of descent and prevent overshooting. However, it is important that the helicopter be returned to balanced flight prior to commencing the recovery (flare).

7.24 HOVERING AUTOROTATION

From a normal hover (not more than 5 feet), roll off the throttles to idle, taking care not to raise or lower the collective inadvertently. Use sufficient right directional control pedal and right cyclic to maintain heading and ensure a vertical descent. The helicopter will tend to maintain altitude momentarily, then will begin to settle. As it settles, apply up collective to cushion the landing. After the helicopter is firmly on the deck, lower the collective to the full-down position and smoothly roll the throttles to full open.

CAUTION

Hovering autorotations should only be practiced at or below 12,500 pounds gross weight. At heavier weights, greater skill and training are required to cushion the landing, and there is a greater possibility of structural damage to the helicopter.

Note

During multiple hovering autorotations, the VSS should be turned off to preclude the system cycling on and off as N_r passes 90 percent.

7.25 DUAL-ENGINE FAILURE (SIMULATED)

Simulated dual-engine failures may be performed during day, night, and under hooded instrument conditions. They shall be practiced over suitable terrain for the purpose of developing sound pilot judgment in the selection of the best available emergency landing site. Wind direction, airstart procedures, and Mayday calls should also be considered. Deviations from straight-in autorotations and varying entry airspeeds should be practiced to ensure full utilization of the helicopter capabilities and additional pilot training. Simulated dual-engine failures shall be terminated no lower than 300 feet AGL and not less than 70 KIAS.

WARNING

- Flight below +0.5g is prohibited.
- During simulated dual-engine failure initiated above 120 knots (or at high power and high airspeed), an aft cyclic input should be made to reduce a nose-low and high airspeed entry into autorotation and to minimize main rotor rpm decay. If a loss of engine power is combined with a very rapid decrease of collective, it can cause less than +0.5g loading that will result in reduced controllability. An aft cyclic input will help maintain a positive g loading on the main rotor. Large or rapid lateral cyclic inputs should be avoided to minimize any increase in main rotor flapping that might lead to mast bumping.

7.26 QUICK STOP

The quick stop is a maneuver used to reduce airspeed as rapidly and as safely as is feasible. It is useful in aborting takeoffs, avoiding other aircraft, or transitioning from flight to an immediate landing attitude. Establish stable 100 KIAS flight at a constant altitude of 100 feet. For the quick stop, reduce the collective and apply coordinated aft cyclic to slow airspeed while maintaining constant altitude. (Do not flare so abruptly that the helicopter balloons.) Adjust collective and throttle as necessary to maintain rotor rpm within limits. When airspeed has slowed to 45 KIAS, level the helicopter and smoothly transition from a steep approach to landing.

WARNING

Collective pull from a low transmission torque setting or near flat pitch condition, such as a quick-stop maneuver or collective anticipator check, can result in transient N_p/N_r droop below power-on limits. Subsequent rapid engine response can lead to severe transient transmission overtorque. Flight test data revealed a collective pull from 0 to 35 percent transmission torque in 2.5 seconds produced a transient N_p/N_r droop to 92 percent and a transmission overtorque of 109 percent.

7.27 TWENTY AND THIRTY DEGREE DIVES

Twenty and 30° dives are practiced to simulate high-level rocket attack and to acquaint the pilot with low-threat ordnance delivery maneuvers. These dives should be initiated at or above 2000 feet AGL to provide ample time and altitude for a smooth pulloff. Set 40 percent torque and raise the nose 20° above the horizon. Slow to approximately 60 knots and smoothly roll the helicopter toward the target line while maintaining the nose on the horizon. Begin to roll wings level and allow the nose of the helicopter to fall below the horizon 15° prior to intercepting the target line. Stabilize on the target line at the desired dive angle while maintaining balanced flight and 40 percent torque. To avoid the weapons fragmentation pattern, recover prior to 1000 feet AGL by raising the nose and then rolling the helicopter away from the gun-target line while simultaneously increasing collective.

7.28 PRACTICE HIGH-SPEED LOW LEVEL AUTOROTATIONS

The practice high-speed, low-level autorotation is a maneuver used to simulate dual-engine failure at low level. To perform the maneuver, establish 120 KIAS at a constant altitude not less than 100 feet AGL or 50 feet above the highest approach obstacle. To enter the autorotation, reduce the throttles to flight idle and apply coordinated aft cyclic with collective reduction to slow the helicopter and to maintain rotor rpm (N_r) within limits. At 80 KIAS and 75 feet AGL, complete a normal practice autorotational approach.

WARNING

During autorotations above 120 knots (or at high power and high airspeed), an aft cyclic input should be made to reduce a nose-low and high airspeed entry into autorotation and to minimize main rotor rpm decay. If a loss of engine power is combined with a very rapid decrease of collective, it can cause a less than +0.5g loading that will result in reduced controllability. An aft cyclic input will help maintain a positive g loading on the main rotor. Large or rapid lateral cyclic inputs should be avoided to minimize any increase in main rotor flapping that might lead to mast bumping.

7.29 SINGLE-ENGINE FAILURE (SIMULATED)

This maneuver will be performed in the training environment to simulate a single-engine emergency. Simulated single-engine failures shall be practiced only when single-engine flight, landing, or recovery by autorotation is possible in the event of dual-engine power loss. Fly the landing pattern to arrive at 500 feet AGL and 80 KIAS at the abeam position. Commence a coordinated descending turn to arrive at the 90° position at 300 feet AGL and 70 KIAS. Continue to decelerate and turn to arrive on the wind line with a shallow glideslope. Slow the helicopter while continuing descent to arrive at the landing site. Procedural steps should conform to single-engine emergency procedures as stated in Chapter 14 with simulation of appropriate steps. Single-engine waveoffs may be initiated as judgment dictates but should not be attempted below 75 feet AGL or 45 KIAS.

WARNING

Any single-engine failure should be treated as if a total power loss is forthcoming. An approach to a suitable field should not be attempted until landing is assured. Consideration should be given to increasing altitude to place the aircraft in autorotative parameters to a suitable landing site. Further, sufficient altitude and airspeed should be maintained to remain outside the avoid region of the height-velocity diagram.

CAUTION

It is important to closely monitor the MGT and N_g of the operable engine to preclude engine damage.

Note

Intentional single-engine takeoffs are prohibited.

7.30 PRACTICE ENGINE ELECTRICAL CONTROL UNIT LOCKOUT

EECU lockout is practiced to familiarize the pilot with the procedure and increase proficiency in performing lockout during an actual emergency. Practice EECU lockout will be performed on only one engine at a time. The following maneuvers should be performed to increase pilot confidence in flying the helicopter while in EECU lockout:

1. Normal takeoff to a hover
2. Taxiing
3. Takeoff from a hover
4. Climb
5. Cruise
6. Descent
7. Normal approach and landing.

Perform practice EECU lockout procedures with the helicopter on deck as follows:

1. Collective full down.
2. Both throttles full open (100 percent N_p/N_r).
3. Activate the idle release for the desired engine.
4. Momentarily advance the throttle, then rapidly decrease it to prevent an overspeed.

Note

Rolling the throttle down too far may result in the engine being shut down.

5. Adjust the throttle of the engine in lockout to set torque 10 percent below governed engine torque.
6. Increase collective to establish a hover.
7. Take off.

CAUTION

The pilot shall closely monitor N_p/N_r during the maneuvers to prevent an overspeed condition from occurring.

Note

The pilot must continually adjust the throttle on power changes during maneuvers to maintain the engine in lockout at 10 percent below governed engine torque.

After landing, the pilot shall return the engine in lockout to normal EECU as follows:

1. Reduce the throttle to flight idle.
2. Cautiously roll the throttle up to full open to ensure normal governing is in effect.

7.31 TAIL ROTOR MALFUNCTION (SIMULATED)

The simulated tail rotor malfunction maneuver is practiced to simulate landing with a fixed pitch on the tail rotor. Once established at pattern altitude, the pilot not actually flying the maneuver will hold the pedals in a fixed position. (The pilot in control does not remove his feet from the pedals.) The helicopter will react to control inputs in the following manner:

1. Collective increase — Yaw right

2. Collective decrease — Yaw left
3. Throttle increase — Yaw right
4. Throttle decrease — Yaw left
5. Airspeed increase — Yaw left
6. Airspeed decrease — Yaw right.

The pilot may adjust the collective, throttle, and airspeed to become familiar with the helicopter reaction to each adjustment and to determine how these responses may be used on final approach to effect a landing. When possible, turns should be made in the direction of the yaw. The approach should be flown with a slightly wider abeam position, on a shallow glideslope, and with no rapid power applications. Minimum control movements should be made on final. On short final, adjust the collective and airspeed as necessary to align the helicopter with the left side of the runway. Continue a low approach to simulate a sliding landing at not less than 3 feet AGL. At no time will throttles be reduced below minimum power-on rpm. Waveoff should be executed in balanced flight at 100 percent N_r.

7.32 NO. 1 HYDRAULIC FAILURE (SIMULATED)

A simulated No. 1 hydraulic system failure is a maneuver practiced to enable the pilot to land in the event of a No. 1 hydraulic system failure. Perform a simulated No. 1 hydraulic failure landing as follows:

1. HYD SYS 1 — OFF.
2. MASTER CAUTION light — RESET.
3. Verify HYD PSI 1 indicator — NEAR ZERO.
4. Extend the downwind leg to allow for a shallow straight-in approach.

Note

Increased forces to operate the pedals and loss of yaw SCAS require the pilot to devote more attention to pedal inputs and yaw rate.

5. The abeam position should be wider to allow for a shallow turn.
6. Execute a normal approach to a hover.

WARNING

Do not attempt to land unless yaw rates are under control.

7. Smoothly land the helicopter.
8. Lower the collective to full down and center the pedals.
9. HYD SYS 1 — ON.
10. Engage yaw SCAS.

Note

All landings shall be made to a prepared surface. The downwind leg should be flown in level, balanced flight at 500 feet AGL and 80 KIAS.

7.33 DUAL HYDRAULIC FAILURE (SIMULATED)

Dual hydraulic system failure (simulated) is a maneuver practiced to enable the pilot to land the helicopter in the event of a dual hydraulic system failure. All approaches shall be made to a simulated sliding landing (low approach) at no less than 3 feet AGL and not less than 20 knots airspeed. On the downwing leg at 500 feet and 80 knots, set 30 percent torque, turn off the No. 1 hydraulic system, and disengage the SCAS. Reset the MASTER CAUTION light and check the NO. 1 HYD PSI gauge for a zero psi reading. The collective should be fixed at a position between 30 and 50 percent torque. Extend the downwind leg to establish a straight-in approach of at least 2 nm. The abeam position should be wider to allow for a shallow turn. Throttles may be reduced to assist in establishing a descent, but at no time below minimum power-on rpm. Maneuver the helicopter as necessary to establish a rate of descent. At light gross weight configurations, the minimum power setting (30 percent torque) may result in a sufficient rate of descent unless the airspeed is reduced below 35 knots. Airspeed should not be reduced below 20 knots. Ensure that both throttles are full open and the helicopter is aligned with the runway heading prior to commencing the simulated sliding landing. The maneuver is terminated at no less than 3 feet AGL and, upon waveoff, full systems will be restored prior to turning downwind.

7.34 WAVEOFF

7.34.1 Power-On Approach.

1. Collective — Smoothly increase to takeoff power.
2. Airspeed — Increase to climb airspeed.
3. Cyclic — Establish a climb.

7.34.2 Autorotative Approach.

1. Throttles — Increase to full open. (coordinate with collective to prevent overspeed.)
2. Collective — Smoothly increase to takeoff power.
3. Airspeed — Increase to climb airspeed.
4. Cyclic — Establish a climb.

7.35 SHUTDOWN

WARNING

Pilots shall ensure, prior to shutdown, that area is clear and that unnecessary personnel around helicopter are outside rotor tip path plane. During any ground operation, the pilot is also responsible for ensuring that the number of personnel around helicopter is kept to a minimum to ensure a safe operation.

1. Collective — DOWN.
2. Controls — CENTERED.
3. VSS — OFF.
4. Canopy removal system (CRS) safety pins — IN.
5. Throttles — DECREASE (75 to 80 percent N_p).

CAUTION

- Excessive pressure applied against Idle Stop while retarding throttle may cause engine flameout. Also, movement of the throttles as little as 1/8 inch below the flight idle stop may cause flameout.
- Avoid engine rpm steady state operation below 75 percent N_p.

CAUTION

- The engine must be cooled for 2 minutes at an N_g speed of 90 percent or less. If the engine is shut down from a high power setting without being cooled for 2 minutes and it is necessary to restart the engine, the restart should be made within 5 minutes after shutdown. If the restart cannot be done within 5 minutes, the engine should be allowed to cool for 4 hours before attempting a restart.
- If engine N_g speed has not been advanced above 90 percent (i.e. ground turns or other extended periods of operating above 100 percent N_r/N_p), the two minute cooling period is not required. Throttle closure may be initiated from 100 percent N_r/N_p.

6. FORCE TRIM switch — ON.
7. AUX PUMPS — OFF.
8. Radar Altimeters — OFF.
9. VCR — STOP.
10. ACQ/TRK/STOW — STOW.
11. THCDP BRT — OFF.
12. IFF MODE 4 — SECURE.
    a. IFF CODE HOLD (instrument panel) — HOLD.
    b. MODE 4 CODE (rotary switch) — HOLD (momentarily).
    c. IFF MASTER power — OFF (within 15 seconds).
13. MASTER ARM — OFF.

14. Countermeasure systems — OFF.
15. HUD — Secure as follows:
    a. NIGHT FILTER — OFF
    b. AUTO BRT — OFF
    c. POWER — OFF.
16. ANVIS HUDs — OFF.
17. Radios/Nav equip/KYs/IFF — OFF.
18. DC circuit breakers (PLT and GNR CDU, and NO. 1 and NO. 2 ICU) — OUT.
19. Lights — As required.
20. ECU/VENT — OFF.
21. IDLE STOP RELEASE — ENG 1.
22. Engine No. 1 throttle — CLOSED (MGT and N_g decreasing).
23. IDLE STOP RELEASE — ENG 2.
24. Engine No. 2 throttle — CLOSED (MGT and N_g decreasing).

Note

Momentary actuation of the IDLE STOP REL will result in the solenoid remaining retracted for a period of 5 seconds. The respective throttle may be rotated to the closed position during this period.

25. SCAS POWER — OFF.
26. GEN NO. 1 and NO. 2 — OFF.
27. FUEL ENG 1 and ENG 2 — OFF.

CAUTION

Do not set the FUEL ENG 1 and ENG 2 switches to OFF until MGT has decreased and is stabilized below 540 °C. Starters will be disabled and preclude motoring of engines. This may result in an overtemperature condition in the event of an internal engine fire.

28. FUEL TANK INTCON — OPEN.
29. FUEL CROSS FEED — OPEN.
30. INV switch — OFF.
31. Rotor brake — ENGAGE (60 to 25 percent N_r).

CAUTION

- Without the use of the rotor brake upon shutdown, winds of approximately 35 knots or above may cause the rotor to windmill indefinitely (e.g., 20 percent rotor rpm).
- If severe main rotor flapping or mast bumping occurs because of high/gusty winds, apply the cyclic into the wind as required to prevent or eliminate mast bumping.

Note

If rotor brake chatter or loud ticking noise occurs upon application of the rotor brake, notify maintenance.

32. Lights — OFF.
33. BATT NO. 1 and NO. 2 — OFF.
34. DCVM — OFF (12 o'clock).
35. Collective strap — SECURE.

Note

Ensure CRS safety pins are installed in CRS handles before exiting helicopter crew stations.

7.36 POSTFLIGHT EXTERNAL INSPECTION

A postflight inspection should be made by the pilot upon leaving the helicopter after completing the assigned mission. This inspection is a general visual inspection of the landing skids, fuselage, tail rotor and drive systems, tail assembly and engine compartment. In addition to the established requirements for reporting any system defects, the pilot will also make entries on the OPNAV form 3760/2D, Part A, to indicate when any normal operating limits contained in this manual have been exceeded. When an emergency fuel is used, report the type fuel and length of operation.

Note

Any contact with salt-water spray shall be noted on the VIDS/MAD.

7.37 NIGHT FLYING

The procedures for night flying will be essentially the same as those for days; however, visual reference and depth perception are reduced.

7.37.1 Restrictions on Night Flying.

Helicopters shall not be flown at night if any of the following equipment is not in operating condition:

CAUTION

When landing in a grass area, turn the searchlight OFF after landing to prevent fire hazard.

1. Pilot and copilot/gunner compartment instrument and console lights
2. All exterior lights
3. UHF radio
4. Attitude indicator
5. Radar altimeter.

Helicopters shall not be flown beyond the immediate vicinity of the field unless under positive control of the tower if any of the following equipment is not in operating condition:

1. TACAN
2. Gyro compass.

CHAPTER 8

Ship-Based Procedures

8.1 COMMAND RESPONSIBILITY

Shipboard environment, procedures, and operations must be as normal as those used ashore. The squadron is no longer an independent command when embarked aboard ship but has become an integrated part of an operating system. Marine squadrons embarked for amphibious operations are component parts of the landing force under the command of the landing force commander. The amphibious task force commander exercises his command authority of these units through the landing force commander. All squadrons embarked become a part of the overall ship function for coordination, control, and support. The commanding officer of the squadron is responsible at all times for the combat readiness of his organization. Command relations and general procedures are contained in NWP 42 and NWP 22-3.

8.2 FIELD CARRIER LANDING PRACTICE

An FCLP is required of all pilots within 30 days prior to carrier qualification to ensure maximum crew proficiency. The number of periods will depend on the experience and ability of the individual pilot; however, a minimum of two FCLP periods are required (one day and one night period). FCLPs will be conducted to simulate shipboard operations as closely as possible.

8.2.1 Briefing Prior to Field Carrier Landing Practice.

1. Patterns, altitudes, and airspeeds
2. Helicopter director signals.

8.2.2 Night Field Carrier Landing Practice. When facilities permit, pilots should complete FCLPs prior to night carrier qualification to familiarize themselves with night shipboard landing procedures.

8.3 CARRIER QUALIFICATION

The term carrier qualification referred to herein encompasses all shipboard landing operations. Initial day/night carrier qualification should be made under ideal weather conditions including a visible horizon.

8.3.1 Carrier Qualification and Requalification Requirements. Nothing in this manual precludes the commanding officer from exercising his own judgment concerning the ability of a pilot to perform a mission involving recovery on board or when operational necessity dictates.

8.3.1.1 Carrier Qualification Requirements.

1. Day initial qualification — No less than five landings and takeoffs.
2. Night initial qualification: Day qualified and not less than five night landings and takeoffs. At least two day landings must be made on the day of the night qualification.

8.3.1.2 Requalification Requirements.

1. Day — Not less than two landings.
2. Night — Not less than three landings and at least two day carrier landings must be made on the day of the night qualification.
3. Currency — Requalify every 12 months.
4. If a pilot has not met the requirements for requalification in a 12-month period, subject pilot is no longer current and must meet initial qualification requirements.

8.3.1.3 Landing and Recovery Procedures. Shipboard qualifications are conducted using the same procedures contained in the launch and recovery operations in this chapter.

8.3.2 Flight Scheduling. Refer to NWP 42.

8.3.3 Briefing. All pilots will receive a thorough briefing by the ship air department officer or the appropriate representative on ship air operations and procedures. Flight briefings will be conducted by the units operation department prior to each flight. This detailed briefing will include the information set forth in this section and shall include the following:

1. Landing signals
2. Wind direction and velocity for flight operations
3. Use of helicopter lights (if night operation)
4. Traffic patterns and altitudes about ship
5. Instrument recovery and/or scheduled recovery time
6. Special safety precautions during shipboard operation
7. Ship's point of intended movement and nearest land
8. Aircraft deck spotting
9. Ship navigational aids
10. Weather forecast and weather over nearest land
11. Ship position in the force.

8.3.4 Hangar and Flight Deck Procedures. Deck procedures are found in LPH/LHA/LHD, CV, and Aircraft Signals NATOPS manuals, and NWP 42.

8.4 OPERATION OF EQUIPMENT

Only qualified personnel shall operate ground handling equipment. Towing couplings and ground handling equipment shall be inspected prior to towing. Only approved tow bars will be used. Refer to paragraph 3.10 for proper ground handling gear installation and operation.

8.5 FLIGHT DECK OPERATIONS

1. Flight deck handling procedures and aircraft handling signals are contained in NWP 42 and the NATOPS Aircraft Signals manual.
2. Personnel not required for helicopter operations shall remain clear of the flight deck during launch and recovery of helicopters.
3. Starting engines and rotor shall be done only upon direction of personnel from the ship air department.
4. Air taxiing and movement of helicopters shall be under the positive control of LSEs.

8.5.1 Manning Helicopters. Upon receipt of the word to "Man aircraft," flightcrews will expedite movement toward helicopters, complete the preflight inspection, and man aircraft.

8.5.2 Starting Engines and Rotor. Preparations for starting the engines and rotor shall be completed by the helicopter crew immediately after they enter the helicopter.

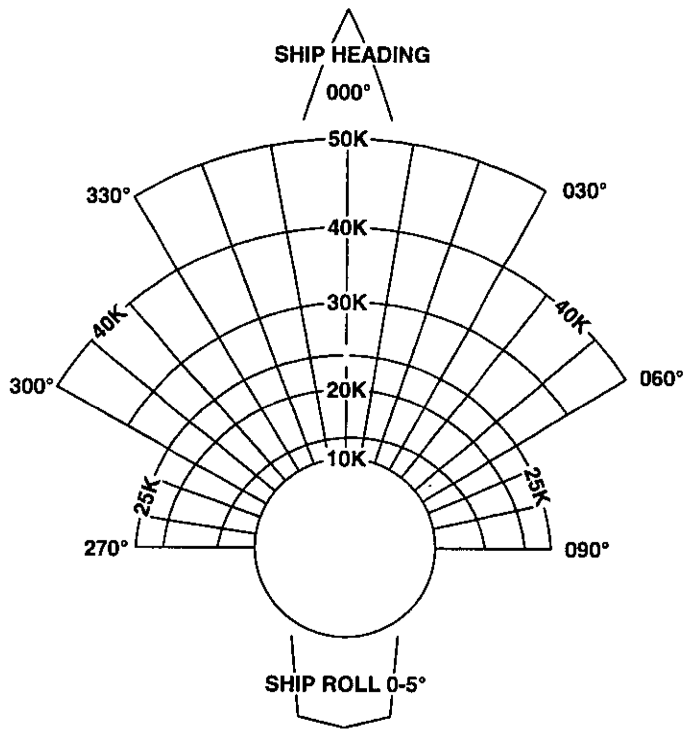
CAUTION

Monitor voltage supplied by the APU (if used) at 26 to 29 Vdc.

Mandatory requirements for starting engines and rotor consist of the following items:

1. Main rotor and tail rotor blade tiedowns shall be removed.
2. Offset main rotor blade to prevent tailboom strike.
3. Deck tiedown secure.
4. Flight deck area clear of unnecessary personnel.
5. Rotor brake engagement/disengagement wind limits (Figure 8-1).
6. Fireguard on station.

STARTUP/SHUTDOWN WITH ROTOR BRAKE ENGAGED



APPLICABLE FOR:

LPH SPOTS 1-5

LHA SPOTS 1-7

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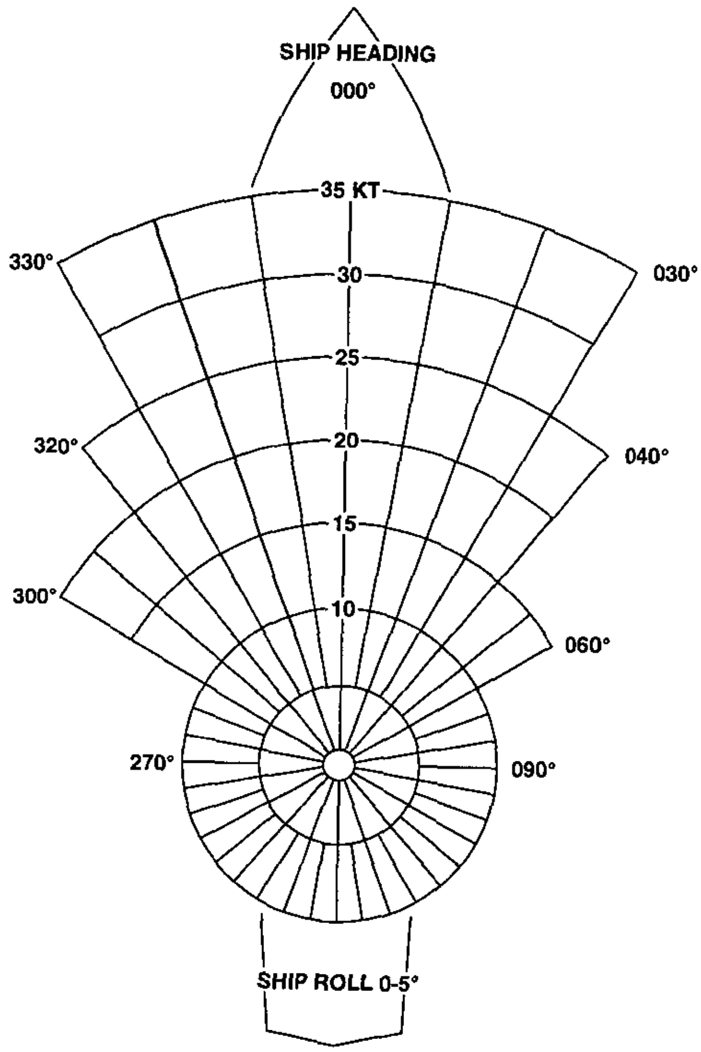
J1408

Figure 8-1. Wind Limitations (Sheet 1 of 2)

STARTUP/SHUTDOWN WITHOUT ROTOR BRAKE ENGAGED



APPLICABLE FOR:

LHA SPOTS 2-5

LPH SPOTS 2, 3, 4

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J1408

Figure 8-1. Wind Limitations (Sheet 2 of 2)

Engines shall be started only on signal from an LSE and under positive control of PriFly. The start procedure is normal. It may be necessary for the pilot to adjust the tip-path plane. Cockpit checks are accomplished in the normal sequence but should be made as expeditiously as possible consistent with safety.

WARNING

Flight control checks, if necessary, shall be performed with an absolute minimum of flight control displacement. When the helicopter is operating at 100 percent engine RPM (N_P), a moderate amount of right directional control pedals shall be applied when the collective pitch control is full down to prevent the helicopter from skidding on the flight deck.

Tiedowns shall be removed when the pilot signifies that he is ready for launch and the LSE has received permission to launch from PriFly. The pilot will ensure complete removal of tiedown chains prior to takeoff. In case of a downed helicopter, tiedown chains shall be left on and the disposition of the helicopter will be determined immediately after the launch. All flight deck operations, including starting engines and rotors, removing tiedown chains, etc., are executed on signals relayed from PriFly. The pilot should keep the LSE in sight and be prepared to receive signals at any time.

8.5.3 Launch and Recovery Operations. All commands are given by PriFly. LSEs relay all signals given by PriFly when the helicopter is in close proximity to the flight deck.

8.5.3.1 Relative Wind for Launch and Recovery.

1. For launch and recovery wind limits, see Figure 8-2. In an emergency, the helicopter may be launched in 60-knot relative winds.

2. Operations in the island wash area should be held to a minimum.

8.5.3.2 Launch Procedures.

1. Helicopters shall not take off until cleared by PriFly and a signal has been received from the LSE.

2. Helicopters shall take maximum advantage of the available deck while gaining translational lift.

CAUTION

Moderate engine and rotor rpm droop and a slight settling of the helicopter may be experienced immediately after lift-off while clearing the deck. Transient droop can be reduced by raising the collective slowly and smoothly.

3. Helicopters taking off will avoid crossing the bow of the ship.

4. Rendezvous will be in accordance with Chapter 9.

8.5.3.3 Recovery Procedures.

8.5.3.3.1 Standard Signals. Any of the following standard signals may be given by flag hoist, blinker, and/or radio:

1. Signal Delta — The flight leader will orbit his flight in the designated pattern.

2. Signal Charlie — Commence landing.

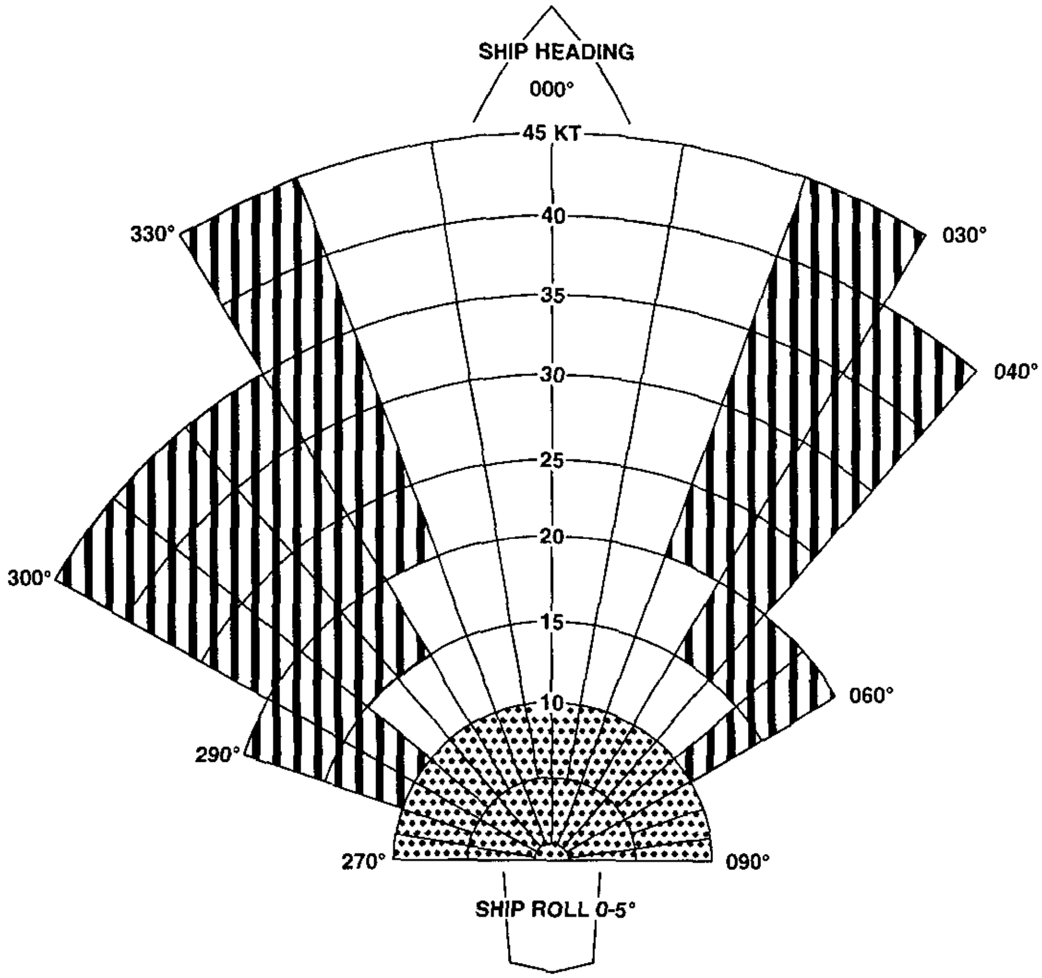
8.5.3.3.2 Delta Pattern (Holding Pattern). The delta pattern for helicopters is as designated in NWP 42 or by the individual ship. More than one delta pattern may be designated. This pattern may be assigned to any helicopter or flights of helicopters during launch or recovery operations. When helicopters are orbiting in a delta pattern, they will be prepared to break on order from PriFly to join the Charlie pattern.

8.5.3.3.3 Landing Pattern Entry Breakup Procedures. Unless cleared by PriFly for direct entry, helicopters shall approach the ship on a heading that will parallel the ship's base recovery course close abeam the starboard side. The flight leader starts his upwind turn 400 yards ahead of the bow at a 300-foot altitude. Each succeeding helicopter breaks to maintain a minimum but safe interval.

8.5.3.3.4 Charlie Pattern. This pattern is a racetrack landing pattern oriented on the port side of the ship and extending upwind a sufficient distance to allow a normal landing interval between helicopters. A designated altitude of 300 feet and 80

DAY LAUNCH/RECOVERY WIND ENVELOPE

HELICOPTER ALIGNED WITH SHIP CENTERLINE

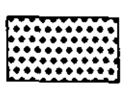


APPLICABLE FOR:

LHA SPOTS 1-6

LPH SPOTS 1-4

FLIGHT OPERATIONS IN THIS AREA MAY REQUIRE LARGE, RAPID YAW AND ROLL CONTROL INPUTS. APPROACHES, LANDING AND TAKEOFFS SHOULD BE SLOW AND PRECISE.



FLIGHT OPERATIONS IN THIS AREA ARE CHARACTERIZED BY LARGE POWER CHANGES AT THE DECK EDGE. THE PILOT SHOULD ENSURE THAT THERE IS SUFFICIENT POWER AVAILABLE FOR A NO WIND OGE HOVER IN THE EXISTING AMBIENT CONDITIONS PRIOR TO A TAKEOFF OR LANDING.

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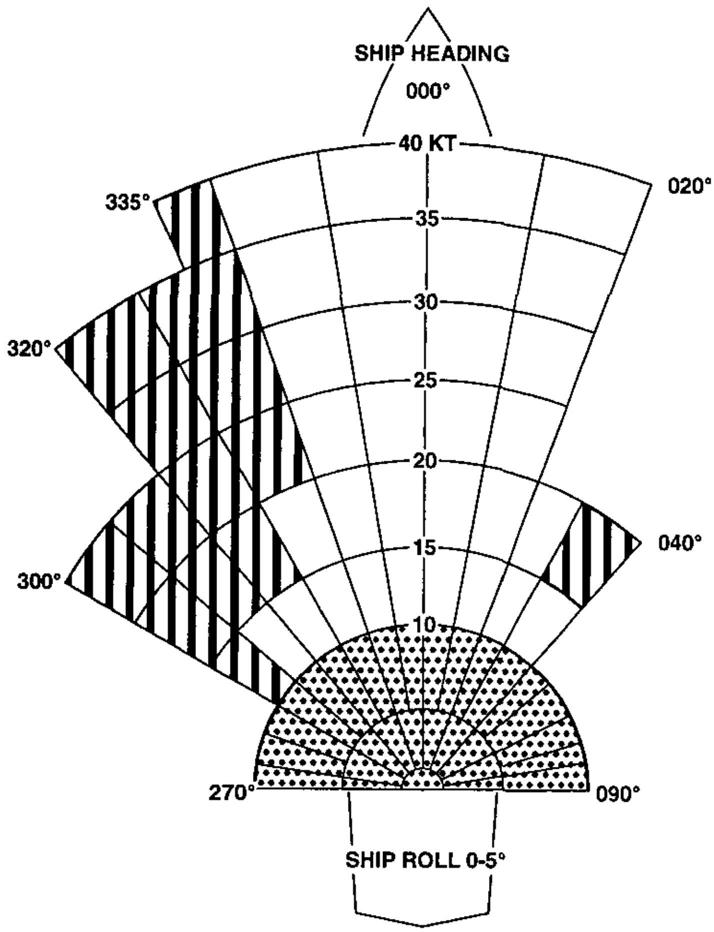
J1406

Figure 8-2. Wind Envelope (Sheet 1 of 9)

NIGHT LAUNCH/RECOVERY WIND ENVELOPE

HELICOPTER ALIGNED WITH SHIP CENTERLINE

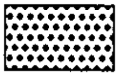


APPLICABLE FOR:

LHA SPOTS 4-6

LPH SPOTS 3, 4, 5

FLIGHT OPERATIONS IN THIS AREA MAY REQUIRE LARGE, RAPID YAW AND ROLL CONTROL INPUTS. APPROACHES, LANDING AND TAKEOFFS SHOULD BE SLOW AND PRECISE.



FLIGHT OPERATIONS IN THIS AREA ARE CHARACTERIZED BY LARGE POWER CHANGES AT THE DECK EDGE. THE PILOT SHOULD ENSURE THAT THERE IS SUFFICIENT POWER AVAILABLE FOR A NO WIND OGE HOVER IN THE EXISTING AMBIENT CONDITIONS PRIOR TO A TAKEOFF OR LANDING.

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Figure 8-2. Wind Envelope (Sheet 2 of 9)

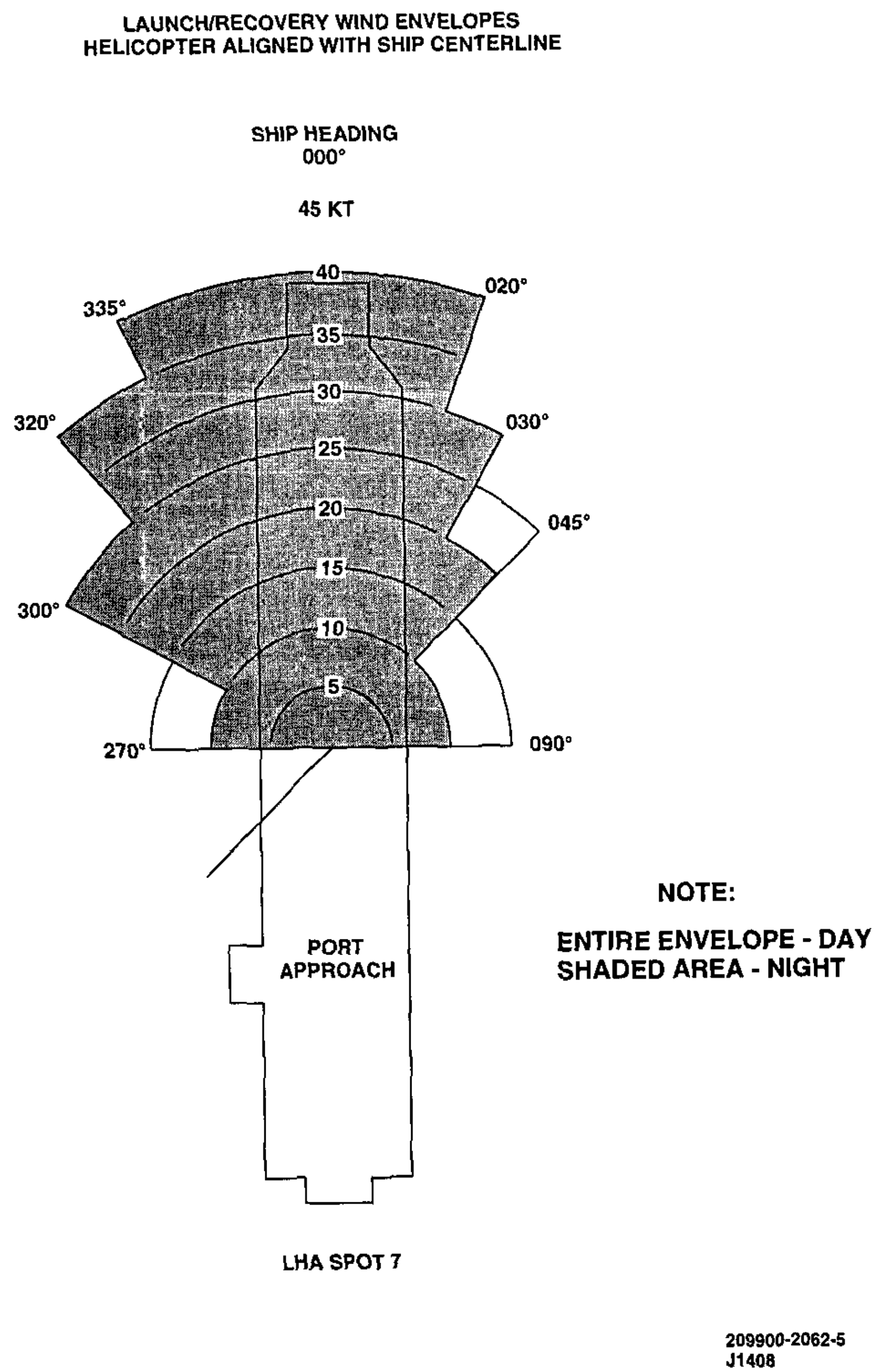


Figure 8-2. Wind Envelope (Sheet 3 of 9)

LAUNCH/RECOVERY WIND ENVELOPES
HELICOPTER ALIGNED WITH SHIP CENTERLINE

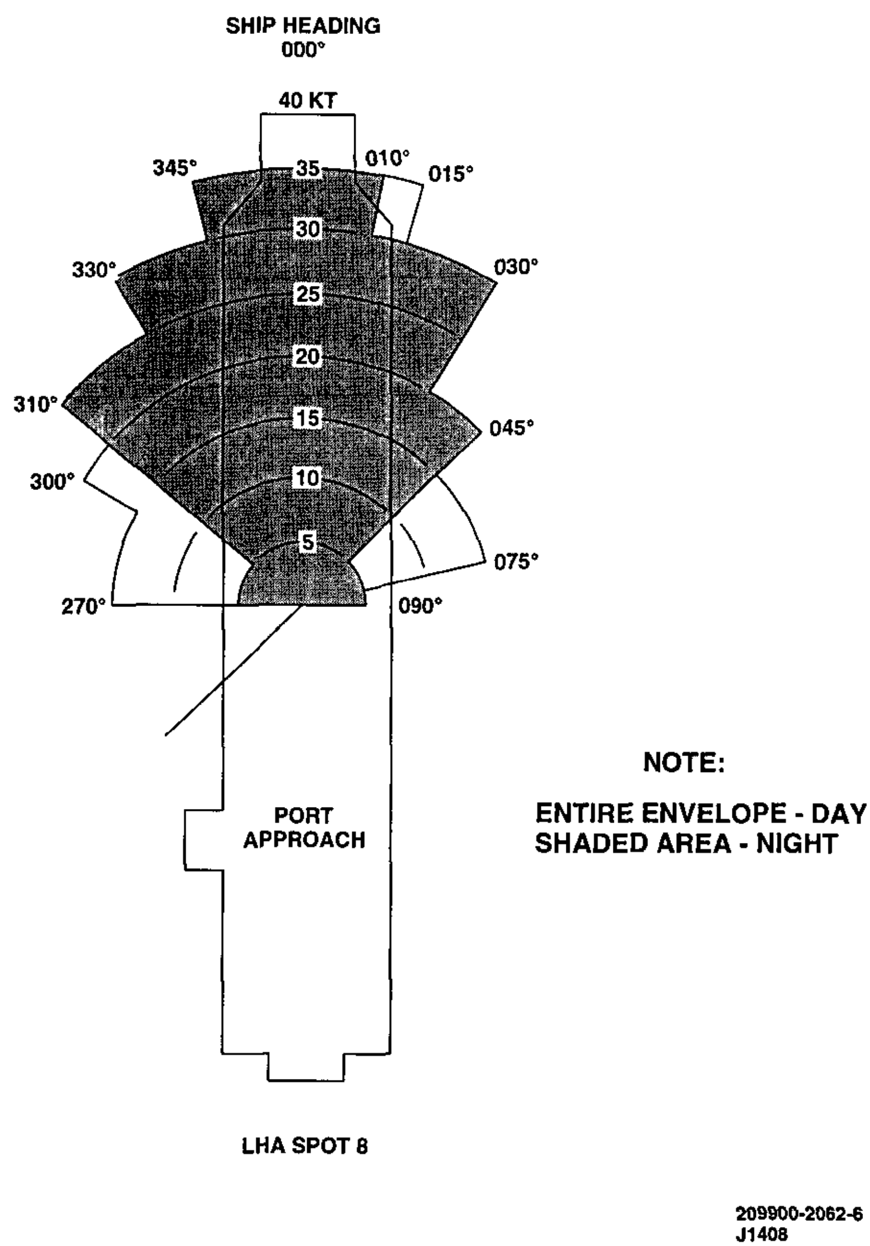


Figure 8-2. Wind Envelope (Sheet 4 of 9)

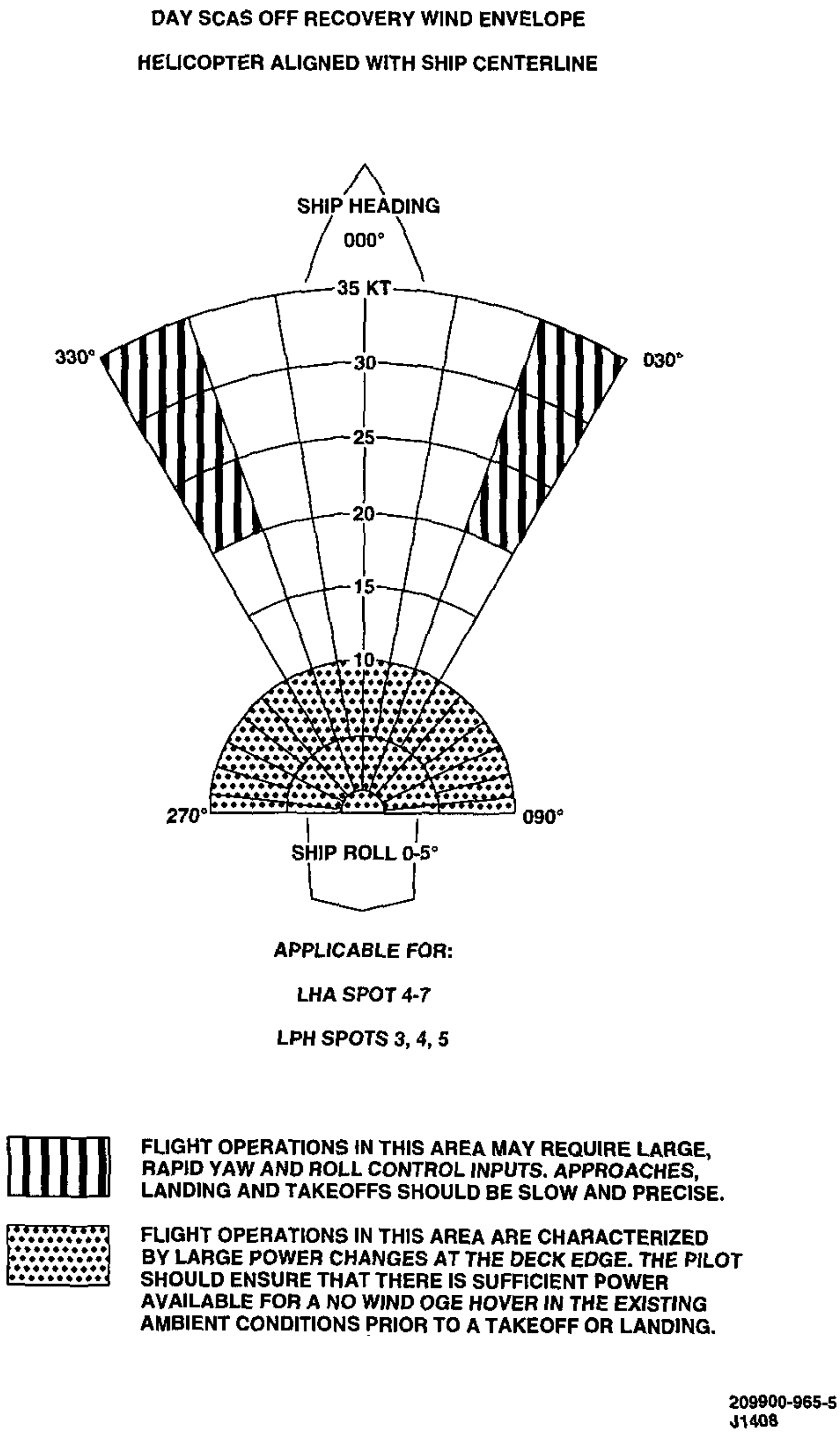
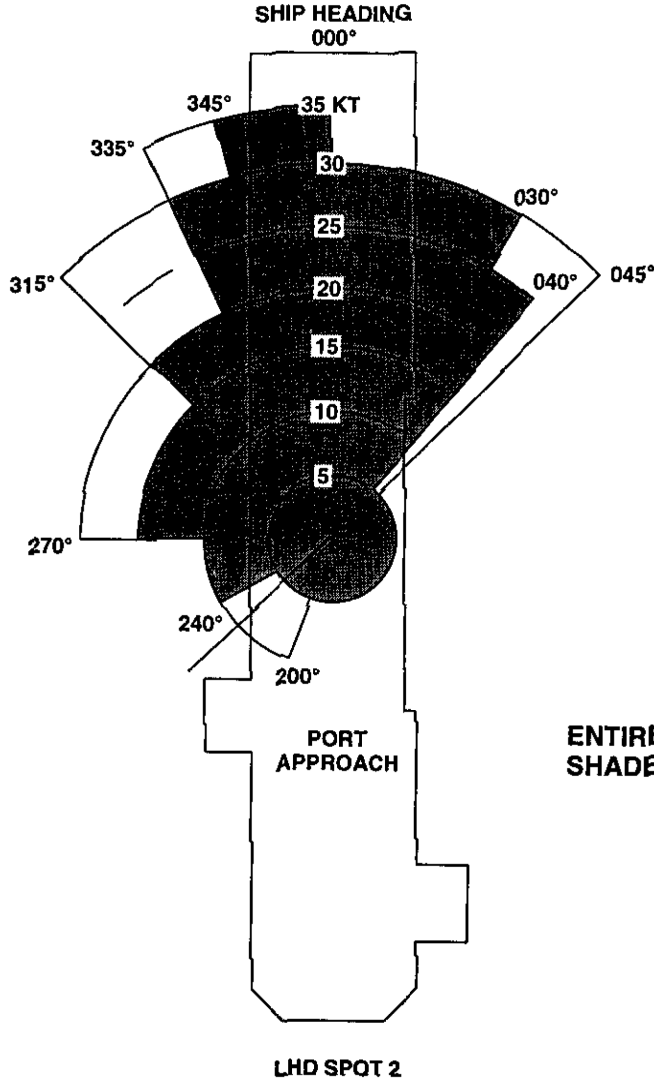


Figure 8-2. Wind Envelope (Sheet 5 of 9)

LAUNCH/RECOVERY WIND ENVELOPES
HELICOPTER ALIGNED WITH SHIP CENTERLINE



NOTE:

ENTIRE ENVELOPE - DAY
SHADED AREA - NIGHT

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Figure 8-2. Wind Envelope (Sheet 6 of 9)

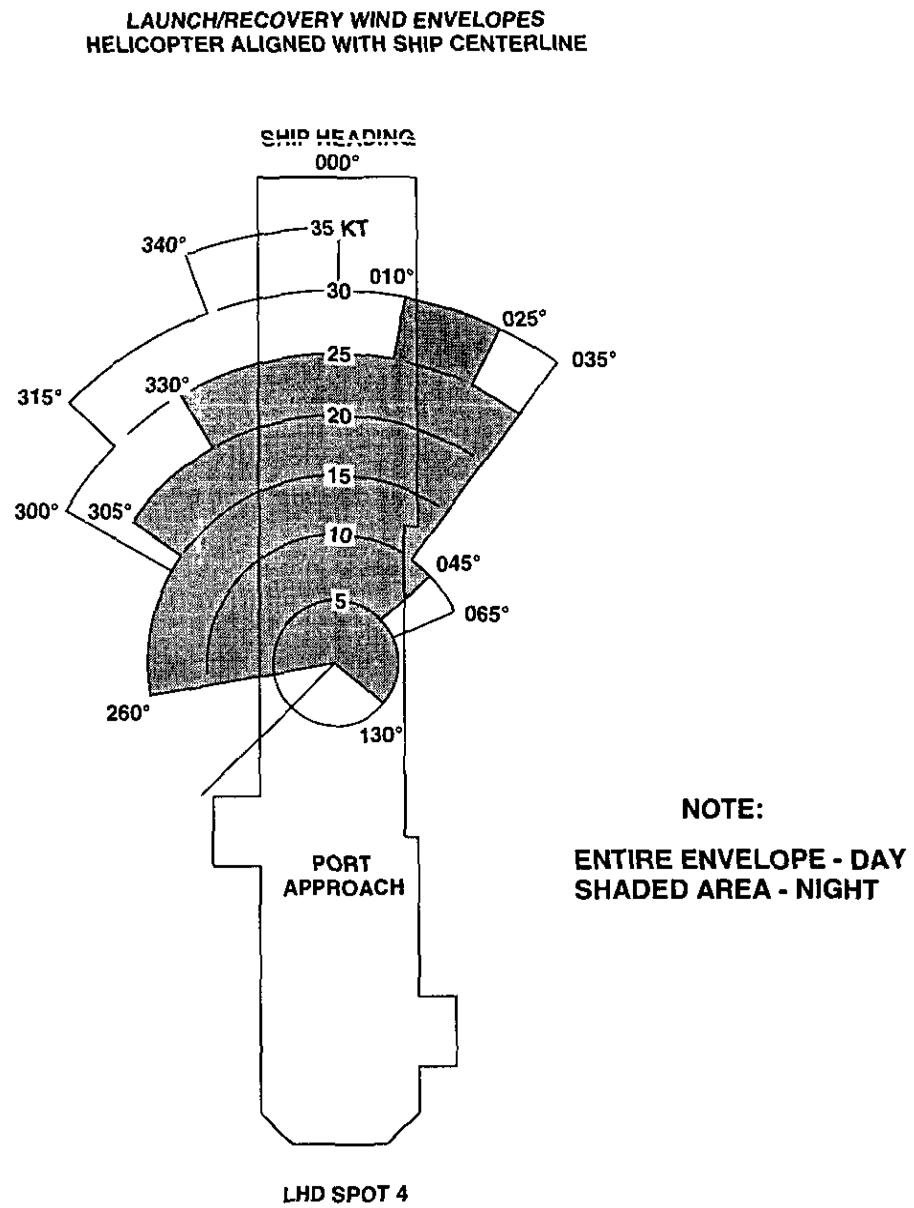

Figure 8-2. Wind Envelope (Sheet 7 of 9)

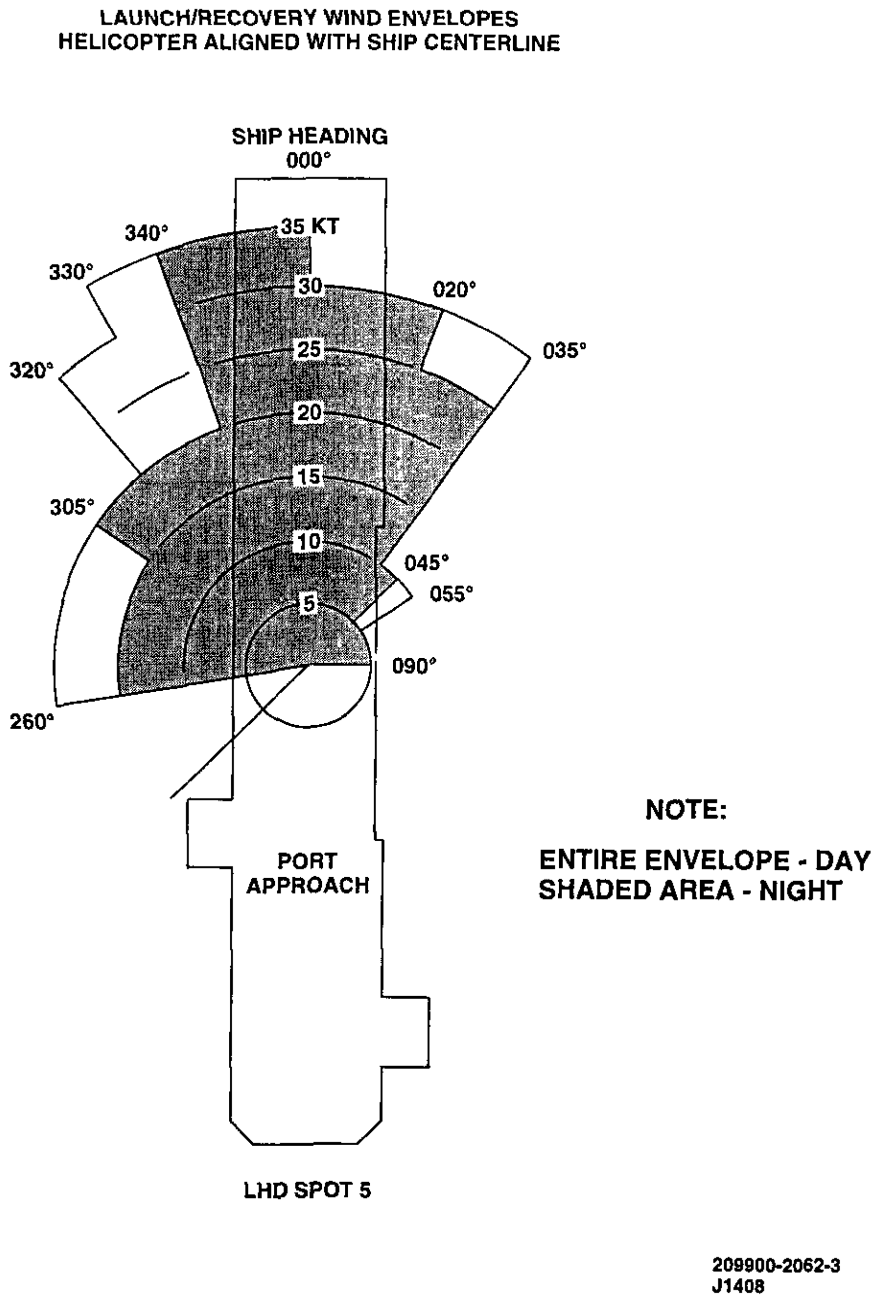

Figure 8-2. Wind Envelope (Sheet 8 of 9)

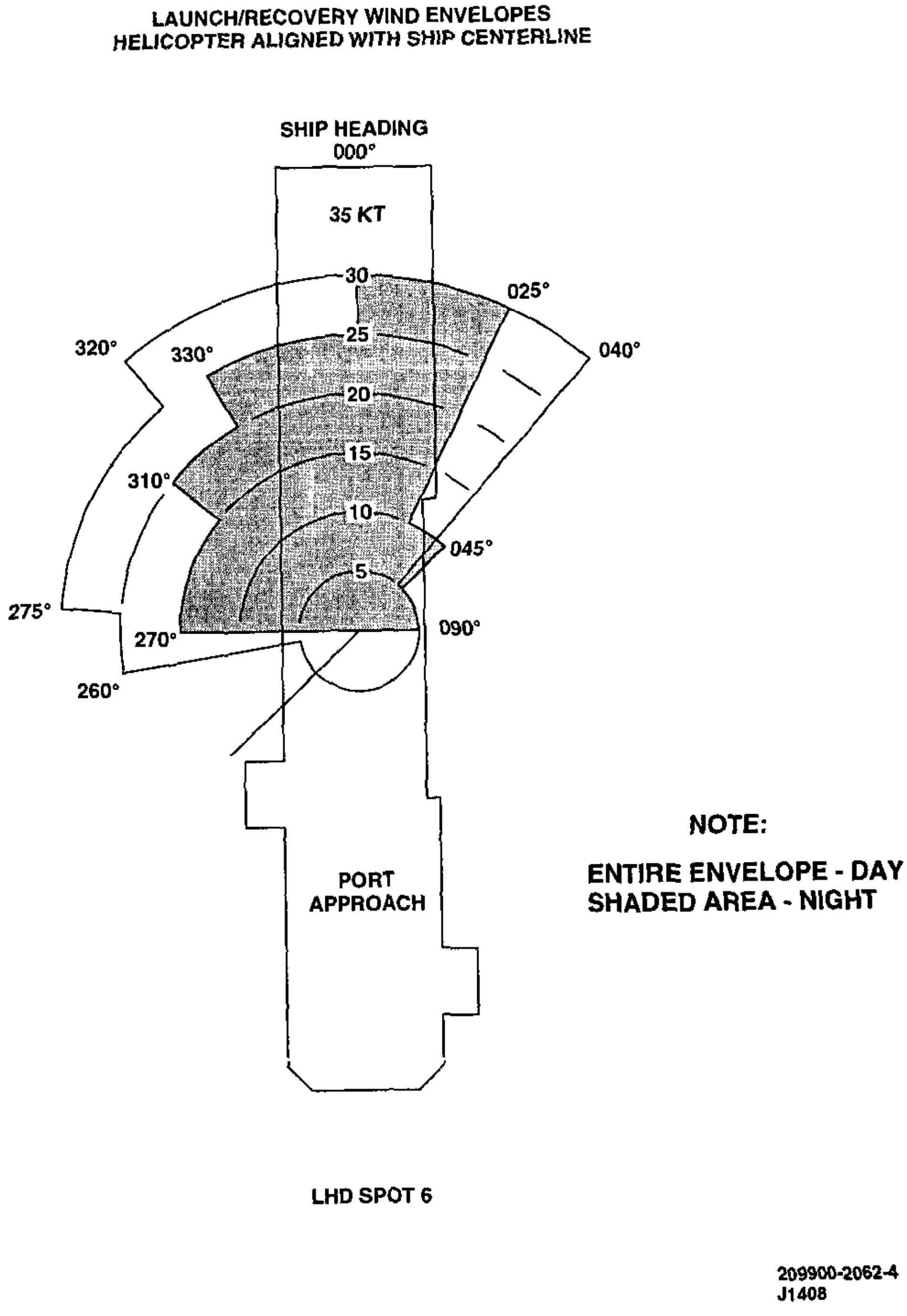

Figure 8-2. Wind Envelope (Sheet 9 of 9)

KIAS are maintained until starting the approach to landing. On the downwind leg during daylight operations, airspeed is reduced to arrive at the 180° position at 70 KIAS, 300-foot altitude, and about 400 yards abeam the carrier. During night operations, the 180° position is 70 KIAS, 300 feet of altitude, and about 600 yards abeam of the ship. Depending on the relative wind, the turn into the final approach is normally started at a position even with the bow or just ahead of the intended landing spot.

8.5.3.3.5 Final Landing Procedures. The approach turn from the 180° position is begun at 70 KIAS, adjusting speed as necessary to maintain a rate of closure commensurate with the relative speed of the ship. The final approach should be relatively flat to eliminate the necessity for exaggerated power changes or excessive flare near the deck. Final movement of the helicopter onto the deck position is normally accomplished by forward and starboard movement of the helicopter at air-taxi speed from the deck edge about 8 to 10 feet above the deck. The pilot is advised by signals from the LSE. Tiedowns shall be attached prior to shutdown. Rotor rpm shall not be decreased or engines shut down until signalled by the LSE.

Note

A waveoff or hold signal from the LSE is mandatory.

8.5.3.3.6 Starboard Approach. The starboard approach may be authorized to facilitate ordnance evolutions (including approaches with hung ordnance) aboard LPH and LHA class ships. When directed by PriFly, enter the normal downwind at 80 knots, 300-foot altitude, and approximately 500 yards abeam the ship. Continue downwind to a 180° position past the ship stern turning to parallel the base recovery course about 50 yards on the starboard side. Reduce altitude and airspeed as necessary to permit a flat slide across the deck edge in a controlled air taxi. During the final portion of the approach, slide on at approximately a 45° angle to the intended landing spot. The helicopter should be landed on the spot parallel to the ship centerline.

Note

On starboard approaches with unsafe guns or hung or unexpended ordnance, the final slide should be on a 30° angle to the intended landing spot with about a 15° nose-right skid. The helicopter should be landed on the spot pointing to the ship 1-o'clock position.

8.5.3.3.7 Emergency Procedures. Any helicopter experiencing trouble in flight will immediately notify the flight leader by radio or by visual signals as the situation dictates.

If the nature of the emergency warrants an immediate return to the ship, a radio call will be made to enable the ship to prepare for landing. In any case, the following information will be transmitted to the ship:

1. Side number of the helicopter
2. Position
3. Difficulty
4. Intentions.

If the helicopter having the emergency does not have radio contact with the parent ship, all possible information is relayed visually to the wingman who makes the necessary radio transmission. If communications are lost, the helicopter signal to indicate an emergency is as follows. Turn the navigation lights to FLASH and the landing light (searchlight) to ON during the approach to the ship.

8.6 AIR-CAPABLE SHIP OPERATIONS

Air-capable ships include all ships other than aviation ships (CVs) and amphibious aviation ships (LPHs/LHAs); for example, LPD, LSD, LCC, LKA, DD, CG, etc. Basic shipboard procedures used on LPH and LHA class ships normally apply to operating on air-capable ships as set forth in NWP 42. Pilots should be aware that except for LPDs, air-capable ships have no air department and will have little experience operating with marine helicopters. LPDs have two landing spots and all other air-capable ships with a landing capability have one. Specific ship helicopter capabilities including obstructions and specific restrictions are included in "Air Capable Ships Helicopter Facility Resume," NAEC-ENG-7576.

CAUTION

Avoid introducing JP-4/JP-8/Jet A-1 fuels into any shipboard environment if operationally feasible.

8.6.1 Launch Procedures. The LSE will signal for launch to either port or starboard depending on obstructions and relative wind (usually within 30° of the ship heading). Following the LSE signal to lift, the pilot will lift into a 9- to 10-foot hover and depart the ship using one of the following methods:

1. Slide perpendicular to the ship centerline over the deck edge to a minimum of one rotor diameter from the ship; then transition to a normal climb into the wind.
2. When wind conditions are favorable and there are no obstructions to flight, transition from a hover, parallel the extended lineup line, and climb straight away from the ship (approximately 45° from the ship heading).

Note

Special care shall be exercised to remain clear of the crane and deck-edge obstructions.

8.6.2 Recovery Procedures. Helicopters will be recovered individually from the designated delta pattern. Landing patterns are normally flown at 300 feet and 80 knots. The final approach should be relatively flat to avoid flares in the immediate vicinity of the ship. Normal recovery procedures are as follows:

1. Obtain landing clearance and the wind condition from the ship.
2. At the abeam position, commence a normal approach. Fly the approach down the approach line to arrive just short of the deck edge about 10 feet above flight deck level with a gradual transition to an air-taxi condition; continue over the deck edge and over the approach/lineup line; and land smoothly with the skids in the center of the circle and the axis of the helicopter over the lineup line.

Note

Because of the potential turbulence caused by the ship superstructure and/or flight deck edge and slow airspeed while crossing over the deck edge, gross weights should be limited to provide HOGE capability.

8.6.3 Stabilized Glideslope Indicator. SGSIs are designed for use on air-capable ships to provide a visual assist to helicopter approaches, including operations at night and during conditions of reduced visibility. These units are being installed on some surface ships.

Note

SGSI pilot procedures are different from those used with the standard Marine GAIL; therefore, reference must be made to NWP 42 for proper SGSI procedures.

8.7 NIGHT OPERATIONS

8.7.1 Preflight Procedures. A flashlight will be used while conducting the external inspections. In addition to the normal cockpit inspections, ensure that all light switches are positioned properly. Lighting at night becomes a critical area. The general rule of limiting non-NVG compatible lights on the flight deck should be observed.

8.7.2 Helicopter Lighting. The helicopter lighting procedures (Figure 8-3) shall be used for all night shipboard operations.

8.7.3 Taxi and Operations. The first rule the pilot should remember concerning night shipboard operations is that the tempo of operations, both in volume and speed, is considerably reduced from day operations. Slow and careful handling of helicopters by both helicopter directors and pilots is mandatory. When a pilot has doubts about an LSE signal, he should hold his position and request confirmation from PriFly.

8.7.4 Postflight Procedures. Postflight procedures and the postflight inspection are performed in the same manner with the same caution concerning night visibility as is required for preflight operations.

8.8 DEBRIEFING

When based aboard ship, debriefing can be equally as beneficial as that required when based ashore. For detailed debriefing, refer to paragraph 6.3. Debrief those portions applicable to the flight.

CONDITION	SHIP RED DECK LIGHTING	SHIP WHITE DECK LIGHTING
Ready for external power	As required	As required
Ready to start engines	Nav lights FLASH DIM	Nav lights FLASH DIM
Ready for takeoff	Nav lights STEADY DIM	Nav lights STEADY BRT Anticollision light ON
After takeoff	Nav lights STEADY BRT Anticollision light ON	Nav lights STEADY BRT Anticollision light ON
Established downwind prior to 180° position	Nav lights STEADY DIM Anticollision light OFF	Nav lights STEADY DIM Anticollision light OFF
After final landing or holding on flight deck	Nav lights STEADY DIM Anticollision light OFF	Nav lights FLASH DIM Anticollision light OFF

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Figure 8-3. Helicopter Lighting Procedures

CHAPTER 9

Special Procedures

9.1 FULL AUTOROTATION LANDING

A full autorotation landing is performed in the same manner as the practice autorotation with power recovery with the exception that the throttles remain at approximately idle speed when the flare is commenced. At about 10 to 12 feet of altitude, smoothly raise the collective pitch control to slow the rate of descent, apply sufficient forward cyclic control to level the helicopter, and maintain heading with directional control pedals to ensure proper alignment upon touchdown. At about 2 feet of altitude, increase the rate of collective pitch control movement so as to effect a gentle touchdown. When the helicopter is on the ground, stop collective pitch control movement and allow the helicopter to slide to a gradual stop, maintaining heading. The touchdown will be made in a near-level attitude to prevent adverse pitching of the helicopter.

CAUTION

Zero-airspeed autorotative landings should be avoided except when the available landing surface is unsuitable for a sliding landing.

9.2 FORMATION AND TACTICS

9.2.1 Introduction. It is essential that the basic fundamentals of formation flying be practiced in preparation for combat readiness. The procedures and positions contained herein are intended to provide a foundation that will meet most mission requirements, both combat and noncombat.

The signal for a change in a formation may be accomplished by the use of the radio, appropriate hand signals, or appropriate helicopter signal, as contained in the Aircraft Signals NATOPS Manual (NAVAIR 00-80T-113).

In any case, no changes in the formation will take place until all helicopters in the formation understand and acknowledge the signal.

9.2.2 Formations.

9.2.2.1 Elements of a Formation. The number of helicopters required to accomplish a mission varies. A section will consist of two helicopters, and a division will consist of three or four helicopters (two sections). Two or more divisions constitute a flight. The disposition of members within a formation is at the discretion of the leader.

9.2.2.2 Basic formations. The two basic types of formations are parade and tactical. Parade is used primarily when there is a requirement for helicopters to fly a fixed bearing position in close proximity to each other and maximum maneuverability is not essential. It is most frequently employed during arrival at or departure from ships or airfields, or during flight demonstrations. Power is varied to maintain position. Maneuverability is a prime consideration for formations engaged in combat tactics. The leader must be able to use his formation as an integral unit and still be free to turn, climb, and dive the formation with few restrictions. The tactical formations outlined herein afford this flexibility. The radius of turn is varied rather than the power to maintain position.

9.2.3 Parade Formations.

9.2.3.1 Types. The four basic types of parade formations are echelon, fingertip (Figure 9-1), diamond (Figure 9-2), and column.

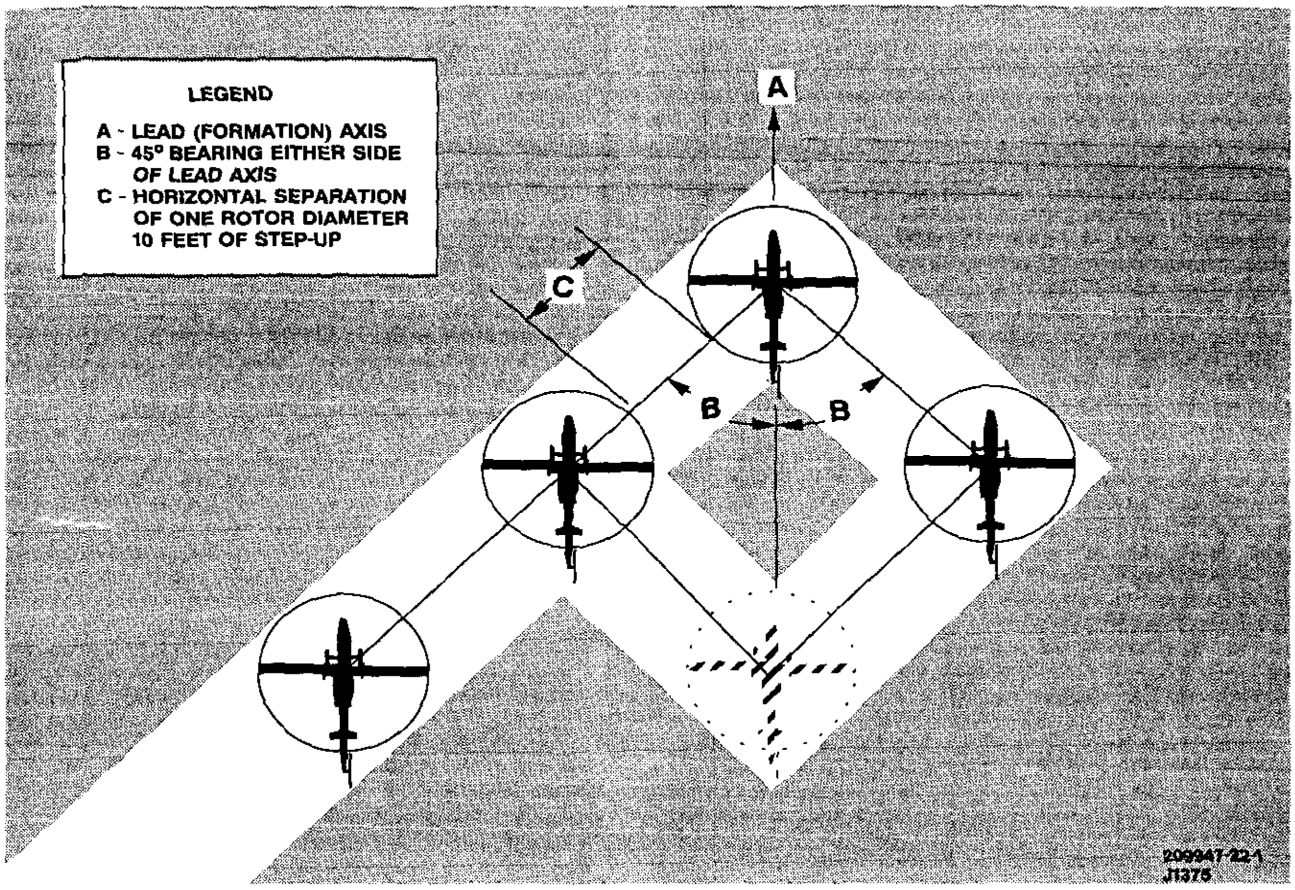


Figure 9-1. Fingertip Parade

9.2.3.2 Positions. The parade position for echelon, fingertip, and diamond is on a 45° bearing either side of the lead axis with 10 feet of step-up, and one rotor diameter diagonal clearance. This position provides longitudinal and lateral clearance between helicopters. In the fingertip and diamond formations, the section leader will fly the same position on the leader as the number two man. The column position is on a 0° bearing with 10 feet of step-up and two rotor diameters longitudinal clearance.

9.2.3.3 Parade Turns.

9.2.3.3.1 Echelon, Diamond, Fingertip, and Column. Wingmen should maintain a fixed position and roll about the leader's longitudinal axis on all turns.

9.2.3.4 Crossovers. Crossovers shall be accomplished by individual wingmen or sections when directed by the leader. The leader shall ensure that all helicopters in his formation are aware of the change in formation. The following procedures will be followed:

1. When a wingman is required to cross over, he will move to the corresponding position on the opposite side maintaining constant longitudinal blade-tip clearance. The section leader will slide out on bearing, allowing room for the No. 2 helicopter when applicable.

2. When the section is required to cross over, it shall be accomplished by the section moving across to the appropriate position on the opposite side. The section leader's wingman will not effect his crossover on the section leader until the section leader is in his new position.

9.2.3.5 Lead Changes. All changes of the lead position in a formation shall be acknowledged by the recipient in such a manner as to preclude any possibility of misunderstanding by any member of the formation. Preferably, a lead change will be executed from level flight and in such a manner as to

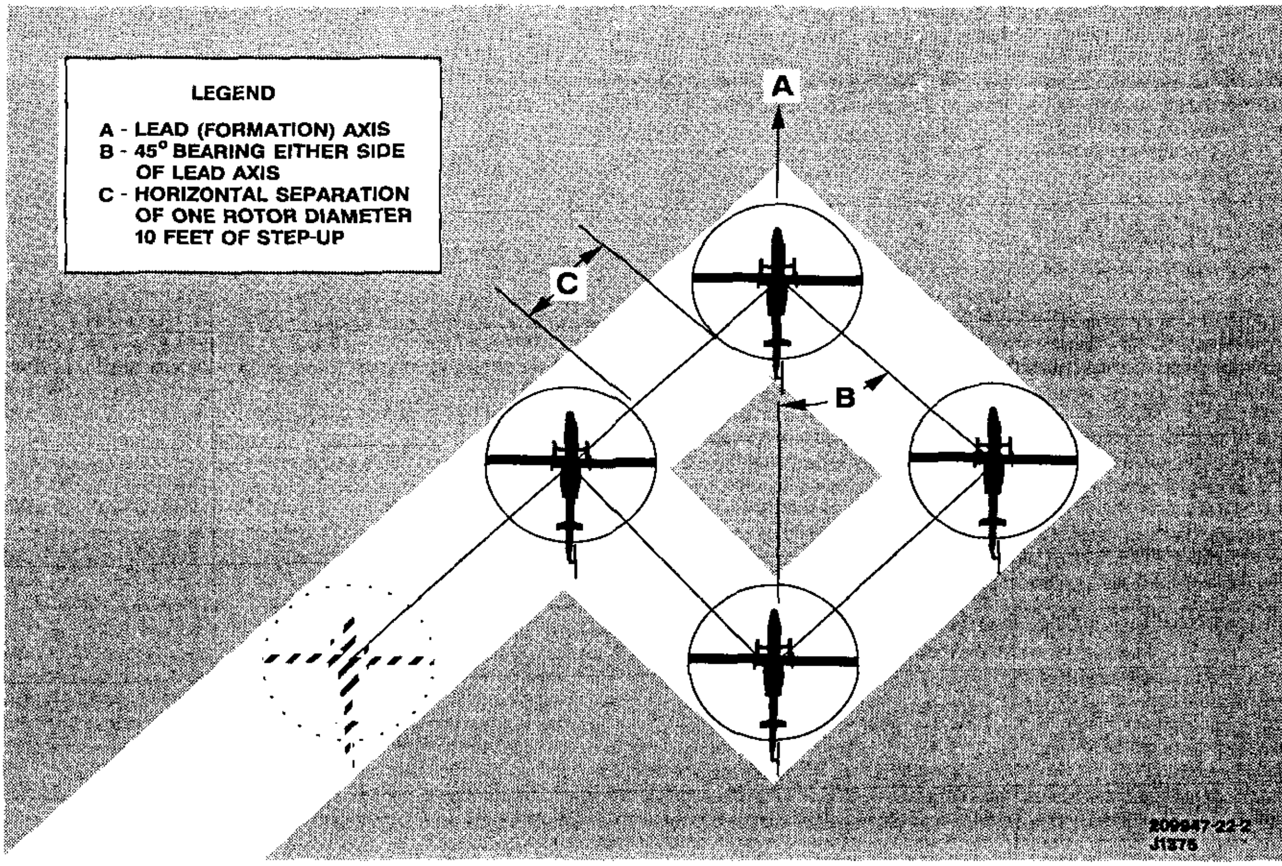


Figure 9-2. Diamond Parade

allow the old leader time to assume his new position before maneuvering flight is commenced. The old leader shall maneuver to establish step-up and maintain one rotor diameter separation while he moves back to his new position.

9.2.4 Tactical Formations. The three basic types of tactical formations are cruise, combat cruise, and combat spread. Refer to NWP 55-3-AH1, Volume I, AH-1 Tactics Manual.

9.2.4.1 Cruise. The cruise position is on a 30° bearing off the tail with 10 feet of step-up, and three to five rotor diameters diagonal clearance. This position will provide adequate longitudinal and lateral clearance between helicopters for maximum maneuverability. The No. 3 helicopter will fly a position to allow room for the No. 2 helicopter between himself and the leader. When the leader initiates a turn, each helicopter will maintain longitudinal clearance on the helicopter directly ahead by sliding and utilizing the radius of turn created by the leader. As soon as the leader rolls level, the normal cruise position will be resumed with the No. 2 helicopter balancing the formation.

9.2.4.2 Combat Cruise. Combat cruise is the basic formation used by flights of armed helicopters. Combat cruise is designed to provide maximum flexibility and individual pilot freedom to increase maneuverability, lookout doctrine, and terrain masking. The position is a rearward arc 10° forward of the abeam position on either side of the lead aircraft with a minimum of 500 feet of separation and level altitude. The preferred position is 45° off the leader's tail.

9.2.4.3 Combat Spread. Combat spread is flown by the wingman within 10° of the lead aircraft abeam with a minimum of 500 feet of separation. Combat spread is useful when crossing large open areas to minimize exposure time.

9.3 RENDEZVOUS

The two types of basic rendezvous are the running rendezvous and the carrier-type rendezvous. A combination of the principles of these two is most commonly employed to join helicopters after takeoff.

9.3.1 Running Rendezvous. The leader will depart maintaining a prebriefed airspeed and will allow wingmen to use an airspeed differential and/or radius of turn that will enable them to overtake the leader and join as briefed.

9.3.2 Carrier Type Rendezvous. Basically this is a join-up executed while the division leader makes a 180° level turn, using a 10° to 15° angle of bank and 100 KIAS. Joining helicopters will assume a rendezvous bearing on the division leader using the cutoff vector to effect the join-up. The final phase of the rendezvous will be on a 45° rendezvous bearing. Join-ups will be made to the inside of the turn. After relative motion is stopped, effect a crossover.

When practicing carrier-type rendezvous, breakups will be executed from an echelon. The leader will break maintaining altitude and a 30° bank throughout his turn. Each succeeding wingman breaks at a prebriefed interval with 30° of bank, adjusting his bank to be in an extended column position when the leader completes his turn.

9.4 FORMATION TAKEOFFS AND LANDINGS

Formation takeoffs and landings are frequently used during normal missions and should be practiced. Power available, size of zone, obstacles to flight, wind direction and velocity, enemy fire, terrain features, rotor turbulence, and other considerations will determine the positions to be assumed by members of a formation.

Section and division leaders must endeavor to fly as smoothly and as steadily as possible, maintaining constant altitudes, headings, and power settings Section and division leaders are responsible for maintaining positions within the formation as instructed. The leader is responsible for briefing, conduct, and discipline of the flight. He normally handles radio transmissions and navigation for the flight. All section leaders must be prepared to assume lead of the division.

9.5 TERRAIN FLIGHT MANEUVERS

9.5.1 Power Checks. While conducting Terrain Flight Maneuvers (TERF) operations, it may be necessary to hover downwind out of ground effect. To verify the actual power available in comparison to planned power required, a power check should be conducted prior to commencing TERF operations.

The check is accomplished in three steps by initially hovering into the wind at 10, 25, and 50 feet, respectively. At each level, check hover power and initiate a 360° left-pedal turn and note maximum Ng and torque. Pause in all four quadrants to determine hovering characteristics.

9.5.2 Nap of the Earth Takeoff. A Nap of the Earth (NOE) takeoff differs from the normal takeoff in that it is a positive transition to a low and slow profile. Upon lift-off, maintain a constant rate of climb to clear surrounding barriers, then transition smoothly to NOE flight.

9.5.3 Nap of the Earth Approach. This approach allows the pilot to initiate a landing sequence from the NOE profile. Approaching the intended point of landing, the pilot should slow airspeed. After intercepting a shallow glidepath, reduce the collective to maintain the approach angle to a hover or no-hover landing.

9.5.4 Nap of the Earth Quick Stop. Performing a normal quick stop when operating in the NOE flight profile could cause the tail rotor to strike the ground or other obstacles. The NOE quick stop is a decelerating technique that rotates the aircraft about the tail rotor, vice center of the aircraft, thus ensuring tail rotor clearance at low altitudes.

To accomplish the NOE quick stop, first increase the collective slightly and then coordinate aft cyclic and down collective to raise the nose and maintain a constant tail rotor altitude.

9.5.5 Masking/Unmasking. This is a maneuver that minimizes the exposure to enemy observation while affording friendly aircraft the opportunity to observe terrain along the axis of advance.

From a hover, increase collective to climb straight up until reaching an altitude to see over or "through" the obstacle. Do not remain unmasked any longer than necessary, then descend vertically to the initial masked condition/position.

9.5.6 Bunt. This maneuver enables the pilot to negotiate a terrain obstacle that lies generally perpendicular to his flightpath by gaining minimum altitude and maintaining forward movement.

Approaching an obstacle, a bunt may be performed by initiating a climb to the approximate height of the obstacle. Prior to crossing the obstacle, the descent should be led by a reduction in collective. As the obstacle is crossed, lower the nose to facilitate the descent and provide terrain clearance for the tail rotor.

9.5.7 Roll. This maneuver enables the pilot to cross an obstacle/terrain feature from other than a wings-level attitude. Generally, the obstacle will be parallel to the direction of movement or nearly so. Approaching the crest of the obstacle, increase altitude and maneuver the aircraft about the roll axis as necessary to achieve obstacle clearance. Upon crossing the crest of the obstacle, coordinate the cyclic, pedals, and collective to establish the descent desired.

WARNING

Abrupt flight control movements can contribute to low-g flight and mast bumping.

CHAPTER 10

Functional Checkflight Procedures

10.1 INTRODUCTION

10.1.1 Checkpilots. Commanding officers will designate, in writing, those pilots within their command who are currently eligible to perform this duty.

10.1.2 Checkflights and Forms. Checkflights will be performed, when directed, by and in accordance with, OPNAVINST 4790.2 series and the directions of NAVAIRSYSCOM type commanders, or other appropriate authority. Functional checkflight requirements and applicable minimums are described below. Functional checkflight checklists are promulgated separately.

10.2 REQUIREMENTS

10.2.1 Conditions Requiring Functional Checkflights. Checkflights are required under the following conditions (after the necessary ground check and prior to the release of the helicopter for operational use):

A. At the completion of helicopter rework and all phase inspections (all checkflight items required are prefixed A).

B. After the installation of an engine, major fuel system component, or any components that cannot be checked in ground operation (minimum required are prefixed B).

C. When fixed or movable flight surfaces or flight control system components have been installed or reinstalled, adjusted, or rerigged and improper adjustment or replacement of such components could cause an unsafe operating condition (minimum required are prefixed C).

10.2.2 Extent of Checkflight. When a checkflight is performed for the purpose of determining if specific equipment or systems are operating properly, completion of only that portion of the Functional Checkflight Checklist applicable to the specific equipment or systems being tested is required.

10.3 PROCEDURES

10.3.1 Functional Checkflight. The following items provide a detailed description of the functional checks sequenced in the order in which they should be performed. In order to complete the required checks in the most efficient and logical order, a flight profile has been established for each checkflight condition and identified by the letter corresponding to the purpose for which the checkflight is being flown. The applicable letter identifying the profile is prefixed to each check both in the following text and in the functional checkflight checklist.

Checkflight personnel shall familiarize themselves with these requirements prior to the flight. NATOPS procedures shall apply during the entire checkflight unless specific deviation is required by the functional check to record data or ensure proper operation within the approved flight envelope. A daily inspection is required prior to the checkflight. Checkflight pilots shall be briefed by maintenance control or quality assurance personnel prior to flight.

10.3.2 Before Preflight. The checkpilot shall ensure the following have been accomplished:

1. All applicable discrepancies have been signed off by the inspector, a qualified plane captain has signed off the preflight, and a responsible authority has signed the helicopter off as safe for flight.
2. The purpose of the flight portion of the check card has been properly filled out.
3. There is no doubt what is required for a complete and accurate check.
4. The plane captain has unbuttoned each portion of the helicopter that is accessible to preflight. Keep in mind the most important aspects of a checkflight are the PREFLIGHT and POSTFLIGHT.

WARNING

Do not begin maintenance flight readiness inspections until armament systems are determined to be safe.

PROFILE

ABC

10.3.3 Exterior Check.

1. Main rotor blades — Visually check condition and cleanliness.
2. TSU — Security, cleanliness.
3. Emergency CRS arm/fire mechanism — Secure, unobstructed, safety pin not installed.
4. Cover — Condition, all screws installed.
5. Stress panels (right side) — Condition, all screws installed.
6. Gun turret — Dzus fasteners secured, skin damage, gun locked in stow position, and no excessive play in barrels.
7. Vibration suppressor assembly components — Check for security and no hydraulic leaks.
8. Copilot/gunner windshield and window — Check for heat damage, scratches, and evidence of leakage.
9. Rain removal jet pump — Unobstructed.
10. Static port — Check for damage, obstruction (i.e., painted over).
11. Ammunition bay — Trays installed properly with security pins in place. Slides and door cables for damage. Condition, operation, and proper latching of bay door.
12. Pilot canopy door — Check for excessive scratches, damage or distortion, and proper fit. Handle and hinges for proper operation.
13. ADF sensing antenna — Check for damage and proper installation.
14. Battery compartment — Battery for security, cleanliness, evidence of corrosion, leakage, and vent lines clear and lockwired.
15. Hydraulic system NO. 2 compartment — Hydraulic lines and fittings for security and leakage, all bypass button indicators in, reservoir full, ECU duct for condition, and door latches for condition and operation.
16. Gravity fill fuel filler cap — Secure.
17. Right wing — Surface condition, navigation, IR position, and formation lights for cracked glass and security. Ensure safety levers are locked and safety pins in. Check slip marks on four mounting bolts. Check tiedown ring is secure.
18. Auxiliary fuel tanks — Check condition and security. Filler cap secure.

Note

For auxiliary fuel tank functional checkflight, check for 25 gallons of fuel in each tank.

19. Compartment under wing — Check lines for leakage, looseness, and chafing; fore/aft servo and synchronized elevator control rods for security.

PROFILE

20. Landing gear — Check fairing for damage; fuselage for wrinkles (evidence of hard landing); crosstubes for bends; skid shoes for proper installation, damage, and security; weather stripping for installation and security.

21. Transmission area — Check for oil leakage, foreign material, and frayed lines; mounts for lockwire, wear, and damage. Check control tubes for chafing.

22. Transmission oil filler cap and sight gauge — Security of cap and proper oil level.

23. Transmission chip detectors and drain — Security, leakage, and lockwire.

24. Main driveshaft couplings — Security, damage, and overheating. (Zinc chromate strips will turn brown.)

25. Main driveshaft — Proper alignment, not throwing grease, check drain line from input quill.

26. Transmission oil jets — Installed, safetied.

27. Rotor brake assembly — Condition, security.

28. Power cylinder mounts, hydraulic pumps, and tachometer generator — Secure.

29. Lift link — Check for cracks, bends, and security of attaching points.

30. Tail rotor driveshaft — No grease leakage or scratches.

31. Combining gearbox — Oil level, leakage, and all accessories for security. Filter bypass indicator in. Chip detectors and drain secure and lockwired.

32. *Engine intake area — Check for cleanliness, security, damage, and foreign matter.*

33. Transmission cowling — Check fasteners and hinges for cracks and proper fastening. Check NO. 1 hydraulic filter buttons.

34. Engine oil — Proper oil level, leakage, filler cap security, and chip detector. Oil filter bypass indicator.

35. *Engine compartment — Check for fuel and oil leakage; all lines and wiring for* tightness, chafing, leakage, and security. Check fuel filter bypass indicators in. Check N_p governor linkage for security. Check engine mounts and displacement isolator arm for condition and security.

36. Combustion chamber area — Check for fuel leakage, condition of fire detector; no obstruction to fire extinguisher.

37. Engine cowling — Check fasteners and hinges for cracks and proper fastening.

38. Pressure fueling receptacle — Secure.

39. Oil cooler compartment — Check oil cooler and oil lines for condition, security, and leakage. Check face of oil cooler for debris. Check utility hydraulic system module, lines, and fill port. Check valve for condition, security and leakage, and filter bypass indicator in. Check combining gearbox filter bypass indicator in. Check engine fire extinguisher for condition, security, and proper charge. Check door for condition and proper closure.

PROFILE

40. Electrical compartment — Tail rotor servo for leakage, all lines and wires for tightness, tailboom mounting bolts for looseness (slip marks), all circuit breakers in, and inverters for proper installation. Check inlet heater fault indicators are black.

41. Exhaust pipe — Note any evidence of oil and check for cracks. Check for security of thermal cover.

42. Tailboom (underside) — Skin condition, antennas for condition and security, and all access panel fasteners installed.

43. Tailboom (right side) — Skin condition, popped rivets, structural damage, and all access fasteners installed.

44. Driveshaft cover (right side) — Condition and security of skin and hinge.

45. Synchronized elevator (right side) — Skin condition and excessive play in spar. Check trailing edge for separation.

46. Intermediate gearbox — Security, grease and oil leakage. No dzus fasteners absent or cracks in cover.

47. Tail skid — No excessive play.

48. Aft navigation and IR position lights — Check for loose rivets, cracked glass, and condition.

49. Vertical fin (right side) — Skin condition, loose or popped rivets.

50. Fifth driveshaft — Scratches, dents, and condition of intermediate gearbox driveshaft fan.

51. Vertical driveshaft cover — Fasteners for security.

52. Tail rotor blades — Check for damage, freedom to flap, and tiedown removed.

53. Tail rotor hub and components — Check for excessive looseness of the yoke and crosshead bearings, counterweights for correct positioning, and pitch change links for correct installation and wear; check appropriate components are lockwired.

54. Tail rotor gearbox — Oil level, leakage, and filler cap secure.

55. Vertical fin (left side) — Skin and hinges for condition, loose or popped rivets.

56. Intermediate gearbox — Check for leakage and oil level; filler cap and cover secure.

57. First, second, third, and fourth driveshaft — Associated hanger bearings and clamps for grease, security, nicks, dents, and scratches.

58. Driveshaft cover (left side) — Condition, cracks, dzus fasteners installed and secured.

59. Tailboom (left side) — Skin condition, popped rivets and structural damage. Check underside for breather screens attached and screws in place.

60. Synchronized elevator (left side) — Skin condition and excessive play in spar. Check trailing edge for separation.

61. Aft avionics compartment — Check condition of door and ensure electronic equipment is secure with wires attached properly.

PROFILE

62. Exhaust pipe — Note any evidence of oil and check for cracks.
63. Exhaust extension — Check for cracks, chafing, and looseness.
64. External power receptacle — Security of unit, condition of prongs, and door secured.
65. Oil cooler compartment — Check condition of door. Check engine fire extinguisher for condition, security, and proper charge. Check utility hydraulic system reservoir and filter for condition, security, leakage, fluid level, and filter bypass indicator in. Oil cooler for leaks, debris, and condition.
66. Engine compartment — Check for fuel and oil leakage, and all lines and wiring for tightness, chafing, and security. Fuel and oil filter bypass indicators in. Check N_P governor linkage for security. Check engine mounts for axial play and cracks.
67. Engine oil — Proper oil level, leakage, filler cap security, and chip detector. Oil filter bypass indicator.
68. Engine cowling — Check fasteners and hinges for cracks and proper fastening.
69. Transmission area — Check main driveshaft and rotor brake assembly condition and security. Check transmission mounts for wear, damage, and proper lockwire. Check for oil leaks and transmission oil filter bypass indicator in.
70. Transmission cowling — Check fasteners, hinges for cracks, proper fastening and pitot tube.
71. Hydraulic system NO. 1 sight gauge — Check level. Check hydraulic system NO. 1 reservoir and filter for leakage and condition. Check bypass indicators in.
72. Pylon access doors — Check hinges and operation.
73. Drive links — No excessive looseness.
74. Antidrive link — No excessive looseness.
75. Mast boot — Check for security and damage.
76. Friction collet — In place, secure.
77. Segmented clamp — Secure.
78. Scissors assembly — No excessive looseness.

WARNING

The bolt attaching the pitch change links to the scissor assembly must be installed with the bolthead in the opposite direction of rotation.

Note

Particularly check scissors area for wear.

79. Lower bearing — Check for excessive looseness.

PROFILE

80. Swashplate — No vertical looseness or visual wear. Rotating swashplate. Check for lockwire and condition. Check double interrupter is positioned over magnetic pickup with red blade forward.

81. Collective sleeve hub — Check for security and condition.

82. Static stops — Check for evidence of mast bumping and check attaching bolts for shear offset.

83. Mast — Check for scratches, nicks, and dents.

84. Upper bearings — No excessive looseness.

85. Pitch change rod and barrel — Scratches, dents, lockwire, and jamnuts secure.

86. Main rotor hub — Check for damage and corrosion.

87. Coning restraint — Check condition and security.

88. Grips — Check oil level and leakage.

89. Pitch horn — Check rod end attachment for looseness of bolts, nicks and scratches.

90. Drag brace — Check condition and locknuts secure.

91. Trunnion and bearing — Check for looseness of bolts.

92. Blade attachment bolts — Condition, locks installed.

93. Mast nut — Secure with lock in place. Check split cones for evidence of slippage.

94. Main rotor blades — Check for bonding separation, cracks, and cleanliness. Check bladetip main spar drain holes unobstructed.

95. Upper cowling, IR light beacon ring, and anticollision light — Check for damage and security. If ALQ-144 is installed, check for condition and security. If not installed, check security of connector plugs and cables.

96. Left wing — Surface condition, IR position, and formation lights for cracked glass and security. Ensure safety levers are locked and safety pins in. Check slip marks on four mounting bolts. Check that tiedown ring is secure.

97. Auxiliary fuel tanks — Check condition and security. Filler cap secure.

Note

For auxiliary fuel tank functional checkflight, check for 25 gallons of fuel in each tank.

98. Compartment under wing — Check lines for leakage, looseness, cleanliness, and chafing; lateral and collective servo control rods for security, servos for leakage, and LDS linkage for security and signs of binding. Check interconnect and crossfeed valves and lines for leakage and security.

99. Landing gear — Check fairing for damage; fuselage for wrinkles (evidence of hard landing); cross tubes for bends; skid shoes for proper installation, damage, and security; weather stripping for installation and security.

PROFILE

100. ECU compartment — ECU for condition and security. Rotor brake control unit for condition. Compartment door condition and operation.

101. Stress panels (left side) — Condition, all screws installed.

102. Battery compartment — Battery for security, cleanliness, evidence of corrosion, and leakage. Vent lines clear and lockwired.

103. Avionics compartment — Proper installation and security of equipment. Security of cable/wire connectors and condition of wiring. Door cables for damage. Condition, operation, and proper latching of bay door.

104. Pilot window — Check for scratches and distortion.

105. Static port — Check for damage or obstruction.

106. Copilot/gunner canopy door — Check for scratches, damage or distortion, and proper fit. Handle and hinges for proper operation.

107. VSS accumulator gauge — Check condition, 2000 psi pressure.

ABC **10.3.4 Preentry Inspection.** As stated in NATOPS Normal Procedures, Chapter 7.

10.3.5 Interior Inspection (Pilot Station) and Prestart Checklist.

ABC 1. First-aid installed, unopened.

ABC 2. Condition of detachment cord.

ABC 3. Check all gauges for limit marks and proper installation.

ABC 4. Proceed with interior inspection and Prestart Checklist as stated in NATOPS Normal Procedures, Chapter 7.

ABC 5. Auxiliary fuel tank check.

Note

- For auxiliary fuel tank functional checkflight, the FUEL QTY indicator should read approximately 1170 pounds.
- An APU is required to accomplish the auxiliary fuel check. A minimum of 20 minutes is required to pressurize tanks and illuminate AUX FUEL XFR lights.

a. AUX FUEL PUMP switches — UP (on). Check AUX FUEL XFR lights illuminate.

b. AUX FUEL PUMP switches — OFF.

10.3.6 Start.

1. After electrical power has been applied to the helicopter, the following lights should be illuminated on the caution advisory panel:

PROFILE

a. ENG 1 OIL PRESS/BYP and ENG 2 OIL PRESS/BYP.

b. NO. 1 FUEL PRESS and NO. 2 FUEL PRESS. (Set FUEL CROSS FEED switch to OPEN and note lights go out. Set FUEL CROSS FEED switch to AUTO and note lights come back on. Set FUEL CROSS FEED switch to OPEN.)

Note

If fuel pressure is trapped in the fuel lines between the engine fuel valve and the HMU, the FUEL PRESS lights may not come on until the FUEL ENG 1/ENG 2 switches are cycled on.

c. 90° TEMP/PRESS and 42° TEMP/PRESS

d. XMSN TEMP/PRESS

e. C BOX TEMP/PRESS

f. NO. 1 HYD TEMP/PRESS and NO. 2 HYD TEMP/PRESS

g. NO. 1 DC GEN and NO. 2 DC GEN

h. UTILITY HYD

i. XMSN OIL BYP

j. HUD

k. EXT PWR DOOR OPEN (only if external power is open)

l. XMSN OIL COOLER

Start helicopter (refer to paragraph 7.10, Start Checklist).

ABC 2. Engine 1 — Check engine idle (67 +3 percent N_g).

ABC 3. Engine 2 — Check engine idle (67 +3 percent N_g).

A C 4. Flight controls — Refer to paragraph 7.10, Start Checklist.

A C 5. Force trim check — Refer to paragraph 7.10, Start Checklist.

A C 6. Hydraulic check — Refer to paragraph 7.10, Start Checklist.

AB 7. Anti-ice and inlet heater check — Refer to paragraph 7.11, Poststart Checklist.

AB 8. Engine acceleration check — Return to flat pitch and 100 percent N_r. Roll NO. 2 throttle to the idle stop. Perform an acceleration check on the NO. 1 engine from 75 percent N_p until N_p reaches 97 to 98 percent. Roll throttle back at this point to avoid transient N_p/N_r overspeed. Record the acceleration time, approximately 4 to 7 seconds, not to exceed 7 seconds. Repeat the check for the remaining engine.

CAUTION

Retard the throttle immediately upon reaching 97 to 98 percent N_p during the engine acceleration check.

PROFILE

AB

9. Engine overspeed sensing circuit check — Refer to paragraph 7.11, Poststart Checklist.

AB

10. Engine overspeed check — Pressing TEST A and TEST B switches simultaneously simulates an N_p overspeed. The engine will flame out. Fuel when one or both switches are released.

a. N_g — Note.

b. N_p — Set at 100 percent.

c. ENG OVSP TEST ENG 1/ENG 2 switch — ENG 1.

d. Test A and B switches — Press simultaneously. (Release A and B switches immediately when N_g speed starts to decrease).

CAUTION

N_p overspeeds may be experienced as engines relight. Pilots should be prepare to adjust throttles to prevent overspeeds.

CAUTION

A rapidly decreasing N_g during relight may result in an overtemperature. If an overtemperature condition appears possible, shut down the engine and restart it.

Note

Failure of the engine to automatically relight is acceptable. Restart engine and continue with the checklist without repeating the overspeed test.

e. Verify test engine N_g returns to speed noted in step a.

f. ENG OVSP TEST ENG 1/ENG 2 switch — ENG 2.

g. Repeat steps d. and e. for engine NO. 2.

AB

11. Engine rigging check — Set throttles at full open position and observe N_p reading.

a. Check ENGINE GOVERNOR, ENGINE RPM switch for adjustment range from 97 +0.5 percent minimum, to 103 +0.5 percent maximum. Engine 1 and engine 2 N_p should remain matched with ENG 2 TRIM switch in null (centered) position.

b. Check ENG 2 TRIM switch for adjustment range of +1 percent N_p/N_r.

PROFILE

ABC

12. Rpm warning system — Check that the rpm warning light illuminates when rotor rpm (N_r) decreases to 96 ±1 percent, or increases to 105 ±1 percent. The voice message "Rotor rpm" will come on when rotor rpm limits (high or low) are reached. A swept tone (whoop) will also be heard when rotor rpm is low.

Note

The high side rpm warning system check will be accomplished during the EECU lockout check.

AB

13. EECU lockout check — Check as follows:

a. Advance throttle into cushion at bottom of flight stop. Ensure engine will not enter EECU lockout below flight stop.

CAUTION

Be prepared to rapidly retard the throttle in the event that the engine enters EECU lockout.

b. Enter EECU lockout one engine at a time; refer to paragraph 7.30. Verify manual and proportional engine rpm (N_p) control is achieved.

AB

14. Boost pump check — Position FUEL CROSS FEED switch to OPEN. Pull FUEL NO. 1 PRESS circuit breaker. Check NO. 1 FUEL PRESS and MASTER CAUTION lights illuminate, and NO. 2 FUEL PRESS caution light is off. Pull FUEL NO. 2 PRESS circuit breaker. Check NO. 2 FUEL PRESS and MASTER CAUTION lights illuminate. Set FUEL CROSS FEED switch to AUTO and check FUEL PRESS caution lights out. Reset FUEL NO. 1 PRESS and FUEL NO. 2 PRESS circuit breakers.

B

15. Auxiliary fuel tank check — Place AUX FUEL PUMP switches to UP (on) position. After AUX FUEL EMPTY lights illuminate, place AUX FUEL PUMP switches OFF.

AB

16. Generators — Check as follows:

a. Condition 1:

(1) BUS — NORM.

(2) GEN NO. 1 — ON.

(3) GEN NO. 2 — OFF. Check NO. 2 DC GEN caution light and MASTER CAUTION light illuminated; AMPS 2 load near zero. Nonessential bus electrical equipment operative. Record NO. 1 DC GEN volts and amps. Repeat for NO. 2 DC GEN.

b. Condition 2:

(1) BUS — NORM.

(2) GEN NO. 1 and GEN NO. 2 — OFF. Check NO. 1 DC GEN and NO. 2 DC GEN caution lights and MASTER CAUTION light illuminated; generator loads near zero; all nonessential bus electrical equipment inoperative. (Check for zero volts on nonessential bus.)

PROFILE

(3) BUS switch — MAN. Ensure that nonessential bus electrical equipment is operative with battery power only.

c. Condition 3:

(1) BUS — NORM.

(2) GEN NO. 1 — ON.

(3) GEN NO. 2 — ON.

(4) WEAPON CONTR circuit breaker — OUTBOARD.

(5) MASTER ARM — STBY. Ensure that essential and nonessential bus electrical equipment is operative.

ABC 17. SCAS — Approximately 30 seconds after engaging the SCAS POWER switch, the NO-GO lights should be out, provided controls are stationary. Move cyclic forward slightly and note that NO-GO light illuminates. Hold all controls stationary and note the PITCH light goes out within 30 seconds. Move cyclic back to center and note PITCH NO-GO light illuminates. When NO-GO light goes out, engage PITCH channel. Repeat above for ROLL and YAW using appropriate control movements. After all channels are engaged, check cyclic SCAS release button in both cockpits. Engage SCAS, move tip-path approximately 12 inches in pitch, and note SCAS corrects back; repeat for roll.

ABC 18. ECU, rain removal, and pitot heat check — Energize ECU and check MGT rise on both engine MGT gauges (approximately 10 to 25 °C). Turn ECU off. Energize RAIN RMV and note MGT rise and heated airflow on windshield. Energize PITOT HTR and observe ammeter fluctuation. Turn RAIN RMV and PITOT HTR off.

AB 19. Compare cockpit instruments/gauges. Record gauge readings and note any gauge splits between cockpits in excess of:

a. 1 percent rotor rpm (N_r), engine rpm (N_p), and gas producer rpm (N_g)

b. 2 percent torque

c. 10 °C MGT.

ABC 20. UHF/VHF radios — Check operation.

10.3.7 Hover Checks.

ABC 1. Controls — Check helicopter performs correctly to control inputs by hovering forward, rearward, sideward and turning left and right 360°.

ABC 2. Pylon rock — With SCAS ON, move cyclic fore and aft (1 to 2 inches) rapidly once or twice and center cyclic. Induced oscillations should damp out within five cycles. Repeat check with SCAS OFF. Induced oscillations should damp out within eight cycles. If cycles exceed five with SCAS ON, the SCAS pitch channel may be defective. If cycles exceed eight with SCAS OFF, the viscous dampers may be defective.

ABC 3. SCAS yaw check — Once established in a stable hover with the force trim ON, pull in 10 to 15 percent above hover torque without directional control input. Note that the helicopter attempts to slow the yaw rate.

PROFILE

ABC

4. Ground/hover — power assurance check — This check shall be used for daily or preflight power available checks required by unit policy or maintenance action. Check each engine separately with the other engine off or at idle. This can be done on the ground (light on the skids) or in a hover as follows:

Note

- Engine torque must be greater than 40 percent to use the power assurance chart.
- Do not conduct power assurance check in visible moisture.

a. Set altimeter to 29.92 inches H_g.

b. Set ENG 1/ENG/2/ANTI-ICE, ECU, and RAIN RMV switches to OFF.

c. Set throttle of nontest engine to idle or closed position as required.

d. Trim test engine N_P to 100 percent using ENGINE RPM switch.

e. Increase collective to obtain engine torque setting between 40 and 79 percent and allow engine to stabilize for 1 to 3 minutes.

Note

Allowing the engine to stabilize for a longer period of time will provide a more accurate MGT reading. The longer stabilizing period may be a critical factor in determining the true performance of a marginal engine. Observe single-engine torque limit between 74 and 79 percent for 2-1/2 minutes.

f. Record OAT, pressure altitude, MGT, and engine torque.

g. Refer to Figure 10-1 to determine if the engine passes power assurance check.

EXAMPLE: The helicopter is hovering at 1000-foot pressure altitude, 5 °C OAT, 770 °C MGT, and 60 percent indicated torque.

SOLUTION:

(1) Enter chart on the top left side at 770 °C on the MGT scale.

(2) Move right horizontally to intersect the 5 °C OAT line.

(3) Move down vertically to the 1000-foot pressure altitude line.

(4) Move right horizontally to minimum specification percent torque scale and read approximately 66.5 percent.

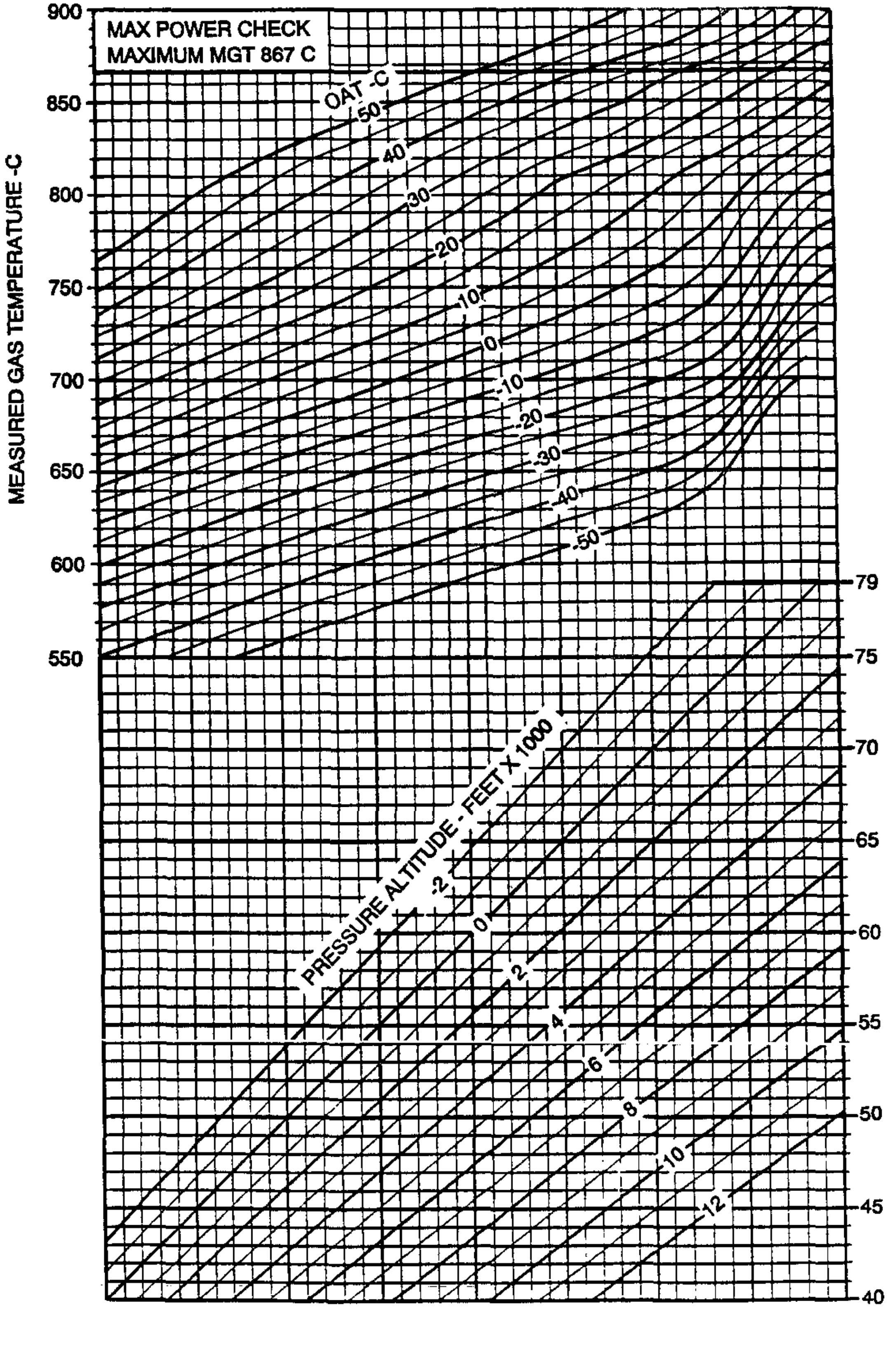


Figure 10-1. Power Assurance (Ground/Hover)

PROFILE

(5) The indicated torque (60 percent) is less than minimum specification torque; therefore, the engine has deteriorated below minimum specification. A second power assurance check should be accomplished at a higher MGT reading.

Note

It may be necessary to conduct the second power assurance check in flight to obtain a higher MGT reading.

(6) If the observed parameters still fail chart requirements, instrument or engine faults are indicated. Failure of this check is sufficient reason to troubleshoot the engine installation and instruments and/or do an engine maximum power check.

5. Torque repeatability check (as required) — This check may be accomplished on the ground or at altitude. If it is accomplished on the ground, the aircraft should be headed into the wind to reduce the effects of exhaust gas ingestion. If it is accomplished at altitude, all steps should be accomplished at the same altitude. In either case, all steps shall be accomplished at the same OAT and at the same N_p.

a. Check the torque system for repeatability as follows:

(1) Reduce nontest engine to idle.

(2) Slowly increase engine power until MGT reaches 650 °C. If 650 °C is exceeded, reduce power until MGT is below 600 °C and then slowly approach 650 °C again in an increasing direction.

(3) Stabilize MGT at 650 °C for 1 minute and record torque, N_g, MGT, airspeed, OAT, and altitude.

(4) Increase power until MGT is 700 to 750 °C.

(5) Slowly reduce power until MGT is 650 °C. If MGT goes below 650 °C, increase power until MGT is 700 to 750 °C and then slowly approach 650 °C again in a decreasing direction.

(6) Stabilize MGT at 650 °C for 1 minute and record torque, N_g, and MGT. Airspeed, OAT, and altitude must be the same step as (2).

(7) With the helicopter on the ground, reduce power quickly to idle speed. Record torque, N_g, and MGT with the engine stabilized at ground idle speed.

(8) Compare the torque value recorded in step (2) with that recorded in step (5). The difference between the two values is the repeatability error.

(9) Repeat for the other engine.

b. The following conditions indicate a torque system repeatability problem:

(1) A repeatability error of more than 5 percent torque when checked as specified in step a.

(2) Transient torque splits that do not match up during steady-state operation.

PROFILE

(3) Torque is high at ground idle speed (0 to 3 percent is normal).

(4) A torque split of more than 5 percent during normal steady-state operation.

10.3.8 Flight Checks.

AB

1. Rotor (N_r) droop check — Accomplish over hard, level surface. Reduce one engine to idle and set the other engine rpm (N_p) at 100 percent. Repeat for the other engine. Set both throttles to the full open position and check that torque is matched and engine rpm (N_p) for both engines is at the selected value of 100 percent. Execute a rapid takeoff with full power climb. Note that droop is transitory and proportional to the severity of the maneuver, not lower than 97 percent N_r, followed by a return to 100 percent N_r after stabilization.

Note

Transient torque splits during large power changes are normal and are a function of engine acceleration/deceleration rates and EECU cross talking. Torque splits up to 50 percent are possible, but splits in excess of 20 percent are rare and above 30 percent require troubleshooting. Transient torque splits should damp out to matched torques (less than 5 percent difference between engines) in less than 6 seconds.

AB

2. Collective anticipator check — At 1000 feet AGL and 100 KIAS, execute a level speed change maneuver that is sufficient to stabilize both engines at 5 percent torque or less and N_p/N_r at 100 percent for approximately 5 seconds. As airspeed decelerates to 45 KIAS, level the helicopter and increase collective pitch to the midtorque setting. Transient droop will vary with the severity of the collective application but should not go lower than 94 percent N_r. This procedure should be repeated until the pilot is satisfied that the collective anticipator is functioning properly, or an electrical maintenance check of the system is required.

WARNING

Collective pull from a low transmission torque setting or near flat pitch condition, such as a quick-stop maneuver or collective anticipator check, can result in transient N_p/N_r droop below power-on limits. Subsequent rapid engine response can lead to severe transient transmission overtorque. Flight test data revealed a collective pull from 0 to 35 percent transmission torque in 2.5 seconds produced a transient N_p/N_r droop to 92 percent and a transmission overtorque of 109 percent.

CAUTION

Engine rpm (N_p) and rotor rpm (N_r) needles must remain joined during the collective anticipator check.

PROFILE

Note

The collective anticipator provides the EECU with early input of initial acceleration to reduce the amount of transitory droop when a collective input is made. The collective anticipator only provides a signal for 9 percent or less indicated engine torque.

B 3. Transmission torque limiter check — For the purpose of this check only, the transient range is 101 to 110 percent for a maximum 10-second duration. Increase collective until torque is 100 percent. Stabilize at 100 percent for 3 seconds. Slowly increase collective until torque is 102 percent. Stabilize at 102 percent for 3 seconds. Slowly increase collective until torque limit (N_r droop) or 110 percent is reached. Do not exceed 110 percent torque. Record torque.

CAUTION

Transmission torque limiter check shall not be performed more frequently than two times per helicopter operating hour.

ABC 4. Hydraulic boost checks — Hydraulic system boost checks are accomplished in level flight at 100 KIAS. Complete the check on one system before checking the other system. Be prepared to reactivate the system if control forces become excessive. Turn each system off and check the response of caution lights, pressure indicators, SCAS system, and controls. perform 30° angle-of-bank turns in both directions, moderate noseup and nosedown maneuvers (±10°), and power changes (±20 percent). Turn the system on at the completion of the check.

   a. HYD SYS 2 — Check.

Note

VSS must be off prior to checking HYD SYS 2.

   b. HYD SYS 1 — Check.

ABC 5. Tail rotor rigging check — At airspeeds above 60 knots, the right pedals should be slightly ahead of the left pedal. At 55 knots 30° angle-of-bank left turns should be possible at full power. While autorotating at 100 knots, 30° angle-of-bank right turns should be possible. There should be no need for excessive lateral control as airspeed is increased.

ABC 6. Tracking and vibration — The check for lateral vibrations shall be performed during a hover at an altitude greater than 1500 feet AGL. Increase airspeed to 140 KIAS to check for vertical vibrations. A vibration analyzer unit should be utilized to evaluate excessive helicopter vibrations with the VSS switch ON, then OFF. Refer to the appropriate maintenance manual for installation of unit, flight procedures, and data analysis.

PROFILE

AB

7. In-flight power assurance check — This check shall be accomplished at a stabilized airspeed between 100 and 130 KIAS in level flight as an alternative to the ground/hover power assurance check. Check the performance of each engine separately as follows:

CAUTION

Maintain a minimum of 1000 feet AGL during the check.

Note

- Engine torque must be greater than 40 percent to use the power assurance chart.
- Do not conduct the power assurance check in visible moisture.

a. Set altimeter to 29.92 inches H_g.

b. Set ENG 1/ENG 2 ANTI-ICE, ECU, and RAIN RMV switches to OFF.

c. Decrease the throttle of nontest engine to idle or minimum power to establish torque on test engine between 40 and 79 percent while maintaining stabilized airspeed between 100 and 130 KIAS and level flight.

d. Trim test engine N_P to 100 percent using ENGINE RPM and allow engine to stabilize for 1 to 3 minutes.

Note

Allowing the engine to stabilize for a longer period of time will provide a more accurate MGT reading. The longer stabilizing period may be a critical factor in determining the true performance of a marginal engine. Observe the single-engine torque limit between 74 and 79 percent for 2-1/2 minutes.

e. Record OAT, pressure altitude, MGT, and ENG TORQUE.

f. Refer to Figure 10-2 to determine if the engine passes power assurance.

EXAMPLE: The helicopter is maintaining 100 KIAS in level flight at 2000-foot pressure altitude, 0 °C OAT, 730 °C MGT, and 55 percent indicated torque.

SOLUTION:

(1) Enter chart on the top left side at the 730 °C on the MGT scale.

(2) Move right horizontally to intersect the 0 °C OAT line.

(3) Move down vertically to the 2000-foot pressure altitude line.

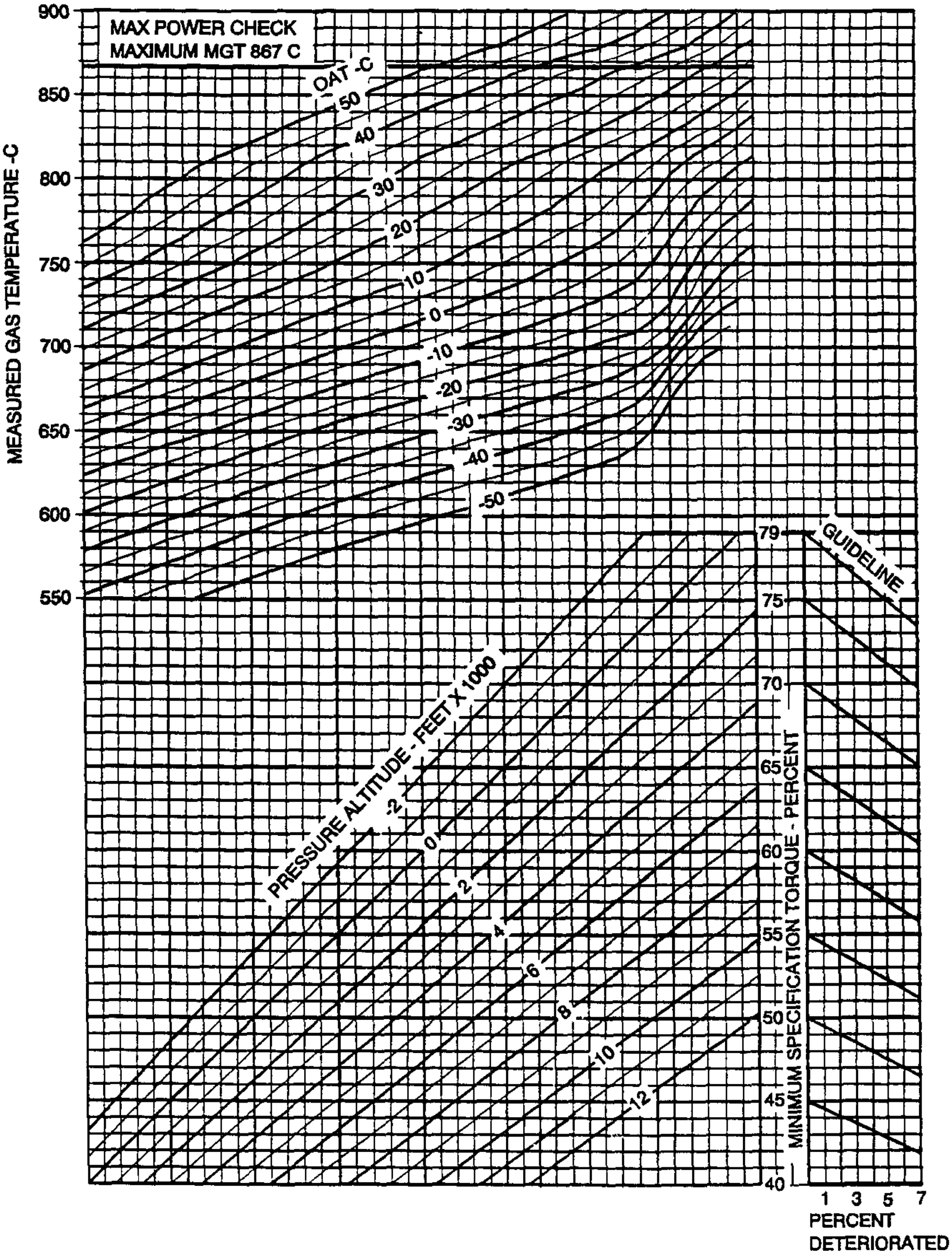


Figure 10-2. Power Assurance (In Flight)

PROFILE

(4) Move right horizontally to the minimum specification percent torque scale and read approximately 60 percent.

(5) The indicated torque (55 percent) is less than minimum specification torque. A second power assurance check should be accomplished at a higher MGT reading.

(6) If observed parameters still fail chart requirements, instrument or engine faults are indicated. Failure of this check is sufficient reason to troubleshoot the engine installation and instruments and/or do an engine maximum power check.

B

8. Maximum power check — This check shall be accomplished at a stabilized airspeed between 100 and 130 KIAS in level flight. Check the performance of each engine separately as follows:

CAUTION

Maintain a minimum of 1000 feet AGL during the check.

Note

- To avoid premature engine performance deterioration, maximum power checks should only be accomplished following engine or engine fuel system component installation or after failure to pass the power assurance check.

- The maximum power check is conducted with MGT between 800 and 867 °C while maintaining a stabilized airspeed between 100 and 130 KIAS in level flight; therefore, it may be necessary to increase weight, fly at a higher altitude, or wait for a warmer OAT to perform the test. Refer to Figure 29-4 to determine if the helicopter requires intermediate power to maintain 100 to 130 KIAS level flight for a given weight, altitude, and OAT.

a. Set altimeter to 29.92 inches H_g.

b. Set ENG 1/ENG 2 ANTI-ICE, ECU and RAIN REM switches to OFF.

c. Trim test engine to 100 percent N_p using the ENGINE RPM switch.

d. Decrease throttle of nontest engine and increase power on test engine to establish 800 to 867 °C MGT while maintaining stabilized airspeed between 100 and 130 KIAS in level flight. Allow test engine to stabilize at desired MGT for 3 minutes.

Note

If 800 to 867 °C is unobtainable, increase level flight altitude.

PROFILE

e. Record OAT, pressure altitude, MGT, and engine torque.

f. Refer to Figure 10-2 to determine the performance level of the test engine. If torque indicated is less than minimum specification torque required, move right from the minimum specification required value and enter the percent deteriorated portion of the chart. Plot a line down and to the right, parallel to the printed guideline until the horizontal line that corresponds to the indicated torque is intersected. From this intersection, project down to read the percent deteriorated scale.

g. If indicated torque is less than minimum specification but greater than 96 percent of the chart minimum specification torque, annotate VIDS/MAF (OPNAV 4790/60) that 15 °C shall be subtracted from the measured MGT on future ground/hover or in-flight power assurance checks. This can be done two times for a total of 30 °C being subtracted from the measured MGT or until the engine fails the maximum power check.

Note

Subtracting 15 °C from the measured MGT reading reduces minimum specification percent torque by 3 to 4 percent.

h. The indicated torque should be lower than 93 percent of the chart minimum specification torque. If the observed parameters fail chart requirements, the engine requires overhaul.

CAUTION

The engine can be kept in service if indicated torque is greater than or equal to 93 percent of minimum specification torque. If engine indicated torque is less than minimum specification torque, refer to Chapter 30 to determine the decrease in helicopter performance.

B

9. MGT limiter check — Check the limiter setting of each engine separately. The limiter should be set between 902.5 and 917.5 °C. The check should be conducted with an OAT greater than 10 °C to assure the engine is not N_g limited. Altitude should be selected to avoid exceeding the OEI torque limit.

CAUTION

- The maximum time limit for transient operation above 917 °C is 12 seconds.
- Do not exceed the transient MGT limit of 965 °C.
- Do not exceed the OEI torque limit of 79 percent.

a. Decrease throttle of nontest engine to idle.

PROFILE

b. Stabilize power of test engine at approximately 867 °C MGT.

c. Slowly increase collective until a drop in N_r is observed.

Note

If MGT reaches 920 °C before a drop in N_r is observed, the check can be aborted and 920 °C recorded as the MGT observed during check.

d. Record MGT and OAT.

A C 10. Autorotation rpm check — Autorotation is to be conducted at 70 KIAS, balanced, unaccelerated, wings-level flight, with collective full down. Record OAT, pressure altitude, gross weight, and rotor rpm (N_r). Recorded autorotation rpm shall be within ±2 percent of the rotor rpm prescribed in Figure 10-3.

A 11. Avionics/flight instruments — Check operation of all equipment.

10.3.9 Shutdown. Shutdown as stated in NATOPS Normal Procedures, Chapter 7.

A C 1. Check pressure readings on the respective gauges when the following caution lights illuminate:

a. ENG 1 OIL PRESS/BYP

b. ENG 2 OIL PRES/BYP

c. XMSN TEMP/PRESS

d. C BOX TEMP/PRESS

e. NO. 1 HYD TEMP/PRESS

f. NO. 2 HYD TEMP/PRESS

Note

- Do not turn the INV switch OFF until pressure readings are recorded.
- Record hydraulic system pressure readings after application and release of the rotor brake.

ABC 2. Rotor brake and warning light — CHECK (light on when brake is engaged).

B 3. Visually check each auxiliary fuel tank to verify fuel transfer.

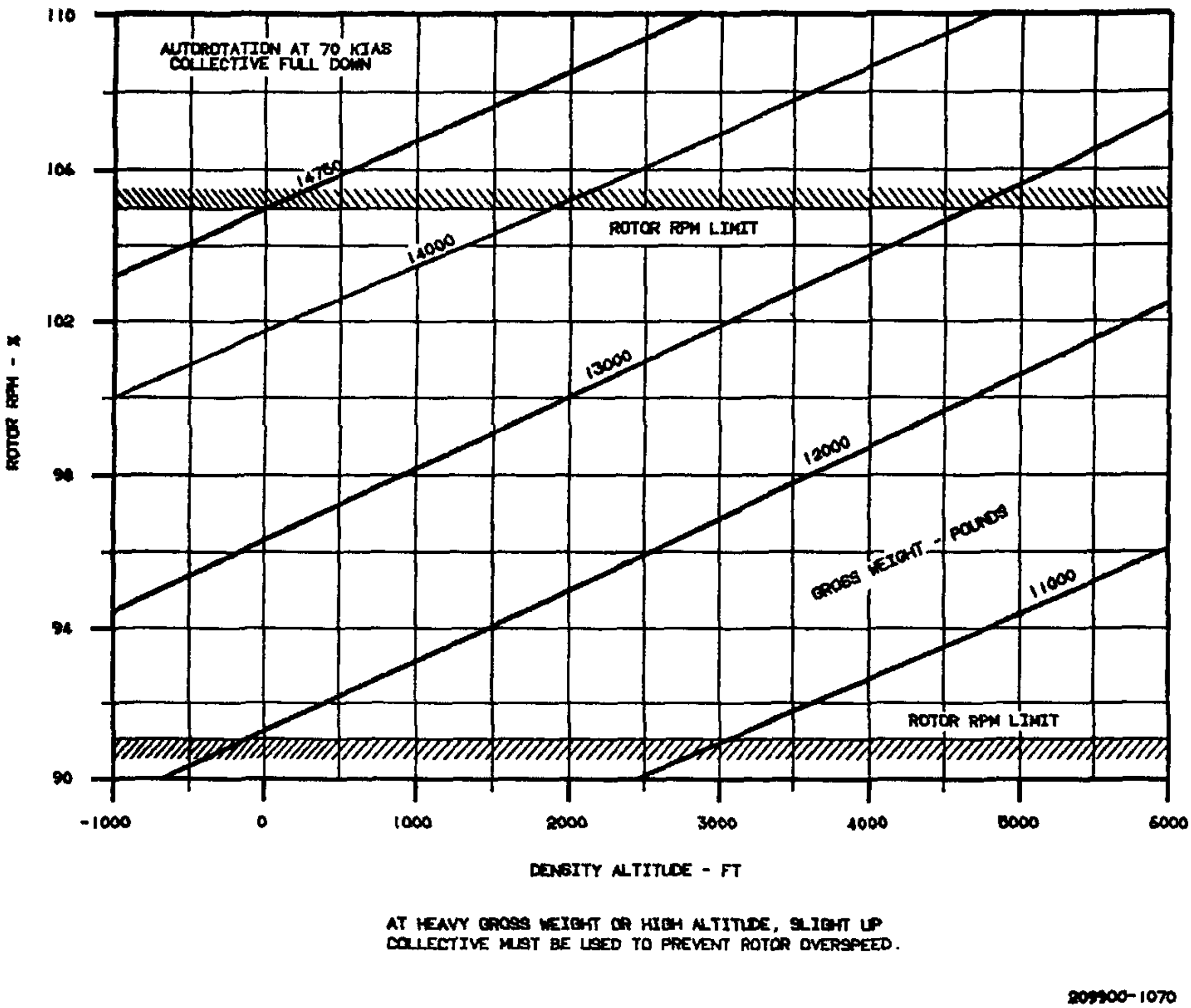


Figure 10-3. Autorotation Rpm

PART IV

Flight Characteristics

CHAPTER 11
Flight Characteristics

11.1 INTRODUCTION

The flight characteristics of this helicopter are similar to other single-rotor helicopters. The basic flying qualities are enhanced by the SCAS. This system provides good stability and control response throughout the operating flight envelope. The control system, with hydraulic servo assist, provides the pilot with a light force required for control movements. Control feel is induced into the cycle stick and tail rotor controls by means of a force trim system.

11.2 ROTOR BLADE STALL

Note

Main rotor blade stall is not a problem when the helicopter is operated within the approved flight envelope. However, main rotor blade stall may occur at some combination of excessive airspeed and high-g loading.

Blade stall occurs when the angle of attack of the retreating blade exceeds the specific stall angle for any blade segment. When the condition is attained, increased blade pitch (or collective) will not result in increased lift and may result in reduced lift. The threshold of stall is approached as gross weight, airspeed, altitude, and g loading increase and rpm decreases. One of the more important features of the two-bladed, semi-rigid system is its warning to the pilot of impending blade stall. Prior to progressing fully into the stall region, the pilot will feel a marked increase in airframe vibration, and possibly control feedback. Consequently, corrective action can be taken before the stall becomes severe.

The use of the following procedures depends on the helicopter altitude above the terrain. Sufficient recovery altitude must be available for these to be effective. When blade stall is evident, the condition may be eliminated by accomplishing one or a combination of the following corrective actions:

1. Reduce collective
2. Reduce airspeed
3. Decrease severity of maneuvers
4. Increase operating rpm
5. Descend to lower altitude, if appropriate.

11.3 CONTROL FEEDBACK

Feedback in the cyclic stick or collective stick is caused by high loads in the control system. These loads are generated during severe maneuvers and can be of sufficient magnitude to overpower or feed through the main boost cylinders back to the cyclic and/or collective stick. The pilot will feel the feedback as an oscillatory shaking of the controls even though he may or may not be making control inputs after the maneuver is established. This type of feedback will normally vary with the severity of the maneuver. The pilot should regard it as a cue that high control system loads are occurring and should immediately reduce the severity of the maneuver.

WARNING

The copilot/gunner station cyclic and collective flight controls have a reduced mechanical advantage. Because of this reduced mechanical advantage, severe maneuvers should be avoided while flying from the copilot/gunner station.

11.4 PITCH-CONE COUPLING

Pitch-cone is the tendency of the rotor blade to reduce pitch as thrust is increased or rotor rpm is reduced. With large amounts of pitch-cone coupling, the rotor may overspeed during pullups or flares unless the pilot adds collective pitch. The AH-1W main rotor design minimizes pitch-cone coupling.

11.5 MANEUVERING FLIGHT

When performing maneuvers at higher airspeeds, it is necessary to devote more attention to flying and to planning maneuvers because of the increased distance needed to perform pullouts and turns. The increased distance required for pullouts and turns is a direct result of the higher airspeed.

CAUTION

During left rolling maneuvers or high-power dives, torque, N_g, and MGT will increase while N_p and N_r decrease momentarily. Care shall be exercised to monitor instruments, especially the torquemeter. This will enable the pilot to adjust power as required to prevent exceeding helicopter engine limitations and prevent a low rotor rpm condition. This can be accomplished by lowering the collective, reducing the severity of the maneuver, or a combination of both.

11.5.1 Wake Turbulence. Every aircraft generates wake turbulence while producing lift. Turbulence is evident as counterrotating conical vortices trailing from each wingtip or side of the rotor disk. The strength of the vortices is a function of weight and g loading of the generating aircraft.

Depending upon the angle of encounter, two hazards exist because of high velocity and highly directional currents of the vortices: uncommanded roll and large g transients. An encounter along the preceding aircraft line of flight can cause a roll beyond the lateral control authority of the encountering aircraft to correct. An encounter across the preceding aircraft line of flight can cause a sudden g acceleration, then reversal (positive/negative or inverse). Oblique encounters will result in combinations of roll and g pulses.

Characteristics that help the pilot visualize the wake location are:

1. Vortices are generated about the wingtip/rotor tip from the moment the aircraft begins to produce lift.
2. The vortex flow field is normally two wing spans/rotor diameters in width and one wing span/rotor diameter in length.
3. Flight tests have shown that the vortices recede opposite to the lift vector of the generating aircraft at a rate of 400 to 500 fpm with a leveling off about 900 feet below the flightpath.
4. When vortices sink close to the ground (within about 200 feet), they tend to move laterally outward over the ground at a speed of about 5 knots.

WARNING

Wake vortices should be avoided while maneuvering at low altitude. An encounter with wake vortices may result in conditions from which recovery may be impossible.

11.5.2 Radius of Turn. The turn radius is a function of the bank angle (g loading) and the square of the constant airspeed. For any given condition of altitude and weight where the g capability is defined by rotor characteristics, the turn radius can be markedly affected by constant airspeed. The effect of speed can be ascertained by an inspection of figure 11-1. From the examples A and B, it can be seen that for a bank angle of 30° (1.15g), the radius of turn is increased by a factor of four when the constant airspeed is increased from 80 KTAS to 160 KTAS. Figure 11-2 provides a graphic chart of the turning radius in relationship to constant airspeed.

11.5.3 Low-G Maneuvers. The helicopter has a tendency to roll to the right when forward cyclic is used to initiate a lower-than-1g maneuver in forward flight. The reason for this low-g roll tendency is the thrust produced by the tail rotor. Because the tail rotor is above the helicopter center of gravity, the tail rotor thrust produces a right roll tendency. During normal 1g flight, a portion of the main rotor thrust balances the tail rotor thrust and counteracts this right roll tendency. During low-g flight, however, main rotor thrust is greatly reduced while the tail rotor thrust remains high; thus, a right roll can develop during low-g maneuvers. Instinctive pilot reaction is to correct the roll with lateral cyclic.

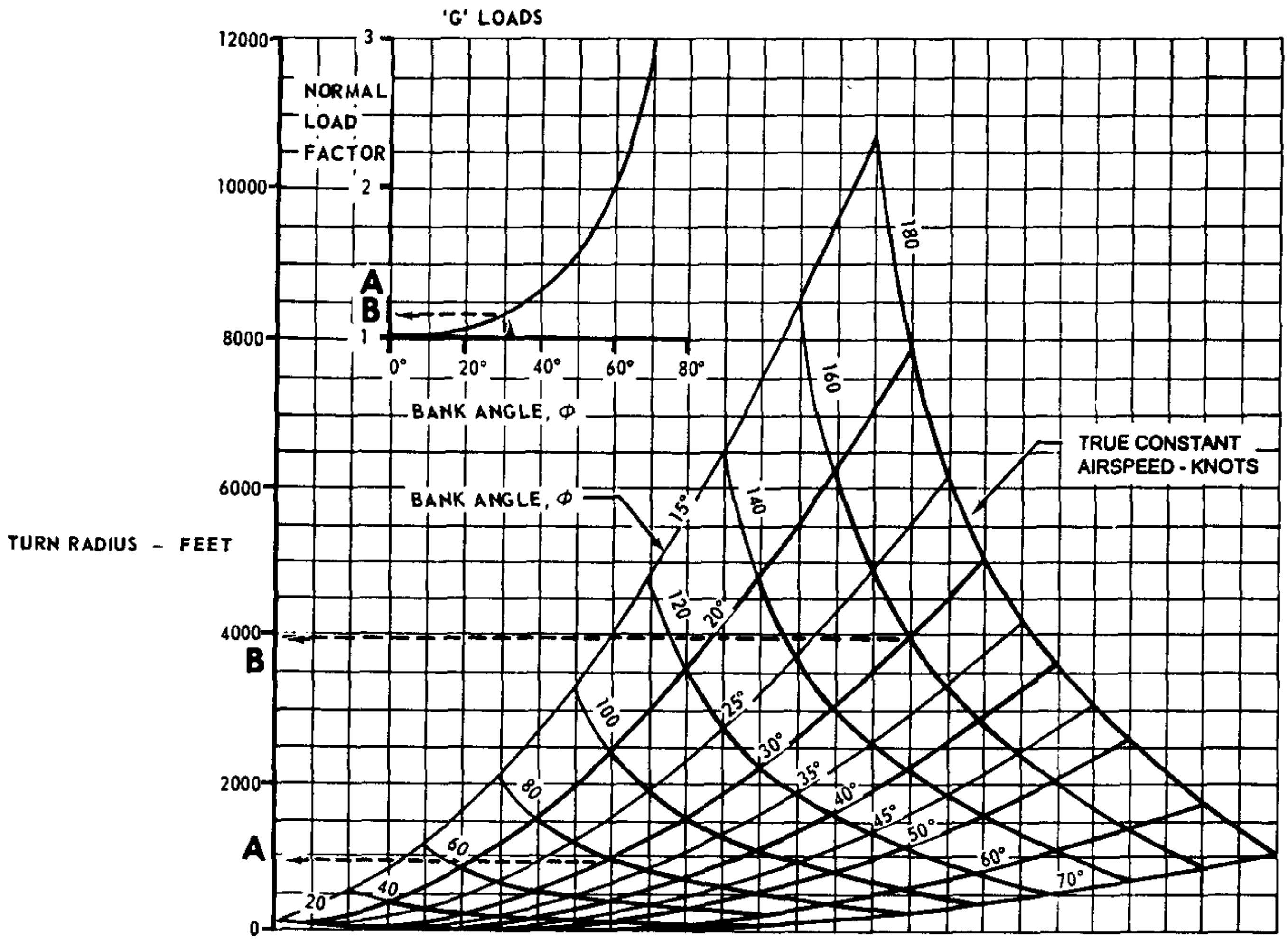
Since main rotor thrust has been greatly reduced, lateral cyclic effectiveness is also greatly reduced. Left cyclic application may also result in mast bumping. Aft cyclic will quickly increase rotor thrust (higher g loading) and will return lateral cyclic effectiveness.

Because of mission requirements, it may be necessary to rapidly lower the nose to acquire a target, stay on target, or recover from a pullup. At moderate to high airspeeds, fairly small abrupt forward cyclic inputs can yield g levels near zero.

$$\text{TURN RADIUS} = \frac{V^2}{g \tan \phi} \qquad \text{NORMAL LOAD FACTOR} = \frac{1}{\cos \phi}$$

Note

This chart gives turn radius in feet as a function of constant airspeed and either bank angle or normal load factor. The capability of the aircraft is not inferred by this chart, but tradeoff or bank angle versus turn radius is valid.



EXAMPLE A	EXAMPLE B
CONSTANT AIRSPEED — 80 KTAS BANK ANGLE — 30°	CONSTANT AIRSPEED — 160 KTAS BANK ANGLE — 30°
SOLUTION: TURN RADIUS — 981 FEET 'G' LOAD — 1.15	SOLUTION: TURN RADIUS — 3,925 FEET 'G' LOAD — 1.15

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Figure 11-1. Radius of Turn

Note

This chart gives turn radius in feet as a function of airspeed and either bank angle or normal load factor. The capability of the aircraft is not inferred by this chart, but tradeoff of bank angle versus turn radius is valid.

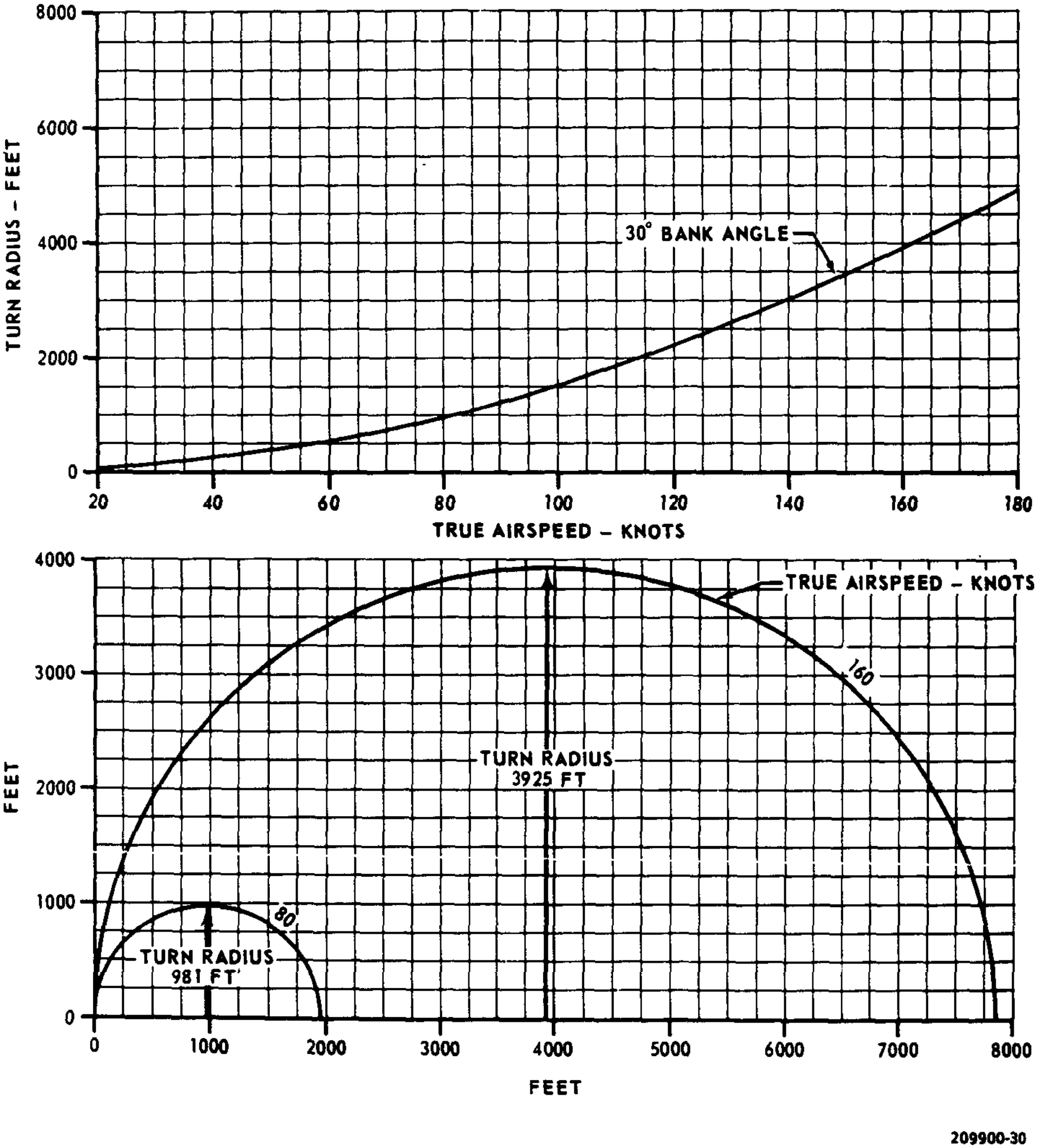


Figure 11-2. Radius of Turn — 30° Bank

The helicopter may roll to the right simultaneously with forward cyclic, the roll rate being greater as g levels approach zero and when the roll SCAS is disengaged. Left lateral cyclic will not effect recovery from a well-developed right roll during flight below 0.5g and may increase the probability of mast bumping. If it is necessary to rapidly lower the nose, it is essential that the pilot monitor changes in roll attitude and apparent load factor as the cyclic is moved forward. Collective inputs should not be used as a recovery technique for the roll reaction to the low-g maneuver. Increased collective above torque limit may result in rotor underspeed, overtorque, or uncoordinated sideslip.

11.5.4 Mast Bumping. Mast bumping occurs when the rotor exceeds its flapping limits and the underside of the rotor hub contacts (bumps) the rotor mast. If contact is severe, mast deformation can occur and cause mast structural failure. Excessive rotor flapping can also cause rotor blade contact with the tailboom or cockpit. The most frequent causes are:

1. Low-g maneuvers (below the approved maneuver limit of plus 0.5g) such as those caused by a rapid forward cyclic input and/ or a rapid downward collective motion.

2. Abrupt cyclic or collective inputs while hovering in high winds with longitudinal/ lateral cg at or in excess of limits.

3. Abrupt cyclic or collective inputs at high power and/or high collective settings with low rotor rpm.

4. Slope landing.

WARNING

Flight below 0.5g is prohibited.

There are varying degrees of mast contact, with the mildest occurring when the flapping stops are contacted during engine start or rotor coastdown. This form of mast contact will be felt and heard by the pilot as a solid thumping and will normally occur as a function of cyclic position, wind direction, wind velocity, and rotor rpm.

Mast bumping may occur at low airspeed and is associated with mishandling of the controls, low rotor rpm, and with center of gravity and gross weight beyond their respective limits. It may occur during such maneuvers as slope landings. The pilot may feel and hear the flapping stops hitting the mast at a frequency of two times for each rotor revolution. In severe cases, very small but abrupt aircraft attitude changes will be sensed.

The most severe level of mast bumping can occur at airspeeds above approximately 30 knots and is associated with improper pilot handling of the controls in situations such as complete loss of engine power or operation at less than 0.5g following a rapid forward cyclic input. If mast bumping occurs in such situations, the pilot may be subjected to vibration at two-per-revolution frequency plus uncommanded roll and yaw attitude changes. The sound of this magnitude of mast bumping is very loud, which may cause pilot disorientation. Mast bumping as a result of low-g maneuvering can occur even though rotor rpm, gross weight, airspeed, and cg are within limits.

WARNING

If mast bumping occurs in flight, catastrophic results are highly probable. Since conditions that cause rotor flapping are cumulative, improper pilot response/ recovery techniques to flight situations approaching or favorable to mast bumping can aggravate the situation and lead to in-flight mast bumping and mast separation.

11.5.5 Diving Flight. Diving flight presents no particular problems; however, the pilot should have a good understanding of such things as rates of descent versus airspeed, rate of closure, and rates of descent versus power. Because of relatively low drag, the helicopter gains airspeed quite rapidly in a dive and it is fairly easy to exceed the maximum allowable airspeed. Rates of descent over 3000 fpm are common during high-speed dives. These high rates of descent coupled with the high flightpath speeds (290 feet per second at 170 KIAS) require that the pilot monitor both rate of closure and terrain features very closely and plan dive recovery in time to avoid having to make an abrupt recovery.

WARNING

If an abrupt recovery is attempted at speeds near maximum allowable airspeed, mushing can occur (i.e., high-g load exceeds lift capability of the rotor system resulting in high-speed rotor stall). If mushing is experienced, do not increase collective. Application of increased collective will aggravate the condition. Therefore, ensure dive recovery is initiated at sufficient altitude to perform the maneuver within the approved flight envelope.

11.5.5.1 Power Dives. At airspeeds above the maximum obtainable level-flight airspeed (V_h), the rate of descent will increase approximately 1000 fpm for every 10-knot increase in airspeed for the full-power condition.

CAUTION

Do not exceed 65-percent transmission torque at airspeeds above V_h while in a dive.

11.6 HOVERING CAPABILITY

Hovering capability is affected by height above ground, OAT, pressure altitude, windspeed and direction, engine torque (power available), and gross weight of the helicopter. HIGE performance is better than HOGE performance. Temperature/humidity variations affect engine and rotor performance. Hovering with heavier gross weights or at higher altitudes is possible with lower temperatures and higher wind velocities. Lower temperatures increase engine efficiency and wind represents airspeed; therefore, either condition or both will increase hovering performance because of the ability of the main rotor to provide more lift.

11.7 DYNAMIC ROLLOVER CHARACTERISTICS

During normal takeoffs and landings, slope takeoffs and landings, or landings and takeoffs with some bank angle or side drift, the bank angle or side drift can cause the helicopter to get into a situation where it is pivoting about a skid. When this happens, lateral cyclic control response is more sluggish and less effective than for the free hovering helicopter. Consequently, if the bank angle (the angle between the helicopter and the horizon) is allowed to build up past 15°, the helicopter will enter a rolling maneuver that cannot be corrected with full cyclic input and the helicopter will roll over on its side. In addition, as the roll rate and acceleration of the rolling motion increase, the angle at which recovery is still possible is significantly reduced. The critical roll-over angle is also reduced for a right-skid-down condition, crosswinds, lateral cg offset, and left rudder pedal inputs.

When performing maneuvers with one skid on the ground, care must be taken to keep the helicopter trimmed, especially laterally. For example, if a slow takeoff is attempted and the tail rotor thrust contribution to rolling moment is not trimmed out with cyclic, the critical recovery angle will be exceeded in less than 2 seconds. Control can be maintained if the pilot maintains trim, does not allow helicopter roll rates to become large, and keeps the bank angle from getting too large. The pilot must fly the helicopter into the air smoothly, keeping executions in pitch, roll, and yaw low and not allowing any untrimmed moments.

When performing slope takeoff and landing maneuvers, follow the published procedures, being careful to keep roll rates small. Slowly raise the downslope skid to bring the helicopter level and then lift off. (If landing, land on one skid and slowly lower the downslope skid.) If the helicopter rolls to the upslope side (5° to 8°), reduce collective to correct the bank angle, return to wings level, and then start the takeoff procedure again.

Collective is much more effective in controlling the rolling motion than lateral cyclic because it reduces the main rotor thrust. A smooth, moderate, collective reduction of less than approximately 40 percent (at a rate less than approximate full up to full down in 2 seconds) is adequate to stop the rolling motion with about 2° bank angle overshoot from where down collective is applied. Care must be taken not to lower collective at too high a rate as to cause fuselage-rotor blade contact. Additionally, if the helicopter is on a slope and the roll starts to the upslope side, reducing collective too fast creates a high roll rate in the opposite direction. When the low slope skid hits the ground, the dynamics of the motion can cause the helicopter to roll about the downslope skid and over on its side. Do not pull collective suddenly to get airborne as a large and abrupt rolling moment in the opposite direction will result. This moment may be uncontrollable.

WARNING

If the helicopter reaches 15° of bank angle with one skid on the ground and thrust approximately equal to the weight, the helicopter will roll over on its side. Reduce collective to stop the roll and correct the bank angle to wings level.

CAUTION

When landing or taking off with thrust approximately equal to the weight and one skid on the ground, keep the helicopter trimmed and do not allow helicopter roll rates to build up. Fly the helicopter smoothly off (or onto) the ground, carefully maintaining trim.

11.8 PYLON ROCK

The helicopter is not subject to pylon rock under normal conditions. Pylon rock is the phenomenon of the helicopter pylon moving periodically (1/2 per revolution or 2.4 cps). This pylon motion is commonly noted by several short self-damping oscillations with the number of perceptible oscillations indicative of the state of wear of pylon dampers.

If pylon rock is encountered, a change of flight condition, preferably by lowering the collective, should eliminate the motion.

11.9 POWER SETTLING

Power settling is most likely to occur during conditions of high gross weight, high density altitude, low airspeed, and descending powered flight. Under these conditions, a helicopter is settling through the air displaced by its own rotor system. The downwash then recirculates through the helicopter rotor system, resulting in reduction of lift, increased roughness, and poor control response.

Power settling is an uncommanded rate of descent caused by the helicopter rotor encountering the vortex ring state as it settles into its own downwash. In this state, the flow through the rotor system is upward near the center of the rotor disk and downward in the outer portion. This results in near zero net thrust from the rotor and extremely high helicopter descent rates. Power settling is not restricted to high gross weights or high density altitudes. It may not be recognized and a recovery effected until considerable altitude has been lost. Helicopter rotor theory indicates that it is most likely to occur when descent rates exceed 800 fpm during vertical descents initiated from a hover and steep approaches at less than 40 knots.

INDICATIONS:

1. Rapid descent rate increase
2. Increase in overall vibration level
3. Loss of control effectiveness.

PROCEDURES:

1. Forward cyclic to gain airspeed
2. Decrease collective.

WARNING

Increasing collective has no effect toward recovery and will aggravate power settling. During approaches at less than 40 knots, avoid descent rates exceeding 800 fpm.

11.10 ROTOR DROOP

Droop is a term used to denote a change in power turbine speed (N_p) and rotor speed that occurs with a demand for increased power with the governor at a constant speed setting. Droop may be further categorized as either transient or steady state. Transient droop is the momentary change in power turbine speed and rotor speed resulting from an increased power demand, and it is compensated for by the hydromechanical unit.

Note

After transient droop, engines will accelerate rapidly in an attempt to regain reference N_p. Monitor torque and N_r. Adjust collective as necessary to prevent exceeding limits.

11.11 VIBRATION IDENTIFICATION

11.11.1 One-Per-Revolution Vibration (Main Rotor). This vibration is relatively easy to recognize in that it is quite easy to count (approximately 5 cps). The following are normal causes of one-per-revolution vibration:

1. A rotor-out-of-balance condition causes a lateral one-per-revolution vibration. The rotor can be out of balance either chordwise or spanwise. An out-of-balance condition can appear as a vertical vibration during forward flight. Consult the MIMs for corrective action.

2. A rotor-out-of-track condition causes a vertical vibration and will normally increase in amplitude with airspeed. Appropriate corrective action is outlined in the MIMs.

3. Binding in the scissor links or mixing levers.

4. Binding in rotor grip bearings.

11.11.2 Low-Frequency Vibration (Pylon Rock). This vibration manifests itself as a lateral vibration (about 2.4 cps). It is more noticeable with a forward cg at low airspeeds and higher power. This rocking motion can usually be reduced by reducing speed and power. It is the result of the pylon mounts either having failed or deteriorated. It can also be induced by erratic cyclic motion.

11.11.3 Two-Per-Revolution Vibration. This vibration (10.4 cps) is extremely difficult to count. Amplitude increases with airspeed as a result of unequal drag causing the top of the mast to move in a manner to shake the pylon at a two-per-revolution frequency. This can be caused by soft pylon mounts, although a certain amount of two-per-revolution vibration is inherent in the helicopter. A check of the following may identify the cause of unusual two-per-revolution vibrations:

1. Pylon mounts for separation or bottoming out

2. Drag braces on the rotor to see that they are mounted securely and have no play in attachment points

3. Vibration suppression system

4. Tailboom attachment bolts.

11.11.4 High-Frequency Vibration. High-frequency vibrations are much too fast to count and feel like a buzz. These frequencies may emanate from the engines, improper driveshaft alignment, couplings improperly functioning, bearings dry or excessively worn, or tail rotor out of track or balance. If excessively high frequency vibration exists, it is recommended that the helicopter land and a crewmember attempt to locate the source. The area where the highest amplitude of vibration exists is generally the area from which the vibration is originating.

11.11.5 Erratic Vibration. Failure of the VSS can cause erratic vibrations through the cockpit deck and/or tail rotor pedals. These vibrations can be erratic in both frequency and amplitude. In the event the VSS fails, press the VSS switch to VSS OFF and pull the VSS circuit breaker.

11.12 AUTOROTATION CHARACTERISTICS

Because of the wide speed-range capability, some discussion of the power-off characteristics of the main rotor system is essential. The following paragraphs explain the necessity of maintaining rotor rpm in its normal power-off range (91 to 105 percent).

11.12.1 Normal Rotor Speed. The normal rotor speed ensures that the pilot will retain adequate control effectiveness. Low rpm (underspeed) causes a proportional loss of response to control inputs. High rpm (overspeed) can cause structural damage to the rotor system. An increased rate of descent will result from rotor speed outside the normal range.

11.12.2 Rotor Flapping. The angle between the tip-path plane and the mast increases at low rpm. By maintaining rotor rpm in the normal range, the pilot ensures safe clearance between the rotor and the tailboom.

11.12.3 Rotor Inertia. Rotor inertia is a characteristic that tends to prolong the effectiveness of collective control in the autorotation landing. This effectiveness decreases as rpm decreases. Normal rotor rpm provides the pilot normal inertia and normal collective control response with which to arrest the sink rate in the autorotation landing.

11.12.4 Rotor Rpm. The following factors affect power-off rotor rpm.

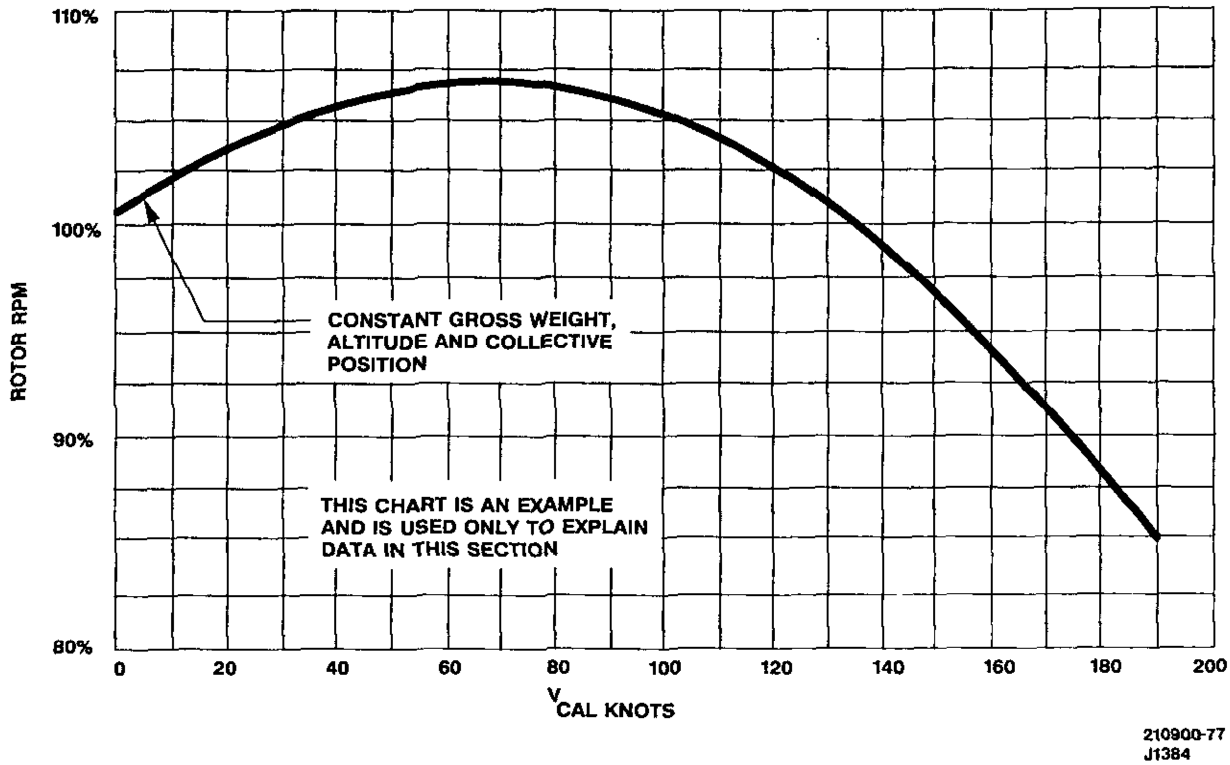


Figure 11-3. Autorotation Rpm Versus Airspeed

11.12.4.1 Airspeed. In autorotation, rotor rpm varies with airspeed. Maximum rotor rpm is achieved at a steady state of 60 to 80 KIAS (Figure 11-3). Rotor rpm decreases at stabilized airspeeds above or below the 60 to 80 KIAS range. When changing airspeeds, cyclic movement will produce a rotor rpm other than that produced under steady state conditions as follows:

1. Acceleration from low airspeed. Example: From a stabilized 30-KIAS autorotative condition, a positive forward cyclic movement to increase airspeed will cause the rotor rpm to decrease initially and then increase when the helicopter is stabilized at a higher speed.
2. Deceleration from high airspeed. Example: From a stabilized 120-KIAS autorotative condition, a positive aft cyclic movement to decrease airspeed will cause the rotor rpm to increase initially and decrease when helicopter is stabilized at a lower speed.

Note

Maximum permissible steady state autorotation airspeed is 120 KIAS.

11.12.4.2 Gross Weight. The power-off rpm varies significantly with gross weight for identical collective settings. Low gross weight will produce low rotor rpm; high gross weight will produce high rotor rpm. With the collective system correctly rigged to a minimum blade angle (full down collective stick) of approximately 6.75°, the pilot must manually control rpm with the collective stick in order to prevent overspeeding of the rotor when at high gross weight.

11.12.4.3 Density Altitude. The power-off rotor rpm varies with altitude (low altitude, low rpm; high altitude, high rpm). The pilot will find that the higher the altitude, the higher the collective stick position required to prevent overspeed of the rotor.

11.12.4.4 Cyclic Flare. Aft cyclic control application (noseup pitching) produces an increase in rotor rpm proportional to the flare and entry speed. The higher the speed, the greater the flare effectiveness. From a high-speed entry condition, a steep flare can produce an overspeed unless limited by collective pitch control.

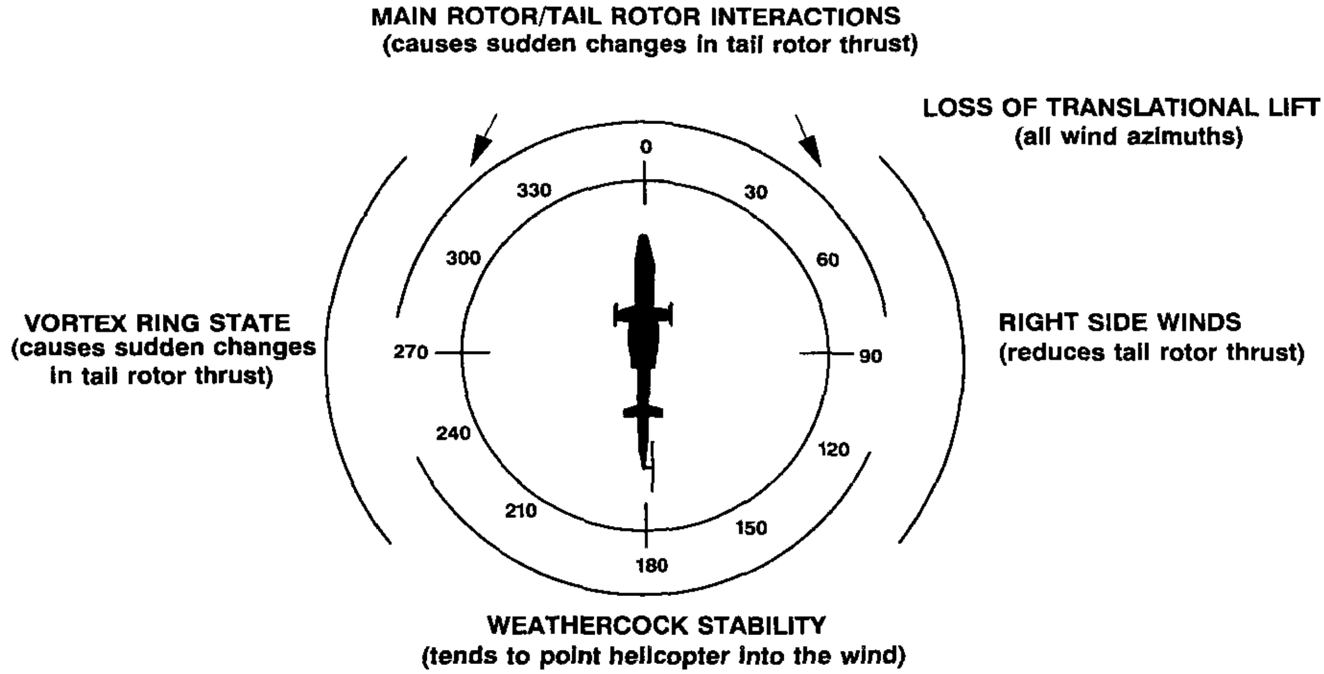


Figure 11-4. Aerodynamic Factors Affecting Aircraft Yaw Control

11.12.5 Pilot Technique. It can be readily seen from the information provided that the pilot technique must vary in accordance with the actual conditions of airspeed, altitude, and gross weight at the time of engine failure.

11.13 UNANTICIPATED RIGHT YAW

Unanticipated Right Yaw (URY) is defined as the occurrence of an uncommanded and rapid right yaw rate which does not subside of its own accord and that, if not quickly reacted to, can result in loss of aircraft control. URY is a result of several aerodynamic characteristics affecting aircraft yaw control. In general, URY contributing factors (as noted below) must be present in combination to produce a URY incident. Helicopters frequently and routinely operate in conditions conducive to URY without incident. However, a thorough knowledge of the phenomenon and heightened situational awareness are required to do so safely.

11.14 AERODYNAMIC FACTORS AFFECTING AIRCRAFT YAW CONTROL

There are four distinct low-speed characteristics and two hover conditions that are contributing factors in URY (see Figure 11-4).

11.14.1 Low-Speed Flight. These factors are present at airspeeds less than 40 knots and are common to all single-rotor helicopters.

Note

Wind azimuths, as noted, are relative to the aircraft.

11.14.1.1 Weathercock Stability (Winds Approximately 120° to 240° Relative). This characteristic is an inherent quality of the fuselage and the vertical fin. Within the region, winds tend to weathervane the aircraft. Winds will initiate an uncommanded yaw which will attempt to point the nose of the aircraft into the wind unless a resisting pedal input is made. Additionally, if a yaw rate has already been established, such as in a pedal turn, weathercocking stability will act to accelerate the yaw in the same direction as the turn when the tail passes through the relative wind.

11.14.1.2 Tail Rotor Vortex Ring State (Winds Approximately 210° to 330° Relative). Winds in this region cause the tail rotor to work in its own recirculated airflow. If the fore/aft wind component at the tail rotor is small as compared to the left sideward component (i.e., winds primarily from the beam), the result will be large variations in tail rotor thrust which occur intermittently. These variations in thrust will cause unpredictable and uncommanded yaw rates and a corresponding increase in pilot pedal workload to maintain directional control.

11.14.1.3 Main Rotor Disk Vortex Interaction (Winds Approximately 280° to 330° Relative and 030° to 080° Relative). Primarily, relative winds from the left forward quadrant will cause the retreating, main rotor tip vortices to be directed onto the tail rotor. Less frequently, relative winds from the right forward quadrant will cause the advancing main rotor tip vortices to be directed onto the tail rotor. When main rotor tip vortices are directed onto the tail rotor, its thrust will vary unpredictably, resulting in high pilot pedal workload to maintain directional control. This factor may be exaggerated with the aft center of gravity associated with high gross-weight operations or the tail-low attitude of a high-speed deceleration or autorotation flare recovery.

11.14.1.4 Loss of Main Rotor Translational Lift (All Wind Azimuths). This event can establish an abrupt requirement for increased lift, necessitating a collective input that in turn requires increased antitorque/left pedal. It is the most common factor in recorded URY incidents. This phenomenon is complicated by the difficulty in accurately assessing and maintaining true airspeed during low-speed turning flight with ambient winds.

11.14.2 Hover/Taxi. Two primary hover/taxi conditions can also lead to an occurrence of URY. Weathercocking stability may act as a yaw accelerator in these cases.

11.14.2.1 Right Relative Crosswind (Winds Approximately 60° to 120° Relative). Right sideward flight or a right crosswind increases airflow across the tail rotor, resulting in a reduction of the tail rotor angle of attack and, for a set pedal position, a reduction in tail rotor thrust. If this reduction in thrust is not offset by an increase in left pedal, a right yaw will occur.

11.14.2.2 Main Rotor Vortex Ground Interaction (Winds Approximately 180° Relative). When an aircraft is operated at low wheel heights (i.e., maximum gross weight takeoffs), the main rotor tip vortex can produce an area of downwash turbulence which may interact with the tail rotor causing tail rotor thrust variations. The aircraft may become "skittish" in yaw, causing increased pilot workloads since large and rapid pedal movements are required to maintain directional control. Slow rearward flight or a tailwind can aggravate the situation.

11.15 URY-CONDUCIVE FLIGHT MANEUVERS

Incidents of unanticipated right yaw have been recorded during downwind approaches to hover, downwind approaches to ship, and during ground-referenced downwind turns. One common URY scenario follows:

1. During a downwind, descending, ground-referenced right turn, the pilot unintentionally decelerates (i.e., loses true airspeed) while attempting to fly a constant radius in the presence of a wind. This increases power required and, if not compensated for, will cause or increase a rate of descent.
2. Once the descent is recognized, a higher torque (increased collective) is required to arrest the increasing descent rate.
3. As collective is increased, a right yaw is generated if not compensated for. Coupled with any intentional right yaw rate caused by the turn and any yaw acceleration caused by weathercock effect as the tail passes through the wind, this may result in an uncommanded right yaw rate that takes several seconds (or two or three revolutions) to arrest.

11.16 FACTORS INCREASING THE LIKELIHOOD OF UNANTICIPATED RIGHT YAW OCCURRENCE

The following situations can serve to aggravate the URY phenomenon or reduce the effectiveness of recovery procedures:

1. High power required — Recovery from a large right yaw rate is more difficult in conditions requiring higher main rotor power (examples: high gross weight, high density altitude, stopping a high descent rate).
2. Low airspeeds — More power (more tail rotor antitorque) is required to maintain flight. and accurate assessment of true airspeed and direction of the relative wind is

difficult. Also, the streamlining fin effect contribution of the airframe to maintain directional control is reduced.

3. Low rotor rpm — A rapid application of collective may cause a transient rotor rpm droop to occur. Any decrease in main rotor rpm causes a greater proportional decrease in tail rotor rpm/thrust. Drooping rotor speed (N_r) with the left pedal at or near the stop can cause a loss of directional control because of the rapid loss of tail rotor thrust as rpm decays.

4. Delay in corrective action — Because of high pilot workload, distraction, or inattention, an intentional right yaw can result in an unexpected acceleration of yaw rate.

11.17 RECOMMENDATIONS TO REDUCE THE LIKELIHOOD OF AN UNANTICIPATED RIGHT YAW INCIDENT

A thorough knowledge of aircraft behavior in all flight regimes is necessary to identify situations where URY can occur. If the warning signs of URY are known (uncommanded heading variations, high pedal workload, unanticipated rapid right yaw), true/relative winds to the aircraft are considered, excessive descent rates are avoided, flight controls are moved smoothly, and care is taken in the transition to low-speed flight, a URY incident is unlikely. The following guidelines will help minimize the chances of a URY incident occurring:

1. Avoid low-speed turning maneuvers when high ambient winds are present. Necessary turns should be conducted at low turn rates with a large turn radius.

2. Be aware of the limitations of the aircraft's airspeed sensor system and maintain true airspeed above the minimum reliable limit.

3. During low-speed flight, avoid flying in a ground reference system. When visual cues from objects on the ground are required to adjust aircraft velocity and heading, the pilot should take care to maintain full situational awareness (i.e., true airspeed and wind conditions).

4. Approach objects on the ground (or in the water) using a straight-line approach when high ambient winds are present.

5. Be prepared to take timely corrective action. This is vital to prevent an excessive yaw rate from building. In some cases a delay in corrective action greater than 2 to 3 seconds may be critical.

11.18 UNANTICIPATED RIGHT YAW RECOVERY GUIDANCE

Should a URY occur, a correct and timely response is critical. If the response is incorrect or slow, the yaw rate may accelerate to the point from which it is extremely difficult to recover. One or more complete revolutions may be experienced. When URY is encountered, recovery is best achieved by:

1. Applying full left pedal — Recognize that it takes a finite time (possibly several seconds or several revolutions) for control inputs to take effect in a fully developed URY situation. Neutralizing the pedals or adding right pedal will only accelerate the yaw rate, driving the aircraft further out of control.

2. Using forward cyclic to increase airspeed — This results in a reduction in tail rotor thrust required as the aircraft passes through transitional lift (less main rotor thrust required) and an additional reduction of tail rotor thrust required because of the streamlining fin effect.

3. Lowering collective — Altitude permitting, will reduce torque and assist in stopping a right yaw. However, if a significant descent rate is set up, it may require additional power to arrest and may aggravate or reintroduce URY.

PART V

Emergency Procedures

CHAPTER 12

Emergency Procedures Introduction

12.1 SCOPE

Emergency procedures are divided into two categories, critical and noncritical. The critical items are those that must be performed immediately if the emergency is not to be aggravated. Items marked with an asterisk (*) are critical items and must be performed immediately in proper sequence. Noncritical emergency procedure actions are those that contribute to an orderly sequence of events and assure that all necessary actions are taken. These procedures are accomplished with direct reference to the checklist.

The procedures in the following chapters contain the indications of failures or malfunctions that affect: safety of the crew, helicopter, ground personnel, or property; the use of emergency features of primary and backup systems; and appropriate warnings, cautions, and explanatory notes.

Aviate, navigate, perform the procedures, and then communicate. Completing the procedures correctly is not worthwhile if the aircrew does not aviate and navigate first. If the helicopter does not experience unexpected changes in attitude, then instantaneous action is not required.

12.2 SPECIAL INSTRUCTIONS

The following terms indicate the degree of urgency in landing the helicopter:

1. Land immediately — Self-explanatory. Landing in trees, water, or otherwise unsafe areas should be considered as a last resort.
2. Land as soon as possible — Land at the first site where a safe landing is reasonably assured.
3. Land as soon as practicable — Extended flight is not recommended, and the landing site and duration of flight are at the discretion of the pilot.

The following terms are used to describe the operating condition of a system, subsystem, assembly, or component:

1. Affected — Fails to operate in the normal or usual manner.
2. Normal — Operates in the normal or usual manner.

12.3 MASTER CAUTION SYSTEM

The MASTER CAUTION light will illuminate when any caution advisory panel light illuminates except for advisory lights. Refer to Figure 2-26 for a detailed functional description.

CHAPTER 13

Ground Emergencies

13.1 EMERGENCY SHUTDOWN

*1. Throttles — CLOSE.

*2. Rotor brake — ENGAGE.

*3. Batteries — OFF.

4. Exit helicopter.

CAUTION

An emergency engine shutdown occurs when the engine is shut down from a high power setting (above 90 percent N_g) without performing a 2-minute cooldown. If a normal engine cooldown was not possible, the engine can be restarted if:

a. The reason for shutdown is known and restarting will not cause engine damage.

b. The engine is motored to cool MGT to 150 °C and restart is initiated within 5 minutes after shutdown.

c. The engine is allowed to cool for 4 hours if restart cannot be initiated within 5 minutes after shutdown.

13.2 EMERGENCY EGRESS AND RESCUE

Pilot and copilot/gunner access is provided by canopy doors that are hinged at the top and swing outward and up. Both doors can be opened or closed from inside or outside. Emergency exit or entrance is provided by a detonation cord system to cut the windows from the canopy support structure. The linear explosive system is installed around both canopy doors and around the windows on each side. Interconnecting lines of flexible detonating cord connect the linear explosive system with the three CRS arm/fire mechanisms. The system can be actuated from any of these locations as shown in Figures 13-1 and 13-2. The pilot and copilot/gunner station arm/fire mechanisms are equipped with a CRS handle for actuation. The mechanism in the nose is equipped with a ring.

13.2.1 Manual Egress.

1. Lap belt/shoulder harness release — OPEN.
2. Helmet — DISCONNECT (HSS/ICS).
3. Canopy door handle — ROTATE (upward).
4. Canopy — OPEN.
5. Exit helicopter.

13.2.2 Emergency Egress. If the canopy door cannot be opened manually:

1. Helmet visor — DOWN.
2. Pilot and Copilot/Gunner COORDINATE firing the system.

WARNING

Simultaneous or near simultaneous pulling of both pilot and copilot/gunner arm/fire mechanism handles may result in injury to one or both crew members. The pilot and copilot/gunner must coordinate prior to firing the system.

3. CM CRS handle — PULL handle completely out of arm/fire mechanism.
4. B CRS handle — ROTATE handle 90° counterclockwise and PULL completely out.

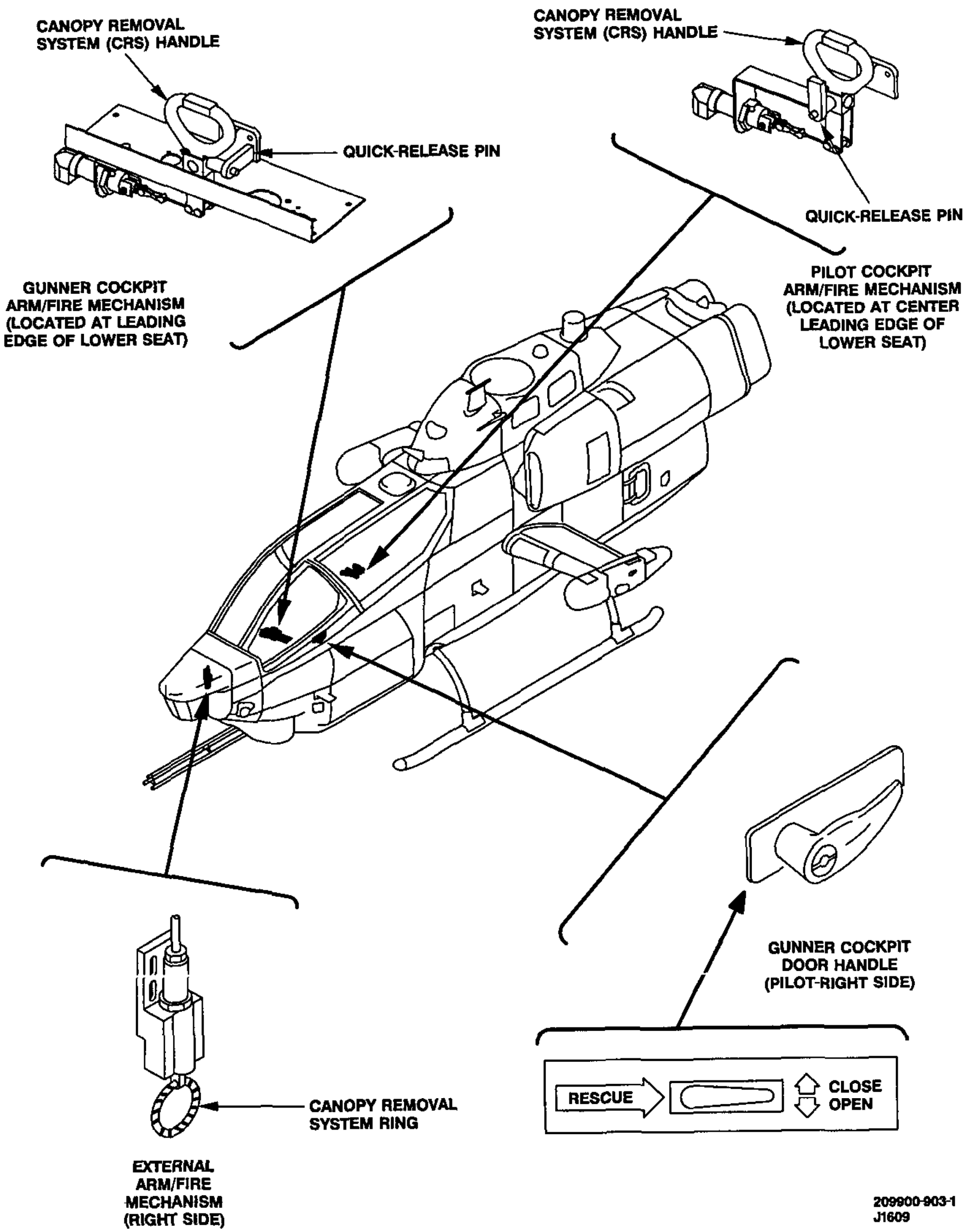


Figure 13-1. CM Emergency Egress and Rescue

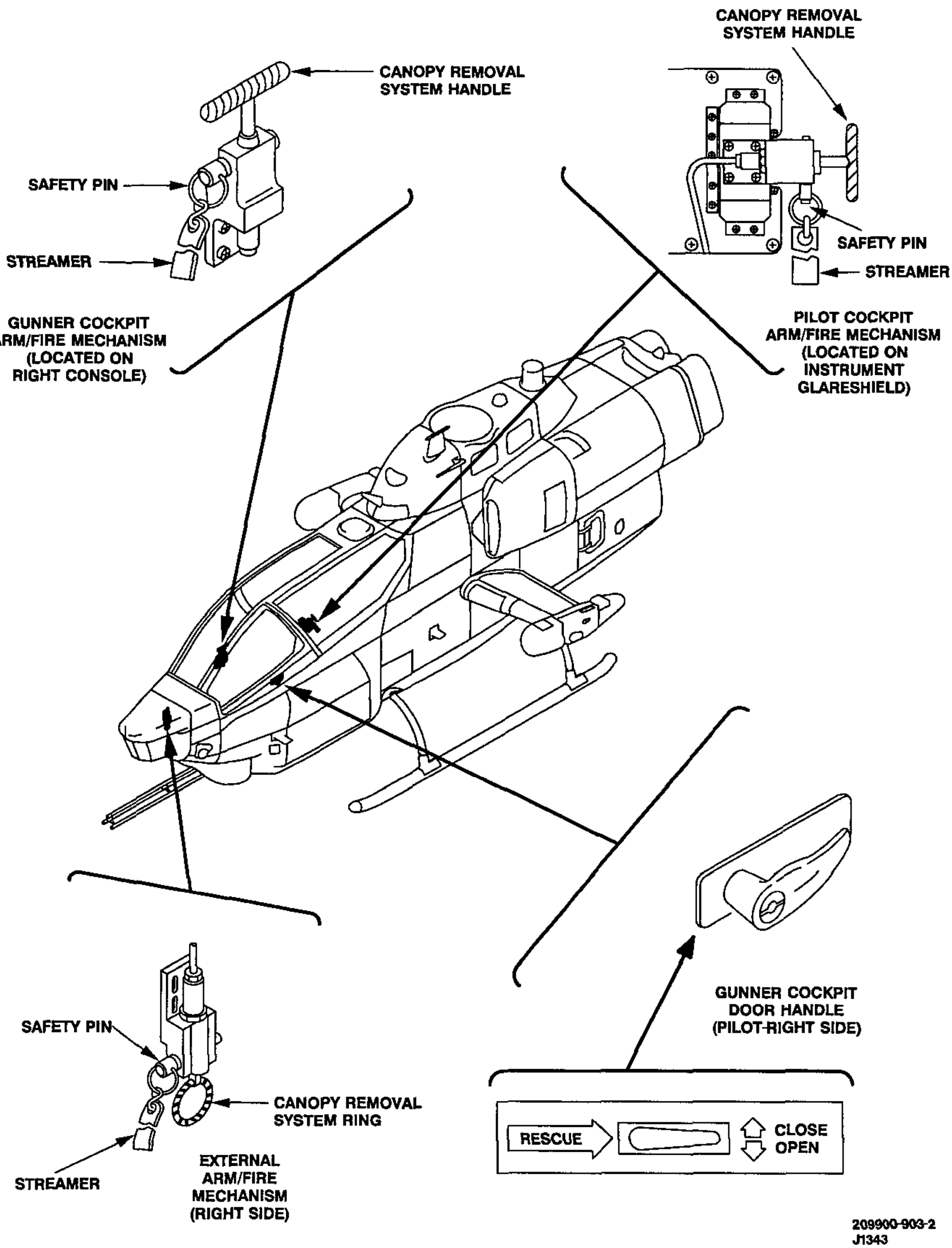


Figure 13-2. B Emergency Egress and Rescue

WARNING

- Personnel positioned within 50 feet of the helicopter could be injured by debris.
- Activation of CRS when combustible fuel and/or vapors are present may result in an explosion/fire.
- The CRS handle must be pulled completely out of the arm/fire mechanism or the CRS will not function.
- The CRS handle must be pulled straight out of the arm/fire mechanism without bending the initiator or extreme force will be required to remove the initiator and actuate the system.
- The canopy breakout knife or pilot survival knife may be used as an alternate means of egress.

5. Lap belt/shoulder harness — RELEASE.
6. Helmet — DISCONNECT (HSS/ICS).
7. Exit helicopter.

13.2.3 Rescue. To open canopy and remove occupants:

1. Canopy door handles — ROTATE (downward)
2. Lap belt/shoulder harness — RELEASE.
3. Helmet — DISCONNECT (HSS/ICS).
4. Occupants — REMOVE.

If canopy doors cannot be opened manually:

1. External CRS ring access panel — REMOVE.
2. Ring — ROTATE 90° counterclockwise and pull completely out.

WARNING

- Personnel positioned within 50 feet of the helicopter could be injured by debris.
- Activation of CRS when combustible fuel and/or vapors are present may result in an explosion/fire.
- The CRS ring must be pulled completely out of the arm/fire mechanism or the CRS will not function.
- The canopy breakout knife or pilot survival knife may be used as an alternate means of egress.

3. Occupants — REMOVE.

13.3 HOT START

INDICATION (affected engine):

1. MGT reaches 867 °C before starter cutout.

PROCEDURES:

*1. Throttle (affected engine) — CLOSE.

CAUTION

Do not secure the affected engine FUEL switch. The starter would be disabled and preclude motoring of the engine.

*2. START switch (affected engine) — ENGAGE. Motor affected engine for approximately 20 seconds or until MGT decreases below 150 °C.

CAUTION

Observe starter limits.

3. Helicopter — *SHUT DOWN.*

13.4 ENGINE FIRE ON START (EXTERNAL)

INDICATIONS:

1. FIRE PULL warning light and aural alert
2. Smoke
3. Fire.

PROCEDURES:

*1. Throttles — CLOSE.

*2. START switch — OFF.

*3. FIRE PULL handle (affected engine) — PULL.

*4. FIRE EXT switch — MAIN/RESERVE. If fire indications persist, switch the extinguisher to RESERVE.

5. Helicopter — SHUT DOWN.

6. Exit helicopter.

CHAPTER 14

Takeoff Emergencies

14.1 DUAL-ENGINE FAILURE DURING TAKEOFF

INDICATIONS:

1. Left yaw
2. Rotor rpm decreases
3. Rapid settling
4. Engine instruments (for both engines) decrease
5. MASTER CAUTION light
6. RPM warning light and aural alert
7. Caution lights and aural alert.

PROCEDURE:

Note

Gross weight, temperature, altitude, and airspeed will determine if autorotation can be established.

When two-engine failure is experienced:

*1. Autorotation — ACCOMPLISH.

WARNING

The rotor brake should be applied to stop the rotor prior to the crew exiting the helicopter.

CAUTION

Ground contact should be in a level attitude to minimize helicopter damage.

14.2 SINGLE-ENGINE FAILURE DURING TAKEOFF

INDICATIONS:

1. Left yaw
2. Rotor rpm decreases
3. Engine instruments (affected engine) decrease
4. MASTER CAUTION light
5. RPM warning light and aural alert
6. Caution lights and aural alert.

PROCEDURES:

Note

Gross weight, temperature, altitude, and airspeed will determine if flight can be continued.

*1. Collective — ADJUST (to maintain rpm and desired power).

*2. Wing stores — JETTISON (as appropriate).

If insufficient altitude exists to continue flight:

3. Groundspeed — DECREASE.
4. Landing attitude — ASSUME.
5. Collective — INCREASE (just prior to ground contact to cushion the landing).
6. Helicopter — SHUT DOWN.

If altitude permits, adjust airspeed for maximum rate of climb or maintain rate of descent. After gaining sufficient altitude or establishing minimum rate of descent:

7. Affected engine — SHUT DOWN.
8. MASTER CAUTION light — RESET.
9. Land as soon as possible.

CHAPTER 15

In-Flight Emergencies

15.1 HYDRAULIC MALFUNCTIONS

15.1.1 Hydraulic System No. 1 Failure.

INDICATIONS:

1. Grinding or howling noise from pump
2. Fluctuating or low hydraulic system pressure
3. MASTER CAUTION light
4. NO. 1 HYD TEMP/PRESS caution light and aural alert
5. High tail rotor pedal force
6. YAW SCAS disengaged.

Note

Cyclic and collective rate limiting and/or control feedback may be evident during abrupt maneuvers.

PROCEDURES:

1. HYD switch — SYS 1 OFF.
2. HYDR CONT circuit breaker — IN.
3. MASTER CAUTION light — RESET.
4. Land as soon as possible.

15.1.2 Hydraulic System No. 2 Failure.

INDICATIONS:

1. Grinding or howling noise from pump
2. Fluctuating or low hydraulic system pressure
3. MASTER CAUTION light
4. No. 2 HYD TEMP/PRESS caution light and aural alert
5. PITCH and ROLL SCAS disengaged
6. VSS erratic or disengaged

Note

Cyclic and collective rate limiting and/or control feedback may be evident during abrupt maneuvers.

7. XMSN OIL COOLER caution light and aural alert; GRBX OIL temperature if the OIL COOLER switch is in the SEC position.

CAUTION

The GRBX OIL temperature will rise very rapidly (approximately 28 °C per minute) without cooling air through the heat exchanger.

PROCEDURES:

1. VSS — OFF.
2. HYD switch — SYS 2 OFF.
3. HYDR CONT circuit breaker — IN.
4. MASTER CAUTION light — RESET.
5. Land as soon as possible.

If the OIL COOLER switch is in the SEC position:

6. XMSN and GRBX OIL temperature — MONITOR.
7. Land as soon as possible.

If the XMSN or C BOX TEMP/PRESS caution light illuminates:

8. Land immediately.

15.1.3 Complete (Dual) Loss of Flight Control Hydraulic Boost (Systems No. 1 and No. 2). A safe recovery and landing from this type of malfunction can be achieved provided the following favorable conditions are satisfied:

- The helicopter attitude control is maintained. Although flight control forces are manageable by single-pilot effort, the transition from a power-boosted to a nonpower-boosted flight control system could be critical if encountered during high-performance maneuvers.
- A suitable landing site is available, preferably a hard surfaced runway (at least 3000 feet) with a long, shallow approach capability.

The collective should be adjusted for minimum power required to maintain level flight. Control movements will result in normal flight reactions in all respects except for the increased force required for the control movement. Flight control force characteristics are as follows:

- Fore-and-aft cyclic — Nosedown (forward cyclic) stick force higher than noseup.

WARNING

Pitch rates in excess of 3° per second should be avoided.

- Lateral cyclic — Roll right force higher than left roll.

WARNING

Roll rates in excess of 3° per second should be avoided.

- Pedals — Left pedal force slightly higher than right. If a yaw oscillation develops, establish a steady rate right sideslip attitude (one-half ball width right).
- Collective — Collective may be fixed at a position between 30 percent torque and 50 percent torque. Collective movement will be extremely difficult.

When landing without hydraulic boost, it is recommended that a very shallow approach to a sliding landing be accomplished on a smooth, hard surface. The approach should be initiated from a straight-in position, 500 feet AGL or less, and 2 nmi from the touchdown point. Ideally, the approach should be flown so as to touch down at a minimum of 20 KIAS with adequate margin for the landing slide and stop; the primary flight objectives will keep control movements to a minimum but still maintain the airspeed and sink rate that will terminate in a successful landing.

WARNING

At airspeeds below 20 KIAS cyclic feedback may be encountered. Do not attempt to dampen feedback.

Note

- At light gross weight configurations, the minimum power obtainable (approximately 30 percent torque) may not result in the desired sink rate unless airspeed is reduced below 35 KIAS. In this instance, a gross weight of 11,500 to 13,000 pounds would be desirable, so the decision to retain wing stores should be judiciously weighed in view of the possibility of the requirement to wave off the approach.
- Manipulation of the throttles may be utilized to establish a rate of descent or climb as required.

INDICATIONS:

1. MASTER CAUTION light
2. HYD TEMP/PRESS caution lights and aural alert
3. HYD PSI gauges low
4. All SCAS channels disengaged
5. Increased control forces
6. VSS off.

PROCEDURES:

WARNING

Avoid overcontrol and abrupt movements.

1. SCAS (all channels) — CHECK OFF.
2. VSS — OFF.
3. Wing stores — JETTISON (as appropriate).
4. MASTER CAUTION light — RESET.

Note

Investigate collective limits.

5. Landing site — EVALUATE.

Note

A landing site with a hard surface and the capability for a long, shallow approach should be selected.

6. Collective — DECREASE (to minimum obtainable).
7. Airspeed — ADJUST (to attain a 300 to 500 fpm rate of descent).

Note

- At very low gross weight, it may be necessary to decrease airspeed to 35 KIAS or less to achieve a 300- to 500-fpm rate of descent. In the airspeed range of 25 to 35 KIAS, it will be necessary to decrease airspeed to increase rate of descent. It will also be necessary to increase airspeed to decrease rate of descent.
- At high gross weights, the desired rate of descent should be easily attained within the obtainable power range.
- Attitude should be maintained once a 300- to 500-fpm rate of descent is achieved.

As the landing point is approached:

8. Rate of descent — MAINTAIN desired rate of descent with longitudinal cyclic.

Prior to touchdown:

9. ENG RPM (N_p) — 100 percent.
10. Sliding landing — EXECUTE.

WARNING

RPM is necessary to maintain directional control during the landing slide. Rolling off throttles after touchdown will result in a decrease of directional control.

CAUTION

Since it will not be possible to move the collective full down, the landing slide will be very long. In zero wind conditions, it will be necessary to hold left cyclic during the slide in order to maintain lateral position.

11. Helicopter — SHUT DOWN (hold collective at minimum until rotor stops).

15.1.4 Waveoff With Complete Hydraulic Failure.

PROCEDURES:

1. ENG RPM (N_p) — 100 percent.
2. Power — INCREASE (sufficiently to clear obstacles and obtain a positive rate of climb).

Note

EECU lockout may be used to increase N_r, thereby increasing lift to arrest rate of descent and establish a climb.

3. Airspeed — ADJUST to 70 KIAS minimum.

15.1.5 Hydraulic System Overtemperature.

INDICATIONS:

1. MASTER CAUTION light
2. HYD TEMP/PRESS caution light and aural alert
3. Hydraulic pressure normal.

PROCEDURES:

1. HYD switch (affected system) — OFF.
2. HYDR CONT circuit breaker — IN.

3. MASTER CAUTION light — RESET.

4. Land as soon as possible.

Note

If a HYD TEMP/PRESS caution light is illuminated and prolonged operation is necessary to reach a safe landing area, the affected system should be turned off to prevent further overheating. The system may be turned on again for a short period of time for the landing procedure.

15.1.6 Hydraulic Actuator/Servo Malfunctions. The hydraulic system consists of two completely independent power control subsystems. If an actuator servo valve malfunction occurs, such as a jammed valve caused by foreign material, the emergency servo valve bypass is actuated through pilot control inputs to maintain hydraulic powered flight control. In this event, the control force required to accomplish the bypass operation in the affected actuator will be higher than normal and should cue the pilot that a hydraulic malfunction has occurred. This increase in force will be noted only in the control axis powered by the malfunctioning actuator. Hydraulic system pressure will remain normal, but a system operating in the bypass mode may cause overheating and an overtemperature condition in the affected system (hydraulic system No. 1 or 2).

INDICATIONS:

1. Erratic control inputs
2. Intermittent, uncalled-for control inputs
3. Abnormally high control force in a single axis
4. Possible MASTER CAUTION light
5. Possible HYD TEMP/PRESS caution light and aural alert.

PROCEDURES:

1. SCAS (affected channels) — OFF.
2. Airspeed — ADJUST (100 KIAS or less).
3. MASTER CAUTION light — RESET (if illuminated).
4. Land as soon as possible.

15.1.7 Utility Hydraulic System Failure.

INDICATIONS:

1. MASTER CAUTION light
2. UTILITY HYD caution light and aural alert (overtemperature condition)
3. UTILITY HYD and XMSN OIL COOLER caution lights and aural alert (loss of pressure)
4. Depending upon conditions, the XMSN and C BOX TEMP/PRESS caution lights may also illuminate.

CAUTION

The GRBX OIL temperature will rise very rapidly (approximately 28 °C per minute) without cooling air through the heat exchanger.

PROCEDURES:

1. OIL COOLER switch — SEC.
2. MASTER CAUTION — RESET.

Note

When the OIL COOLER switch is positioned to SEC, the VSS will shut off.

3. XMSN and GRBX OIL temperatures — MONITOR.
4. Land as soon as practicable.

If the XMSN or C BOX TEMP/PRESS caution light illuminates:

5. Land as soon as possible.

CAUTION

The effectiveness of the rotor brake will be degraded with the OIL COOLER switch in secondary (SEC). When operating aboard ship or in high winds, turn the OIL COOLER switch to NORMAL just prior to rotor brake application.

15.2 VIBRATION SUPPRESSION SYSTEM FAILURE

INDICATIONS:

1. Increased two-per-revolution vibration intensity
2. Erratic vibrations.

PROCEDURES:

1. VSS switch — OFF.
2. VSS circuit breaker — OUT.

15.3 ROTOR BRAKE PRESSURIZES IN FLIGHT

INDICATIONS:

1. MASTER CAUTION light
2. ROTOR BRAKE warning light and aural alert
3. Rotor brake handle out of down position
4. Decrease in rotor rpm
5. RPM warning light and aural alert.

PROCEDURES:

*1. Rotor brake handle — FULL DOWN.

If warning light(s) remains illuminated:

*2. HYD switch — SYS 2 OFF.

Note

With hydraulic system No. 2 off, VSS and SCAS pitch and roll channels will be inoperative.

*3. Rotor rpm — MONITOR.

4. Land as soon as practicable.

If warning light(s) remains illuminated:

5. Land as soon as possible.

15.4 SCAS FAILURE

INDICATIONS:

1. Reduction in helicopter stability in affected axis(es)
2. Increase in pilot workload to maintain desired attitude
3. Larger attitude deviations than desirable with correction by the SCAS
4. SCAS hardover may result in roll, pitch, or yaw rates separately.

PROCEDURES:

1. SCAS (affected channels) — OFF.

Note

If the helicopter pitches, rolls, or yaws without pilot input, use the cyclic stick SAS REL switch to disengage all SCAS channels to stop excessive control input, then engage the unaffected channel(s). If the SCAS is not disengaged, the possibility of the SCAS returning to the centered position coupled with the pilot input to stop the attitude excursion could result in a greater than expected helicopter response in the opposite direction. When the affected SCAS channel is disengaged, the SCAS actuator will return to the centered position almost instantaneously; this coupled with a simultaneous pilot input to stop the attitude excursion could also result in a greater than expected helicopter response in the opposite direction.

2. Airspeed — Less than 100 KIAS.
3. Land as soon as practicable.

15.5 CONTROL SYSTEM MALFUNCTIONS

15.5.1 Cyclic Control Interference.

INDICATIONS:

1. Stiffness or binding in control movement
2. Restricted control travel.

PROCEDURES:

1. Force trim — CHECK proper release.
2. Control movements — KEEP to a minimum.
3. Land as soon as practicable (sliding landing).

15.5.2 Collective Control Interference.

INDICATIONS:

1. Stiffness or binding in control movement
2. Restricted control travel.

PROCEDURES:

1. Control movements — KEEP to a minimum.
2. Land as soon as practicable (sliding landing).

CAUTION

A shear pin is incorporated in the LDS linkage connection to the collective linkage. In case of a bind in the LDS linkage, the pin can be sheared to prevent binding of the collective control. Droop compensation is then inoperative and extreme care must be taken to prevent gas turbine overspeed and engine/rotor underspeed.

Note

Use throttles for rpm control if desired.

15.6 TAIL ROTOR MALFUNCTIONS

There is no single emergency procedure for all types of tail rotor malfunctions. The key to a pilot's successful handling of a tail rotor emergency lies in his ability to quickly recognize the type of malfunction that has occurred.

15.6.1 Loss of Tail Rotor Thrust. This is a situation involving a break in the drive system, such as a severed driveshaft, wherein the tail rotor stops turning and no thrust is delivered by the tail rotor. A failure of this type in powered flight will always result in the nose of the helicopter swinging to the right (left sideslip) and usually a roll of the fuselage. Nosedown tucking will also be present. The most advisable procedure is to reduce power (to engine idle if necessary) and coordinate the resulting maneuver with cyclic control. At some gross weights, it is possible that a stabilized powered flight condition can be achieved if the loss of the tail rotor thrust occurs at a high enough airspeed. Once stabilized in an autorotation, some power may be applied (altitude permitting) to see if powered flight is possible.

WARNING

For most gross weights, it is unlikely that the helicopter can achieve a stabilized powered flight condition following loss of tail rotor thrust. Emphasis should be placed on entering the autorotation immediately by simultaneously reducing the collective and throttle settings. The pilot should expect that some rotation will be present until touchdown. Touchdown should be executed in as level an attitude as can be achieved. Ground speed should be as slow as possible to minimize the possibility of turnover.

15.6.2 Loss of Tail Rotor Components. The loss of any tail rotor components will result in a forward cg shift. Other than additional nosedown tuck, this situation would be quite similar to complete loss of tail rotor thrust as discussed above.

15.6.3 Fixed Pitch Failures. Failures of this type (broken control tubes, jammed slider, etc.) are characterized by either a lack of directional response when a pedal is pushed or the pedals being in a locked position. If the pedals cannot be moved with a moderate amount of force, do not attempt to apply a maximum effort since a more serious malfunction could result. If the helicopter is in a trimmed condition when the malfunction is discovered, the engine power and airspeed should be noted and the helicopter flown to a suitable landing area. Combinations of engine torque, rotor rpm, airspeed, and landing crosswind component will correct or aggravate a yaw attitude. Controlled combinations of engine torque, rotor rpm, and airspeed are used to land the helicopter.

15.6.3.1 Left Pedal Applied. If the tail rotor pitch becomes fixed during a high-power condition (left pedal applied), the helicopter will yaw to the left when power is reduced. Under these conditions, the power should be reapplied and airspeed adjusted to a value where a comfortable yaw angle can be maintained. If airspeed is increased, the vertical fin will become more effective and an increased left yaw attitude will develop. To accomplish landing, establish a powered approach with sufficiently low airspeed (zero, if necessary) to attain a rate of descent with a comfortable sideslip angle. A right crosswind component will help reduce a left yawing moment. As collective is increased just before touchdown, left yaw will be reduced.

Note

Use throttles for rpm control if desired.

15.6.3.2 Right Pedal Applied. If the tail rotor pitch becomes fixed during cruise flight or a reduced power situation occurs (right pedal applied), the helicopter will yaw to the right when power is increased. For either of these situations, a sliding landing can be performed. Throttles may be reduced as required when adding collective at touchdown to cushion the landing. If the right yaw becomes excessive, roll on the throttles and indicate a waveoff. The greatest problem is the compromise that may have to be made between rate of descent and yaw attitude since the collective (power) is the primary control for both of these parameters. A left crosswind component will help reduce a right yawing moment. Within reasonable limits, it is probably preferable to land hard with a zero yaw attitude than to make a soft landing while in a severe yaw attitude.

15.6.4 Emergency Procedures for Antitorque Malfunctions While at a Hover.

15.6.4.1 Complete Loss of Tail Rotor Thrust or Pitch Control.

INDICATION:

1. Uncontrollable yaw.

PROCEDURES:

*1. Throttles — IDLE.

*2. Hovering autorotation — ACCOMPLISH.

3. Emergency shutdown — ACCOMPLISH.

15.6.4.2 Loss of Tail Rotor Components.

INDICATIONS:

1. Uncontrollable yaw
2. Nose tuck
3. High frequency vibrations.

PROCEDURES:

*1. Throttles — IDLE.

*2. Hovering autorotation — ACCOMPLISH.

3. Emergency shutdown — ACCOMPLISH.

15.6.4.3 Jammed Tail Rotor Pitch Control.

INDICATIONS:

1. Directional pedals will not move
2. Uncontrollable yaw with changes in collective.

PROCEDURES:

1. Collective pitch — GRADUALLY REDUCE.
2. Power touchdown — ACCOMPLISH.

15.7 MAST BUMPING

INDICATION:

1. Sharp two-per-revolution knocking.

WARNING

If mast bumping is suspected or has occurred, land as soon as possible while maintaining minimum power during descent and landing.

PROCEDURES — START/SHUTDOWN:

1. Collective — FULL DOWN.
2. Simultaneously displace cyclic into the wind.
3. If damage is suspected — SHUT DOWN helicopter.

PROCEDURES — SIDEWARD OR REARWARD FLIGHT:

*1. Cyclic — NEUTRALIZE.

*2. Pedals — APPLY as required to bring nose into relative wind.

CAUTION

Adding left pedal to initiate a turn will aggravate mast bumping if main rotor rpm is below the power-on minimum.

3. Land as soon as possible.

PROCEDURES — SLOPE LANDING:

1. At the onset of mast contact, abort the landing attempt by increasing the collective slightly while moving the cyclic away from the slope. Before another attempt is made, ensure that rotor rpm is at maximum power-on rpm.
2. If mast contact occurs while slowly lowering the collective after both skids are in ground contact, raise the collective enough to eliminate the bumping.

CAUTION

- During slope landings, main rotor flapping will increase proportionally with the velocity of an upslope wind.
- For cross-slope landings, it is preferable to land with the right gear upslope to minimize main rotor flapping.

PROCEDURES — COMPLETE LOSS OF ENGINE POWER AT HIGH FORWARD AIRSPEED:

*1. Cyclic — AFT (to maintain a positive load factor, minimize rotor rpm loss, and reduce airspeed).

*2. Collective — DECREASE (to allow the cyclic flare effect or rotor inflow to start building rotor rpm).

WARNING

Do not abruptly decrease the collective or slam it to the down stop following engine power loss. Excessive main rotor flapping with possible mast bumping will result.

*3. Autorotation — ACCOMPLISH.

PROCEDURES — DURING ALL OTHER FLIGHT CONDITIONS:

*1. Cyclic — AFT AND CENTER.

*2. Controls — As Required to regain balanced flight.

3. Land as soon as possible.

WARNING

If mast bumping occurs in flight, catastrophic results are highly probable. Since conditions causing rotor flapping are cumulative, improper pilot response/ recovery techniques to flight situations approaching, or favorable to, mast bumping can aggravate the situation and lead to in-flight mast bumping and mast separation.

15.8 UNCOMMANDED RIGHT ROLL DURING FLIGHT BELOW 1G

INDICATIONS:

1. Uncommanded right roll
2. Ineffective lateral cyclic.
3. In severe cases, mast bumping is evidenced by severe vibration, loud thumping noises at two-per-revolution frequency, and high side forces to the right caused by left yaw.

PROCEDURES:

*1. Cyclic — AFT AND CENTER.

WARNING

Lateral cyclic is decreasingly effective below 1g and increases main rotor flapping that can result in mast bumping. Do not engage/disengage the SCAS during recovery.

Note

The purpose of the aft input is to restore pitch and roll effectiveness by increasing the thrust of the main rotor to equal or exceed the gross weight. At high airspeed, much of the noseup pitching is generated by the elevator, which responds to the aft cyclic.

When the main rotor returns to a positive thrust condition:

*2. Controls — As Required to regain balanced flight.

If mast bumping is evidenced:

3. Land as soon as possible.

15.9 ENGINE MALFUNCTIONS

During normal engine operation, rotor speed governing is isochronous (constant speed) so that normal operation of engines will result in constant main rotor speed independent of load applied. Torque is also automatically shared so that engine torques will be equal (within 5 percent) during normal operation.

Note

Transient torque splits during large power changes are normal and are a function of engine acceleration/deceleration rates and EECU cross talking. Torque splits up to 50 percent are possible, but splits in excess of 20 percent are rare and above 30 percent require troubleshooting. Transient torque splits should damp out to matched torques (less than a 5-percent difference between engines) in less than 6 seconds.

Engine failures or malfunctions can be grouped into two major categories: electrical (normally associated with the EECU) and nonelectrical (normally associated with the HMU).

15.9.1 Engine Shutdown in Flight.

PROCEDURES:

1. Throttle (affected engine) — CLOSE.
2. ENG FUEL switch (affected engine) — OFF.
3. FUEL CROSS FEED switch — VERIFY OPEN.
4. FUEL TANK INTCON switch — VERIFY OPEN.
5. Land as soon as practicable.

15.9.2 Dual-Engine Failure. Under operational conditions, the altitude-airspeed combination for a safe autorotative landing is dependent upon many variables such as pilot capabilities, density altitude, helicopter gross weight, proximity of a suitable landing area, and wind direction and velocity in relation to the flightpath. This does not preclude operation in the shaded area of the height-velocity diagram under emergency or pressing operational requirements. Immediately upon a two-engine failure, rotor rpm will decay and the nose of the helicopter will swing to the left. This is caused by the loss in power and corresponding reduction in torque. Except in those instances when a two-engine failure is encountered in close proximity to the surface, it is mandatory that autorotation be established by immediately lowering the collective pitch to minimum.

Heading can be maintained by depressing the right pedal to decrease the tail rotor thrust. Autorotative rpm will vary with different ambient temperature, pressure altitude, g loading, and gross weight conditions. High gross weights, increased g loads, and higher altitudes and temperatures will cause increased rpm that can be controlled by increasing collective pitch. Any increase of rotor rpm, other than that specified for maximum glide, will result in a greater rate of descent. Therefore, if time permits, adjusting collective pitch to produce the desired rotor rpm will result in an extended glide.

At an altitude of approximately 75 to 100 feet, a progressive flare should be established by moving the cyclic stick aft with no change in collective pitch. This will decrease both airspeed and rate of descent and cause an increase in rotor rpm. The amount of the rotor rpm increase is dependent upon gross weight and the rate that the flare is executed. An increase is desirable because more energy will be available to the main rotor when collective pitch is applied.

15.9.2.1 Dual-Engine Failure — HIGE.

INDICATIONS:

1. Left yaw
2. Rotor rpm decreases
3. Rapid settling
4. Engine instruments for both engines decrease
5. MASTER CAUTION light
6. RPM warning light and aural alert
7. Caution lights and aural alert.

PROCEDURES:

*1. Hovering autorotation — ACCOMPLISH.

Upon touchdown:

2. Cyclic — CENTERED.
3. Collective — FULL DECREASE.
4. Rotor brake handle — ENGAGE.

CAUTION

Regardless of sink rate at touchdown damage will be minimized when in a level attitude.

15.9.2.2 Dual-Engine Failure — HOGE.

INDICATION:

*1. Same as indications for dual engine failure — HIGE. (Refer to paragraph 15.9.2.1.)

PROCEDURES:

*1. Autorotation — ACCOMPLISH.

Note

If altitude permits, attempt to attain optimum autorotation flare airspeed.

Prior to touchdown:

2. Collective — INCREASE (to cushion landing).
3. Cyclic — As Required (to level helicopter).

CAUTION

Regardless of sink rate at touchdown, damage will be minimized when in a level attitude.

Upon touchdown:

4. Cyclic — CENTERED.
5. Collective — FULL DECREASE.
6. Rotor brake handle — ENGAGE.

15.9.2.3 Dual-Engine Failure In Flight.

INDICATIONS:

1. Left yaw
2. Rotor rpm decreases
3. Rapid settling
4. Engine instruments for both engines decrease
5. MASTER CAUTION light
6. RPM warning light and aural alert
7. Caution lights and aural alert.

PROCEDURES:

*1. Autorotation — ACCOMPLISH.

If conditions permit:

2. Airstart — ATTEMPT (on one or both engines).

If airstart is successful, follow procedures for single-engine landing.

If airstart is unsuccessful, follow procedures for autorotative landing.

15.9.2.4 Dual-Engine Failure at High Power and High Airspeed.

INDICATION:

1. Same as indications for a dual-engine failure in flight. (Refer to paragraph 15.9.2.3.)

PROCEDURES:

*1. Cyclic — AFT.

*2. Collective — DECREASE.

WARNING

- Flight below +0.5g is prohibited.
- During dual-engine failure initiated above 120 knots (or at high power and high airspeed), an aft cyclic input should be made to reduce a nose-low and nose-high airspeed entry into autorotation and to minimize main rotor rpm decay. If a loss of engine power is combined with a very rapid decrease of collective, it can cause a less than +0.5g loading that will result in reduced control power available. An aft cyclic input will help maintain a positive-g loading on the main rotor. Large or rapid lateral cyclic inputs should be avoided to minimize any increase in main rotor flapping that might lead to mast bumping.

*3. Autorotation — ACCOMPLISH.

15.9.2.5 Dual-Engine Failure at Low Altitude.

15.9.2.5.1 0 to 50 KIAS, 20-Foot Altitude or Below. From this condition of low airspeed and low altitude, flare capability is limited and caution should be exercised to avoid striking the ground with the tail; the primary objective is to level the skids prior to ground contact. Initial collective reduction varies with altitude; below 4-foot skid height, do not attempt collective reduction but use the available rotor energy and collective to cushion the touchdown; above a 4-foot skid height, a partial reduction to collective is initiated to cushion the touchdown.

15.9.2.5.2 50 to 70 KIAS, 20-Foot Altitude or Below. From this condition, flare capability is good. Initiate a cyclic flare and reduce collective to maintain rotor rpm, minimize rate of descent, and decelerate the helicopter; level skids prior to ground contact and utilize collective to cushion the touchdown.

Note

The optimum flare airspeed for all gross weights is 75 KIAS.

15.9.2.5.3 75 KIAS to V_H Airspeed, 20-Foot Altitude or Below. Immediately execute a cyclic flare to initiate a climb to 25 feet or higher and lower collective as necessary to maintain rotor rpm; achieve 75 KIAS and maintain until a normal flare is accomplished.

15.9.3 Single-Engine Failure — HIGE.

INDICATIONS:

1. Left yaw
2. Rotor rpm decreases
3. Engine instruments decrease
4. MASTER CAUTION light
5. RPM warning light (gas producer) and aural alert
6. Caution lights and aural alert.

PROCEDURES:

*1. Altitude control — MAINTAIN (as appropriate to accomplish landing).

*2. Collective — ADJUST (to control rate of descent and cushion landing).

15.9.4 Single-Engine Failure — HOGE.

INDICATION:

1. Same as indications for single-engine failure — HIGE. (Refer to paragraph 15.9.3.)

PROCEDURES:

*1. Attitude control — MAINTAIN.

*2. Collective — ADJUST (to maintain rpm and desired power).

If insufficient power exists to fly away:

3. Attitude — ASSUME landing attitude.
4. Collective — INCREASE (just prior to ground contact to cushion landing).

If altitude permits, adjust airspeed for maximum rate of climb or minimum rate of descent. After gaining sufficient altitude or establishing minimum rate of descent:

5. Affected engine — SHUT DOWN.
6. Land as soon as possible.

15.9.5 Single-Engine Failure in Flight. The pilot reaction to the failure of a single engine should be concerned primarily with control of the helicopter and secondarily with possible engine restart. In all cases, control of the helicopter, i.e., attitude, altitude, and rotor rpm should take precedence over any attempt to restart a failed engine. Under high gross weight and density altitude conditions, level flight may not be possible. At maximum single-engine power available and at low AGL altitude, the external wing stores should be jettisoned to reduce gross weight so that level flight can be achieved. This should give the pilot sufficient time to analyze possible causes of the failure and make a decision whether or not to attempt an airstart. When one engine fails, rotor speed can be expected to droop. The desired rotor rpm can be regained, if sufficient power is available, by using collective.

WARNING

Any single-engine failure should be treated as if a total power loss is forthcoming. An approach to a suitable field should not be attempted until landing is assured. Consideration should be given to increasing altitude to place the helicopter in autorotative parameters to a suitable landing site. Further, sufficient altitude and airspeed should be maintained to remain outside the avoid region of the height-velocity diagram.

INDICATIONS:

1. Left yaw
2. Rotor rpm decreases
3. Engine instruments decrease
4. MASTER CAUTION light
5. RPM warning light (gas producer) and aural alert
6. Caution lights and aural alert.

PROCEDURES:

*1. Collective — ADJUST (to maintain rpm and desired power).

*2. Wing stores — JETTISON (as appropriate).

Under conditions of high gross weight or low altitude and low airspeed, strong consideration should be given to jettisoning wing stores simultaneously with step 1.

3. Failed engine — IDENTIFY.
4. Throttle (affected engine) — CLOSE.
5. ENG FUEL switch (affected engine) — OFF.
6. FUEL CROSS FEED switch — OPEN.
7. FUEL TANK INTCON switch — OPEN.
8. MASTER CAUTION light — RESET.
9. If desired — AIRSTART.
10. Land as soon as possible.

15.9.6 Engine Electrical System Failures.
The engine control system power available spindle (PAS) provides for manual throttle control in the event of an electrical system failure. The engine electrical system is designed so the predominant mode of failure is to drive the engine to high power. Pilot action to correct a high side failure is to retard throttle to desired power. However, since the electrical N_p governing system can trim the gas generator to idle N_g power (low side failure), there still remains a potential for failure to idle power, as well as potential for an actual engine failure. Pilot action to correct a low side failure is to advance the throttle to EECU lockout and then rapidly retard the throttle to the desired power.

Each engine has an alternator on the accessory drive section. The alternator powers the N_g signal circuitry, ignition circuitry, and EECU circuitry. Any one or combination of these circuits could fail. If the N_g circuit fails, N_g indication will be lost. If ignition circuit fails, the engine cannot be started. If EECU circuit fails, N_p and engine torque indicators will be lost and engine will enter an overspeed condition. Rotating shaft of alternator could fail resulting in no N_g, N_p, or engine torque indications and the engine will enter an overspeed condition.

The engine control systems are designed to maintain constant N_p speed even in the event of failure of one engine. In order to maintain constant rotor speed, the control system of the good engine will adjust power output to compensate for a change in power output of a failed engine. For example, if an engine has failed to high power, the other engine will reduce power to maintain constant total power output and rotor speed, and vice versa.

Following a failure, rotor speed will vary during the first 2 or 3 seconds from the normally constant speed selected by N_p reference. Rotor speed may or may not return to the previously selected reference speed.

Action for an engine that has failed and that requires manual control is covered in the following examples.

1. If the rotor speed is high, the engine with higher MGT has failed and its throttle should be retarded to equalize MGT of the two engines as desired.

2. If the rotor speed is at reference or is low, the engine with the lower MGT has failed and its throttle should be advanced to EECU lockout. When the failed engine has increased in power, the throttle should be retarded to equalize the MGT of the two engines, or to maintain engine torque about 10 percent below that of the other engine.

The general rule to follow in the event of a failure that drives one engine high and the other engine low in power, is as follows:

1. If main rotor speed is above N_p demand speed, engines are delivering too much power. The throttle of the engine with the high MGT should be reduced.

2. If the main rotor speed is at or below N_p demand speed, the low engine is delivering too little power. The throttle of the engine with the low MGT may be manually controlled in EECU lockout.

15.9.7 Engine N_p Underspeed.

INDICATIONS:

1. Left yaw

2. N_r/N_p decrease of normal engine if power demand exceeds single-engine limit

3. MGT decrease

4. N_g decrease

5. Torque split.

PROCEDURES:

*1. Collective — ADJUST (to maintain rpm and desired PWR).

*2. Wing stores — JETTISON (as appropriate).

3. Affected engine — IDENTIFY.

4. Throttle (affected engine) — ADVANCE to EECU lockout.

5. Bleed air (ECU, RAIN RMV, ENGINE ANTI-ICE) — As Required.

Note

Securing bleed air system increases power available.

6. Land as soon as practical.

15.9.8 Engine N_p Overspeed.

INDICATIONS:

1. Small right yaw

2. Increase in N_p and N_r

3. Increase in MGT

4. Torque split

5. Possible rotor rpm warning light and aural alert

6. The good engine reduces power and N_p may increase well over 100 percent.

WARNING

If the high N_r/N_p is not controlled and is allowed to reach 125 ±1.25% N_p, the overspeed protection system will shut off fuel to the engine, causing it to flame out. If the overspeed was caused by a shaft failure in the engine alternator, the engine will not relight automatically.

Note

There are failure modes (i.e., engine alternator failure) that may result in zero N_g, N_p, and/or engine torque indications in conjunction with an overspeed condition. High N_r will then indicate the overspeed condition and high MGT will be evidenced on the overspeeding engine. N_p overspeed protection is still available in the event of an EECU failure.

PROCEDURES:

*1. Control N_r.

*2. *Affected engine — IDENTIFY.*

*3. Throttle (affected engine) — CONTROL manually to set one of the following:

a. Torque 10 percent below good engine.

b. Match MGT.

c. *Match N_g.*

4. Land as soon as practicable.

15.9.9 Compressor Stalls. A compressor stall is an aerodynamic interruption of airflow through the compressor section. Factors that can increase stall sensitivity and decrease stall margin are FOD, a fouled or dirty compressor, hot gas ingestion, or malfunctioning fuel control components. Operation of the bleed air equipment may increase or decrease stall characteristics.

INDICATIONS:

1. Affected engine bangs/pops
2. No throttle response
3. Decreasing or erratic N_g
4. *Increasing or erratic MGT.*

PROCEDURES:

*1. Reduce power/control N_r.

CAUTION

Large, rapid collective inputs or throttle changes may cause engine flameout.

If conditions persist:

2. Throttle (affected engine) — IDLE.

3. Bleed air (ECU, RAIN RMV, ENGINE *ANTI-ICE) — As Required.*

Note

If reducing power is not effective, then switch bleed air to the opposite condition (all bleed air switches on or off).

If MGT decreases or stall clears:

4. *Throttle (affected engine)* — ADVANCE slowly to full open.

5. MGT — MONITOR.

If compressor stall persists (MGT continues to rise above normal, N_g decreases below normal idle speed, or any other malfunction is indicated):

6. Throttle (affected engine) — REDUCE OR CLOSE as required.

7. Perform single-engine procedure (as required).

15.9.10 Load Demand Spindle (LDS) Malfunction. In the event a jam occurs in the LDS or its linkage, a shear section is provided so the pilot may pull up the collective stick and separate collective input to the engine. The LDS to that engine is then inoperative and extreme care must be exercised during collective movements to prevent gas turbine overspeed and engine/rotor underspeed. *Both engines have separate shear sections,* so it is possible that if a jam occurs in only one LDS system, the other engine LDS may operate properly.

INDICATIONS:

1. Erratic N_g indications with changes in collective
2. Torque split.

PROCEDURES:

1. Throttle (affected engine) — REDUCE (approximately 10 percent torque below normal engine).

2. Land as soon as practicable.

15.9.11 Collective Anticipator Malfunction. *In the event of a malfunction in the* collective anticipator (control motion transducer), there will be an increase in the transient droop during power changes from below 20 percent torque to high power/torque requirements (i.e., quick stops and practice autorotation recoveries). If excessive transient droop is noticed, avoid rapid power changes and land as soon as possible.

Note

When transient droop exceeds normal limits, maneuvers requiring large power changes (i.e., quick stops, NOE, practice autorotations) should be avoided to prevent possible rotor droop below minimum rotor rpm.

INDICATION:

1. Increased transient droop during power changes.

PROCEDURES:

1. Collective — AVOID rapid power changes.
2. Land as soon as practicable.

15.9.12 Engine Chip Caution Light.

INDICATIONS:

1. MASTER CAUTION light
2. ENG CHIP caution light (affected engine) and aural alert.

PROCEDURES:

In the event of an ENG CHIP light with no secondary indications, consideration should be given to applicable single-engine procedures without securing the affected engine. The affected engine may be advanced to accomplish a safe landing.

1. Throttle (affected engine) — IDLE.
2. Land as soon as practicable.

If secondary indications exist:

3. Single-engine procedure — EXECUTE.

15.9.13 Engine Oil Pressure Low/Oil Bypassing Filter.

INDICATIONS:

1. ENG OIL pressure decreases (affected engine)
2. MASTER CAUTION light
3. OIL PRESS/BYP caution light (affected engine) and aural alert.

PROCEDURES:

1. ENG OIL pressure — CHECK.

If oil pressure is in operating range or greater:

2. MASTER CAUTION light — RESET.
3. ENG OIL pressure gauge — MONITOR.
4. Land as soon as practicable.

If oil pressure is below 30 psi:

5. Affected engine — SHUT DOWN.
6. Single-engine procedures — EXECUTE.

15.9.14 Engine Oil Overtemperature.

INDICATION:

1. ENG OIL temperature high.

PROCEDURES:

1. ENG OIL pressure — CHECK.

If oil temperature is 132 to 150 °C and pressure is within limits:

2. If power is not required — REDUCE power on affected engine.
3. Monitor ENG CHIP detector light, changes in oil pressure, and possible engine vibration.
4. Operation is limited to 30 minutes.

If oil temperature is above 150 °C or oil pressure is below 30 psi:

5. Affected engine — SHUT DOWN.
6. Single-engine procedure — EXECUTE.

15.9.15 Airstart.

CAUTION

If the cause of the failure is obviously mechanical, as evidenced by abnormal, metallic, or grinding sounds, do not attempt an airstart.

PROCEDURES:

1. Throttle (affected engine) — CLOSE.
2. ENG FUEL switch — ON.
3. FUEL CROSS FEED switch — VERIFY OPEN.
4. FUEL TANK INTCON switch — VERIFY OPEN.
5. FUEL PRESS caution lights — VERIFY extinguished.

6. ENG OIL gauge — VERIFY normal temperature or less.

Note

Abnormal instrument readings on the failed engine may indicate that an airstart might be advisable.

7. START switch (affected engine) — ON.
8. *MGT — 200 °C or less.*
9. Throttle (affected engine) — OPEN slowly to lower side of idle stop.
10. ENG OIL gauge — VERIFY positive pressure indication.
11. Starter — VERIFY OFF at 52 to 59 percent N_g.
12. MGT and N_g gauges — MONITOR.
13. ENG OIL gauge — *CHECK* pressure and temperature.
14. Throttle — INCREASE (match engine torques).
15. Land as soon as practicable.

15.10 ELECTRICAL SYSTEM MALFUNCTIONS

15.10.1 Complete Electrical Failure.

INDICATION:

1. All electrical functions cease.

WARNING

A total loss of electrical power will disable the transmission and gearbox oil cooler blower and will cause the loss of all engine, transmission, rotor, and component instruments and indicators. The gearbox oil temperature will rise very rapidly (approximately 28 °C per minute) and no cockpit indications will be available.

PROCEDURES:

1. Copilot/gunner ELEC PWR switch — ON.
2. Airspeed — REDUCE (100 KIAS or less).
3. Land as soon as possible.

15.10.2 Battery Overtemperature.

INDICATIONS:

1. *MASTER CAUTION light*
2. NO. 1 BATT TEMP and/or NO. 2 BATT TEMP light and aural alert.

PROCEDURES:

1. Affected BATT switch — OFF.

If on deck:

2. Helicopter — SHUT DOWN (alert crash crew).

If in flight and light does not extinguish:

3. Land as soon as possible.
4. Helicopter — SHUT DOWN (alert crash crew).

WARNING

Do not use the fire extinguisher on the battery if there is no visible fire, as this can cause the battery to explode. If a visible fire has developed, a fire extinguisher may be used.

15.10.3 Battery System Failure.

INDICATIONS:

1. *MASTER CAUTION light*
2. NO. 1 BATT SYS and/or NO. 2 BATT SYS light and aural alert.

PROCEDURES:

1. MASTER CAUTION — RESET.

If light does not extinguish within 5 minutes:

2. Affected BATT switch — OFF.
3. Land as soon as practicable.

15.10.4 Failure of Both Generators. In the event both generators fail in flight, emergency power is supplied by the batteries. Assuming an 85-percent charge, these batteries can supply essential bus power for 25.5 minutes. To conserve battery power, all unneeded navigation and radio equipment should be turned off. In this emergency situation, the NTS should be turned off. Nonessential bus loads are automatically shed; however, nonessential equipment can be reclaimed by placing the BUS switch to MAN.

INDICATIONS:

1. Voltmeter indication low or zero
2. AMPS indicate zero
3. MASTER CAUTION light
4. NO. 1/NO. 2 DC GEN caution lights and aural alert.

PROCEDURES:

1. GEN NO. 1 and NO. 2 switches — OFF.
2. BUS switch — As Required.
3. All unnecessary equipment — OFF.
4. GEN NO. 1 and NO. 2 switches — RESET, then ON.
5. MASTER CAUTION light — RESET.
6. Land as soon as practicable.

If generators do not come on:

7. GEN NO. 1 and NO. 2 switches — OFF.
8. Land as soon as possible.

15.10.5 Failure of One Generator.

INDICATIONS:

1. MASTER CAUTION light
2. DC GEN caution light and aural alert
3. Voltmeter indication low (affected generator)
4. AMPS indication of zero (affected generator).

PROCEDURES:

1. GEN switch (affected generator) — RESET, then ON.

If output not restored:

2. GEN switch (affected generator) — OFF.
3. MASTER CAUTION light — RESET.
4. Land as soon as practicable.

15.10.6 Main Inverter Failure.

INDICATIONS:

1. MASTER CAUTION light
2. AC MAIN caution light and aural alert
3. Nonessential ac bus functions cease
4. INVERTER MAIN circuit breaker out.

PROCEDURES:

1. INVERTER MAIN circuit breaker — IN.

If light remains illuminated:

2. INVERTER MAIN circuit breaker — OUT.
3. INV switch — STBY.
4. MASTER CAUTION light — RESET.
5. Land as soon as practicable.

15.10.7 Failure of Both Inverters.

INDICATIONS:

1. MASTER CAUTION light
2. AC MAIN and AC STBY caution lights and aural alert
3. All ac bus functions cease
4. INVERTER MAIN and STBY circuit breakers out
5. Loss of all SCAS channels.

WARNING

The loss of both inverters may result in the loss of the attitude system.

PROCEDURES:

1. INVERTER STBY circuit breaker — IN.
2. INVERTER MAIN circuit breaker — IN.
3. INV switch — MAIN.

If either inverter functions:

4. Unnecessary equipment — OFF.
5. MASTER CAUTION light — RESET.
6. Land as soon as practicable.

If neither inverter functions:

7. INV switch — OFF.
8. MASTER CAUTION light — RESET.
9. Land as soon as practicable.

15.11 FIRE

15.11.1 Fuselage Fire in Flight.

WARNING

When using hand-held CF_3Br Halon 1301 extinguishers for aircraft in-flight fires, asphyxiation or degraded human motor capabilities will occur with inadequate ventilation.

PROCEDURE:

*1. Land immediately.

15.11.2 Elimination of Smoke and Fumes in Cockpit.

INDICATIONS:

1. Smoke or fumes in cockpit
2. Equipment failure.

PROCEDURES:

1. ECU/VENT switch — OFF.
2. All unnecessary equipment — OFF.
3. Land as soon as possible.

If smoke or fumes persist and extended flight is necessary and appears feasible:

4. Slow below 40 KIAS.
5. CM CRS handle — PULL handle completely out of arm/fire mechanism.
6. B CRS handle — ROTATE (counterclockwise 90°) AND PULL.

WARNING

- The helmet visor shall be down prior to activation of the CRS to preclude possible eye injury.
- The CRS handle must be pulled completely out of the arm/fire mechanism or the CRS may not detonate.
- Reduce airspeed below 40 KIAS prior to CRS activation.

15.11.3 Dual-Engine Fire in Flight.

In the event that both FIRE PULL warning lights illuminate simultaneously in flight, a decision must be made whether or not to terminate the subsequent approach with a full autorotational landing or with a power recovery and landing. This decision will be based on the length of time required to land the helicopter; i.e., the extent to which the fire will spread prior to landing. At higher altitudes, it may be necessary to secure both engines in order to extinguish the fire before incurring catastrophic damage. At low altitudes, it may be more prudent to land with power (on at least one engine) in order to increase the probability of a safe landing. In any event, an immediate landing must be made, and the ultimate decision on how far to proceed beyond Procedures, step 1 (below) must be based on altitude and rests with the pilot in command.

INDICATIONS:

1. Smoke
2. Fumes
3. Fire
4. FIRE PULL and FIRE ENG warning lights and aural alert.

PROCEDURES:

*1. Autorotation — ACCOMPLISH.

*2. FIRE 1 PULL handle — PULL.

*3. FIRE EXT switch — MAIN.

*4. FUEL ENG 1 and ENG 2 switches — OFF.

*5. FIRE 1 PULL handle — PUSH IN.

*6. FIRE 2 PULL handle — PULL.

7. FIRE EXT switch — RESERVE.
8. MAYDAY — BROADCAST.

15.11.4 Single-Engine Fire in Flight.

INDICATIONS:

1. Smoke
2. Fumes
3. Fire
4. FIRE PULL and FIRE ENG warning lights and aural alert (affected engine)
5. Smoke trail observed during yaw maneuver.

PROCEDURES:

*1. Collective — ADJUST (to maintain helicopter control, 65 to 70 KIAS, N_r 100 percent). Check altitude and power.

*2. Throttle (affected engine) — CLOSE.

*3. Wing stores — JETTISON (as appropriate).

*4. FIRE PULL handle (affected engine) — PULL.

*5. FIRE EXT switch — MAIN/RESERVE. If fire indications persist, switch extinguisher to RESERVE.

*6. ENG FUEL switch (affected engine) — OFF.

*7. FUEL CROSS FEED switch — AUTO.

WARNING

If the FUEL LOW caution light is illuminated, the fuel crossfeed valve will open and the fuel boost pumps will activate, pressurizing the fuel system.

8. FUEL TANK INTCON switch — OPEN.
9. MASTER CAUTION light — RESET.
10. MAYDAY — BROADCAST.
11. Land as soon as possible.

If fire persists:

12. Land immediately.

15.11.5 Electrical Fire.

INDICATIONS:

1. Smoke or fumes
2. Equipment failure
3. Fire
4. High AMPS indication.

PROCEDURES:

1. INV, GEN NO. 1, and GEN NO. 2 switches — OFF.

CAUTION

Do not attempt a target run with less than one generator and the battery.

2. Circuit breakers — CHECK.

CAUTION

Do not reset any circuit breakers that are tripped. It is likely that those circuits are the problem.

3. All unnecessary equipment — OFF.
4. MASTER CAUTION light — RESET.

If fire is not evident and continued flight is necessary:

5. GEN NO. 1 switch — ON.
6. GEN NO. 2. switch — ON.
7. INV switch — MAIN.
8. Necessary equipment — ON.

If fire is evident on any step 5 through 8:

9. Applicable equipment — OFF.
10. Applicable circuit breaker — OUT/INBOARD.
11. Land as soon as practicable.

If evidence of fire persists:

12. Both GEN switches — OFF.
13. BATT switches — OFF (only as required).

WARNING

Total loss of electrical power will disable the transmission and gearbox oil cooler blower and will cause the loss of all engine, transmission, rotor, and component instruments and indicators. The gearbox oil temperature will rise very rapidly (approximately 28 °C per minute) and no cockpit indications will be available.

Note

The SCAS will disengage with no electrical power.

14. Land as soon as possible.

15.12 FUEL SYSTEM MALFUNCTIONS

15.12.1 Fuel Cell Boost Pump Failure. The helicopter is equipped with two electrically driven fuel cell boost pumps, either of which is capable of supplying sufficient fuel to both engines. A complete helicopter fuel system failure will not be common because of separate engine No. 1 (forward cell) and engine No. 2 (aft cell) fuel boost pumps. Fuel boost pumps operate when the FUEL CROSS FEED switch is positioned to OPEN or the FWD/AFT FUEL LOW caution light(s) are ON.

WARNING

Avoid helicopter operation with dual fuel cell boost pump failure above 10,000 foot pressure altitude. This can result in an engine flameout because of fuel starvation.

Note

With the forward boost pump inoperative and the tank interconnect valve open, a nosedown attitude in excess of 9° nose down will result in 334 pounds or more of unusable fuel. Flameout could result.

INDICATIONS:

1. MASTER CAUTION light
2. NO. 1 or NO. 2 FUEL PRESS caution light and aural alert
3. FUEL CROSS FEED switch OPEN
4. NO. 1 or NO. 2 FUEL PRESS circuit breaker out.

PROCEDURES:

1. FUEL TANK INTCON switch — VERIFY OPEN.
2. FUEL CROSS FEED switch — VERIFY OPEN.
3. FUEL PRESS circuit breaker (affected boost pump) — RESET if out.
4. MASTER CAUTION light — RESET.

If FUEL PRESS light does not extinguish:

5. Descend below 10,000-foot pressure altitude.
6. Land as soon as practicable.

15.12.2 Engine-Driven Suction Fuel Pump Failure. If an engine-driven suction fuel pump fails, the engine will flameout in less than 15 seconds because of fuel starvation if the fuel cell boost pumps are disabled or not operating.

INDICATIONS:

1. NO. 1 or NO. 2 FUEL PRESS light with MASTER CAUTION light and aural alert
2. Engine instruments decrease (affected engine)
3. Rotor rpm decreases.

PROCEDURES:

*1. FUEL CROSS FEED switch — OPEN.

2. FUEL TANK INTCON switch — VERIFY OPEN.
3. FUEL PRESS light (affected engine) — CHECK.

CAUTION

Do not make rapid collective movements. Flight above 10,000-foot pressure altitude shall not be attempted.

4. Land as soon as possible.

If affected engine has flamed out:

5. Follow procedures for single-engine failure in flight. (Refer to paragraph 15.9.5.)

15.12.3 Engine Fuel Filter Bypass.

INDICATIONS:

1. MASTER CAUTION light
2. FUEL FILTER caution light (affected engine) and aural alert.

PROCEDURES:

1. MASTER CAUTION light — RESET.
2. Land as soon as practicable.

15.13 TRANSMISSION MALFUNCTIONS

15.13.1 Impending Transmission

Failures. An impending transmission failure may be indicated by any unusual noise or vibration from the transmission area, abnormal transmission oil pressure (low) or temperature (high) indications transmission chip light, reduction of N_r, or yaw kicks. These indications may occur singularly or in combination. Generally, there are two extremes that can be expected in a transmission failure: seizure of the drive train or a disconnect of the drive train that would allow the rotor system to turn independently of the engines. If an impending transmission failure is suspected, whether it is due to oil starvation or a power discontinuity, priority must be given to maintaining N_r, descending, and landing as soon as possible. N_r may be maintained by using a combination of collective pitch setting (with throttles full open) and airspeed. A smooth transition to an airspeed providing minimum power requirements should be accomplished. Helicopter controllability will become markedly degraded if N_r decreases below 90 percent.

WARNING

Power shall be maintained throughout the approach and landing as an aid in preventing seizure of gears.

INDICATIONS:

1. Unusual noise or vibrations from transmission areas
2. MASTER CAUTION light
3. XMSN TEMP/PRESS caution light with XMSN OIL temperature gauge high and aural alert
4. XMSN TEMP/PRESS caution light with XMSN OIL pressure gauge low and aural alert
5. XMSN OIL BYP caution light with XMSN OIL temperature gauge high and aural alert
6. CHIP DETR caution light and GEARBOX CHIP indicator XMSN light and aural alert
7. N_r low
8. Yaw kicks.

PROCEDURES:

1. Maintain N_r.
2. Descend — POWER ON.
3. Land as soon as possible.

If N_r decays or more violent vibrations occur:

4. Lower collective with throttles full open.
5. Maintain powered descent.
6. Land immediately.

If continued flight is mandatory and appears feasible:

7. Establish flight of 50-feet AGL and set the minimum required power according to the power chart in NATOPS for the given altitude and gross weight.

If N_r decays or more violent vibrations occur:

8. Maintain N_r.
9. Land immediately.

WARNING

- If an engine-to-transmission disconnect occurs, N_p may tend to overspeed. Priority must be given to maintaining N_r before attempting to control the N_p overspeed.
- Autorotation in the event of transmission oil starvation may contribute to transmission seizure.
- In certain modes of transmission failure, loss of hydraulic systems or tail rotor drive may occur.
- With indications of an impending transmission failure, an approach should be made with minimum power changes to minimize the chance of seizure. Control movements should also be kept to a minimum.

CAUTION

Because of the "wet bulb" temperature system, oil starvation may not be accompanied by a rising temperature indication.

15.13.2 Transmission Chip Detector.

INDICATIONS:

1. MASTER CAUTION light
2. CHIP DETR caution light and aural alert
3. GEARBOX CHIP indicator XMSN light.

PROCEDURES:

1. GEARBOX CHIP indicator PUSH TO CLEAR XMSN switch — PRESS (maximum three times to clear the first chip indication).

Note

A minimum 2-second pause between presses is required to recharge the capacitor for full electrical output.

2. MASTER CAUTION light — RESET.

If light extinguishes:

3. Continue flight.

If light does not extinguish or illuminates again:

4. Land as soon as possible.

If accompanied by XMSN TEMP/PRESS caution light:

5. Land immediately.

15.13.3 Transmission Oil Pressure Low.

INDICATIONS:

1. MASTER CAUTION light
2. XMSN TEMP/PRESS caution light and aural alert
3. XMSN OIL pressure gauge indicates low.

PROCEDURES:

1. XMSN OIL pressure — CHECK.
2. XMSN OIL temperature — CHECK.
3. MASTER CAUTION light — RESET.
4. Land as soon as possible.

If XMSN OIL pressure is below the limit:

5. Execute impending transmission failure procedures.

15.13.4 Transmission Oil Overtemperatures.

INDICATIONS:

1. MASTER CAUTION light
2. XMSN TEMP/PRESS caution light and aural alert
3. XMSN OIL temperature gauge indicates high.

PROCEDURES:

1. XMSN OIL pressure — CHECK.
2. XMSN OIL temperature — CHECK.
3. MASTER CAUTION light — RESET.
4. GRBX OIL temperature — CHECK.

If GRBX OIL temperature is also high (oil cooler malfunction):

5. OIL COOLER switch — SEC.
6. Land as soon as practicable.

If XMSN OIL pressure is below limit or temperature remains above limit when power is reduced:

7. Land as soon as possible.

15.13.5 Transmission Oil Bypassing Cooler.

INDICATIONS:

1. MASTER CAUTION light
2. XMSN OIL BYP caution light and aural alert.

PROCEDURES:

1. XMSN OIL temperature — MONITOR.
2. Collective — DECREASE (as required to maintain temperature within limits).
3. MASTER CAUTION light — RESET.
4. Land as soon as practicable.

If XMSN OIL temperature is above limit:

5. Land as soon as possible.

15.14 MAIN DRIVESHAFT FAILURE

A main driveshaft failure presents the pilot with confusing aural and visual cues that require prompt interpretation and corrective action. The ENG RPM gauge (N_p) will indicate overspeeding but the ROTOR RPM gauge (N_r) will decay rapidly and the helicopter will yaw left; the low rotor RPM caution light and audio signal will activate. Immediate response to the low RPM caution is required to prevent an excessively low rpm condition from which safe recovery would be extremely difficult.

INDICATIONS:

1. Left yaw
2. RPM warning light and aural alert
3. High engine rpm (N_p)
4. MASTER CAUTION light
5. Zero torque indication
6. Grinding sounds with possible loud banging noise.

PROCEDURES:

*1. Autorotation — ACCOMPLISH.

If time and altitude permit:

2. ENG FUEL switches — OFF.

15.15 COMBINING GEARBOX MALFUNCTIONS

WARNING

Power shall be maintained throughout the approach and landing to aid in preventing seizure of gears.

15.15.1 Combining Gearbox Chip Detector.

INDICATIONS:

1. MASTER CAUTION light
2. CHIP DETR caution light and aural alert
3. GEARBOX CHIP indicator, 1, 2, SUMP light
4. Grinding noise.

PROCEDURES:

1. GEARBOX CHIP indicator PUSH TO CLEAR 1, 2, SUMP switch — PRESS (maximum three times to clear first chip indication).

Note

A minimum 2-second pause between presses is required to recharge the capacitor for full electrical output.

2. MASTER CAUTION light — RESET.

If light extinguishes:

3. Continue flight.

If light does not extinguish or illuminates again:

4. Land as soon as possible.

If accompanied by C BOX TEMP/PRESS caution light:

5. Land immediately.

15.15.2 Combining Gearbox Oil Pressure Low.

INDICATIONS:

1. MASTER CAUTION light
2. C BOX TEMP/PRESS caution light and aural alert
3. GRBX OIL pressure gauge indicates low.

PROCEDURES:

1. GRBX OIL pressure — CHECK.
2. GRBX OIL temperature — CHECK.
3. MASTER CAUTION light — RESET.
4. Land as soon as practicable.

If GRBX OIL pressure is below limit or GRBX OIL temperature is above limit:

5. Land as soon as possible.

If GRBX OIL pressure is zero:

6. Be prepared to execute impending transmission failure procedures.

15.15.3 Combining Gearbox Oil Overtemperature.

INDICATIONS:

1. MASTER CAUTION light
2. C BOX TEMP/PRESS caution light and aural alert
3. GRBX OIL temperature gauge indicates high
4. UTILITY HYD caution light and aural alert.

PROCEDURES:

1. GRBX OIL temperature — CHECK.
2. GRBX OIL pressure — CHECK.
3. MASTER CAUTION light — RESET.
4. XMSN OIL temperature — CHECK.

If XMSN OIL temperature is also high (oil cooler malfunction):

5. OIL COOLER switch — SEC.
6. Land as soon as practicable.

If GRBX OIL temperature remains above limit or GRBX OIL pressure is below limit:

7. Land as soon as possible.

15.16 INTERMEDIATE AND TAIL ROTOR GEARBOX MALFUNCTIONS

15.16.1 Intermediate (42°) or Tail Rotor (90°) Gearbox Chip Detector.

INDICATIONS:

1. MASTER CAUTION light illuminates
2. CHIP DETR CAUTION light illuminates and aural alert sounds
3. GEARBOX CHIP indicator 42°/90° XMSN light illuminates.

PROCEDURES:

1. GEARBOX CHIP indicator PUSH TO CLEAR 42°/90° XMSN switch — PRESS (maximum three times to clear first chip indication).

Note

A minimum 2-second pause between presses is required to recharge the capacitor for full electrical output.

2. MASTER CAUTION light — RESET.

If light extinguishes:

3. Continue flight.

If light does not extinguish or illuminate again:

4. Power — REDUCE.
5. MASTER CAUTION light — RESET.
6. Land as soon as practicable.

If accompanied by 42°/90° TEMP/PRESS caution light and aural alert:

7. Land as soon as possible. Be prepared to execute loss of tail rotor procedures.

15.16.2 Intermediate (42°) or Tail Rotor (90°) Gearbox Oil Pressure Low/ Overtemperature.

Note

A sustained hover or very low operating airspeeds may result in overtemperature of the intermediate gearbox oil. In this situation, terminate the low-speed operation and establish a cooling airflow in the gearbox area by establishing forward flight.

INDICATIONS:

1. MASTER CAUTION light
2. 42°/90° TEMP/PRESS caution light and aural alert

PROCEDURES:

1. Establish and maintain forward airspeed.
2. MASTER CAUTION light — RESET.

If indication persists:

3. Land as soon as possible.

15.17 LOST PLANE PROCEDURES

The primary requirements when lost are as follows:

1. Confess
2. Climb
3. Conserve
4. Communicate
5. Conform.

15.18 LOST SIGHT DURING IMC

In the event of lost sight during IMC flight, the reversal base course will be the reciprocal of the flight present heading. Upon signal, the helicopters will acknowledge and take the following action (see Figure 15-1):

1. Helicopter Nos. 2 and 4 will commence a standard rate turn away from the flight. They will call passing through 90° of turn and will turn 170°.
2. Helicopter No. 3. will comb 500 feet on the present heading. After completing the climb, the helicopter will reverse heading away from the flight leader 170°. When the No. 4 helicopter reports passing through 90° of the reversal turn, helicopter No. 3 will descend to the initial altitude.
3. The flight leader, upon receiving the radio call or helicopter No. 2 passing through 90°

of turn, will reverse course 180° on the same side as helicopter No. 2.

4. It is essential that all helicopters maintain the airspeed of the flight when the dispersal was commenced. The flight will regroup when in a clear area.

Modification to this procedure under certain conditions may be necessary to avoid obstacles or maintain flight integrity (i.e., terrain flight, NVG utilization). The flight leader shall ensure all aircrews are briefed accordingly.

15.19 WING STORES JETTISON

Each of the four ejector racks is equipped with an electrically operated ballistic device to jettison the attached weapon. The pilot can select a single station, a combination of stations, or all stations for jettison. The copilot/gunner can select inboard, outboard, or both.

Note

Jettisoning inboard stores with four TOW launchers, four HELLFIRE launchers, an AIM-9 missile, or auxiliary fuel tank installed on the outboard station will cause the outboard store(s) to be jettisoned first regardless of jettison switch positions.

15.19.1 Pilot Procedures for Jettisoning.

1. EMERGENCY JETTISON SELECT switches — UP (as appropriate).
2. JETTISON button — DEPRESS (at least 1 second).

15.19.2 Copilot/Gunner Procedures for Jettisoning.

1. WING STORES JETTISON switch — INBD, OUTBD, or BOTH (as appropriate).
2. JETTISON cover — UP.
3. WGST JETT switch — UP.
4. JETTISON cover — DOWN.

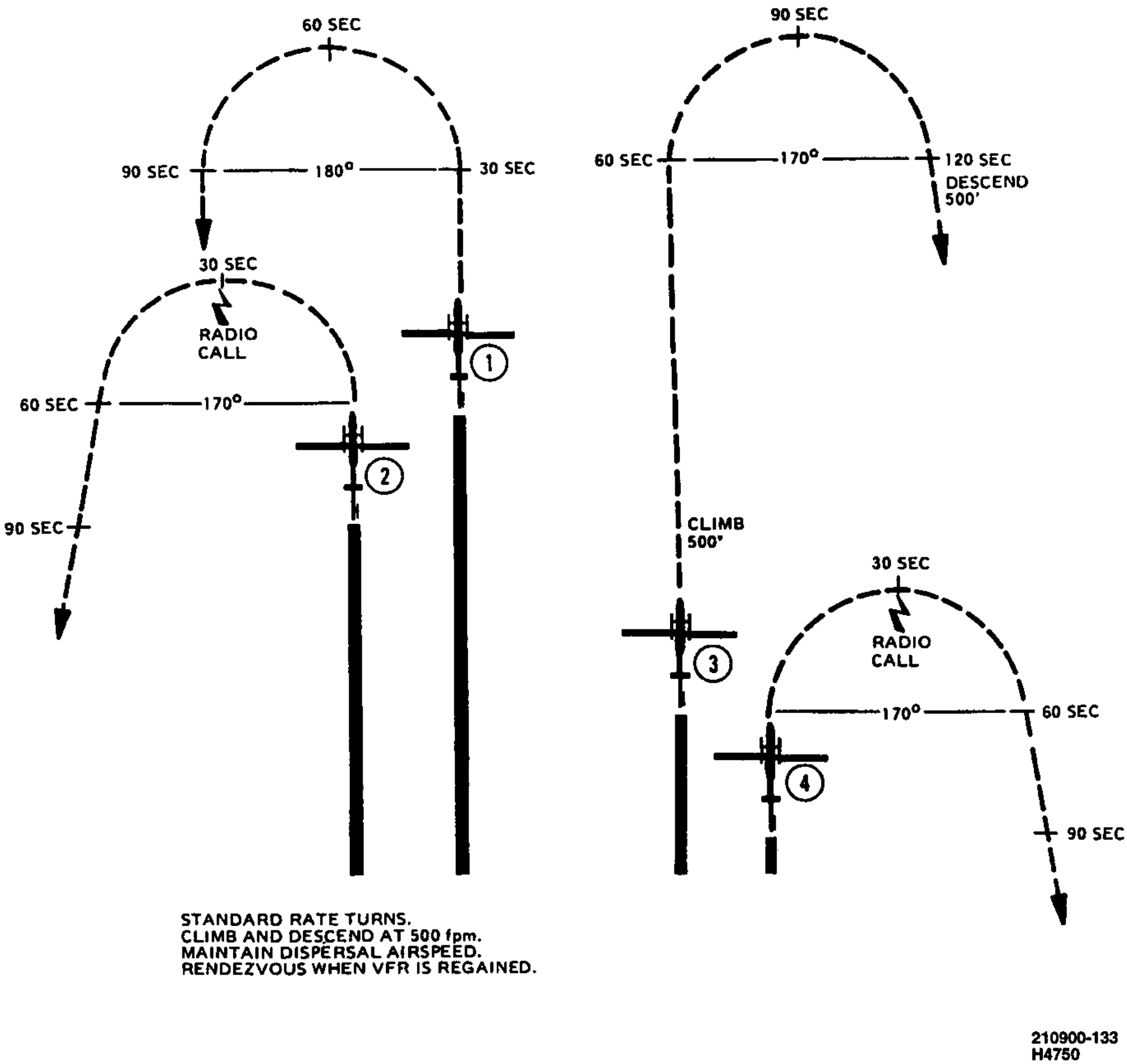


Figure 15-1. Lost Sight During IMC Flight Procedures

CHAPTER 16

Landing Emergencies

WARNING

When anticipating an emergency landing or ditching, each crewman should place his shoulders against the seat back, manually lock the shoulder harness and keep his back straight to obtain maximum protection from the restraint system.

16.1 AUTOROTATIVE LANDING

The term "autorotation" is defined as adjusting the flight controls as necessary to establish an autorotational descent and landing. A safe autorotative approach and landing is dependent upon variables such as pilot capability, density altitude, airspeed, gross weight, proximity of suitable landing area, plus wind direction and velocity. This does not preclude operation in the restricted height velocity area during emergencies or pressing operational requirements. Heading is maintained by applying right pedal to decrease the tail rotor thrust. Autorotative rotor rpm will vary with ambient temperature, pressure altitude, g loading, and gross weight. High gross weights, increased g loads, and higher altitudes and temperatures will cause increased rotor rpm that can be controlled by increasing collective. Do not exceed 120 KIAS in sustained autorotation.

Note

Avoid abrupt control movements during high-speed autorotation to prevent over-controlling.

Any increase of rotor rpm above that specified for maximum glide will result in an increased rate of descent. At an altitude of 100 to 75 feet, a progressive flare should be established by moving the cyclic stick aft. This will decrease both the airspeed and rate of descent and cause an increase in rotor rpm that is dependent upon the rate at which the flare is executed. Increased rotor rpm is desirable because more energy will then be available to the main rotor when collective is applied. Sites for autorotative landings should be hard, flat, smooth surfaces clear of approach and rollout obstruction. During landing, the helicopter should be held in a skids-level attitude and, when contact is made with the ground, the cyclic stick should be moved slightly forward of the neutral position. After touchdown, decrease collective slowly to full down.

Note

The best glide airspeed is 99 KIAS. The minimum-rate-of-descent airspeed is 66 KIAS.

PROCEDURES:

Note

- If time and altitude permit, engine airstart may be attempted after engine failure. It is usually better to concentrate on making a safe landing than to use valuable time attempting an airstart.
- All autorotative landings should be made into the wind if possible.

*1. Controls — ADJUST (to maintain N_r and desired airspeed).

*2. Wing stores — JETTISON (as appropriate).

*3. Throttles — CLOSE.

4. FUEL ENG 1 and ENG 2 — OFF.

5. Collective — INCREASE (cushion landing).

After touchdown:

6. Collective — FULL DECREASE.

7. Rotor brake — ENGAGE.

8. Helicopter — SHUT DOWN.

16.2 SINGLE-ENGINE LANDING

Under certain conditions, airspeed in excess of 25 KIAS may be necessary for a single-engine landing.

16.3 LANDING IN TREES

An autorotation into a heavily wooded area should be accomplished by executing a normal autorotative approach and full flare. The flare should be executed so as to reach a zero rate of descent and zero groundspeed as close to the top of the trees as possible. As the helicopter settles, increase collective to maximum.

16.4 DITCHING

WARNING

- Do not abandon the helicopter until the rotor blades have stopped.
- Do not inflate the life vest until well clear of the helicopter.

PROCEDURES:

1. IFF transponder MASTER switch — EMER.
2. MAYDAY — BROADCAST (give position).

16.4.1 Ditching — Power On.

PROCEDURES:

Perform a normal approach to hover 3 to 5 feet above the water.

1. Helmet visor — DOWN.

WARNING

Helmet visors shall be down prior to activation of the CRS to prevent possible eye injury.

2. CM Canopy removal system (CRS) handle — PULL.
3. B Canopy removal system (CRS) handle — ROTATE (counterclockwise 90°) AND PULL.

WARNING

The CRS handle must be pulled completely out of the arm/fire mechanism or the CRS may not detonate.

4. Both throttles — CLOSE.
5. Collective — INCREASE (smoothly to cushion landing).

As helicopter settles:

6. Collective — INCREASE (to maximum).
7. Rotor brake — ENGAGE.

When rotor blades have stopped:

8. Helicopter — EXIT.

When well clear of the helicopter:

9. Life vest — INFLATE.

16.4.2 Ditching — Power Off.

PROCEDURES:

1. Helmet visor — DOWN.

WARNING

Helmet visors shall be down prior to activation of the CRS to prevent possible eye injury.

2. CM Canopy removal system (CRS) handle — PULL.
3. B Canopy removal system (CRS) handle — ROTATE (counterclockwise 90°) AND PULL.

WARNING

The CRS handle must be pulled completely out of the arm/fire mechanism or the CRS may not detonate.

4. Collective — INCREASE (smoothly to cushion landing).

As helicopter settles:

5. Collective — INCREASE (to maximum).
6. Rotor brake — ENGAGE.

When rotor blades have stopped:

7. Helicopter — EXIT.

When well clear of helicopter:

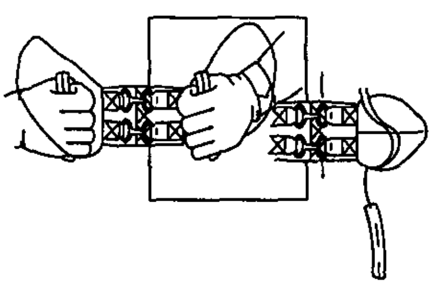
8. Life vest — INFLATE.

WARNING

- Do not abandon the helicopter until the rotor blades have stopped.
- Do not inflate the life vest until well clear of the helicopter.
- In the event the helicopter has submerged prior to egress, allow in-rushing water and bubbles to subside prior to releasing the seat harness and egressing from the helicopter.

16.5 POSTEGRESS PROCEDURES

16.5.1 Life Preserver Assembly Inflation.



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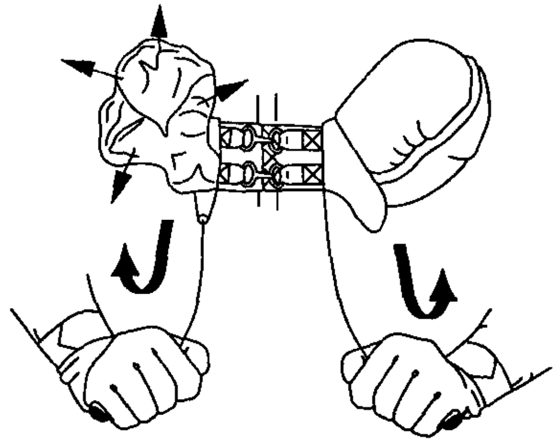
J1400

1. Locate the beaded handles on the LPA.



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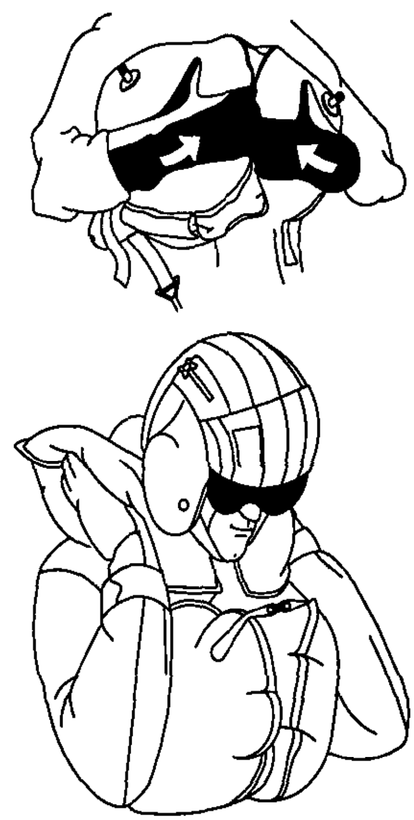
2. Pull beaded handles down and straight out to inflate. If beaded handle inflation fails, use the oral inflation tube.



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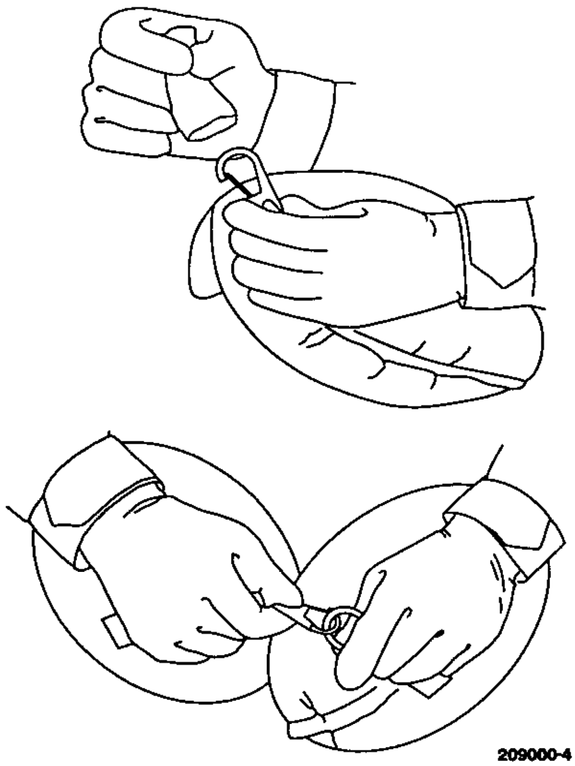
3. Squeeze the LPA waist lobes together to help release the Velcro on the collar lobe or manually release the Velcro on the collar, if necessary, to achieve complete collar lobe information.



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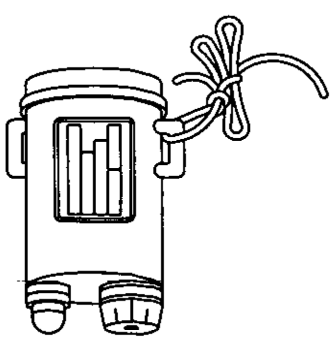
J1400

4. Remove the chafing material (when required), and snap the LPA waist lobes together.

16.5.2 Signaling Devices. The following information describes the use of signaling devices and is not intended to prescribe any given order of priority that would be dictated by the immediate situation of the survivor.

16.5.2.1 SDU-5/E Distress Marker Light. The distress marker light emits a 360° beam of light that flashes at a rate of 40 to 60 flashes per minute for approximately 12 hours.



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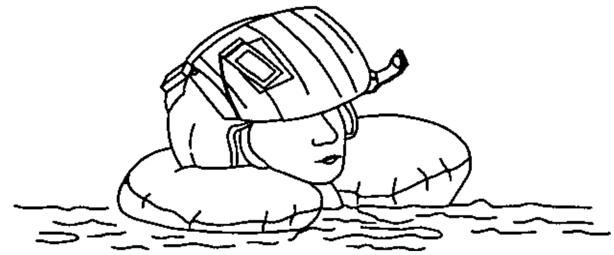
J1400

1. Depress the on/off switch on the bottom of the light to activate.

2. Turn the light off if the rescue helicopter approaches to avoid possible flicker vertigo.

Note

The SDU-5/E strobe light can be attached to the helmet by mating hook and pile (Velcro) tape.



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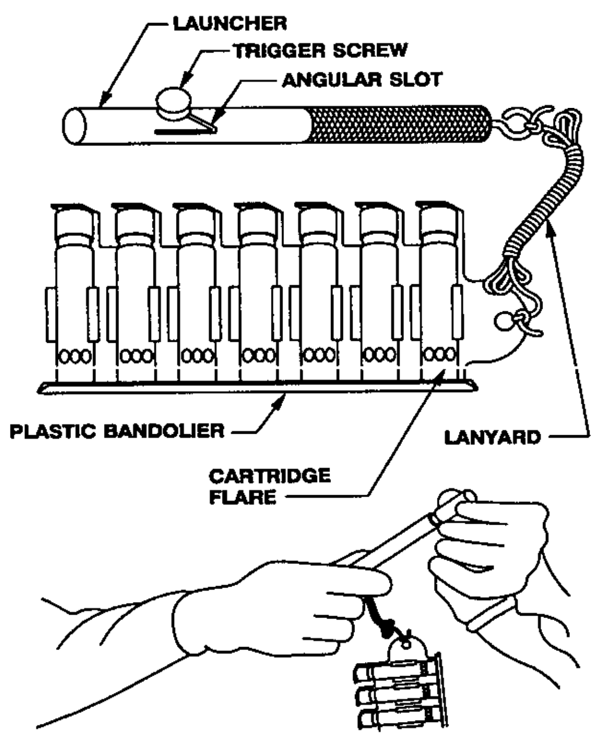
J1400

16.5.2.2 Mk 79 Mod O Illumination Signal Kit. This signaling device uses a pencil-type launcher and cartridge flare to attract the attention of SAR aircraft.



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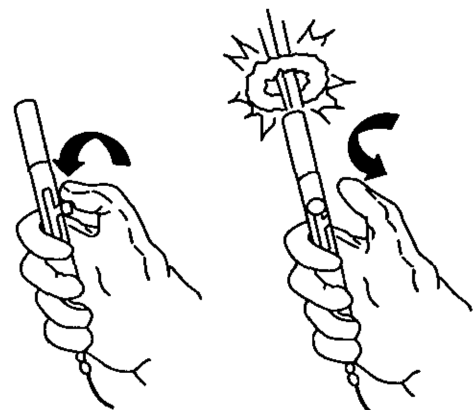
J1400

1. Screw the launcher onto the cartridge flare while pointing the flare in a safe direction.

WARNING

Prior to screwing the launcher into the cartridge flare, ensure the trigger is in the cocked position in the angular slot.



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J1400

2. Hold the launcher directly overhead. Pull back on the trigger and release. The flare has a minimum 4-1/2 second duration and can be launched to 200 feet.

16.5.2.3 Emergency Signaling Mirror With Foresight. The signaling mirror flashes reflected light with a brilliancy of up to 8 million candle power that can be seen 45 to 50 miles on a clear day with search aircraft at 5000 feet.

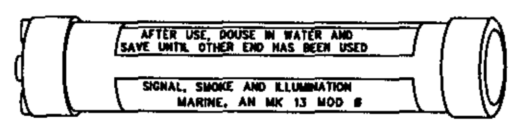
209000-9
J1400

1. While holding the foresight in the left hand, line the foresight up with the target.
2. Place the back of the mirror in front of the eye with the right hand and line up the two holes on the target.
3. Rock the mirror until the cross lines appear on the foresight; the beam should then be on the target.
4. Even if no aircraft or ships are in sight, continue to sweep the horizon. Mirror flashes can be seen for many miles even in hazy weather.

16.5.2.4 Mk 13 Mod 0 Marine Smoke and Illumination Signal. This smoke and illumination signal is a hand-held flare used to attract the attention of SAR aircraft and to give winddrift direction.

WARNING

The Mk 13 Mod 0 signal may reach a temperature that is uncomfortable to handle after ignition. Use of gloves is suggested.



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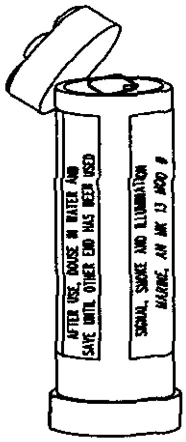
J1400

Note

- The flare, incorporating paper vice plastic end caps, has no protrusions on the cap.
- The flare burns approximately 20 seconds with approximately 3000 candle power.

NIGHT	DAY
RED cap.	Orange cap.
Protrusions on cap.	No protrusions on cap.
Beads around rim.	
Metal washer attached to lanyard.	



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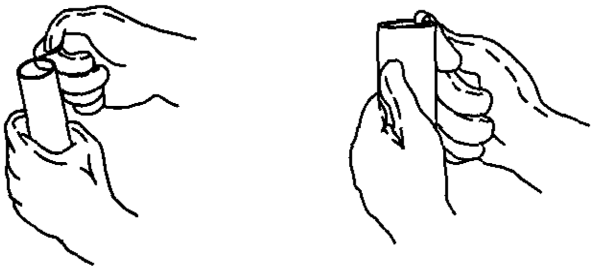
J1400

1. Remove the cap from the desired end.



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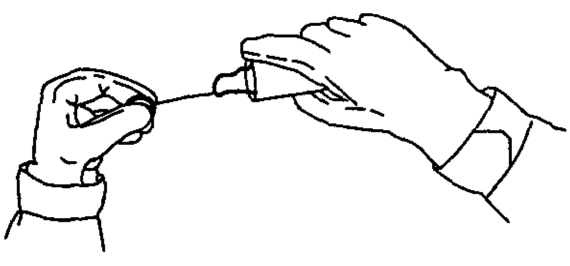
J1400

2. Pull the flip ring over the signal rim to break the lead seal. If the seal does not break, push the ring until it bends against the case.

CAUTION

Do not use undue force as this will cause the ring to snap off. If the seal does not break, wiggle the ring from side to side.



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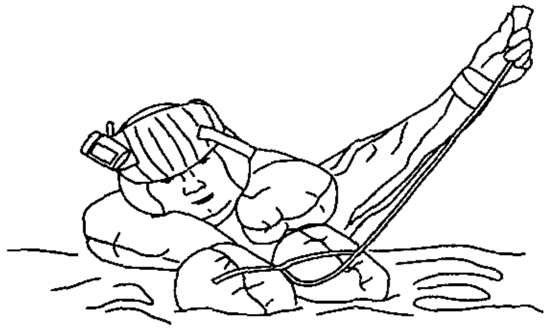
3. Ignite the signal flare by a quick pull on the ring.



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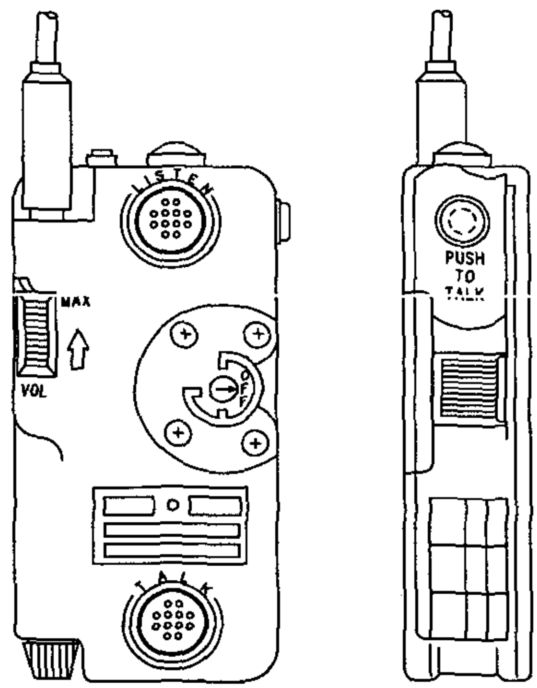
J1400

4. The ignited signal flare must be held at arms length downwind to prevent damage to the flotation device from hot residue.

16.5.2.5 AN/PRC-90 Radio Set. The AN/PRC-90 radio set is a dual-channel transmitter/receiver survival radio capable of transmitting (voice mode) up to 60 nmi (line of sight, depending on the receiving aircraft's altitude). It operates on guard (243.0 MHz) or SAR primary operating frequency (282.8 MHz) with a mode for swept-tone signal on 243.0 MHz only.



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Note

- In order to maximize signal strength, do not point the antenna directly at the aircraft when transmitting or receiving on any frequency. Transmission of the beacon or code can be up to 80 nmi.
- The radio is equipped with an external earphone capability to assist in avoiding enemy detection or for use in the event of aircraft radio failure.

16.5.3 Rescue. If survivor pickup is to be effected by helicopter, the following procedures should be performed for an unassisted rescue (no swimmer deployed):

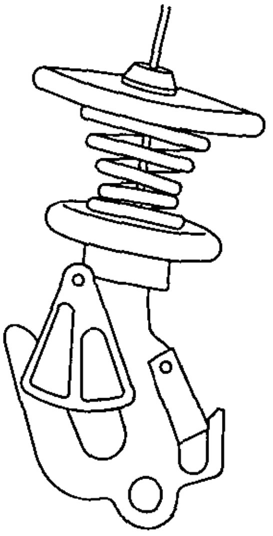
209000-16
J1400

1. Upon approach of the rescue helicopter, lower the visor.
2. Swim toward the rescue device that has been lowered.

16.5.3.1 Procedures for Use of the Rescue Hook.

WARNING

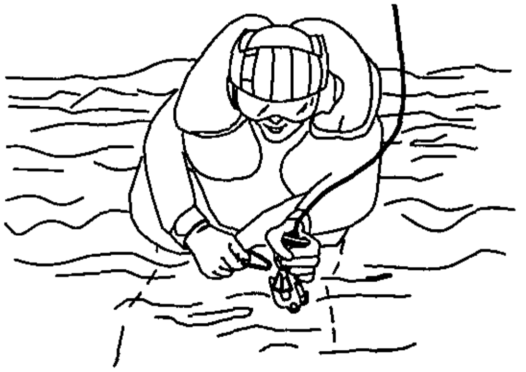
- To allow discharge of static electricity and prevent electrical shock, avoid touching the rescue hook until it has made contact with the water/ground.
- To avoid severe injury, keep hands clear of the hook and ring assemblies during hoisting.



209000-17
J1400

Note

The main hook has a small and large hook. The large hook is the primary hook for hoisting personnel.

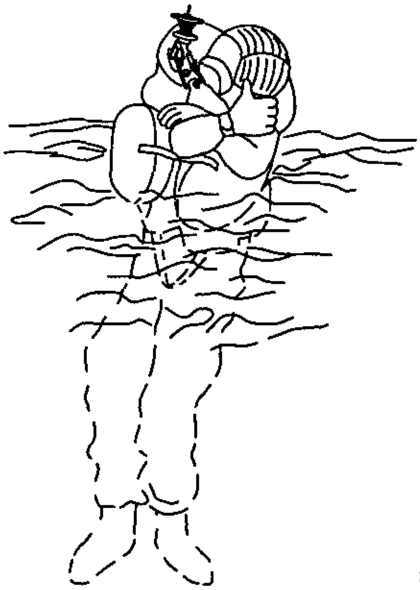


209000-18
J1400

1. Attach the large hook of the rescue device to the V-ring of the survival vest.

WARNING

Do not place fingers directly on the latch mechanism. Sudden tension on the cable could cause fingers to become jammed in the latch and result in serious injury.

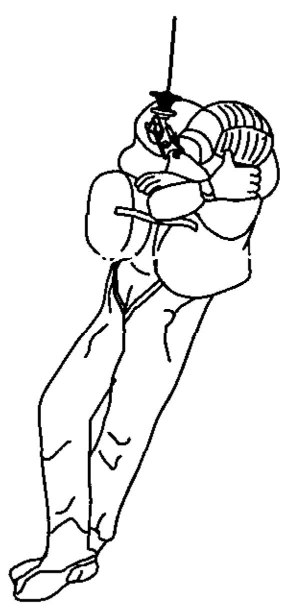


209000-19
J1400

2. Cross arms in front of chest and place head down and to the left. Give a thumbs-up signal to the helicopter hoist operator.

WARNING

Under no circumstances should survivors attempt to assist their entrance into helicopter or move from the rescue device until an aircrewman assists them to a seat *in the helicopter.*



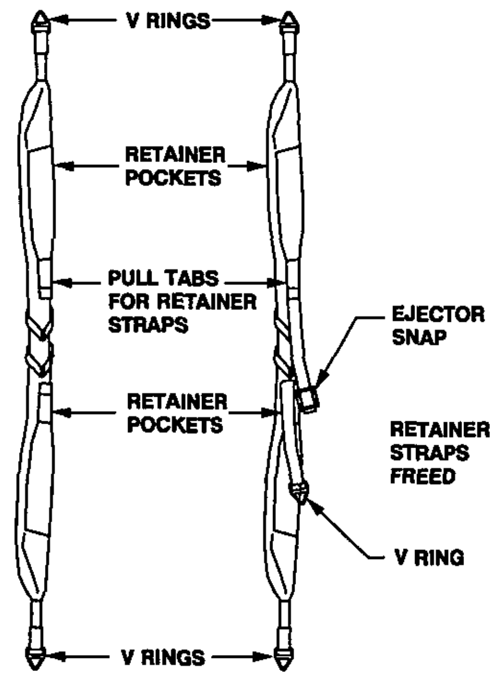
209000-20
J1400

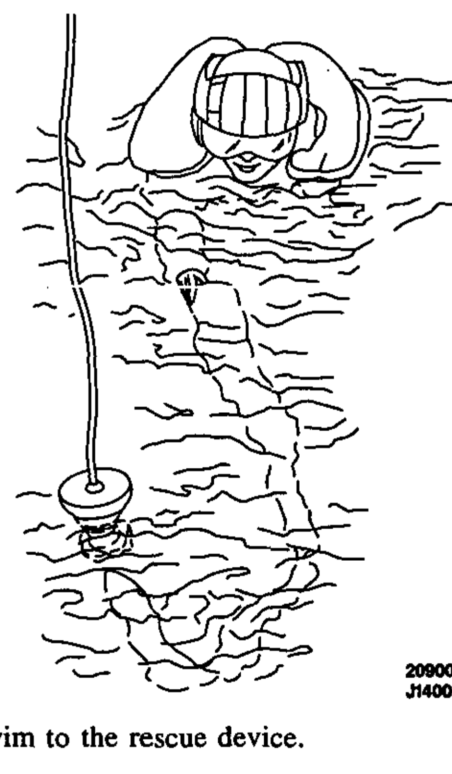
3. Position of the aircrewman during hoist. Upon clearing the water, cross feet.

16.5.3.2 Procedures for Use of the Rescue Strop.

WARNING

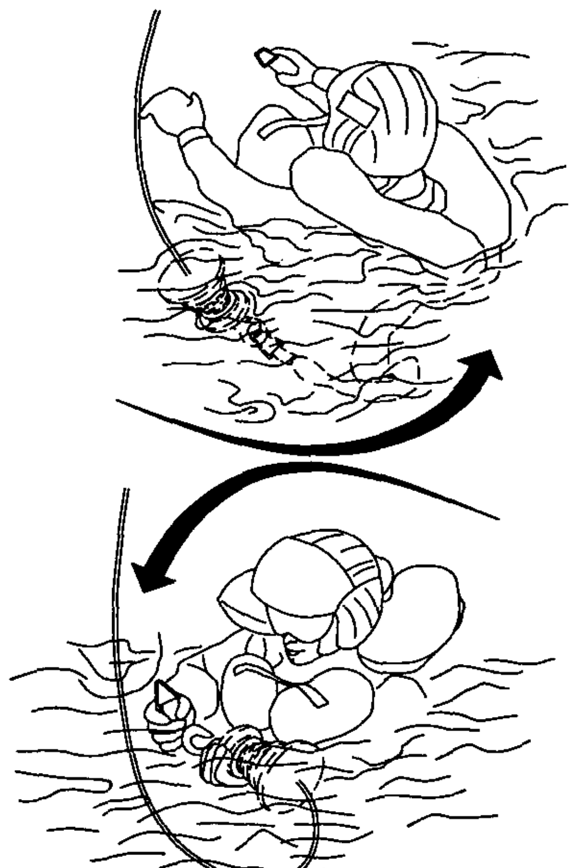
To allow discharge of static electricity and prevent electrical shock, avoid touching the rescue hook until it has made contact with water/ground.





209000-21
J1400

1. Swim to the rescue device.



209000-22
J1400

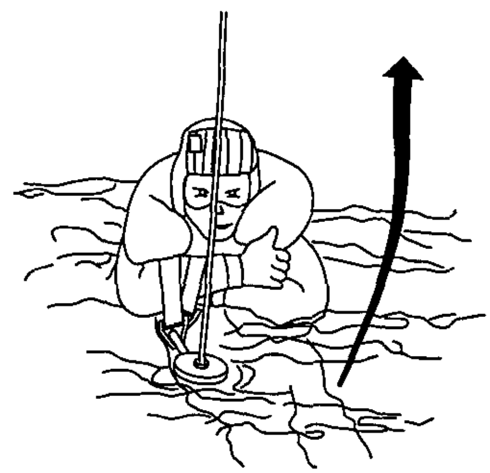
2. Grasp the free end of the rescue strop in the right hand, rotate the body, and swim in a small circle causing the strop to encircle the body.

209000-23
J1400

3. Attach the V-ring of the strop to the large hook. Both arms should be above the strop.

209000-24
J1400

4. Grasp the pull tabs of the retainer straps and pull the straps free. Attach the quick-ejector snap hook of the long strap to the V-ring of the short strap and pull the retainer.



209000-25
J1400

5. Ensure the rescue strop is above the LPA waist lobes and high on the back. Give a thumbs-up signal to the helicopter hoist operator.

WARNING

Under no circumstances should survivors attempt to assist their entrance into helicopter or move from the rescue device until an aircrewman assists them to a seat in the helicopter.

WARNING

To avoid severe injury, keep hands clear of the hook and ring assemblies during hoisting.

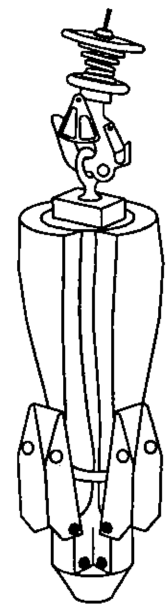
209000-26
J1400

6. Wrap arms around strop and keep head down. Upon clearing the water, cross feet.

16.5.3.3 Procedures for Use of Forest Penetrator.

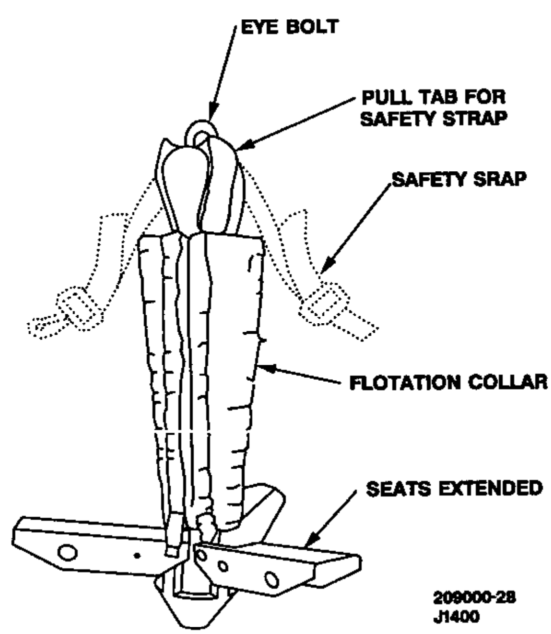
WARNING

- To allow discharge of static electricity and prevent electrical shock, avoid touching the rescue hook until it has made contact with the water/ground.
- To avoid severe injury, keep hands clear of the hook and ring assemblies during hoisting.



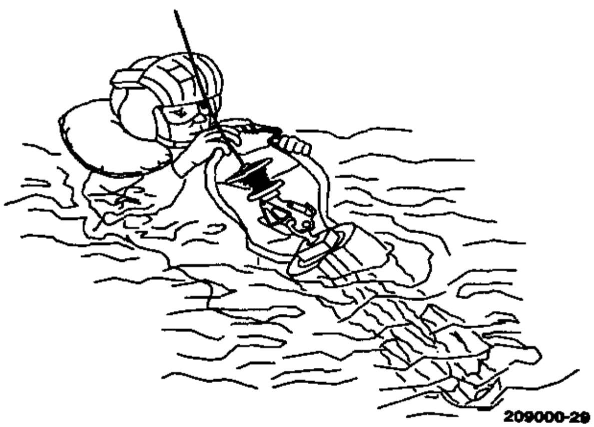
209000-27
J1400

Illustration of the forest penetrator with flotation collar and seats retracted. (The safety straps were omitted to show connection of the rescue hook to the eyebolt.)



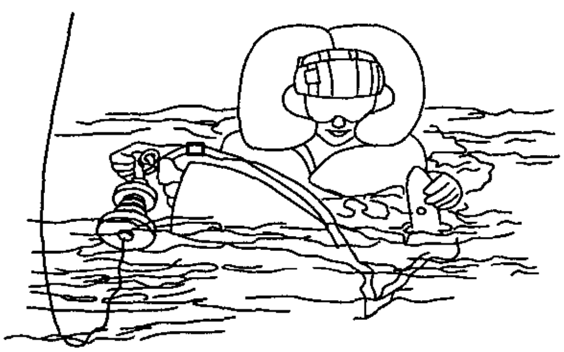
209000-28
J1400

Illustration of the forest penetrator with flotation collar and seats extended.



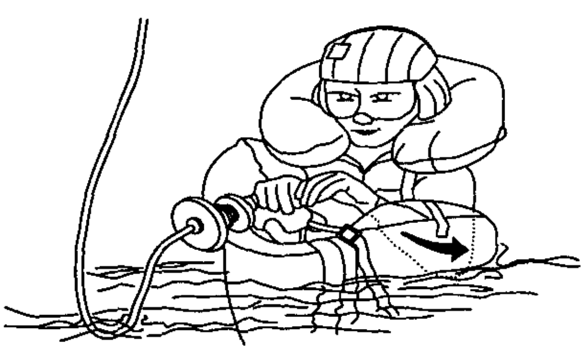
209000-29
J1400

1. Unsnap the LPA waist lobes.



209000-30
J1400

2. Extend only one seat on the forest penetrator.

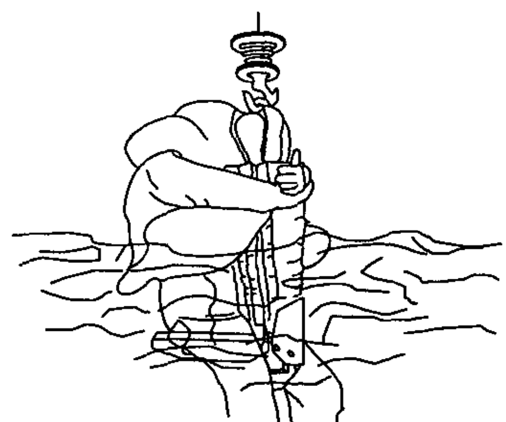


209000-31
J1400

3. Sit on the seat facing the flotation collar. Using elbows, separate the LPA waist lobes and pull the shaft of the penetrator close to the chest.

209000-32
J1400

4. Pass the safety strap under the arm, around the back, and under the other arm. Connect the safety strap and tighten.



209000-33
J1400

5. Give a thumbs-up signal to the helicopter hoist operator.

WARNING

Under no circumstances should survivors attempt to assist their entrance into the helicopter or move from the rescue device until an aircrewman assists them to a seat in the helicopter.

209000-34
J1400

6. Put the head down and wrap the arms around the forest penetrator. Cross the legs upon clearing the water.

Note

It is difficult to predict the precise mode of rescue. Survivors must be alert for modes of rescue that have not been practiced or briefed. Because of the variety and complexity of conditions encountered, it is impossible to formulate procedures to cover every contingency. The key is to develop a survival attitude.

16.5.4 A/P22P-9(V) CBR Protective Assembly. The A/P22P-9(V) CBR protective assembly is worn when considered appropriate for protection against the elements of chemical, biological, or radioactive warfare. For general information, normal donning and doffing, and routine usage, refer to the Aviation Crew System Manual (NAVAIR 13-1-6-10), Special Mission Aircrew Equipment, and the NATOPS Survival Manual (NAVAIR 00-80T-101). For contaminated doffing procedures, refer to the U.S. ARMY 3-5 Decontamination Manual.

WARNING

Thorough familiarization with procedures and operation during emergency situations is essential. Exposure to harmful elements or suffocation may result from improper use.

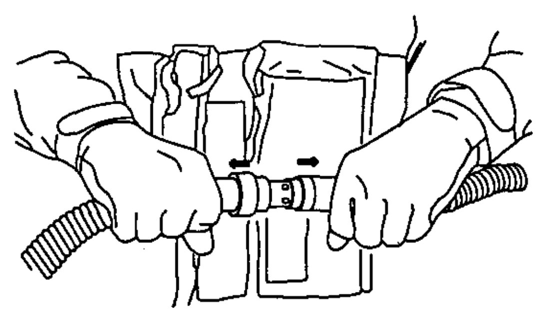
WARNING

Suffocation may result if the CBR protective assembly is exposed to smoke or direct flames. The CBR mask will afford some protection against fire and fumes, although the mask is made of a combustible material and will not provide protection in an oxygen-deficient environment.

While egressing the helicopter over land as previously described and while wearing the CBR protective assembly, the following additional steps must be performed.

16.5.4.1 Emergency Egress Over Land.

1. After releasing the seat harness and, if time permits, disengaging the ventilator from the aircraft mounting bracket, unplug the ventilator power cord and carry the ventilator by the web strap handle while egressing the helicopter.



209000-35
J1400

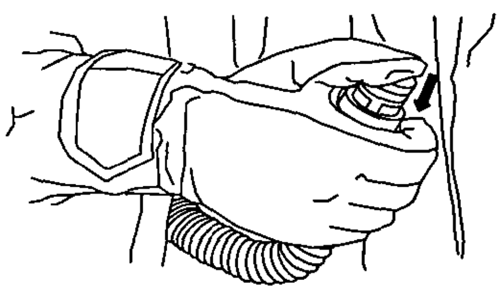
2. If time and circumstance necessitate egress without the ventilator, quickly disconnect the ventilator hose from the manifold inlet hose and leave the ventilator in the aircraft mounting bracket.

Note

An axial pull of 25 pounds at the RIED valve is required to disconnect the ventilator hose from the manifold inlet hose. When the hoses are disconnected, the optical area of the face plate will mist over rapidly.

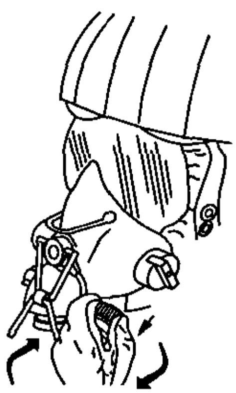
209900-36
J1400

3. Close the hood outlet valve and quickly egress the helicopter.



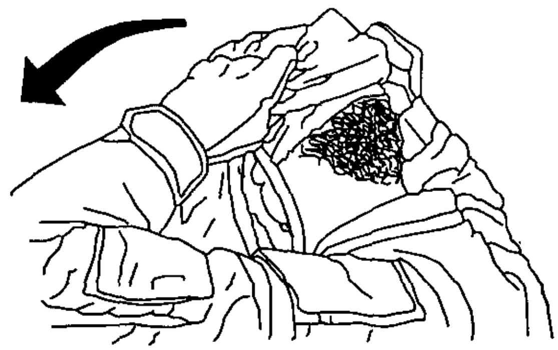
209900-37
J1400

4. Upon egress without the ventilator, depress the perforated snorkel portion of the RIED valve to breathe unfiltered air temporarily.



209900-38
J1400

5. Shear the antidrown connector on the mask for direct breathing of unfiltered air (twist counterclockwise and pull down).



209900-39
J1400

6. Remove the respirator assembly.

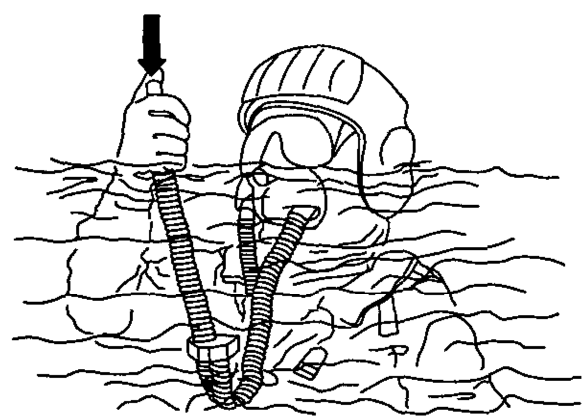
16.5.4.2 Emergency Water Egress.

1. To prevent water entry into the mask, close the hood outlet valve prior to impact. Take a deep breath just prior to the ventilator submerging.
2. Disconnect the ventilator hose from the manifold inlet hose.

WARNING

Failure to close the hood outlet valve and to disconnect the respirator hose from the manifold inlet hose will result in mask flooding.

3. Maintain a reference point with one hand and release the seat harness. Egress and swim clear of the helicopter.
4. Inflate the LPA when clear of the helicopter.



209900-40
J1400

5. Hold the RIED valve above water level and depress the perforated portion to breathe unfiltered air temporarily.

Note

The CBR protective mask provides good visibility, and the manifold hose can be used as a snorkel in rough water.

6. If flooding of the face mask occurs, clear the mask immediately upon surfacing by using the following procedure:

WARNING

Do not attempt to breathe through the inlet hose en route to the surface or with water in either the mask or manifold tube, as drowning may occur.

a. Locate and shear the antidrown connector (twist counterclockwise and pull down).

b. Ensure that the mask exhalation valve is above water and the mask is upright. Exhale forcefully. The mask will rapidly drain.

c. To draw water from the hood, open the hood outlet valve and tilt the hood to the left.

16.5.4.3 Ventilator Malfunction. Ventilator malfunction may be caused by electrical power or ventilator motor failure. This will result in the loss of the positive overpressure feature of the mask and the cooling air used to prevent mask misting.

1. Change the controls to the unimpaired pilot.

2. Close the hood outlet valve.

3. Check that the ventilator power switch is on and the circuit breaker is in.

4. Check the integrity of the ventilator power cord.

5. Install the spare battery.

16.5.4.4 Airsickness in Contaminated Area.

1. Disconnect both of the mask toggle harness leads from the helmet.

2. Disconnect the helmet chin strap.

3. Lift the bottom of the mask from the face to allow vomitus to drain from the mask area to the neck.

4. Replace the mask on the face and reconnect the chin strap mask and mask toggle harness.

PART VI

All Weather Operation

CHAPTER 17

Instrument Procedures

17.1 INTRODUCTION

The purpose of this chapter is to provide information and procedures for operating under light icing, cold weather, and instrument flight conditions. This chapter does not include equipment descriptions since, that information is contained in Part I. Detailed instrument procedures are discussed in the NATOPS Instrument Flight Manual (NAVAIR 00-80T-112).

Note

- Because of various controllable modes of helicopter flight, the possibility of pilot vertigo caused by sideward motion or oscillation is a more prevalent hazard during night and instrument flight than it is in fixed-wing flight.
- Under instrument conditions, particularly at night through conditions of reduced visibility, unnecessary operation of the anticollision light should be avoided. Uncommon reflection on the helicopter windows caused by the rotating light being reflected back from the clouds through the whirling blades may cause vertigo. Crew coordination is discussed in Part XI.

17.2 SIMULATED INSTRUMENT PROCEDURES

Safety precautions and detailed procedures for conducting simulated instrument flight are contained in OPNAVINST 3710.24 series.

17.3 INSTRUMENT FLIGHT PROCEDURES

17.3.1 Start. Complete the normal exterior inspections and the Prestart and Start Checklist items.

17.3.2 Instrument Flight Checklist.

1. Maps, supplement, approach plates — As required.
2. Fuel packet — If required.
3. Cockpit heating equipment — CHECK operation.
4. Pitot heater — CHECK operation.
5. Rain removal — CHECK operation.

CAUTION

Extended use of the rain removal system can cause damage to the windshield.

6. Magnetic compass — CHECK.
7. Vertical speed indicator — CHECK needle position.
8. Altimeters — CHECK and SET.
9. Clock — SET.
10. Radios and IFF — CHECK and SET.
11. BDHI — SLAVED, check alignment.
12. NAVAIDs — CHECK and SET.

WARNING

CNU In the event of EGI failure, turning MASTER ARM to OFF may result in loss of attitude reference. If the MASTER ARM is in STBY or ARM, then attitude reference comes from helicopter ATTITUDE GYRO.

17.3.3 Air Taxi.

1. BDHI — CHECK operation.
2. Turn-and-slip indicator — CHECK alignment and operation.

3. Attitude indicator — CHECK alignment, operation, and SET horizontal bar.

4. Magnetic compass — CHECK operation.

5. Vertical speed indicator — CHECK operation.

6. Exterior lights — As desired.

17.3.4 Instrument Takeoff. When a normal hover is not possible, the helicopter may be flown off the deck and into a normal climb without any outside reference.

1. Maintain a level attitude with reference to the attitude indicator.

2. As the helicopter becomes airborne, move the cyclic control stick forward and adjust collective pitch as necessary for transition into a forward speed climbing flight.

Note

The airspeed indicator is unreliable at airspeeds less than 40 knots.

3. Establish a rate of climb of at least 500 fpm with reference to the altimeter and vertical speed indicator.

Note

Normally, turns should not be executed prior to reaching a 200-foot altitude.

4. Maintain a smooth acceleration up to 10 knots with reference to the attitude indicator and the airspeed indicator.

17.3.5 Instrument Climb. Climb under instrument conditions is similar to the climb technique and procedure described in Chapter 7. Under instrument conditions, use the best rate-of-climb speed for the operating gross weight. Climbing turns should be limited to a maximum bank of 20°.

17.3.6 Instrument Cruising Flight. After leveling off, stabilize airspeed and power. Particular attention should be given to navigation since the slow airspeed associated with helicopters can result in large drift angles.

17.3.6.1 Speed Range. A minimum speed of 70 knots should be observed to maintain the normal flight characteristics associated with forward flight.

17.3.6.2 Electronic Equipment. Radio and navigation equipment are operated in the normal manner.

17.3.6.3 Holding. An airspeed of approximately 100 knots can be easily maintained in the normal holding pattern. However, a navigational problem will be present while attempting to maintain a pattern in high wind.

Note

Drift correction angles of 30° are not uncommon to a helicopter.

17.3.7 Descent. Normal descents are made by reducing power until the desired rate of descent is accomplished. En route descents are normally made at cruising airspeed.

CHAPTER 18

Extreme Weather Operation

18.1 COLD WEATHER OPERATION

18.1.1 Introduction. Operation of the helicopter in cold weather or on an arctic environment presents no unusual problems if the pilot is aware of the changes that take place and conditions that may exist because of the lower temperatures and freezing moisture. The pilot must be more thorough in the walkaround inspection when temperatures have been or are below 0° C (+32 °F). Engine inlet screens shall be installed when operating in possible icing conditions.

18.1.2 Engine Servicing. Fuel and oil servicing should be accomplished immediately after engine shutdown to prevent condensation within the tanks because of temperature change. Refer to Chapter 3.

18.1.3 Engine Ground Operation. During extreme conditions, install covers after engine shutdown. In extreme cold weather, a ground heater unit may be used. Snow, slush, or ice shall be removed from any area where jet engines may be operated. Keeping the areas clean will prevent cinders, sand, or chunks of ice from being sucked into the engines or blown at high velocity into other aircraft that might be in the vicinity.

During extreme cold weather, external vents and drains shall be inspected prior to operating the engines and prior to flight.

CAUTION

If the engines fail to accelerate to proper idle speed (cold hangup) or the time from light-off to idle is excessive, abort the start.

A sudden loss of oil pressure in cold weather, other than a drop caused by the relief valve opening, is usually because of a broken oil line. Shut down and investigate for the cause.

Install the engine inlet and exhaust covers after shutdown.

18.1.4 Preparation For Flight. Preparation for cold weather flights should include normal procedures in PART III with the following exceptions or additions. All vents and openings such as fuel vents, battery vents, transmission breather, heater exhaust and intake, and engine air intakes must be checked for ice.

WARNING

Accumulations of snow and ice shall be removed prior to flight. Failure to do so can result in hazardous flight because of aerodynamic and cg disturbances as well as the introduction of snow, water, and ice into internal moving parts and electrical systems. The pilot shall be particularly attentive to the main rotor and tail rotor systems and exposed control linkages.

Note

At temperatures of –35 °C (–31 °F) and lower, the grease in the couplings of the main transmission drive shaft may congeal to a point that the couplings cannot operate properly. If found frozen, gradually apply heat to thaw the couplings before attempting to start the engines. Indication of proper operation is obtained by turning the main rotor blade opposite to the direction of normal rotation while an observer watches the driveshaft to see that there is no tendency for the transmission to "wobble" and listens for no loud noise coming from the couplings.

18.1.4.1 Preheating. Whenever outside ambient temperature is –40 °C (–40 °F) or below, preheating of the engines, gearbox, transmission, and associated system components is required. Flight and engine controls may be difficult to move after the helicopter has been cold soaked. If the controls are not sufficiently free for a safe start and low-power warmup, have the affected controls thawed by heating. It may also be advisable to apply preheating to other areas such as the main rotor hub and cockpit.

Note

When moving the helicopter into or out of a heated hangar where there is an extreme difference in outside temperature, a canopy door should be open to equalize the temperature inside the cockpit. Extremely unequal temperatures on opposite sides of Plexiglas can cause differential contraction and breakage.

18.1.5 Main Rotor Blades and Elevator. Visually check the upper surfaces to be free of ice and snow. Untie the blades and walk through 360° in the direction of rotation and ensure there is no restriction in operation or flapping freedom because of ice formation. Check the synchronized elevator for ice and snow on the surface and for restricted movement caused by ice and snow between the fuselage and the elevator.

18.1.6 Before Starting Engines. When temperatures are below −18 °C (0 °F), an APU should be used to ensure smooth, fast engine acceleration. When a battery start will be necessary after the helicopter has been cold soaked at temperatures below −18 °C (0 °F) for more than 3 hours, the batteries shall be preheated. If a heater is not available, the batteries should be removed from the helicopter and stored in a warm place.

WARNING

Avoid starting the engines on glare ice to avoid the effect of torque reaction when increasing rpm.

18.1.7 Starting Engines. When OAT is below −18 °C (0 °F), accomplish the following procedures in addition to those listed in Chapter 7.

1. It is normal to observe high engine oil pressure during initial starts when the oil is cold. Run the engine at idle until the oil pressure is within limits. Oil pressure should return to the normal range after operating 5 minutes. However, the time required for warmup will depend on the temperature of the engine and lubrication system before start.

2. During starts in extreme cold weather (near −54 °C/−65 °F), the following oil pressure characteristics are typical:

   a. Oil pressure may remain at zero for about the first 20 to 30 seconds after initiating start. Abort the start if the oil pressure does not register within 1 minute after initiating the start.

   b. Once oil pressure begins to indicate on the gauge, it will increase rapidly and go over the 100 psi limit. The pressure will decrease as oil temperature rises. This condition is considered normal. The time for oil pressure to decrease to 100 psi or below will depend on the severity of the ambient temperature, but it should be in the normal range within 5 minutes after starting the engine.

   c. The oil pressure may increase above the maximum pressure limit of 100 psi if the engine is accelerated above the idle while the oil temperature is below normal operating range. The pressure will decrease to within the normal operating range as the oil temperature increases.

3. It is normal for the OIL PRESS/BYP caution light to be illuminated when starting an engine with oil temperatures below normal operating temperatures because of the relatively high oil viscosity and the degree of contamination accumulation in the oil filter. When the engine oil temperature reaches about 38 °C during warmup, the light should extinguish.

4. When starting in cold weather (below −40 °C), if light-off does not occur within 10 seconds after initial indication of N_g speed, quickly move the throttle for the affected engine back to the closed position and then to the idle detent three times, ending up at idle. If light-off still does not occur within 40 seconds, abort the start, prime the engine(s), and perform another start. The following checklist applies:

   a. FUEL CROSS FEED switch — OPEN.

b. Throttle — OPEN to EECU LOCKOUT.

c. Observe fuel coming out of overboard drain.

d. Throttles — CLOSED.

e. Attempt a normal start.

WARNING

Under cold weather conditions, make sure all instruments have warmed up sufficiently to ensure normal operation. Check for sluggish instruments before takeoff.

CAUTION

- A sudden loss of oil pressure in cold weather, other than a drop caused by relief valve opening, is usually because of a broken oil line. Shut down and investigate for the cause.
- Do not advance beyond 67 ±3 percent N_g until both engines, combining gearbox, and transmission oil pressures are stabilized within the desired operating range.
- When starting an engine that has been exposed to low temperatures overnight, watch for a rise in MGT within 40 seconds. If no MGT rise is evident, prime the engine and attempt another engine start. If there is not overboard fuel flow during prime, inspect for ice in the sumps and filters.

Note

- When the helicopter is positioned on an icy surface, it is advisable to make a free rotor engine start to prevent possible helicopter rotation caused by the rapid increase in torque experienced during a rotor brake start.
- Although cold weather does not particularly affect the engine itself, it may cause the usual problem of ice in the fuel lines, control valves, and fuel sumps, which will prevent a successful cold weather start. Preheating these components before attempting cold weather starts is recommended.

18.1.8 Air Taxi (Snow Conditions). Operating the helicopter during conditions of snow may result in a hazardous situation known as "whiteout." Whiteout, or circulation of snow through the rotorwash, can occur during air taxi, when in a hover, or on a short final approach to landing. It is potentially hazardous because the pilot may lose visual reference outside the cockpit. Air taxiing should be at an airspeed that will keep the snow cloud aft of the stub wings (approximately 10 to 15 knots depending on the wind). Care should be taken not to air taxi near another operating helicopter.

18.1.9 Takeoff. Cold weather presents no particular takeoff problem unless the cold weather is accompanied by snow. The problem of restricted visibility because of blowing or swirling snow (from rotor wash) can be acute and may require a maximum power takeoff or perhaps even an instrument takeoff without hover to get the helicopter safely airborne. Use available objects for reference, such as smoke grenades, oil drums, rocks, etc. If the takeoff is surrounded by a large expanse of smooth, unbroken snow, there is danger that the pilot may become disoriented because of the absence of visible ground reference objects.

Note

- Before takeoff under icy conditions, check that the landing gear is not frozen to the ground.
- It may be necessary to get the helicopter light on the skids and apply small pedal pressure to ensure the skids are not frozen to the ground.

18.1.10 Icing Conditions. Flight through icing conditions should be avoided. However, should icing be inadvertently encountered, the helicopter may exhibit the following characteristics.

WARNING

Engine inlet screens shall be installed when flight into possible icing conditions is expected.

18.1.10.1 Engines. Icing in the air intake system will be evidenced in the cockpit only as a power loss (which could be as much as 5 percent) and a corresponding increase in N_g of less than 2 percent. Engine anti-ice should be activated when flying through visible moisture at temperatures of 4 °C (40 °F) and below. When the engine anti-ice system is on, a power loss of 10 to 12 percent should be anticipated. Refer to paragraph 2.1.4 for a description of the engine anti-ice system.

18.1.10.2 Rain Removal and Pitot Heat. These systems will continue to perform satisfactorily in icing conditions. Both systems should be activated when flying through visible moisture at temperatures of 4 °C (40 °F) and below.

18.1.10.3 Rotor System. Ice will build on the rotor blades and shed naturally in 15- to 20-minute cycles after encountering icing conditions. Ice buildups on the rotor system are characterized by a concurrent increase in torque and MGT. Initiation of the shed cycle usually results in a one-per-revolution vibration caused by asymmetrical shedding. Vibrations are of light to heavy intensity. If vibrations are encountered immediately after or during flight through icing conditions, rapidly beeping the rotor rpm through its entire range may alleviate the problem. The shed cycle should be complete in 5 to 10 minutes after vibrations are initially encountered. After the shed cycle is complete, torque and MGT should drop.

18.1.10.4 Airframe. Ice buildup can be monitored by observing the stub wing and the forward section of either skid.

18.1.10.5 In-Flight. Prior to or immediately after encountering icing conditions, use the rain removal system to keep the windshield clear prior to ice formation.

CAUTION

The rain removal system should be turned OFF as soon as cleared vision will permit. Heat may melt the windshield if operated for a prolonged period on a dry windshield.

18.1.11 Landing. In normal operations, helicopters are often required to land or maneuver in areas other than prepared airfields. In cold weather, this frequently involves landing and taking off from snow-covered terrain. The snow depth is usually less in open areas where there is little or not drift effect. The snow depth is usually greater on the downwind side of ridges and wooded areas. Whenever possible, the pilot should familiarize himself with the type of terrain under the snow (tundra, brush, marshland, etc.).

On all snow landings, anticipate the worst conditions (i.e., restricted visibility because of loose whirling snow and an unfirm ice crust under the snow). When loose or powdery snow is expected, make an approach and landing with little or no hover to minimize the effect of rotor wash on the snow. If possible, have some prominent ground reference objects in view during the approach and landing. If no such objects are available, a smoke grenade, etc., dropped from the helicopter may suffice.

In flights of two or more, separation should be expected prior to arriving in the landing zone to preclude the possibility of having to land in a snow cloud produced by another helicopter.

WARNING

If visual reference is lost, accomplish a go-around.

CAUTION

- *Whenever possible when landing on glare ice, reduce the sink rate as much as practical in order to reduce bending loads on the crosstubes*
- *Radio and radar waves can penetrate the surface of snow and ice fields (such as the polar region); therefore, when radio and radar equipment are used for measuring terrain clearance, they may indicate greater terrain clearance than actually exists.*

After contacting the surface, maintain rotor rpm and slowly decrease collective pitch while slightly rotating the cyclic stick until the helicopter is firmly on the ground. Be ready to take off immediately if, while decreasing collective pitch, one landing gear should hang up or break through the crust. Do not reduce rotor rpm until it is positively determined that the helicopter will not settle.

18.1.12 Shutdown. The rotor brake should not be used on shutdown to preclude airframe damage because of inducing main rotor blade ice shedding. Should operational requirements dictate use of the rotor brake, the rotor system should be allowed to coast down to 30-percent rpm before gently applying the rotor brake. Be prepared to release the brake quickly if the helicopter starts to slip (rotate) on icy landing surfaces.

18.1.13 Postflight. Inspect the underside of both main rotor blades after shutdown for possible damage caused by tail rotor blade ice shedding.

18.1.14 Before Leaving the Helicopter. Perform the following checks in addition to those listed in PART III before leaving the helicopter. Open the pilot and copilot/gunner canopy doors to permit free circulation of air to retard frost formation and reduce cracking of the transparent surfaces because of differential contraction. Check that moisture accumulations are drained as soon as possible after engine shutdown. Check fuel cell sumps, fuel strainer, transmission oil sump, and engine oil systems. Check all vents for ice stoppage.

18.2 HOT WEATHER OPERATION

Operations when OATs are above standard day conditions do not require any special handling technique or procedures, other than closer monitoring of oil temperatures and MGT. As ambient temperature increases, engine efficiency decreases and power can become critical under high gross weight conditions on extremely hot days.

18.2.1 Desert Operation. Desert operation generally means operation in a very hot, dusty, and often windy atmosphere. Under such conditions, sand and dust will often be found in vital areas of the helicopter. Severe damage to the affected parts may be caused by sand and dust. The helicopter should be towed into takeoff position, which if at all possible should be on a hard, clear surface, free from sand and dust. Ensure the engine inlets are free of sand, dust, heavy accumulation, and other foreign matter. Use normal starting procedures.

Note

During warm weather, oil temperature will probably be on the high side of the operating range.

Install the engine inlet and exhaust covers after shutdown.

18.2.2 Preparation For Flight. Plan the flight thoroughly to compensate for the existing conditions by using the charts in PART XI. Check for the presence of sand and dust in control hinges and actuating linkages. Inspect for and have removed any sand or dust deposits on the instrument panel and switches and on and around the flight engine controls.

18.3 MOUNTAIN AND ROUGH TERRAIN FLYING

Many helicopter missions require flight and landings in rough and mountainous terrain. Refined flying techniques, along with complete and precise knowledge of the associated problems to be encountered, are required. Landing site condition, wind direction and velocity, gross weight limitations, and effects of obstacles are a few of the considerations for each landing or takeoff. In a great many cases, meteorological facilities and information are not available at the site of intended operation. The effects of mountains and vegetation can greatly vary wind conditions and temperature. For this reason, each landing site must be evaluated at the time of intended operation. Altitude and temperature are major factors in determining helicopter power performance. Gross weight limitations under specific conditions can be computed from the performance data in PART XI. A major factor improving helicopter lifting performance is wind. Weight carrying capability increases rapidly with increases in wind velocity relative to the rotor system. However, accurate wind information is more difficult to obtain and more variable than other planning data. It is therefore not advisable to include wind in advanced planning data, except to note that any wind encountered in the operating area may serve to improve helicopter performance. In a few cases, operational necessity will require landing on a prepared surface at an altitude above the hovering capability of the helicopter. In these cases, a sliding landing and takeoff will be necessary to accomplish the mission. Data for these conditions can be computed from the charts in PART XI.

18.3.1 Wind Direction and Velocity. There are several methods of determining the wind direction and velocity in rough areas. The most reliable method is by the use of smoke generators. However, it must be noted that the hand-held day/night distress signal and the standard ordnance issue smoke hand grenade, although satisfactory for wind indication, constitute a fire hazard when used in areas covered with combustible vegetation. Observation of foliage will indicate to some degree the direction of the wind but is of limited value in estimating wind velocity. Helicopter drift determined by eyesight without the use of NAVAIDs is the first method generally used by experienced pilots. The accuracy with which wind direction may be determined through the "drift" method becomes a function of wind velocity. The greater the wind value the more closely the direction may be defined.

18.3.2 Landing Site Evaluation. Five major considerations in evaluating the landing area are listed below:

1. Height of obstacles that determine approach angle
2. Size and topography of the landing zone
3. Possible loss of wind effect
4. Power available
5. Departure route.

The transition period is the most difficult part of any approach. The transition period becomes more critical with increased density altitude and/or gross weight; therefore, approaches must be shallower and transition more gradual. As the height of the obstacles increases, larger landing areas will be required. As wind velocity increases so does helicopter performance; however, when the helicopter drops below an obstacle, a loss of wind generally occurs as a result of the airflow being unable to immediately negotiate the change prevalent at the upwind side of the landing zone where a virtual null area exists. This null area extends toward the downwind side of the clearing and will become larger as the height of the obstacle and wind velocity increase. It is therefore increasingly important in the landing phase that this null area be avoided if marginal performance capabilities are anticipated. The null area is of particular concern in making a takeoff from a confined area. Under heavy load or limited power conditions, it is desirable to have sufficient airspeed and translational lift prior to transitioning to a climb so that the overall climb performance of the helicopter will be improved. If the takeoff cycle is not commenced from the most downwind portion of the area and translation velocity achieved prior to arrival in the null area, a significant loss in lift may occur at the most critical portion of the takeoff. It must also be noted that in the vicinity of the null area, a nearly vertical downdraft of air may be encountered that will further reduce the actual climb rate of the helicopter. It is possible that under certain combinations of limited area, high obstacles upwind, and limited power available, the best takeoff route would be either crosswind or downwind, terrain permitting. The effects of detrimental wind flow and the requirement to climb may thus be minimized or circumvented. Even though this is a departure from the cardinal rule of "take off into the wind," it may well be the proper solution when all factors are weighed in their true perspective. Never plan an approach to a confined area wherein there is no reasonable route of departure. The terrain within a site is considered from an evaluation of vegetation, surface characteristics, and slope. Care must be taken to avoid placing the rotor in low brush or branches. Obstacles covered by grass may be located by flattening the grass with rotor wash prior to landing. Power should be maintained so that an immediate takeoff may be accomplished should the helicopter start tipping from soft earth or a skid being placed in a hidden hole.

18.3.3 Effects of High Altitude. Engine power available at altitude is less, and hovering ability can be limited. High gross weight at altitude increases the susceptibility of the helicopter to blade stall. Conditions that contribute to blade stall are high forward speed, high gross weight, high altitude, induced g loading, and turbulence. Shallower turns at slower airspeeds are required to avoid blade stall. A permissible maneuver at sea level must be tempered at a higher altitude. Smooth and timely control application and anticipation of power requirement will do more than anything else to improve high-altitude performance.

18.3.4 Turbulent Air Flight Techniques. Helicopter pilots must be constantly alert to evaluate and avoid areas of severe turbulence; however, if encountered, immediate steps must be taken to avoid continued flight through it to preclude exceeding the structural limits of the helicopter. Severe turbulence is often found in thunderstorms, and helicopter operations should not be conducted in their vicinity. The most frequently encountered type of turbulence is orographic turbulence. It can be dangerous, if severe, and is normally associated with updrafts and downdrafts. It is created by moving air being lifted by natural or manmade obstructions. It is most prevalent in mountainous regions and is always present in mountains if there is a surface wind. Orographic turbulence is directly proportional to the wind velocity. It is found on the upwind side of slopes and ridges near the tops and extending down the downwind slope (Figure 18-1). It will always be found on the tops of ridges associated with updraft on the upwind side and downdrafts on the downwind side. Its extent on the downwind slope depends on the strength of the wind and the steepness of the slope. If the wind is fairly strong (15 to 20 knots) and the slope is steep, the wind will have a tendency to blow off the slope and not follow it down; however, there will still be some tendency to follow the slope. In this situation, there will probably be severe turbulence several hundred yards downwind of the ridge at a level just below the top. Under certain atmospheric conditions, a cloud may be observed at this point. On more gentle slopes, the turbulence will follow down the slope but will be more severe near the top. Orographic turbulence will be affected by other factors. The intensity will not be as great when climbing a smooth surface as when climbing a rough surface. It will not follow sharp contours as readily as gentle contours. Manmade obstructions and vegetation will also cause turbulence. Extreme care should be taken when hovering near buildings, hangars, and similar obstructions. The best method to overfly ridge lines from any direction is to acquire sufficient altitude prior to crossing to avoid leeside downdrafts. If landing on ridge lines (Figure 18-2), the approach should be made along the ridge in the updraft, or select an approach angle into the wind that is above the leeside turbulence. When the wind blows across a narrow canyon or gorge (Figure 18-3), it will often veer down into the canyon. Turbulence will be found near the middle and downwind side of the canyon or gorge. When a helicopter is being operated at or near its service ceiling, and a downdraft of more than 1.6 feet per second is encountered, the helicopter will descend. Although the downdraft does not continue to the ground, a rate of descent may be established of such magnitude that the helicopter will continue descending and crash even though the helicopter is no longer affected by the downdraft. Therefore, the procedure for transiting a mountain pass shall be to fly close abeam that side of the pass or canyon that affords an upslope wind. This procedure not only provides additional lift, but also provides a readily available means of exit in case of emergency. Maximum turning space is available and a turn into the wind is also a turn to lower terrain. The often used procedure of flying through the middle of a pass to avoid mountains invites disaster. This is frequently the area of greatest turbulence (Figure 18-4) and, in case of emergency, the pilot has little or no opportunity to turn back because of insufficient turning space. Rising air currents created by surface heating cause convective turbulence. This is most prevalent over bare areas. Convective turbulence is normally found at a relatively low height above the terrain generally below 2000 feet. It may, however, reach as high as 8000 feet above the terrain. Attempting to fly over convective turbulence should be carefully considered, depending on the mission assigned. The best method is to fly at the lowest altitude consistent with safety. Attempt to keep your flight path over areas covered with vegetation. Turbulence can be anticipated when transitioning from bare areas to areas covered by vegetation or snow. Convective turbulence seldom gets severe enough to cause structural damage.

18.3.5 Adverse Weather Conditions. When flying in and around mountainous terrain under adverse weather conditions, it should be remembered that the possibility of inadvertent entry into clouds is ever present.

Air currents are unpredictable and may cause cloud formations to shift rapidly. Since depth perception is poor with relation to distance from cloud formation and to cloud movement, low hanging clouds and scud should be given a wide berth at all times. In addition to being well-briefed, the pilot should carefully study the route to be flown. A careful check of the helicopter compass should be maintained in order to fly a true heading if the occasion demands.

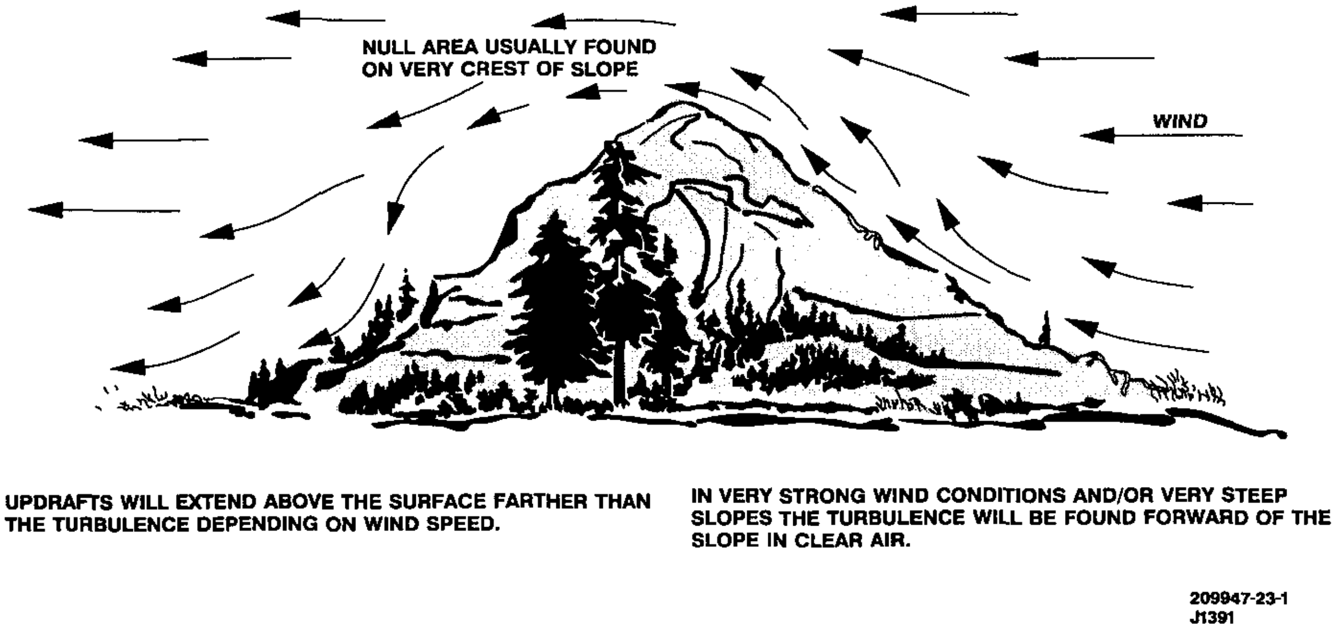


Figure 18-1. Wind Flow Over and Around Peaks

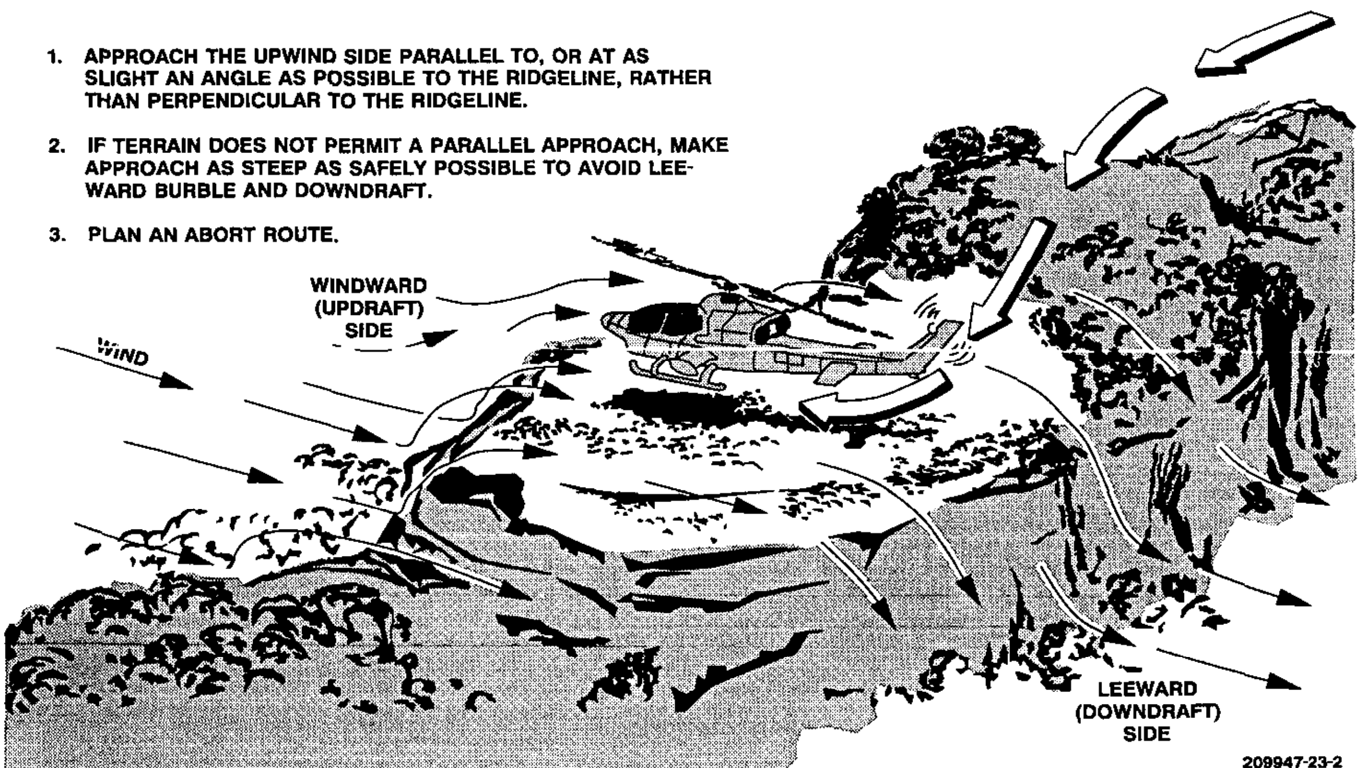


Figure 18-2. Crosswind Effect On Pinnacle Approach

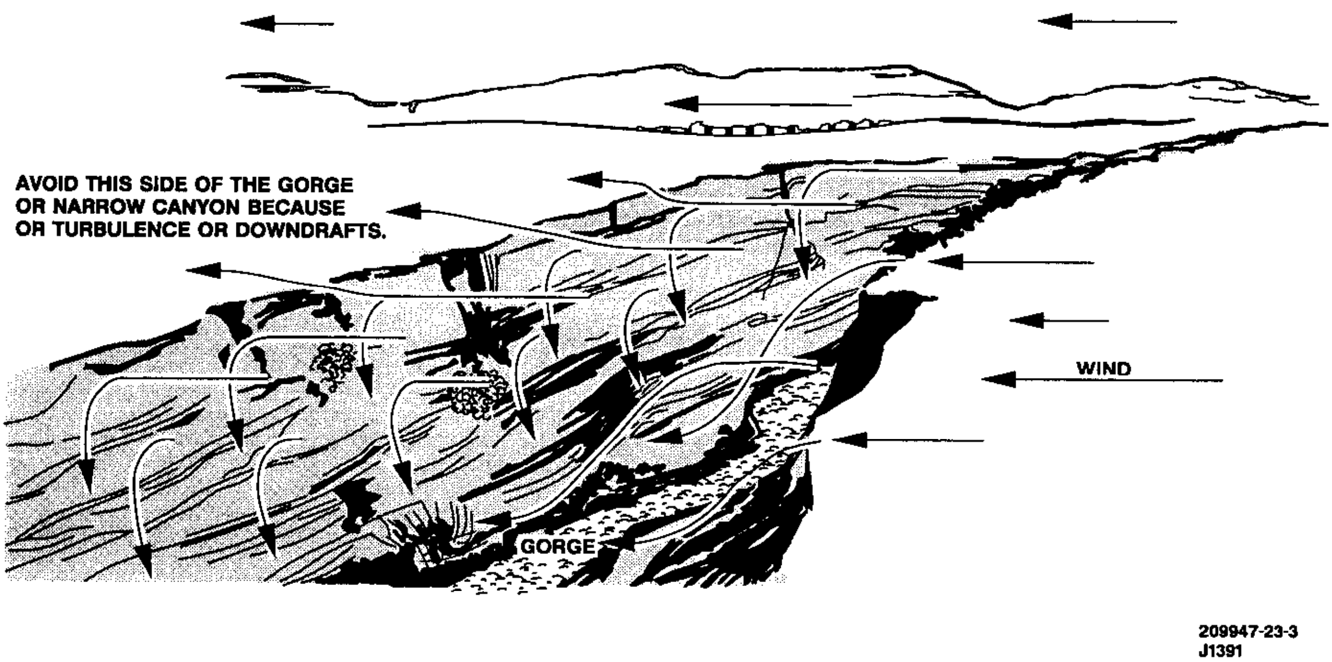


Figure 18-3. Wind Effect Over Gorges or Canyons

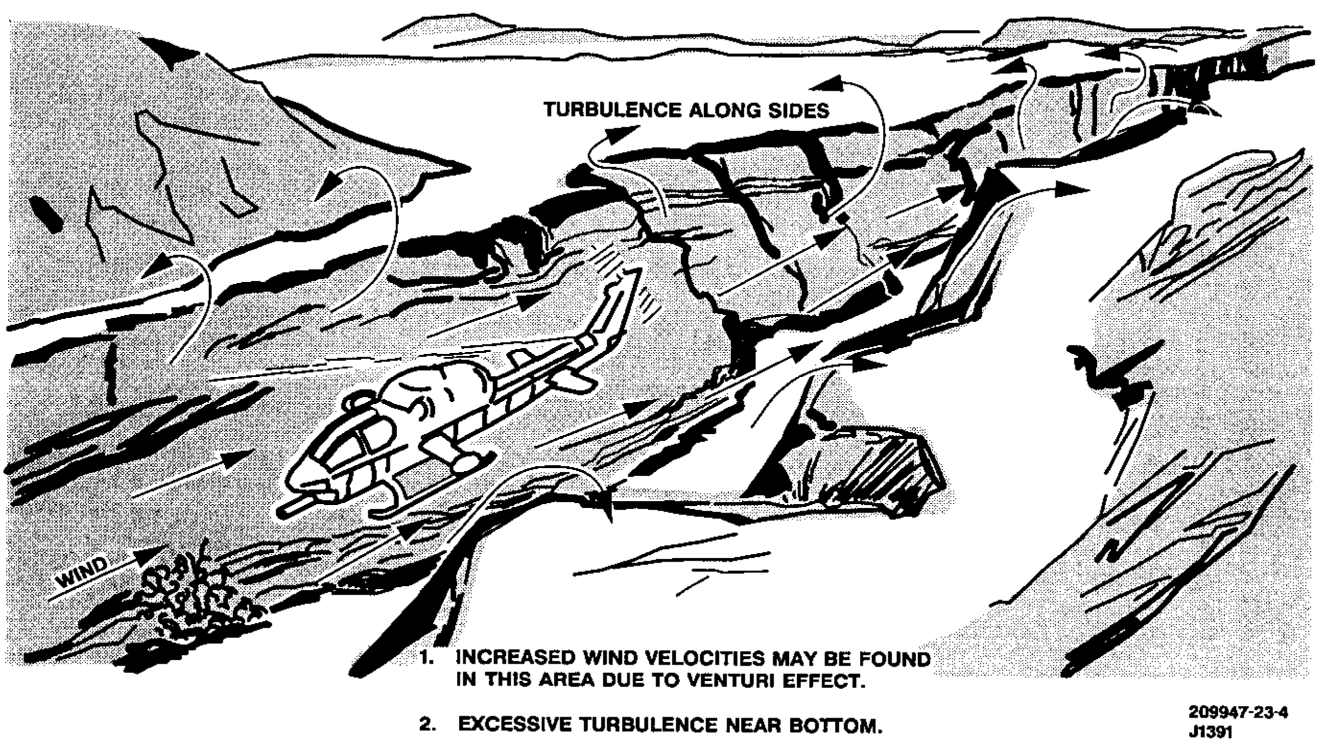


Figure 18-4. Wind Effect in Valleys or Canyons

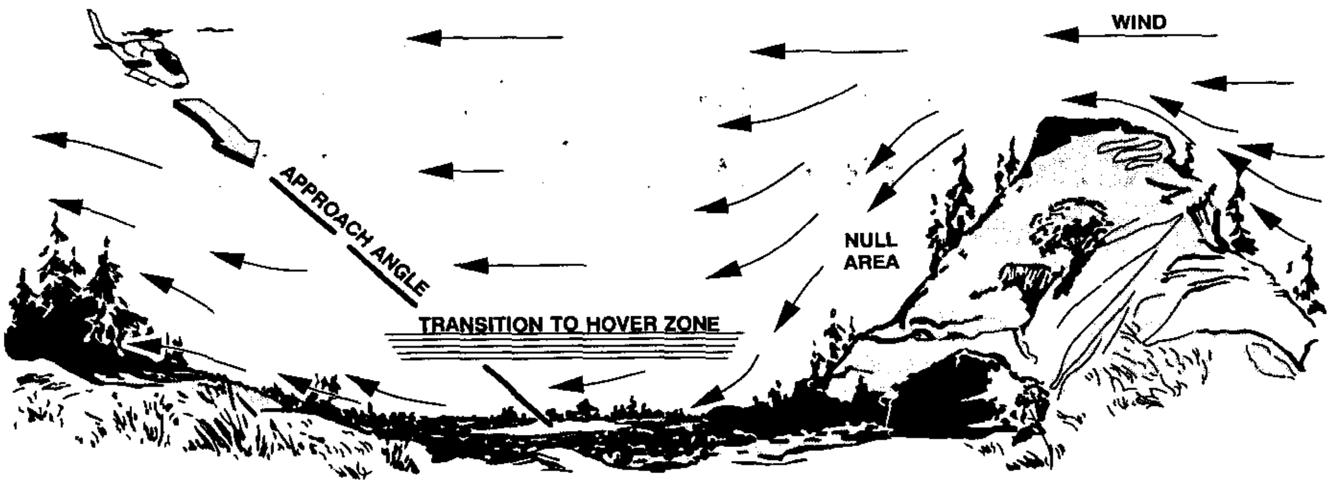


Figure 18-5. Wind Effect in Confined Area

18.3.6 Summary. The following guidelines are considered to be most important for mountain and rough terrain flying:

1. Make a continuous check of wind direction and estimated velocity.
2. Plan the approach so that an abort can be made downhill and/or into the wind without climbing.
3. If the wind is relatively calm, try to select a hill or knoll for landing so as to take full advantage of any possible wind effect.
4. When evaluating a landing site in noncombat operations, execute as many flybys as necessary with at least one high and one low pass before conducting operations into a strange landing area.
5. Evaluate the obstacles in the landing site and consider possible null areas and routes of departure (Figure 18-5).
6. Landing site selection should not be based solely on convenience, but consideration should be given to all relevant factors.
7. Determine the ability to hover out of ground effect prior to attempting a landing.
8. Watch for rpm surges during turbulent conditions. Strong updrafts will cause rpm to increase, whereas downdraft will cause rpm to decrease.
9. Avoid flight in or near thunderstorms.
10. Give all cloud formations a wide berth.
11. Fly as smoothly as possible and avoid steep turns.
12. Cross mountain peaks and ridges high enough to stay out of downdrafts on the leeside of the crest.
13. Avoid downdrafts prevalent on leeward slopes.
14. Plan your flight to take advantage of the updrafts on the windward slopes.
15. Whenever possible, approaches to ridges should be along the ridge rather than perpendicular.
16. Avoid high rates of descent when approaching landing sites.
17. Know your route and brief well for flying in these areas.

PART VII

Communications — Navigation Equipment and Procedures

CHAPTER 19

Communications

19.1 SCOPE

The communication and navigation systems are closely related. This chapter presents information on the communication and identification systems used on the AH-1W. Chapter 20 presents information on the navigation systems.

In the following areas where communication and navigation functions are shared or overlap, the information is presented in this chapter only:

- Interface Control Unit (ICU)
- Control Display Unit (CDU)
- Squat Switch
- GND/AIR/NORM Override Switch
- CDU INDEX, POWER, TIMERS, ZEROIZE, and TEST (other than navigation systems) pages.

19.2 COMMUNICATION AND IDENTIFICATION SYSTEM INTRODUCTION

The communication and navigation systems in the AH-1W have four basic configurations. The specific communication and navigation systems associated with each configuration are presented in figure 19-1.

- Baseline B : Original, production aircraft with control panels for AN/ARC-182 radios, ARN-89 ADF and AN/ARN-118 TACAN.
- Tactical Navigation System TNS : Control Display Unit (CDU) and Doppler Navigation.
- Canopy Modification CM: TNS aircraft modified for either Night Targeting System NTS or the M-65 TSU. Includes a second CDU in the copilot/gunner cockpit.
- Comm/Nav Upgrade CNU : Canopy Mod aircraft with AN/ARC-210(V) radios, EGI, and AN/ARN-153(V)4 TACAN.

SYSTEM	CONFIGURATION			
	B	TNS	CM	CNU
NTS			X	X
PLT CDU		X	X	X
CPLT CDU			X	X
ICU NO. 1 & NO. 2		X	X	X
DOPPLER		X	X	
EGI				X
ASN-75 COMPASS	X	X	X	
AN/ARC-182 RADIO	X	X	X	
AN/ARC-210 RADIO				X
THCDS	X	X	X	X
FFSP OR IFFSP	X	X	X	X
AN/ARN-118 TACAN	X	X	X	
AN/ARN-153 TACAN				X
AN/ARN-89 ADF	X	X	X	
DF-301 UHF/DF	X	X	X	X
AN/ASQ-205 COCKPIT CONTROL SYSTEM (CCS)		X	X	X
AN/ASQ-215 (MDL)				X

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Figure 19-1. Avionics Configuration

19.2.1 Baseline Configuration B .

The Baseline Configuration uses control panels in the pilot cockpit to control two AN/ARC-182 radios, the AN/ARN-118 TACAN, and the ARN-89 ADF. The communication system controls and displays are presented in Figure 19-2. Antenna locations are presented in Figure 19-3 (Sheet 1).

Text specific to the Basic Configuration is annotated with B .

19.2.2 Tactical Navigation System Configuration TNS .

The TNS includes the systems in the baseline configuration and adds the AN/APN-217(V)3 Doppler Navigation System and the AN/ASQ-205 Cockpit Control System (CCS). Communication and navigation systems are controlled through CDU inputs rather than control panels.

The communication system controls and displays are presented in Figure 19-2 (Sheet 2). See Figure 19-3 (Sheet 1), for the location of TNS components and antenna locations. The CDU controls and functions are presented in Figure 19-4 (Sheet 1).

Text specific to TNS is annotated with TNS .

19.2.3 Canopy Modification Configuration CM.

The Canopy Mod includes all systems in the TNS configuration, and adds a second CDU in the copilot/gunner left instrument panel. The copilot/gunner cockpit is depicted in Figure 19-2 (Sheet 4). Canopy Mod aircraft may be fitted with either the NTS or the M-65 TSU.

Text applicable to TNS also applies to Canopy Mod, unless specifically noted with CM. Text applicable to NTS but not M-65 is annotated with NTS .

19.2.4 Communication/Navigation Upgrade Configuration CNU .

The Comm/Nav Upgrade configuration is an enhancement to the Canopy Mod configuration. Changes to the communication/navigation system include:

- Replacement of the AN/ARC-182 radios with AN/ARC-210 radios.
- Replacement of the CDUs with improved CDUs.
- Addition of the ASQ-215 Mission Data Loader (MDL) provisions. Software provisions for the MDL have not yet been incorporated.
- Addition of the Embedded GPS/INS (EGI). Although a navigation system, the EGI interfaces with the communication systems.

Comm/Nav Upgrade aircraft may be fitted with either the NTS or the M-65 TSU.

There are no features peculiar to Comm/Nav Upgrade with NTS installed over the Canopy Mod aircraft with NTS installed, and text annotated with NTS applies to both the CM and CNU configuration. Text applicable to NTS but not M-65 is annotated with NTS .

The communication system controls and displays are presented in Figure 19-2, (Sheet 1). Antenna locations are presented in Figure 19-3. The CDU controls and functions are presented in Figure 19-4.

Text specific to Comm/Nav Upgrade is annotated with CNU .

19.3 COMPONENT DESCRIPTION

19.3.1 TNS CNU AN/ASQ-205(V) Cockpit Control System (CCS).

The CCS provides centralized control for the communication and navigation systems. The CCS (communication portion) consists of the ICU, CDU, zeroize switch, and EMER UHF 243.0 switch.

ICU 2, by default, is the primary bus controller and ICU 1 is the backup primary bus controller. If both ICU's fail, the secondary bus controller, CDU 1, will take over as primary bus controller. CDU 2 will then be the backup bus controller.

The CCS provides the following communication functions:

- TNS AN/ARC-182(V) UHF/VHF command and tactical radio frequency, channel, mode, and power control
- CNU AN/ARC-210(V) UHF/VHF command and tactical radio frequency, channel, mode, and power control
- TSEC/KY-58 command and tactical voice encryptor modes and power control
- Control SA-2498 CRYPTO relay switch amplifier
- Clock and timer functions
- Zeroize control for communication systems
- Built-in test and status monitoring.

19.3.1.1 TNS CNU Interface Control Unit.

ICU No. 2 is the primary 1553 bus controller (BC) while ICU No. 1 provides a backup capability. ICU No. 2 is the bus controller for all avionic systems, and ICU No.1 is BC for the weapons bus and an RT on the avionics bus. If both ICUs should fail, a CDU will take over as bus controller. The ICUs are

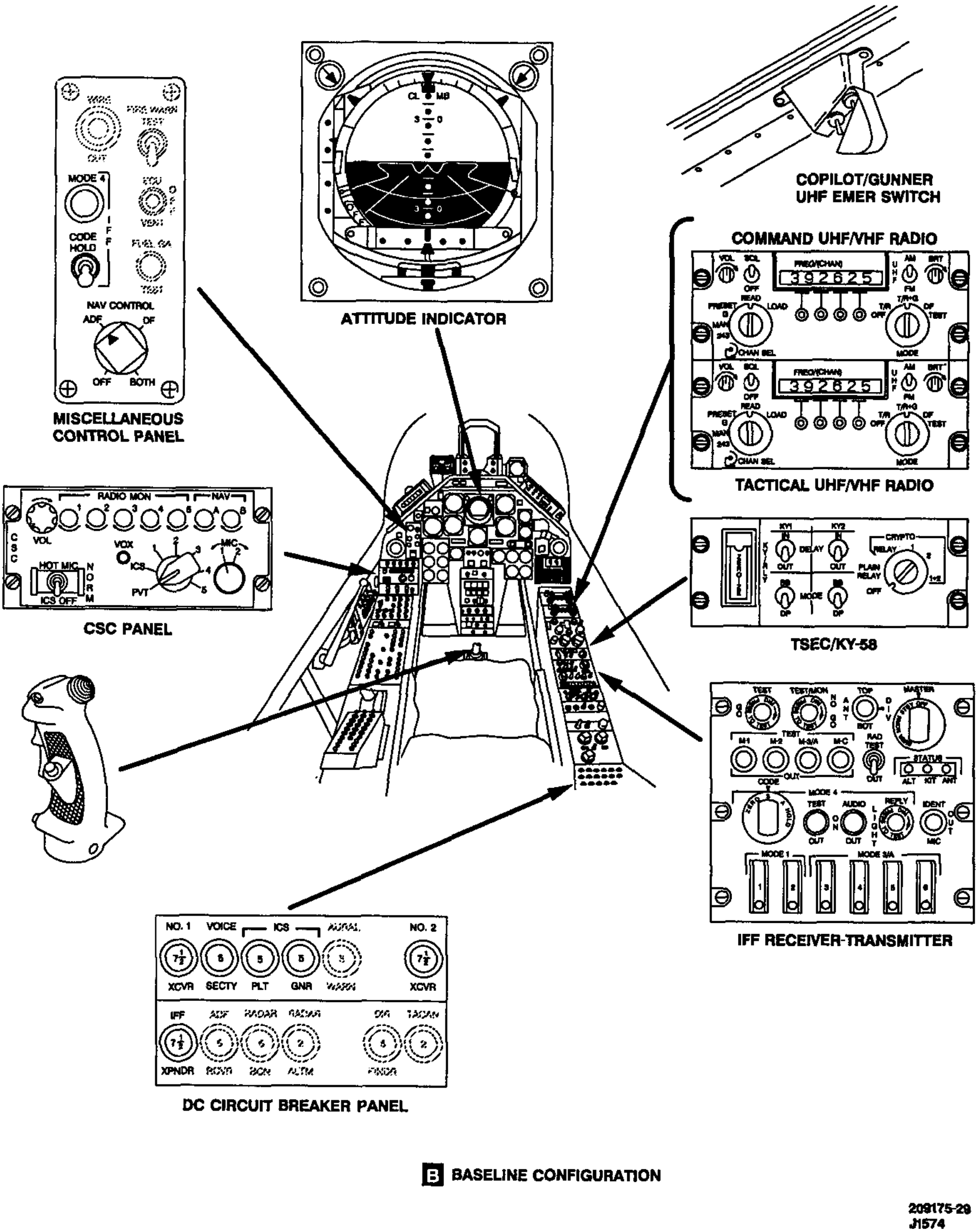


Figure 19-2. Communication System Controls and Displays (Sheet 1 of 4)

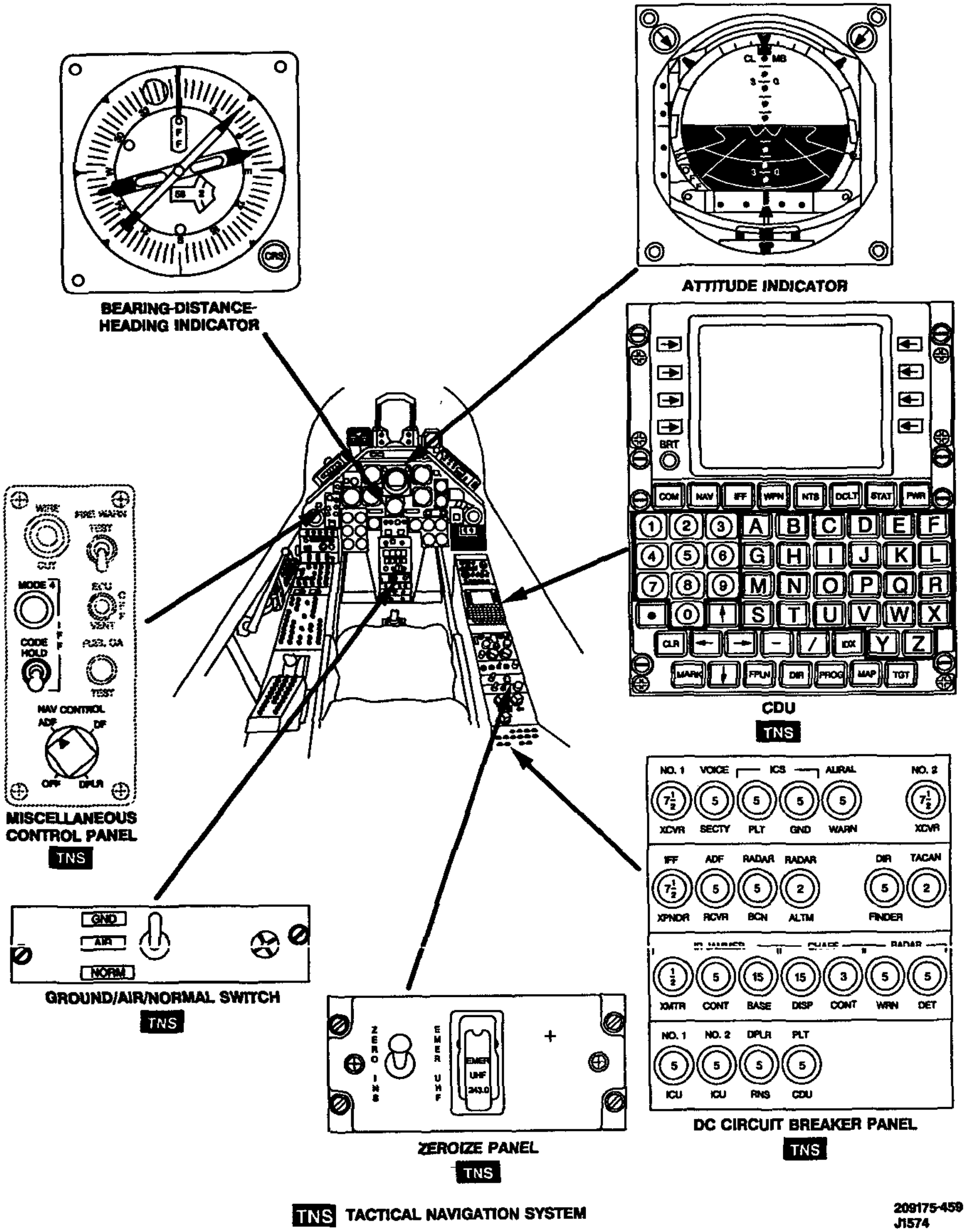


Figure 19-2. Communication System Controls and Displays (Sheet 2 of 4)

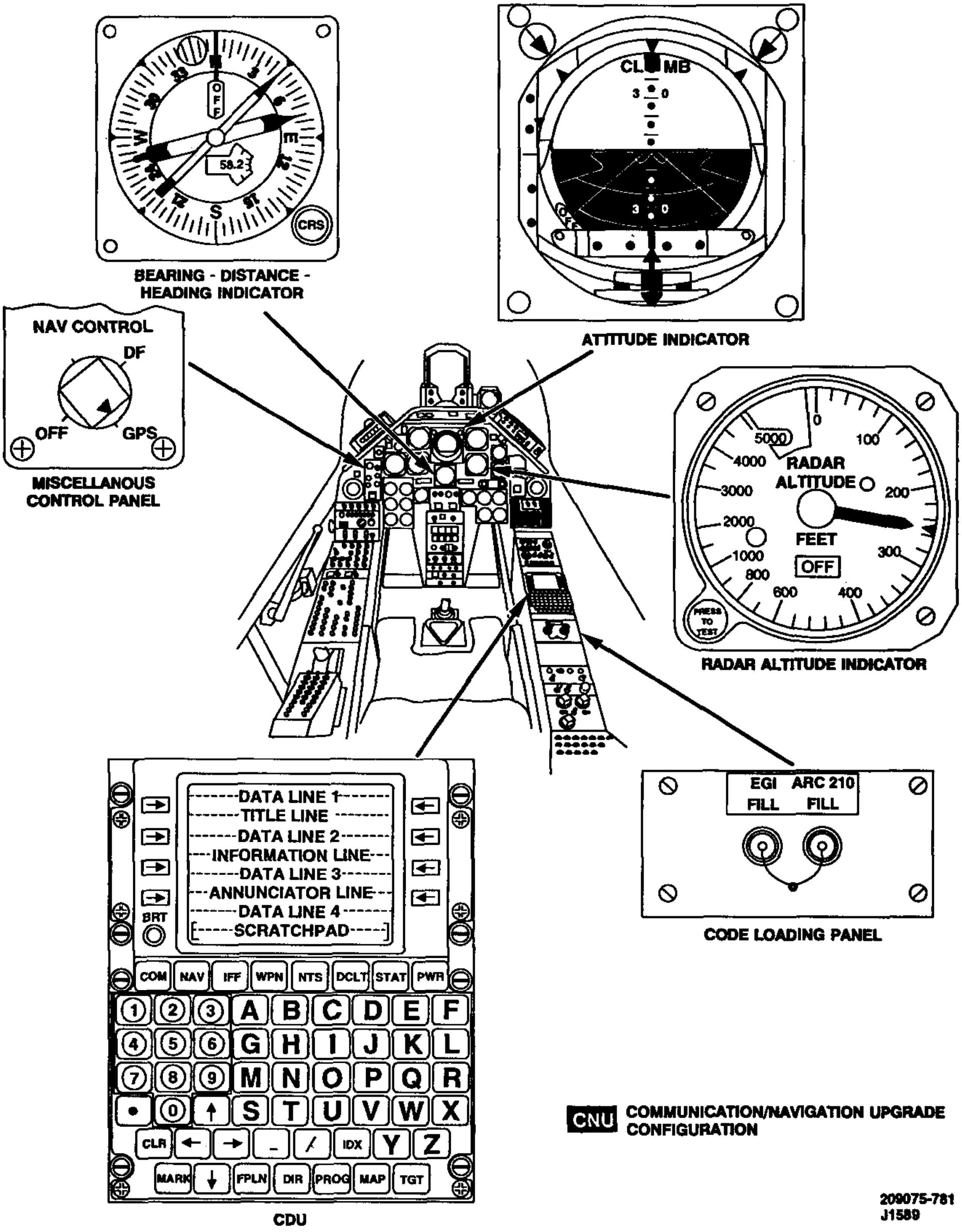


Figure 19-2. Communication System Controls and Displays (Sheet 3 of 4)

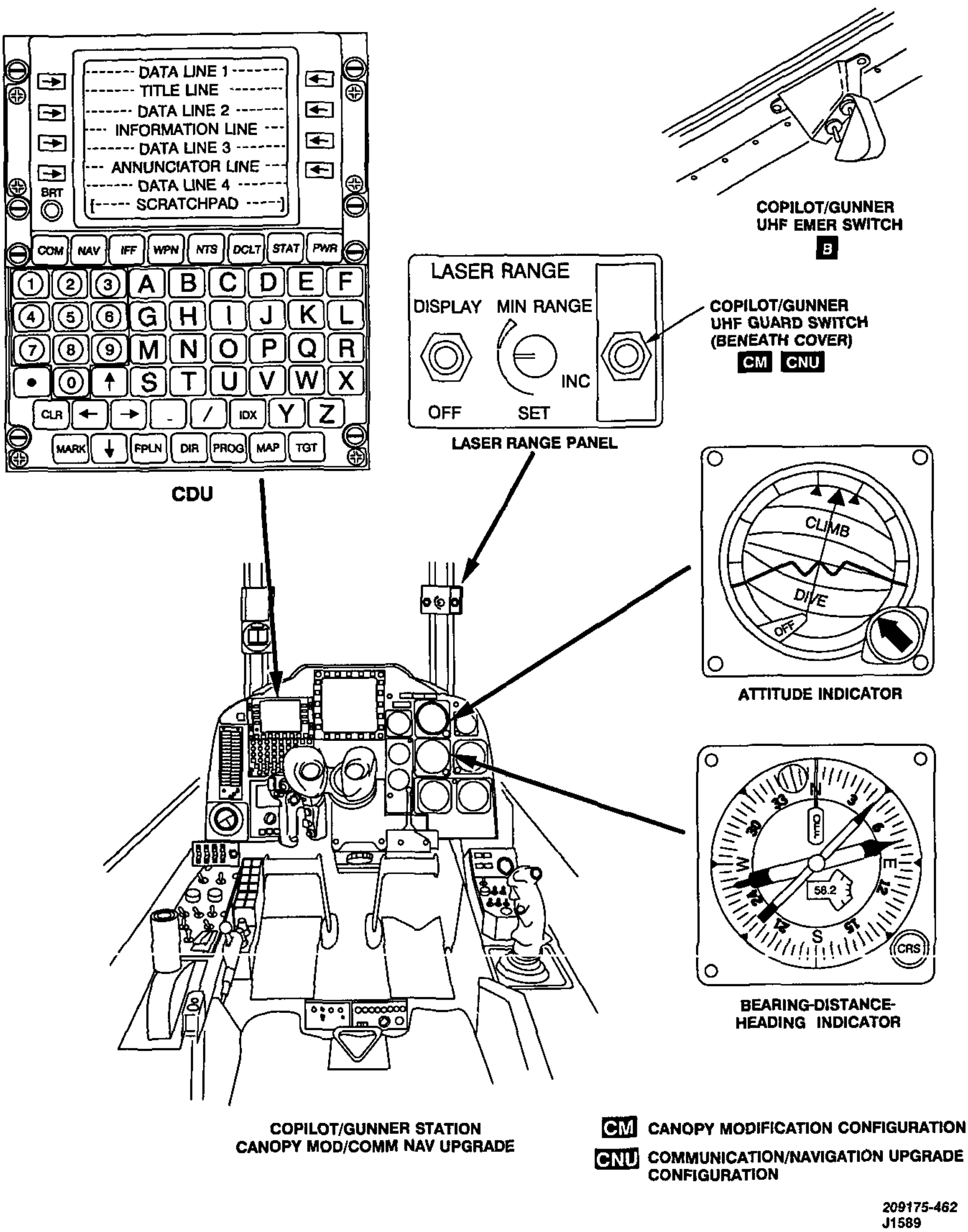


Figure 19-2. Copilot/Gunner Communication System Controls (Sheet 4 of 4)

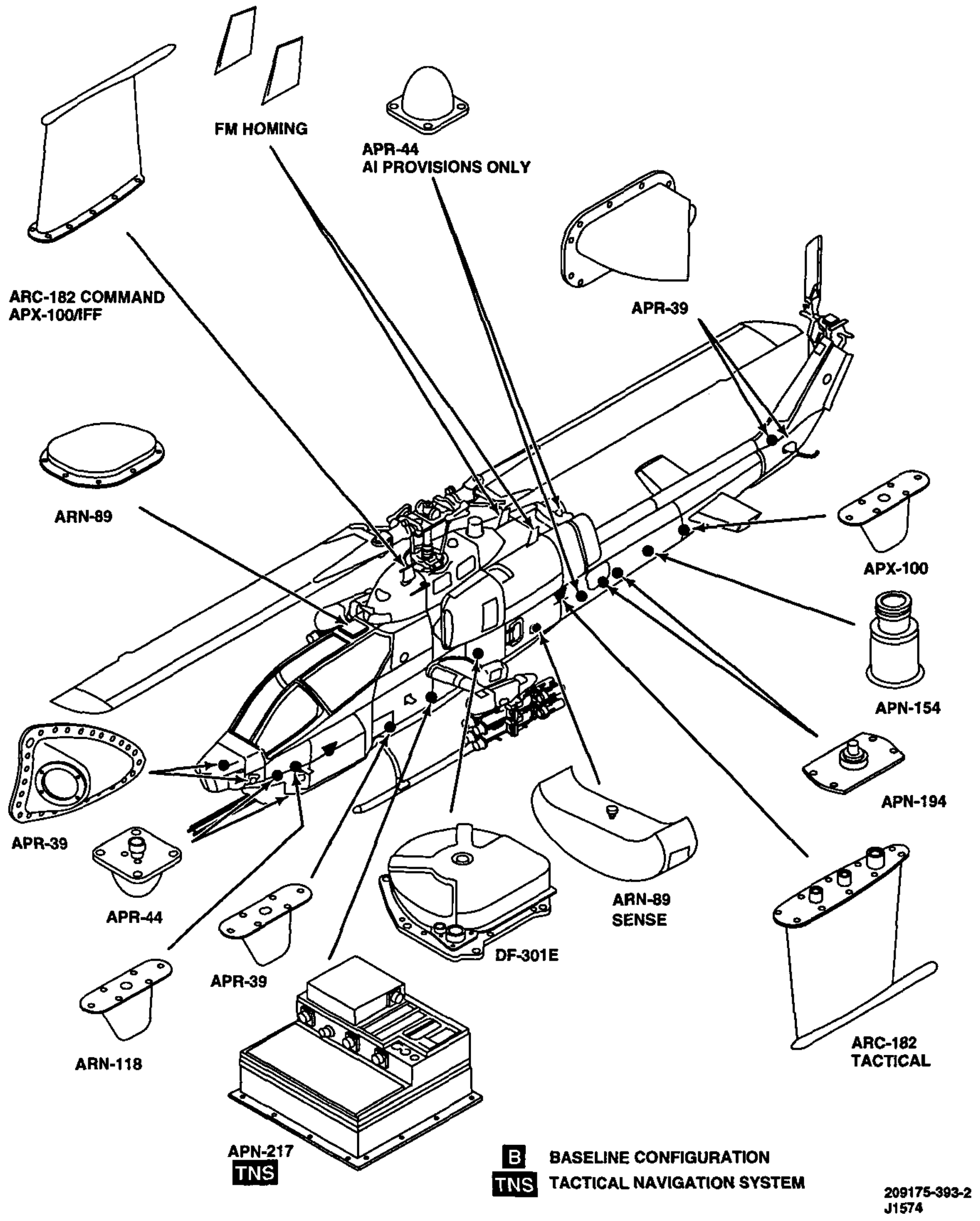


Figure 19-3. Antenna Location (Sheet 1 of 2)

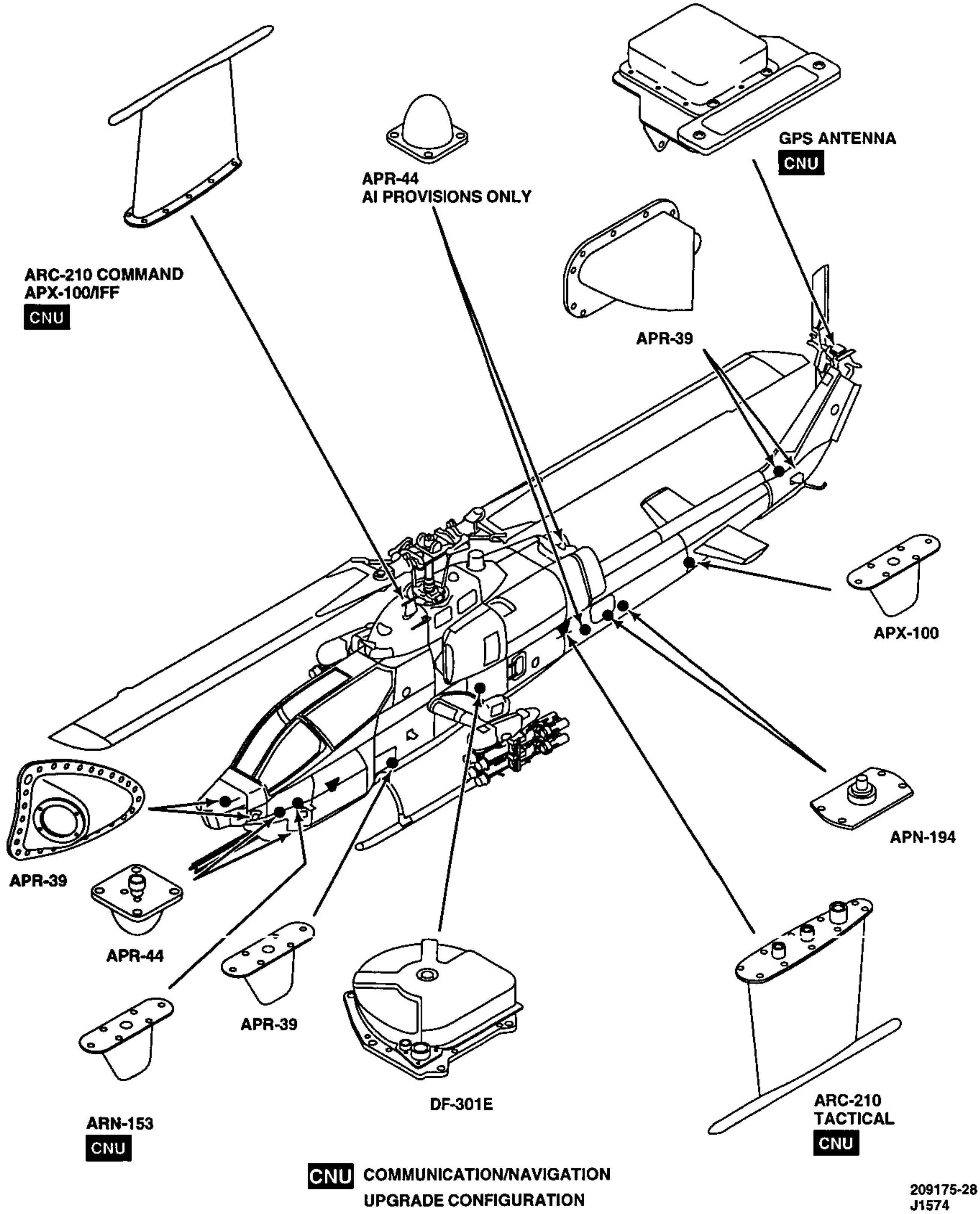


Figure 19-3. Antenna Location (Sheet 2 of 2)

powered by the 28 vdc essential bus and protected by the NO. 1 ICU and NO. 2 ICU circuit breakers.

19.3.1.2 TNS CNU Control Display Unit.

The CDU provides control for the command and tactical radios, TSEC/KY-58 voice security system, TACAN system, and the navigation system. The CDU provides a data entry keyboard for configuring the CCS and a screen for display of avionic equipment status and navigation information (Figure 19-4). The CDU is powered by the 28 vdc essential bus protected by the PLT CDU circuit breaker.

CM CNU The pilot CDU is the secondary 1553 bus controller and the copilot/gunner CDU is the backup secondary 1553 bus controller.

Note

> The CDUs installed in CNU are improved versions of those installed in TNS . They function similarly, but are not interchangeable.

19.3.1.3 TNS CNU Squat Switch.

The squat switch is located on the landing gear forward crosstube. When the override switch is in the NORM position, the squat switch automatically senses when the helicopter is in flight or on the ground.

TNS The squat switch inhibits Doppler position drift when the helicopter is on the ground and prevents maintenance tests in flight.

CNU The squat switch inhibits maintenance test functions when the helicopter is in flight, and in-flight EGI alignment modes when the helicopter is on the ground.

19.3.1.4 TNS CNU GND/AIR/NORM Override Switch.

A GND/AIR/NORM override switch Figure 19-2 (Sheet 2), located on the pilot lower center instrument panel, allows manual override of squat switch sensing. During normal operations, the switch should be placed in the NORM position.

In the AIR position, the switch signals the CCS that the helicopter is in flight regardless of flight condition.

In the GND position, the switch signals the CCS that the helicopter has landed regardless of flight condition. If in flight, MAINT test pages can only be accessed when the GND/AIR/NORM switch is in GND.

TNS GND may also be used when a present position on the ground is unknown, but will pass over a known reference point once airborne. Once over a known point, with appropriate LAT/LONG entered in present position, the GND/AIR/NORM switch should be placed in the NORM or AIR position.

19.3.2 B TNS AN/ARC-182(V) Radio Introduction.

The AN/ARC-182(V) system (Figure 19-2) consists of one UHF/VHF command radio set and one UHF/VHF tactical radio set. The command and tactical radios are interconnected to provide retransmit (relay) capability. The two radios are interfaced with the TSEC/KY-58 voice security system to provide secure voice communications and retransmit capability in plain or secure voice. The tactical radio interfaces with the pilot navigation control panel and the pilot attitude indicator. The command radio set is powered by the 28 vdc essential bus and protected by the No. 1 XCVR circuit breaker. The tactical radio set is powered by the 28 vdc nonessential bus and protected by the No. 2 XCVR circuit breaker. The command radio set uses position 1 on the CSC, and the tactical radio set uses position 2.

The AN/ARC-182(V) system provides two-way simplex UHF/VHF, narrow and wide band, AM and FM voice communications on 11,960 channels over the following frequency ranges. Channel spacing is 25 kHz in all bands.

TABLE 19-1. B TNS FREQUENCY RANGES

Frequency Range (MHz)	Guard Frequency (MHz)	Comments
30.000-87.975 (VHF-FM)	40.5 (VHF-FM)	
108.000-117.975 (VHF-AM)		Receive only
118.000-155.975 (VHF-AM)	121.5 (VHF-AM)	
156.000-173.975 (VHF-FM)	156.8 (VHF-FM)	
225.000-399.975 (UHF-AM or FM)	243.0 (UHF-AM)	Modulation switchable

The AN/ARC-182(V) system has four guard bands for emergency operation. The guard band associated with the frequency range in use is automatically selected as the guard mode. In addition to emergency guard band operation, the command radio set can be set to the emergency band of 243.0 MHz through the use of the copilot/gunner UHF emergency switch. Push-to-talk (PTT) keying can be accomplished through the copilot/gunner foot switch, copilot/gunner cyclic radio/intercom switch with appropriate CSC panel selection.

Note

The copilot/gunner must position the CSC panel selector to the proper position to transmit utilizing the footswitch.

B The AN/ARC-182(V) has the capability of storing up to 30 channels. These preset channels, as well as the last manual frequency selection, are stored in nonvolatile memory and, therefore, do not need to be reentered when the radio system is powered up. The AN/ARC-182(V) radio set has both continuous and pilot initiated BIT. The pilot can put the ARC-182(V) radio into a full BIT by selecting the TEST position on the operational MODE selector switch. Results of either the continuous or initiated BIT are displayed on the FREQ/(CHAN) six-digit readout. A failure detected by the continuous BIT will result in a display of 5"----" where "-" represents an unlit digit. When initiated BIT is selected, all displays other than "888.888" indicate that there is a failure in the unit.

Note

Set the NAV CONTROL switch to OFF if communication reception is marginal. Because of the avionics configuration, degraded communications may occur during DF navigation.

TNS The CCS can store up to 32 preset channels in a single list used for both radios. Channels and the last manual frequency selection are stored in nonvolatile memory in the CDU and, therefore, do not need to be reentered when the radio system is powered up. The AN/ARN-182(V) radio set has both continuous and pilot initiated BIT. The pilot can initiate a full BIT from the CDU COMM TEST page display.

19.3.3 CNU AN/ARC-210(V) Radio Introduction.

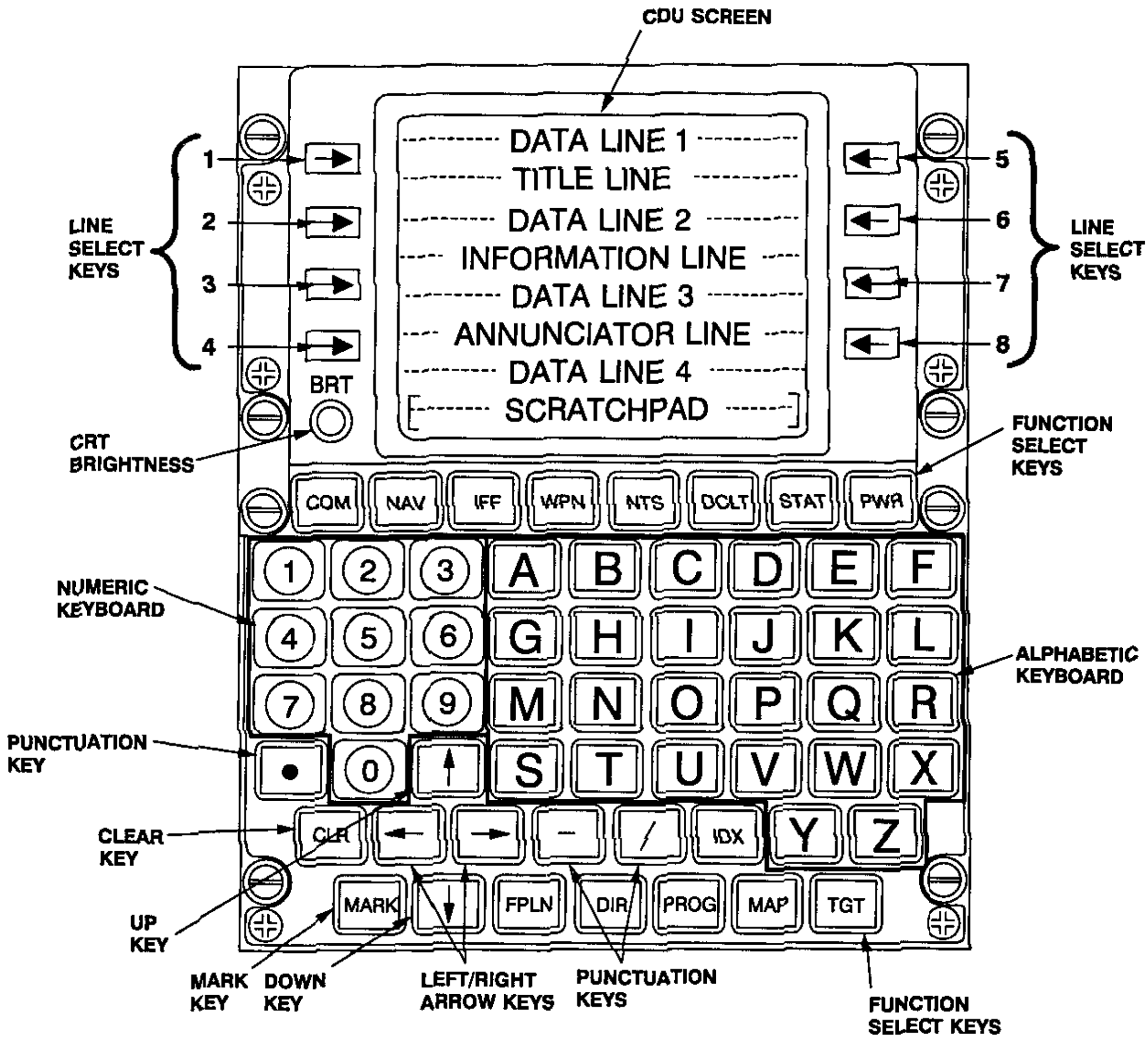
The AN/ARC-210(V) is an airborne communications transceiver that operates in fixed frequency (non anti-jam) and frequency hopping anti-jam (AJ) modes. The AN/ARC-210(V) multimode communication system replaces AN/ARC-182(V) command/tactical radio sets in COMM/NAV Upgrade aircraft. The AN/ARC-210(V) communication system consists of two AN/ARC-210(V) radio sets that interface with the ASQ-205 Cockpit Control System. Refer to Figure 19-3 for antenna locations.

The multimode communication system provides the same non-AJ functions as the AN/ARC-182(V) command/tactical radio sets in addition to the following:

- Individual Command and Tactical radio presets
- International Maritime presets
- Scanning of four frequencies per radio.

AN/ARC-210(V) also provides the following anti-jam (AJ) waveforms:

HAVEQUICK I and II
SINCGARS.



NOMENCLATURE		FUNCTION
CDU Screen	-	Displays 8 lines of data with 22 characters per line.
Data Lines 1-4	-	Displays selected functions and data manipulated by the line select keys.
Title Line	-	Displays the title of the current display page on the center of the line.
	-	Displays labels for the adjacent lines.
Information Line	-	Displays general information specific to the current display page.

NOTE

Line Select Keys 1 through 8 are shown as LS 1 through LS 8 on illustrations for clarity. The keys are not marked this way on the CDU.

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Figure 19-4. TNS CNU Control Display Unit (CDU) Controls and Functions (Sheet 1 of 3)

NOMENCLATURE		FUNCTION
Annunciator Line	-	Displays system-generated annunciations.
Scratchpad	-	Displays messages and operator keyed data.
Line Select(LS) Key	-	Initiates the function indicated, inserts data from the scratchpad, changes the function or mode displayed, or accesses another page.
Function Select Key	-	Enables the operator to view system operational data and flight management status.
PWR	-	CNU CM *Simultaneous power up of all CCS controlled system*
STAT	-	Provides access to the STATUS 1/3 page.
DCLT	-	*Declutters HUD* one level each press. *NOTE* Rear seat only.
TGT	-	Displays target coordinated list and if not on the ground inserts present position coordinates in the next available target list location.
MAP	-	Not used.
IDX	-	Provides access to the INDEX 1/2 page.
PROG	-	Accesses the display *on navigation data relating to progress* along the flight plan, as well as optional COMM and TACAN data.
DIR	-	Provides access to the FPLN page and overwrites line 1 DIR [].
FPLN	-	Provides access to the FPLN page with the present TO *point in data line* 2.
COM	-	Provides access to the COMM page.
NAV	-	Provides access to the NAV page.
IFF	-	Not used.
WPN	-	Not used.
NTS	-	Not used.
Alphanumeric Keyboard	-	*Provides capability* to enter letters, acronyms, and words into scratchpad.
Punctuation Keys	-	Provide capability to enter punctuation *into the scratchpad.*
Left/Right Arrow Keys	-	*Horizontal paging.*
Down Key	-	*Provides capability to scroll* additional pages; scrolls down through display lists and transmits a 1020 Hz tone when on the COMM 1/COMM 2 page.
Up Key	-	Provides capability to scroll additional pages; scrolls down through display lists and transmits a 1020 Hz *tone when* on the COMM 1/COMM 2 page.
CLR Key	-	Provides a method to clear the scratchpad and annunciations. The first press of the CLR key erases the last character entered into the scratchpad. Subsequent presses backspace through entry as it clears. The clear function accelerates as it backspaces when pressed and held. The scratchpad display will be erased with *a single* press of the CLR key following a line select that has been actuated.

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Figure 19-4. TNS CNU Control Display Unit (CDU) Controls and Functions (Sheet 2 of 3)

NOMENCLATURE		FUNCTION
MARK Key	-	Inserts present position coordinates into scratchpad and stores present position in NVW and also freezes update page PPSN to MARK position.
Numeric Keyboard	-	Provides capability to enter numbers into scratchpad.
CRT Brightness Control	-	Provides control of the CRT brightness. Clockwise rotation increases brightness: counterclockwise rotation decreases brightness.
-(MINUS)	-	Deletes manually entered waypoint or target information from data fields and disables/enables ✓ status annunciation.
/(SLASH)	-	Formats/radial/distance, month/day/year, wind direction/speed.

NOTE

Annunciations are displayed on the right side or left half of the annunciation line; MESSAGES are displayed in the scratchpad. Annunciations and messages will be displayed based on their priority.

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Figure 19-4. TNS CNU Control Display Unit (CDU) Controls and Functions (Sheet 3 of 3)

The AN/ARC-210(V) fixed frequency two-way system provides UHF/VHF, narrow and wide band, AM and FM voice communications, 2.5 kHz channel spacing with electronic tuning over the frequency ranges listed in table 19-2.

TABLE 19-2. CNU AN/ARC-210 FREQUENCY RANGES

Frequency Range (MHz)	Guard Frequency (MHz)	Comments
30.000-87.9875 (VHF-FM)	243.0 (UHF-FM)	
108.000-117.9975 (VHF-AM)	121.5 (VHF-AM)	Receive only
118.000-135.9975 (VHF-AM)	121.5 (VHF-AM)	
136.000-155.9975 (VHF-FM or AM)	121.5 (VHF-AM)	Modulation Switchable
156.00-173.9875 (VHF-FM)	243.0 (UHF-AM)	Maritime Frequency
225.000-399.9875 (UHF-AM or FM)	243.0 (UHF-AM)	Modulation Switchable

19.3.3.1 CNU Radio Presets.

Twenty-five single channel and 25 anti-jam preset frequencies are stored within each receiver/ transmitter (RT). This scheme differs from that used with ARC-182 radios. Preset positions 26 and 27 are used for SINCGARS CUE and COLD start frequencies on the single channel and anti-jam preset lists. The RT loads all of its frequencies to the CDU when LOAD PRESETS is commanded, or individually whenever the RT transmits. If a LOAD PRESETS is not commanded after a CDU or RT is replaced, the presets loaded in the RT and displayed on the CDU may not agree. Preset labels are stored within each CDU for each individual command and tactical radio. Labels are not loaded in a LOAD PRESETS command.

19.3.3.2 CNU Maritime Presets.

The radio maritime presets provide access to one of the 57 maritime operating frequencies (ship or shore stations) 1 through 28 and 60 through 88. The maritime presets are paired (SHIP and SHORE), half-duplex frequencies, meaning they transmit on one frequency and receive on another. The exceptions are presets 6, 8, 72, and 77 which are ship-to-ship simplex frequencies. Maritime frequencies are in the VHF-AM band from 156.050 to 162.025 MHz. The receive frequency is displayed on the COMM page. The radio defaults to the SHIP station when a maritime preset is selected.

19.3.3.3 CNU SCAN Mode.

The AN/ARC-210(V) SCAN mode provides the capability to continuously scan four selected frequencies per radio. The scan frequency list allows the pilot to load four frequencies to monitor. The SCAN mode allows for either plain or cipher modes.

19.4 COMMUNICATION SYSTEM CONTROL (CSC)

The CSC provides monitoring control of the audio from radio communications, the aural alerting unit, and the radio keying control. The CSC provides for a pilot and copilot/gunner ICS that includes two groundcrew stations. Identical CSC panels are provided for the pilot and copilot/gunner.

Two models of CSC control panels are used: one without voice activated ICS (VOX) and one with VOX. See Figure 19-5 and Figure 19-6.

In addition to radio control (radio 1 - Command, radio 2 - Tactical), the CSC has the following inputs:

- NAV 1 - TACAN (ARN-118/ARN-153) received audio
- NAV 2 - ADF Directional finder (AN/ARN-89B) received audio
- Radar altimeter audio tone
- Aural alerting unit audio (voice, caution, advisory)
- AN/APX-100 IFF audio
- Radar warning audio
- Radar detector audio

- AIM-9 audio
- NTS VCR audio playback.

The radios, ICS, radar altimeter, NAV 1 (TACAN), NAV 2 (directional finder), and aural alert tones can be controlled by the VOL switch. Other tones (radar detector, radar warning, IFF, and AIM-9) are not adjustable through the CSC. Keying of the CSC is accomplished through the pilot and the copilot/gunner radio/intercom switch located on the respective cyclic and the copilot/gunner footswitch. The CSC is powered by the 28 vdc essential bus and protected by the ICS PLT and ICS GNR circuit breakers.

19.4.1 CSC Operating Procedures.

1. ICS PLT and ICS GNR circuit breakers — IN.
2. Transmit selector switch — AS DESIRED.
3. RADIO MON 1, 2, and 5 switches — IN (adjust as required).
4. VOL knob — AS REQUIRED.
5. HOT MIC/NORM/ICS OFF switch — AS DESIRED.
6. MIC switch — AS REQUIRED.

19.4.2 Ground Crew Interphone Panel.

Two groundcrew interphone panels are provided to enable ground personnel to communicate with the pilot and copilot/gunner through the ICS. One panel is located in each of the outboard bomb arms on the wings. Auxiliary headsets, with or without an external microphone key switch, may be operated from the panels. See Figure 19-7 for a description of the functions of the groundcrew interphone panel.

19.5 TSEC/KY-58 VOICE SECURITY SYSTEM

Two independent TSEC/KY-58 systems provide secure, two-way voice narrow band FM and AM communications through either the tactical or command radio sets.

The following modes are selectable through the B pilot control panel or the TNS CNU CDU COMM page:

- Both radios in an independent secure or cipher text mode
- Either radio in secure or cipher text mode (other radio in plain text)
- Both radios in plain text mode
- Radios in the cipher text retransmit (relay) mode
- Radios in the plain text retransmit (relay mode).

B On the pilot control panel (Figure 19-8), radio 1 refers to the command radio set and radio 2 refers to the tactical radio set.

Note

The tactical and command radio sets must be tuned to frequencies at least 3 MHz apart for proper operation.

Do not transmit over both radios concurrently if one radio is in CIPHER TXT and the other is in PLAIN TXT.

19.5.1 B TSEC/KY-58 Controls and Functions.

19.5.1.1 B Secure Transmission Reception.

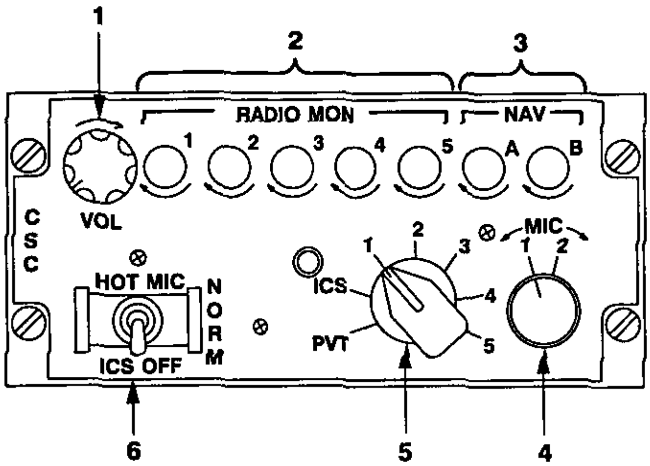
1. Mode selector switch (one of the following):
   a. CRYPTO 1 for command radio set in secure T/R mode
   b. CRYPTO 2 for tactical radio set in the secure T/R mode
   c. CRYPTO 1 + 2 for both radio sets in the secure T/R mode.
2. KY1/KY2 DELAY and MODE switches — AS REQUIRED.

Note

BB and DELAY:IN are the modes normally used for secure communications.

19.5.1.2 B Retransmission.

1. Mode selector switch:
   a. PLAIN RELAY for the plain text or nonsecure mode.
   b. CRYPTO RELAY for the secure mode retransmit.
2. KY1/KY2 DELAY and MODE switches — AS REQUIRED.



CONTROL/INDICATOR	FUNCTION
1. VOL	Controls the audio output of radio ICS and warning audio.
2. RADIO MON 1-5	When pressed, activates selected receive channel and rotates to adjust selected radio receiver audio. RADIO MON 1 is the command radio and RADIO MON 2 is the tactical radio. RADIO MON switches 3 and 4 not used. NTS 5 is for audio playback.
3. NAV A-B	When pressed, activates selected navigation channel and rotates to adjust selected navigation receiver audio. NAV A is for monitoring AN/ARN-118 TACAN audio and NAV B is for monitoring AN/ARN-89B ADF audio. CNU NAV B not used.
4. MIC 1-2	MIC 1 for 5 ohm microphone, MIC 2 for 150 ohm microphone.
5. Transmit selector switch	
PVT	Not used.
ICS	Selects communication to the other (copilot/gunner or pilot) *ICS*.
1, 2, 3, 4, 5	Selects radio set to transmit and receive audio. 1 - Command radio set, 2 - Tactical radio set. Positions 3, 4, and 5 not used.
6. HOT MIC-NORM-ICS OFF	
HOT MIC	Microphone is always activated and ICS lines are selected.
NORM	Microphone is activated only when keyed by pilot or copilot/gunner radio control switch or copilot/gunner foot switch.
ICS OFF	Disables communication between pilot and copilot/gunner ICS.

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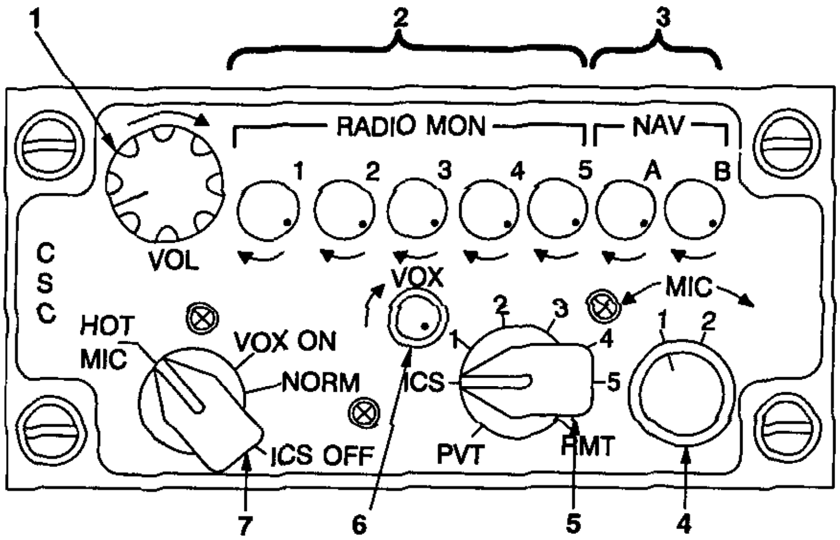
Figure 19-5. CSC Panel without VOX (Pilot and Copilot/Gunner)



INDEX NO.	CONTROL/ INDICATOR	FUNCTION
1.	VOL KNOB	Controls audio output of the radio ICS and warning audio.
2.	RADIO MON 1-5 SWITCHES	When pressed, activates selected receive channel and rotates to adjust selected radio receiver audio. RADIO MON 1 is the command radio and RADIO MON 2 is the tactical radio. RADIO MON switches 3 and 4 are not used. NTS 5 is for audio playback
3.	NAV A-B SWITCH	When pressed, activates selected navigation channel and rotates to adjust, selected navigation receiver audio. NAV A is for monitoring TACAN, audio and NAV B is for monitoring ADF. CNU NAV B not used.
4.	MIC 1-2	MIC 1 for 5 ohm microphone, MIC 2 for 150 ohm microphone.
5.	TRANSMIT SELECTOR SWITCH	
	PVT	Not used.
	ICS	Selects communication to the other (copilot/gunner or pilot) ICS.
	1, 2	Selects radio set to transmit and receive audio: 1-command radio set, 2-tactical radio set.
	3, 4, 5	Not used NTS audio playback.
	RMT	Not used.
6.	VOX KNOB	Adjusts VOX threshold audio level.
7.	HOT MIC/VOX ON/NORM/ICS OFF SWITCH	
	HOT MIC	Activates microphone for hands-free intercom.
	VOX ON	Voice activated microphone for hands-free intercom.
	NORM	Provides normal PTT operation for intercom.
	ICS OFF	Disables primary intercom receive function when not in ICS on transmit select switch.

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Figure 19-6. CSC Panel with VOX (Pilot and Copilot/Gunner)

19.5.2 TNS CNU Secure Transmission, Reception, Retransmission.

Note

After selecting EMER UHF, both radios will reset the cipher mode to PLAIN TEXT mode when the EMER UHF 243 switch is positioned back to OFF.

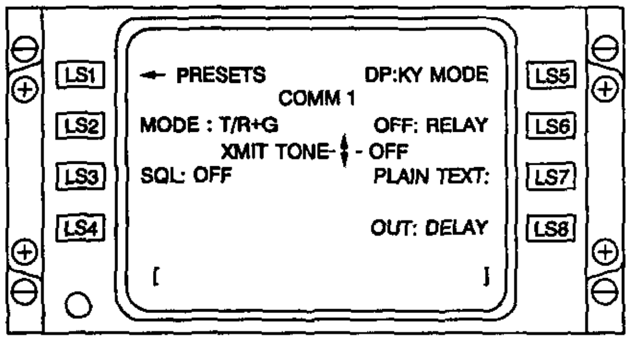
The appropriate net variable must be selected on the respective radios for successful encrypted communication.

19.5.2.1 TNS TSEC/KY-58 Operating Procedures.

KY-58 modes, relay, and delay are selected on the COMM 1 (or 2) modes control page. The COMM 1 (or 2) page is accessed by pressing LS 1 (or LS 2) on the COMM page with a blank scratchpad.

Net variables are assigned to frequencies on the COMM 1 (or 2) PRESETS page or on the COMM page.

The COMM radio control page is accessed by pressing the COM function key on the CDU.



TNS KY-58 MODE SELECTION FROM THE COMM 1 PAGE

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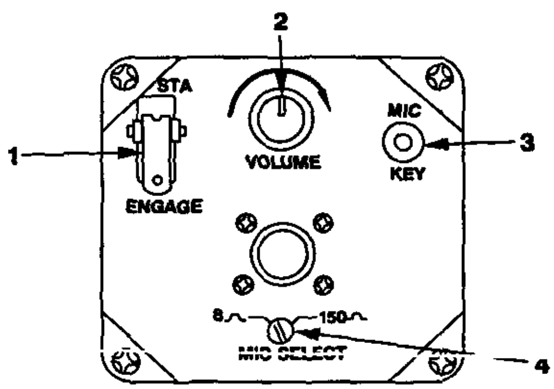
1. COM function — PRESS.
2. LS 1 (C1) or LS 2 (C2) key — PRESS TO SELECT AS REQUIRED.
3. LS 5 — PRESS TO SELECT KY MODE BB/DP: AS REQUIRED.
4. LS 6 — PRESS TO SELECT RELAY ON/OFF: AS REQUIRED.



CONTROL/ INDICATOR	FUNCTION
1. STA ENGAGE switch	Provides 28 vdc power for external microphone relay control.
2. *VOLUME*	Controls audio level to external headset.
3. MIC KEY switch	Two-position spring-loaded. Momentary on keys auxiliary microphone. Maintained position for external microphone key switch.
4. MIC SELECT	Screwdrive switch to select 5 ohm or 150 ohm microphone.

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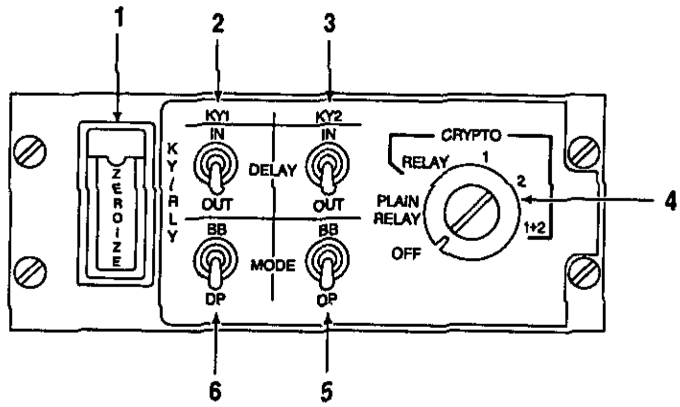
Figure 19-7. Ground Crew Interphone Panel



CONTROL/INDICATOR	FUNCTION
1. ZEROIZE	Erases code in the secure voice unit (TSEC/KY-58).
2. KY/RLY, KY1 DELAY, IN/OUT	Initiates a delay in the command radio set secure voice unit to allow system to act as a master station.
3. KY/RLY, KY2 DELAY, IN/OUT	Initiates a delay in the tactical radio set secure voice unit to allow system to act as a master station.
4. Operational mode selector	
OFF	Both the command and tactical radio sets operate independently in the nonsecure mode.
PLAIN RELAY	Command and tactical radio sets operate in the nonsecure retransmit mode.
CRYPTO RELAY	Command and tactical radio sets operate in the secure retransmit mode.
CRYPTO 1	Radio sets operate independently. Command radio set in the secure mode.
CRYPTO 2	Radio sets operate independently. Tactical radio set in the secure mode.
CRYPTO 1+2	Both command and tactical radio sets operate independently in secure voice mode.
5. KY/RLY, KY2, MODE, BB/DP	Selects baseband or diphase secure voice unit modes for the tactical radio set.
6. KY/RLY, KY1, MODE, BB/DP	Selects baseband or diphase secure voice unit modes for the command radio set.

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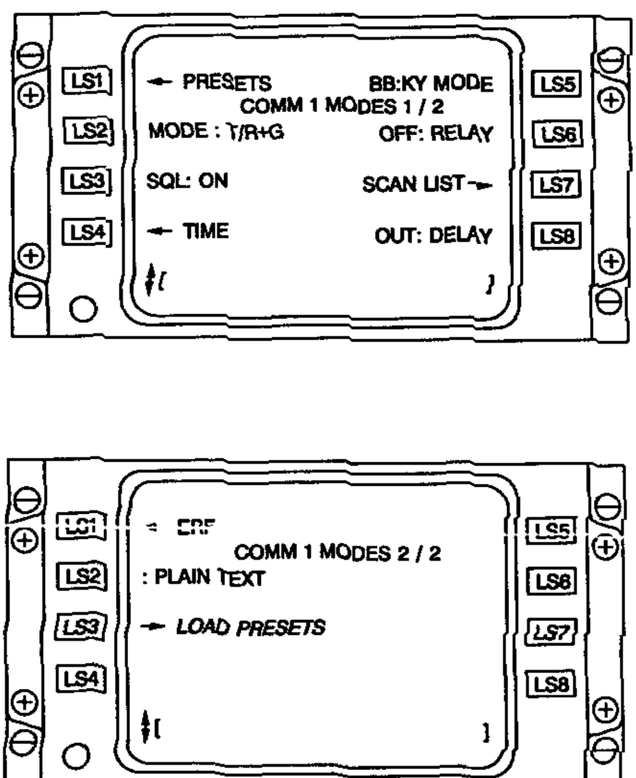
Figure 19-8. B TSEC/KY-58 Voice Security System

5. LS 7 — PRESS TO SELECT CIPHER TEXT.
6. LS 8 — PRESS TO SELECT DELAY IN/OUT: AS REQUIRED.
7. COM Function Key — PRESS.
8. Select appropriate Net Variable and Press LS 5 or LS 6 key.

19.5.2.2 CNU TSEC/KY-58 Operating Procedures.

KY-58 modes, relay, and delay are selected on the COMM 1 (or 2) MODES control pages. The COMM 1 (or 2) MODES page is accessed by pressing LS 1 (or LS 2) on the COMM page with a blank scratchpad.

Net variables are assigned to frequencies on the COMM 1 (or 2) PRESETS page or on the COMM page. The COMM radio control page is accessed by pressing the COM function key on the CDU.



CNU KY-58 MODE SELECTION FROM THE COMM 1 MODES PAGES

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1. COM function — PRESS.
2. LS 1 (C1) or LS 2 (C2) — PRESS TO SELECT AS REQUIRED.
3. LS 5 — PRESS TO SELECT KY MODE BB/DP: AS REQUIRED.
4. LS 6 — PRESS TO SELECT RELAY ON/OFF: AS REQUIRED.
5. LS 8 — PRESS TO SELECT DELAY IN/OUT: AS REQUIRED.
6. DOWN ARROW — PRESS TO DISPLAY PAGE 2/2.
7. LS 2 — PRESS TO SELECT CIPHER TEXT.
8. COM Function — PRESS.
9. Select appropriate Net Variable and Press LS 5 or LS 6 key.

19.6 APX-100 IFF TRANSPONDER

The AN/APX-100(V) transponder set enables the helicopter to identify itself automatically when properly challenged by friendly surface and airborne radar equipment. The control panel, located on the right console (Figure 19-9), enables the set to operate in modes 1, 2, 3A, 4, and test. When the KIT/1A/TSEC computer (classified) is installed, mode 4 is operational. The range of the receiver-transmitter is limited to line-of-sight transmission, since its frequency of operation is in the UHF band.

19.6.1 AN/APX-100(V) Operating Procedures.

1. MASTER control — STBY. Allow approximately 2 minutes for warmup.
2. MODE and CODE — AS REQUIRED.
3. MASTER control — NORM.
4. TEST — AS REQUIRED.
5. ANT — DIV (Diversity).

Note

If top or bottom antenna is selected and opposite antenna receives the stronger signal, the unit will not transmit the reply.

6. IDENT — AS REQUIRED.
7. IFF CODE HOLD PROCEDURES:
   a. IFF CODE HOLD switch (on instrument panel) — HOLD.
   b. MODE 4 CODE control switch (rotary switch) — HOLD MOMENTARILY.

c. MASTER switch — OFF WITHIN 15 SECONDS.

19.6.2 AN/APX-100(V) Emergency Operation.

1. MASTER control — EMERG.

19.6.3 AN/APX-100(V) Mode 4 Operation.

19.6.3.1 Before Exterior Check.

1. MASTER control — OFF.
2. CODE switch — HOLD.
3. IFF CODE HOLD switch (on the instrument panel) — HOLD.

Note

If the IFF CODE HOLD switch is OFF and the MASTER switch is in any position other than OFF, mode 4 codes will zeroize when the battery switch is turned off.

19.6.3.2 Helicopter Runup Test.

1. MASTER control — STBY (for 2 minutes).
2. CODE switch — A.
3. MODE 4 TEST/ON/OUT switch — ON.
4. MODE 4 AUDIO/LIGHT/OUT switch — AUD/LIGHT.

WARNING

OUT position should never be used operationally. If OUT is selected, the IFF warning to master caution panel is disabled. If IFF mode 4 fails, the pilot will receive no indication of a system failure.

5. MODE 4 TEST/ON/OUT switch — TEST MOMENTARILY. The REPLY light should illuminate. If the REPLY light is not illuminated or the IFF caution light illuminates when the switch is at TEST, a malfunction is indicated and mode 4 shall not be used. Release the switch to the ON position. Further testing to check for correct coding responses is done with ground test equipment by moving the MASTER control to NORMAL. When ground test equipment is moved within 50 feet of the helicopter antenna, the following indications should be observed if coding is correct.

   a. REPLY light illuminates.

   b. If the REPLY light does not illuminate and/or the audio tone is heard, select the opposite code (A or B) and repeat the check. If the helicopter transponder does not respond correctly to ground test interrogation, the IFF caution light should illuminate. If there is any indication of an unsatisfactory test, mode 4 shall not be used.

19.7 CNU AN/ARC-210 ANTI-JAM (AJ) OVERVIEW

The Anti-Jam (AJ) features, also termed Electronic Counter-Counter Measures (ECCM), that are available with the ARC-210 radio, are HAVEQUICK for UHF communication and SINCGARS for VHF-FM communication. The AJ modes inhibit enemy communication interception, detection, and jamming. The radios accomplish this by continuously retuning frequencies during communication.

HAVEQUICK and SINCGARS may be used together with the KY-58s to provide jam-resistant and secure communications.

19.7.1 CNU Radio Time.

The two frequency hopping waveforms rely on extremely accurate time parity between net radio stations to maintain communication links.

The AN/ARC-210(V) has two internal clocks that provide frequency hop time sync references: a radio clock and a SINCGARS clock.

The radio clock is used by the HAVEQUICK waveform. The radio clock may be initialized using one of three methods:

- GPS Universal Time Coordinated (UTC) (primary)
- RF Time Receive (alternate)
- EMERGENCY time start (backup).

SINCGARS has a dedicated clock that is initialized using one of four methods:

- GPS-UTC (primary)
- RF Time Receive
- CCS time when EMERG time start is used
- Manually entered time from TIME or COMM page.

The primary time reference for the AH-1W radio system is GPS-provided UTC, and the CCS is designed to make time initialization easy. Unless one of the other methods has already been selected when GPS time becomes available, the radio will automatically initialize to GPS time.

19.7.2 CNU HAVEQUICK Principles.

The HAVEQUICK waveform functions as a jam resistant UHF (225-400 MHz) waveform for air-to-air and air-to-ground communications. It also provides normal and secure voice communication using KY-58s. Operation in the HAVEQUICK mode is accomplished using synchronized precision clocks, programmed frequency switching patterns, uniform frequency hop rates, and common entry into the net frequency table.

The HAVEQUICK waveform has two modes of operation: training and combat. Combat mode is not used during peacetime, since actual combat frequency tables (nets) are utilized. The word-of-day (WOD) and multiple word-of-day (MWOD) selects whether training or combat mode is used. Pilot data entry and net selection is the same in both modes.

The AN/CYZ-10 Data Transfer Device (DTD) loads the training hopsets and associated WOD/MWOD in the radio system. Combat frequency tables are hard coded into the AN/ARC-210 radio memory. Neither the WOD/MWOD nor frequency tables can be viewed on the CDU.

For successful HAVEQUICK communication between two radio stations, three things must match:

- Time-of-day (TOD)
- WOD/MWOD
- Net number.

In the AH-1W, a five-digit number preceded by an "H" indicates a valid HAVEQUICK net number (e.g. H00125). Other aircraft and ground HAVEQUICK-capable systems may precede the net number with an "A" and display a decimal point in the five-digit net identifier (e.g., A00.125).

Conferencing is a technique employed by the AN/ARC-210(V) that allows two radios to simultaneously transmit on the same net and remain distinguishable by those receiving the signals. Conferencing is enabled as a part of the WOD/MWOD when the HQ net contains UHF-AM frequencies. When enabled, the net radios automatically switch to wide-band operation.

Note

> Conferencing does not work with UHF-FM frequencies. The conferencing mode is automatically turned off during cipher AJ communications.

HAVEQUICK is not capable of transmitting digital data.

19.7.3 CNU SINCGARS Principles.

The single channel ground and airborne radio system (SINCGARS) provides frequency hopping operation in the VHF-FM band (30-88 MHz). The SINCGARS mode provides normal AJ VHF-FM operation in plain and secure voice using KY-58 equipment. SINCGARS is capable of transmitting digital data.

SINCGARS incorporates features that allow flexibility in synchronizing coarse initial time inputs and incorporates over the air transmission and reception of SINCGARS nets. SINCGARS is normally initialized to GPS time from the EGI. The SINCGARS clock can also be manually reset and this is commonly referred to as "wristwatch time."

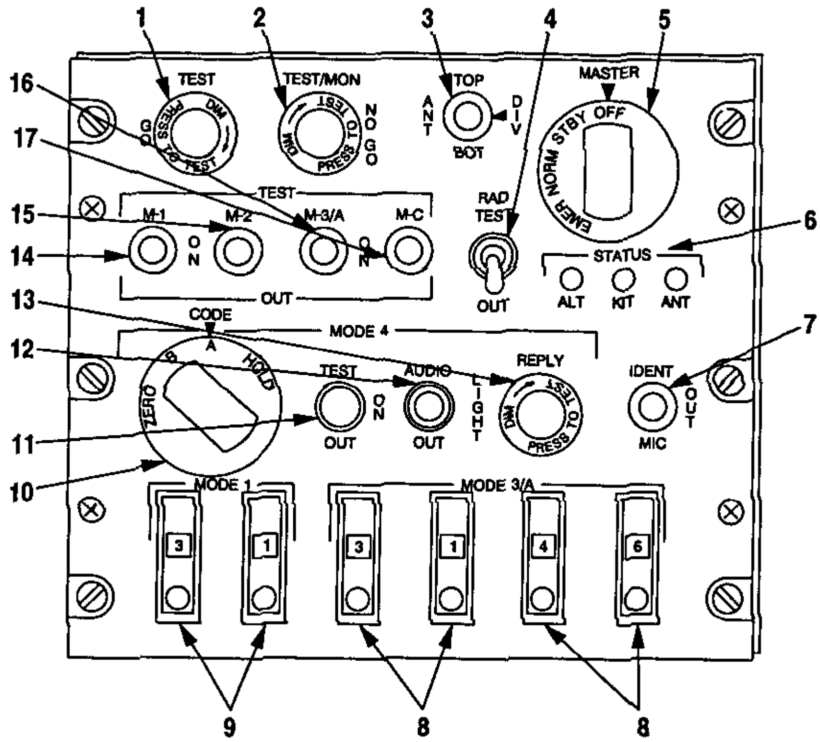
Note

> When the wristwatch time is entered, all net offset times are reset to zero on the selected radio.

Once a net is time synchronized, the time offset is stored for that net within the specific radio. The stored offset times will allow the radio to rapidly re-synchronize upon subsequent reselection of the net.

19.7.3.1 CNU CUE Frequency.

CUE is a method for a non-net station to contact an active SINCGARS net. CUE is a fixed frequency preset loaded by the AN/CYZ-10 and normally does not require modification. The CUE frequency is



CONTROL/INDICATOR	FUNCTION
1. TEST GO	Indicates successful built-in test (BIT).
2. TEST/MON NO GO	Illuminates to indicate unit malfunction.
3. ANT	
TOP	Selects antenna located on top of helicopter.
BOT	Selects antenna located on bottom of helicopter.
DIV	Monitors received signals from both antennas and allows transmission via antenna receiving the strongest signal.
4. RAD TEST switch	
RAD TEST	Used for avionics ground test only. Not to be used in flight.
OUT	
5. MASTER control	
OFF	Turns set off.
STBY	Places set in warmup (standby) condition.
NORM	Set operates at normal receiver sensitivity.
EMER	Transmits emergency reply signal to MODE 1, 2 or 3/A interrogations regardless of mode control settings.
6. STATUS indicators	
ANT	Indicates that built-in test (BIT) or monitor (MON) failure is due to high voltage standing wave ratio (VSWR) in antenna.
KIT	Indicates that built-in test (BIT) or monitor (MON) failure is due to external computer.
ALT	Indicates that built-in test (BIT) or monitor (MON) failure is due to altitude digitizer.

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Figure 19-9. AN/APX-100(V) Transponder Set Control Panel (Sheet 1 of 2)

CONTROL/INDICATOR	FUNCTION
7. IDENT-MIC switch	
IDENT	Initiates identification reply for approximately 25 seconds.
OUT	Prevents triggering of identification reply. Spring-loaded to OUT.
MIC	Identifies when radio transmit switch is activated.
8. MODE 3/A code select switches	Selects and indicates the MODE 3/A four-digit reply code number.
9. MODE 1 code select switches	Selects and indicates the MODE 1 two-digit reply code number.
10. MODE 4/CODE control HOLD/A/B/ZERO	Selects condition of code changer in remote computer.
11. MODE 4 TEST switch	
TEST	Selects MODE 4 BIT operation.
ON	Selects MODE 4 ON operation.
OUT	Disables MODE 4 operation.
12. MODE 4 AUDIO/LIGHT control	
AUDIO	MODE 4 is monitored by audio.
LIGHT	MODE 4 is monitored by a light.
OUT	MODE 4 is not monitored.
13. MODE 4/REPLY	Indicates that a MODE 4 reply is generated.
14. TEST M-1 TEST/ON/OUT	Selects ON, OFF or BIT of MODE 1 operation.
15. TEST M-2 TEST/ON/OUT	Selects ON, OFF or BIT of MODE 2 operation.
16. TEST M-3/A TEST/ON/OUT	Selects ON, OFF or BIT of MODE 3/A operation.
17. TEST M-C TEST/ON/OUT	Selects ON, OFF or BIT of MODE C operation.

209075-122-2
J1589

Figure 19-9. AN/APX-100(V) Transponder Set Control Panel (Sheet 2 of 2) scanned every 4 seconds as part of the normal SINCGARS operation when the net is inactive.

19.7.3.2 CNU ECCM Remote Fill (ERF).

Because SINCGARS nets or load sets cannot be manually entered using the CDU, the ERF function provides a method of remotely filling or updating a radio station with a different load set. ERF transfers the hopset, net offset times, and net ID numbers from the sender to the receiver. ERF must be accomplished over a SINCGARS net, either plain or ciphered. ERF cannot be accomplished over single channel frequencies or HAVEQUICK nets. ERF is often used with COLD start.

The requirements for a successful ERF are as follows:

- Sender and receiver must share common TRANSEC variables.
- Sender and receiver must share common SINCGARS net time.
- SINCGARS net must be established.

19.7.3.3 CNU COLD Start.

A method to accomplish an ERF is COLD start. COLD start is a special SINCGARS net that hops on one frequency. It is used to open a SINCGARS net when radio stations don't otherwise share a common loadset. Radio stations must be loaded with the same TRANSEC variable for ERF to function.

Once a COLD start SINCGARS net is established, the ERF mode can be used to electronically fill radio stations with a different loadset.

19.7.3.4 CNU Time Master.

The SINCGARS Time Master is the net time controller for a communication network. SINCGARS was originally designed as a ground unit communication network with consideration that AJ nets would be in continuous use for many days. The time master concept was intended to support those extended operations by allowing net time synchronization by one station to compensate for station-to-station time drifts.

The time master station constantly resynchronizes net station radios during normal communication transmission. Operationally, the AH-1W will not normally act as the time master for SINCGARS communication nets.

19.7.3.5 CNU Late Entry.

Late Entry allows SINCGARS communication to occur when a radio time is not within 4 seconds of the net time. Late Entry allows up to a 1-minute difference in time. The radio net time is automatically synchronized during normal net communication reception.

Note

> Initial entry on a SINCGARS net, particularly when using Late Entry, may require several seconds of reception of a SINCGARS signal to obtain desired communication quality.

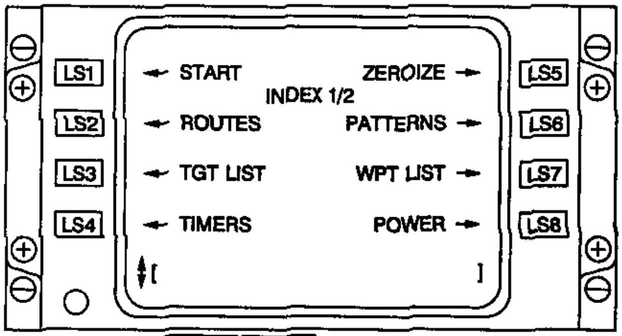
19.8 TNS CNU CDU DISPLAYS AND FUNCTIONS

19.8.1 TNS CNU INDEX Pages.

The INDEX pages are used to access the power page, navigation initialization, timers, zeroize functions, targets, waypoints and routes list.

19.8.1.1 Index 1/2 Page.

The INDEX 1/2 page is accessed via the IDX function key.



TNS CNU INDEX 1/2 PAGE

209000-47
J1413

LS 1: Accesses the START 1/2 page.

LS 2: Accesses the ROUTE IDX (index) 1/2 page.

LS 3: Accesses the TGT (target) LIST page in the last scrolled position.

LS 4: Accesses the TIMERS page.

LS 5: Accesses the ZEROIZE pages.

LS 6: Accesses the PATTERNS INDEX page.

LS 7: Accesses the WPT (waypoint) LIST page in the last scrolled position.

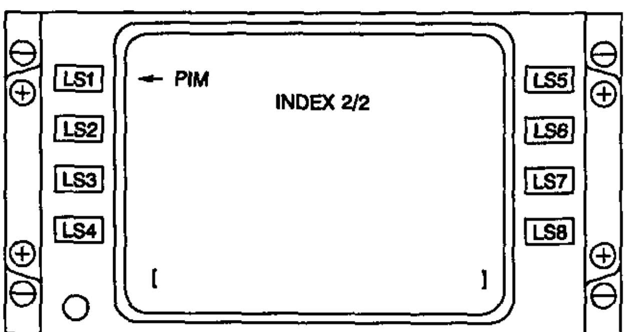
LS 8: Accesses the POWER page.

Note

The INDEX 1/2 page is scrolled up or down to the INDEX 2/2 page using the arrow keys.

19.8.1.2 INDEX 2/2 Page.

The INDEX 2/2 page is accessed by scrolling from the INDEX 1/2 page.



TNS CNU INDEX 2/2 PAGE

209000-48
J1413

LS 1: Accesses the PIM (position and intended movement) page.

19.8.2 TNS CNU POWER Page.

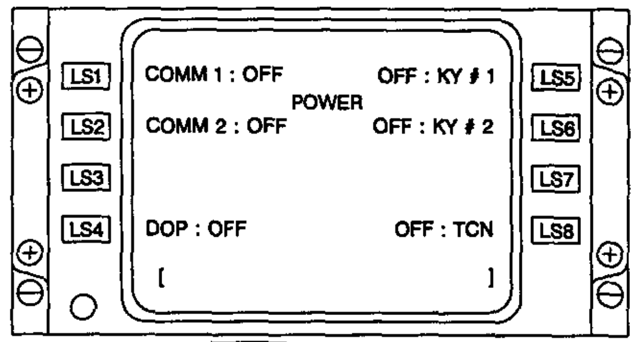
19.8.2.1 TNS CNU PWR Function Key.

The PWR function key (Figure 19-4) simultaneously turns on all systems controlled by the CCS and accesses the POWER page. When power is first applied to the CCS, the KY-58s and TACAN will start in the same on/off state that they were in at shutdown.

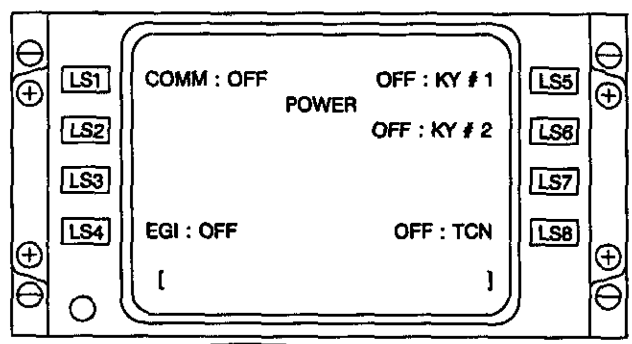
19.8.2.2 TNS CNU POWER Page.

The POWER page is accessed by pressing the PWR function key or LS 8 on the INDEX 1/2 page.

This page is provided to selectively turn on or off CCS-controlled equipment.



TNS POWER PAGE



CNU POWER PAGE

209000-51
J1413

LS 1: TNS Toggles the COMM 1, command radio, power ON/OFF.

CNU Toggles the COMM command and tactical radio power ON/OFF.

LS 2: TNS Toggles the COMM 2, tactical radio, power ON/OFF.

CNU Not used.

Note

TNS Although toggling COMM 1 will turn both radios on, ensure both COMM 1 and COMM 2 are turned ON/OFF together. If only the COMM 1 radio is turned ON, actions to the COMM 2 radio will result in a √ POWER indication.

CM Radio power can be controlled from either CDU. However, power control for the command radio is conducted internally through the pilot CDU and power control for the tactical radio is conducted through the copilot/gunner CDU. In the event of a CDU failure, the respective radio will become inoperative, i.e., pilot CDU/Command (COM 1) radio; copilot/gunner CDU/Tactical (COM 2) radio.

CNU With a failure of either CDU, both radios will continue to function.

LS 3: Not used.

LS 4: TNS Toggles the Doppler navigation system power ON/OFF.

CNU Toggles the EGI navigation system power ON/OFF.

LS 5: Toggles KY No. 1 power ON/OFF.

LS 6: Toggles KY No. 2 power ON/OFF.

LS 7: Not used.

LS 8: Toggles TACAN power ON/OFF.

19.8.3 TNS CNU Communication Functions.

19.8.3.1 TNS CNU COMM Radio Control Page.

The COMM radio control page is the initial communication page on the CDU. The COMM page is accessed by pressing the COM function key on the CDU. This page displays radio page access, current preset number tuned-to frequency, ID (preset label), net variable, modulation mode, and relay mode. The COMM 1 page (C1) is used to configure the command radio. The COMM 2 page (C2) is used to configure the tactical radio.

Radios may be tuned to a different frequency by:

1. Entering the preset number (single channel or CNU AJ) into the scratchpad and pressing LS 1 or 2.

Note

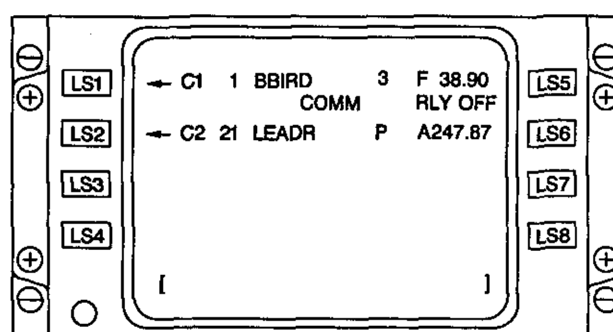
CNU If the LOAD PRESETS function is not executed after the change of an ARC-210, changes to the PRESETS page will occur only after selecting the channel.

2. Manually entering the frequency/modulation into the scratchpad and pressing LS 5 or 6.

Note

When entering UHF frequencies, FM/AM defaults to AM. To change to FM mode of UHF, F must be entered with or without the frequency (e.g., F238.9 or simply F). Entry of trailing zeros and the 5 for TNS 25 kHz/CNU 2.5 kHz increment is optional; the 5 will not be displayed.

3. Pressing LS 5 or 6 with a blank scratchpad will tune the radio to the previously tuned-to frequency.
4. CNU Entering the HAVEQUICK net number into the scratchpad and pressing LS 1 or LS 2.



TNS COMM RADIO CONTROL PAGE

209000-163-15
J1411

LS 1: The function of this key depends on the scratchpad contents:

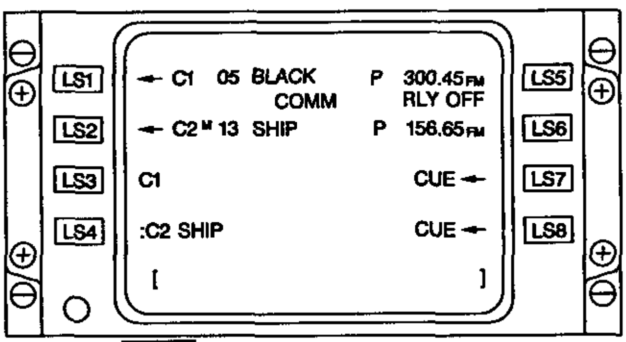
1. With a blank scratchpad, the line select key will access the COMM 1 MODES page.
2. If the scratchpad contains a valid preset, COMM 1 is tuned to the corresponding

frequency (including modulation mode, preset label, and net variable, if applicable). Valid presets for TNS are 1 through 32. Valid presets for CNU are 1 through 27, A1 through A27, M1 through 28, and M60 through M88.

Note

CNU SINCGARS nets are displayed as SXXX on the AH-1W. Other users may display the same net differently (i.e., S123 is the same net as F123).

CNU HAVEQUICK nets are displayed as HXXXXX on the AH-1W. Other users may present the same net differently (i.e., H00125 is the same net as A00.125, and H00x25 is the same as FMT Net x).



CNU COMM RADIO CONTROL PAGE

209000-163-13
J1411

3. CNU If TXXXX is entered, where XXXX is a desired SINCGARS wristwatch time and radio is currently tuned to a SINCGARS net, the new time will be set for the tuned net.

LS 2: Operates the same as LS 1 for the COMM 2 radio.

LS 3 and 4: TNS Not used.

CNU Displays AJ annunciations.

LS 5: The function of this line select key depends on the scratchpad contents:

1. If the scratchpad is empty, COMM 1 is tuned to the previously (last) tuned-to frequency, KY mode/net variable, or the modulation mode depending on the last change.

2. If the scratchpad contains a net variable in the range 1 to 6, the net variable for the COMM 1 KY-58 is changed to that number and displayed. The corresponding preset is updated to reflect the change on the COMM PRESETS page. The KY mode changes to CIPHER on the COMM 1 page when an NV is selected.

Note

There are six selectable net variables (1 through 6). The six net variables allow the KY-58 to be loaded with up to six different codes. Entering a C will result in the previous net variable or 1 (if no previous net variable was selected).

3. If the scratchpad contains the letter P (plain), the net variable display changes to P and COMM 1 is changed to the PLAIN TEXT: KY mode.

Note

If RELAY is selected ON, the COMM 2 net variable changes to reflect the COMM 1 net variable.

4. If the scratchpad contains a valid UHF or VHF frequency, COMM 1 is tuned to that frequency, the preset number changes to M, and COMM 1 changes to the plain text mode indicated by a P in the net variable column.

Note

When entering UHF frequencies, FM/AM defaults to AM. To change to FM mode of UHF, F must be entered with or without the frequency (e.g. F238.9 or simply F). Entry of trailing zeros and the 5 for TNS 25 kHz/CNU 2.5 kHz increment is optional; the 5 will not be displayed.

5. If the scratchpad contains the letter L (load), the KY load function is enabled and the net variable display changes to L.

6. If the scratchpad contains the letter R (receive) followed by an optional net variable, the receive code mode is enabled and a superscript R is displayed next to the net variable (function not used).

7. If the scratchpad contains the letter C (cipher), the KY mode is changed to cipher text, defaulting to the last net variable. KY mode changes (plain text, cipher text, load

code, and receive code) will be reflected on the COMM 1 (and 2) mode pages.

8. CNU If the scratchpad contains the letter S (SCAN), the radio will enter the SCAN mode.

LS 6: This select operates the same as LS 5 for the operation of the COMM 2 radio.

LS 7: TNS Not used.

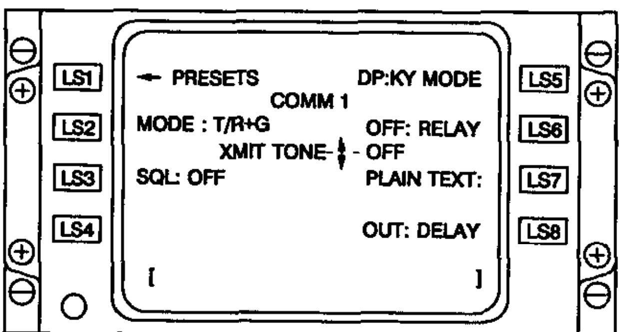
CNU Tunes COMM 1 to SINCGARS CUE frequency.

LS 8: TNS Not used.

CNU Tunes COMM 2 to SINCGARS CUE frequency.

19.8.3.2 TNS COMM 1 Modes Control Page.

The COMM 1 modes control page is accessed by pressing LS 1 on the COMM page with a blank scratchpad.



TNS COMM 1 MODES CONTROL PAGE

209000-45
J1413

LS 1: Accesses the COMM 1 PRESETS 1/8 page.

Note

TNS The ARC-182 COMM 1/COMM 2 PRESETS pages use the same list. COMM 1 PRESETS or COMM 2 PRESETS is displayed to eliminate confusion when using the preset list to tune the selected radio.

LS 2: Toggles COMM MODE among transmit/receive and monitor guard frequency (G) enabled (T/R+G), transmit and receive on guard frequency (GD), and transmit/receive (T/R) only. When GD is selected, 40.5 mHz (VHF-FM), 121.5 (VHF-AM), 156.8 (VHF-FM), or 243.0 (UHF-AM) will be tuned in PLAIN TEXT and displayed on the top level comm page, depending on the COMM 1 operating band; and the KY-58 mode control toggles to PLAIN TXT.

Note

When MODE: GD is selected or the pilot/copilot EMER UHF 243.0 switch is activated, the COMM page data cannot be changed. Reselecting the COMM MODE to T/R or T/R+G results in both radios returning to the previous condition in the plain text mode.

Manual or preset frequencies cannot be selected from the applicable radio COMM page when MODE: GD is selected on the COMM 1 or COMM 2 page.

Information Line: Pressing the up or down arrow scroll keys transmits a 1020 kHz tone on COMM 1. The tone sounds for 4 to 5 seconds after a key is released. The function becomes enabled and toggles ON when either of the scroll arrow keys is pressed and held. OFF displays when a key is released.

LS 3: Toggles COMM 1 squelch (SQL) ON or OFF.

LS 4: Not used.

LS 5: Toggles baseband (BB) or diphase (DP) secure voice unit condition modes for the No. 1 radio.

Note

BB and DELAY:IN are the modes normally used for secure communications.

LS 6: Toggles the RELAY (retransmit) function between COMM 1 and COMM 2 ON and OFF. Selecting the COMM 1 RELAY function ON activates the COMM 2 RELAY and ON displays on COMM 2. Selecting ON also causes the TXT mode (PLAIN or CIPHER) of COMM 2 to match COMM 1. The RELAY mode is also indicated on the COMM page.

Note

Cipher to plain, or plain to cipher retrans will not function.

LS 7: Toggles COMM 1 KY between plain text (PLAIN TXT), cipher text (CIPHER TXT), LOAD CODE, or receive code (RCV CODE). Modes display on COMM pages as P, net variable (1 thru 6), L, or R, respectively. LOAD function removes

KY-58 from the remote control mode so the code input gun operates. PLAIN TXT displays when the guard mode is selected.

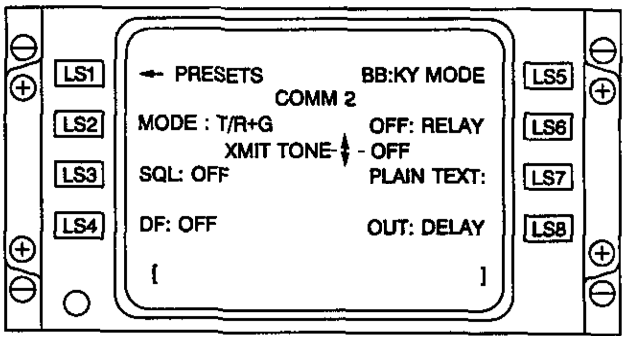
Note

If the KY mode is changed to CIPHER on the COMM 1 mode page, the net variable defaults to the previously used net variable for the frequency.

LS 8: Toggles DELAY between IN (extended preamble length) and OUT (standard preamble length) for COMM 1 KY-58.

19.8.3.3 TNS COMM 2 Modes Control Page.

The functions on the COMM 2 page are the same as the COMM 1 page except the DF: ON/OFF displayed at LS 4. This function is inoperable. UHF DF is selected via the NAV control panel (command radio only).

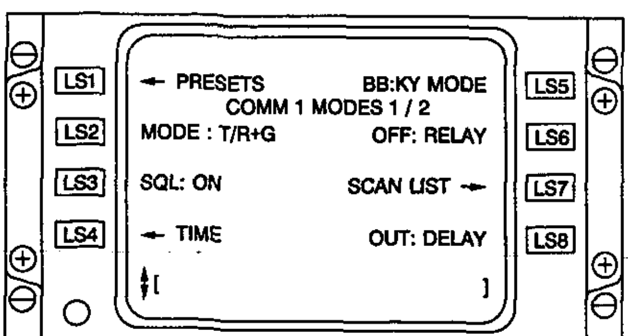


TNS COMM 2 MODES CONTROL PAGE

209000-163-1
J1411

19.8.3.4 CNU COMM 1 MODES 1/2 Page.

The COMM 1 MODES 1/2 page is accessed by pressing LS 1 on the COMM page with a blank scratchpad.



CNU COMM 1 MODES 1/2 PAGE

209000-163-12
J1411

LS 1: Accesses the PRESETS/AJ PRESETS pages.

Note

PRESETS pages 1/7 - 7/7 are accessed when the radio is tuned to a single channel frequency.

AJ PRESETS pages 1/7 - 7/7 are accessed when the radio is currently tuned to an anti-jam preset.

The command and tactical radios may each be loaded with 25 single channel and 25 anti-jam CUE and COLD start presets. The presets may be different between radios. Fifty-seven maritime frequencies are permanently stored within each radio and cannot be changed.

LS 2: Toggles COMM MODE among transmit/receive (T/R), transmit/receive and monitor guard frequency (T/R+G), and transmit and receive on guard (GD) frequency. When GD is selected, 40.5 mHz (VHF-FM), 121.5 (VHF-AM), 156.8 (VHF-FM), or 243.0 (UHF-AM) will be tuned in PLAIN TEXT and displayed on the top level comm page, depending on the COMM 1 operating band; and the KY-58 mode control toggles to PLAIN TXT.

Note

When MODE:GD is selected or the pilot/copilot EMER UHF 243.0 switch is activated, preset labels on the COMM page will change to GUARD and the COMM page data cannot be changed. Reselecting the COMM MODE to T/R or T/R+G results in both radios defaulting to the previous condition in the plain text mode.

When the pilot/copilot EMER UHF 243.0 switch is activated with the ARC-210 radios turned off, the radio will turn on and tune to 243.0 but the CDU COMM page will not display the frequency.

LS 3: Toggles COMM squelch (SQL) ON and OFF.

LS 4: Accesses the radio TIME page.

LS 5: KY mode: BB/DP toggle.

LS 6: Toggles the RELAY (retransmit) function ON and OFF between COMM 1 and COMM 2. Selecting the COMM RELAY function ON activates the retransmit function for both radios. When the RELAY mode is selected, the TXT mode (PLAIN or CIPHER) of the other radio will be changed to match. The relay mode selection also indicates on the COMM page.

LS 7: Accesses the radio SCAN page.

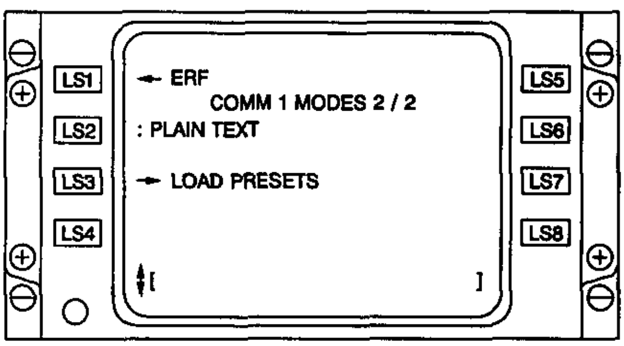
LS 8: Toggles KY DELAY between IN (extended preamble length) and OUT (standard preamble length).

Note

Baseband (BB) and DELAY:IN are the KY defaults and are normally used for anti-jam (AJ) communications.

19.8.3.5 CNU COMM MODES 2/2 Page.

The COMM 1 MODES 2/2 page is accessed by scrolling ↓ or ↑ from COMM 1 MODES 1/2 page.



CNU COMM 1 MODES 2/2 PAGE

209000-163-10
J1411

LS 1: Accesses the SINCGARS ECCM remote fill (ERF) page.

LS 2: Toggles KY radio between PLAIN TEXT, CIPHER TEXT, LOAD and RCV CODE modes.

LS 3: Initiates radio-to-CDU preset load.

The AN/ARC-210(V) and AH-1W Comm/Nav Upgrade utilize an AN/CYZ-10 data transfer device (DTD) for communication system configuration. The CYZ-10 radio presets are stored and maintained in the AN/ARC-210(V) memory. Preset labels however, are stored and maintained within the CDU.

The LOAD PRESETS function is used to load radio presets to the CDU. Selection following radio replacement will download preset frequencies stored in the radio to the CDU, allowing display of the correct communication presets.

Note

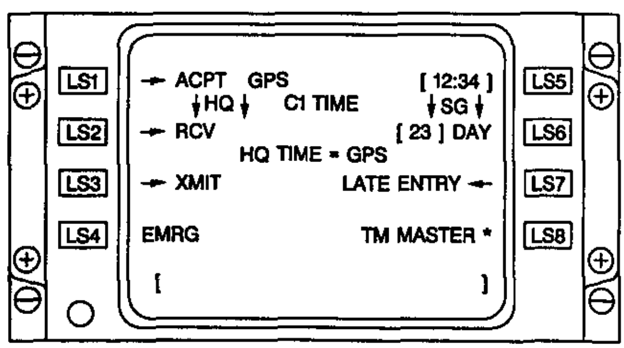
Because preset labels are stored within the CDU and are not loaded by the CYZ-10 or during the LOAD PRESETS function, labels may not match the newly loaded frequencies.

If LOAD PRESETS has not been executed and the presets displayed on the CDU do not match what is loaded on the ARC-210, the CDU-displayed information will update when each individual preset is selected, preset is manually changed (radio information will be changed also), or LOAD PRESETS function is selected.

LOAD PRESETS will normally be performed by maintenance personnel following a CDU or radio change.

19.8.4 CNU C1 TIME Page Description.

The TIME page display and LS keys are divided by function. The left side LS keys are dedicated to radio and HAVEQUICK functions while the right side LS keys are SINCGARS-unique controls. The only interrelation between SINCGARS and the left side controls is when radio time is first initialized.



CNU C1 TIME PAGE

209000-163-8
J1411

Display Line 4 displays the source of HaveQuick and radio time:

NO HQ TIME - indicates the radio time has not been initialized since power-up. NO TIME is also displayed on the COMM page adjacent to LS 3/LS 4 when an AJ preset is selected but radio time has not been initialized.

AWAITING GPS TIME - indicates GPS time is available and selected, radio is initializing/re-initializing using GPS UTC time.

HQ TIME = GPS - indicates the radio is initialized to GPS UTC time.

AWAITING RF TIME - indicates the radio is awaiting time/time update via radio transmission. A 1kHz audio beep is heard in the headset and display changes to HQ TIME = RF when complete.

HQ TIME = RF - indicates the radio is initialized utilizing RF time.

HQ TIME = EMRG - indicates the radio was initialized to the time and date (OpDay) set on the START Page. The time and date set on the START Page are also called CCS Time.

19.8.4.1 CNU Radio/HAVEQUICK Time.

Radio/HaveQuick time and functions are on the left side of the CDU display. The source of radio/HaveQuick time is displayed on display line 4.

LS 1 ACPT GPS - Commands the radio to accept GPS Universal Time Coordinated (UTC) time via the Precise Time and Time Interval (PT-TI) discrete interface with the EGI.

Note

The inward arrow at LS 1 is not displayed when GPS time is not available.

LS 2 Receive (RCV) - Used to re-initialize the radio's time reference within an established anti-jam net. The time transmitter may be an AUTO TOD transmitter or any other HAVEQUICK-capable station. The time transmitter and receiver must be on same single channel frequency or HAVEQUICK net, and time must be transmitted within 5 seconds of LS 2 RCV selection. The RF TIME RCV function must be performed in the PLAIN TEXT mode. It is not available or selectable when in a SINCGARS mode.

When selected, an * replaces the inward arrow and AWAITING RF TIME is displayed on Display Line 4. When RF time is received, an audio beep (1 kHz) is heard in the headset and the display changes to HQ TIME = RF. The asterisk is replaced with an inward arrow. If RF time signal is not received within 5 seconds, LS 2 must be pressed to deselect RCV and pressed again to re-initiate the Receive Time function.

RCV is automatically deselect(ed) and the inward arrow returns if no time signal is received within 60 seconds.

LS 3 RF Time Transmit (XMIT) - Used to synchronize another radio's time reference to this radio. During RF time XMIT functions, the radio must be tuned to a fixed frequency or HAVEQUICK AJ preset that matches the RF time receiver. The time transmitter and receiver must be on the same hopset/frequency, and time must be transmitted within the appropriate time constraints of the receiving radio. In the AH-1W, time must be received within 5 seconds of LS 2 RCV selection. The RF TIME XMIT function must be performed in PLAIN TEXT mode only. It is only available when the radio is tuned to a single channel frequency or HAVEQUICK AJ preset. It is not available or selectable when in a SINCGARS mode.

When selected, an * replaces the inward arrow, and time is transmitted. The function is deselect(ed) automatically after 5 seconds, and an inward arrow returns.

LS 4 Emergency (EMRG) Time - Used when GPS or RF time sources are not available and anti-jam communications are required. EMER time is often used with COLD start and RCV time. This function is only available when the radio time has not already been initialized.

If available, an inward arrow and NO HQ TIME are displayed. When selected, the radio time is initially set to 00:00:00.00 and the operational day is set to 00. Five seconds later, HAVEQUICK and SINCGARS will be set to the time and date set on the START Page.

Note

Once one aircraft has conducted an Emergency Time Start, that aircraft would then RF the time to the other net member.

19.8.4.2 SINCGARS Time and Function Keys.

SINCGARS time and functions are on the right side of the CDU display.

SINCGARS requires precise time synchronization to operate, but the synchronization requirement is less stringent than that of HAVEQUICK. SINCGARS is designed to allow a radio to automatically synchronize time even with an inaccurate initial time. The time associated with a SINCGARS net may be different for every net. Once a net is synchronized and operating, the unique time is stored with that net within the particular radio.

LS 5 Base Time - Time is displayed in brackets and only when the radio is tuned to a SINCGARS AJ preset. "[--:--]" is displayed when the radio is tuned to HAVEQUICK or a single channel frequency. The SINCGARS base time reflects the source used to initialize the radio's time (displayed on display line 4).

LS 6 Mission Day - Mission Day is displayed in brackets and only when a SINCGARS AJ preset is selected. [--] is displayed when the radio is tuned to HAVEQUICK or a single channel frequency. The Mission Day reflects the source used to initialize the radio (displayed on display line 4).

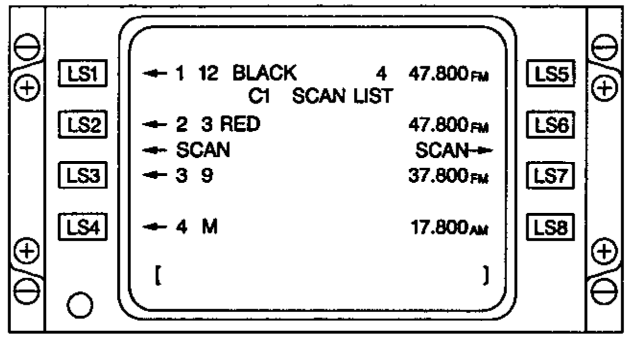
LS 7 LATE ENTRY - Expands the ability to synchronize SINCGARS when time differences are outside the normal limits. Available only when a SINCGARS AJ preset is selected. LATE ENTRY is selectable from the TIME page or COMM page LS 3/LS 4. Selecting LATE ENTRY deselects TIME MASTER.

LS 8 TIME MASTER - Provides control of SINCGARS net time. Available only when a SINCGARS AJ preset is selected. When time master is selected, the SINCGARS net time is updated during normal transmissions by the time master. Time master is automatically deselect(ed) when late entry is selected. The AH-1W will not normally operate in the time master mode.

19.8.5 CNU SCAN LIST Page.

The SCAN function is used to simultaneously scan up to four single channel frequencies.

The SCAN LIST page is accessed from the COMM MODE 1/2 Page, LS 7 SCAN LIST. SCAN LIST page displays the four scan frequencies and associated NV and label identifiers. SCAN LIST position 1 is the priority scan frequency. The NV associated with the priority scan frequency controls the NVs for the three remaining scan frequencies. Single channel frequencies can be assigned manually using LS 5 through LS 8, or the operator can enter an associated preset position number in the scratchpad and select LS 1 through LS 4. The preset label assigned to a preset position is also displayed on the scan list page. The command and tactical radios feature independent scan lists.



CNU SCAN LIST PAGE

209000-163-11
J1411

The SCAN mode is activated by pressing any LS key on the SCAN LIST page with a blank scratchpad. After selecting SCAN, the CDU screen will automatically return to the COMM page.

SCAN may also be commanded from the COMM page by typing an "S" into the scratchpad and selecting the desired radio using the right LS key. When SCAN is initially selected, the radio will initially lock onto the priority frequency.

When a transmission is detected on a SCAN LIST frequency, the radio reception will remain locked on that frequency for 4 seconds after transmission ends. While scanning, the frequency/preset label displayed on the COMM page is the last locked frequency.

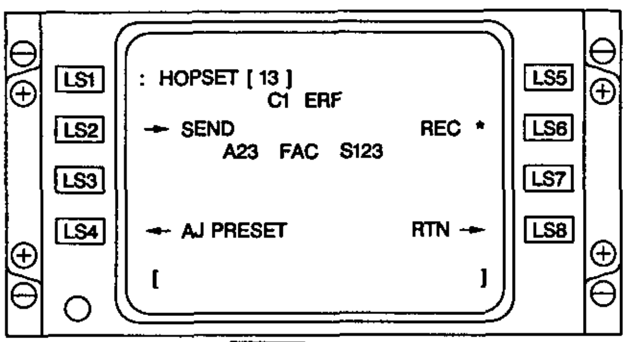
The transmission frequency on the scanning radio depends on whether it is locked or scanning. While the radio is scanning, transmission will occur on the priority frequency. While the radio is locked, transmission will occur on the locked frequency.

To exit the SCAN mode, press the appropriate right LS on the COMM page and the radio will tune to the last locked frequency.

19.8.6 CNU SINCGARS ERF Page.

ERF is a method of remotely filling or updating a radio station with a different load set.

The ERF Page is accessed from the COMM MODES 2/2 Page, LS 1 ERF. It is used and is accessible only when a SINCGARS net is selected.



CNU ERF PAGE

209075-787
J1410

LS 1 - HOPSET/LOCKOUT - Toggles ERF function between HOPSET and LOCKOUT when the scratchpad is empty. HOPSET is the AJ preset to which the ERF will store. LOCKOUT is a table of frequencies on which the radio will not hop and is not normally selected in the AH-1W.

Manually enter an AJ preset number (without the preceding A) corresponding to the position which the ERF will SEND from or RCV to. The bracketed number will change to reflect scratchpad contents. Valid hopset entries are between 1 and 25, while valid lockout entries are between 1 and 8.

Note

The scratchpad displays an HQ SELECTED advisory if an HQ AJ preset position is entered/displayed and SEND is selected.

ERF RCV must be selected prior to the other station transmitting in order for a successful ERF function to occur.

LS 2: SEND - Initiates the ERF send command. Send command signal is active for 2 seconds, during which an inward arrow is replaced by an *.

LS 4: AJ PRESET - Accesses AJ PRESET pages.

LS 6: RCV - Initiates the ERF receive command. Receive command signal is active until deselect(ed) by the pilot or 1 minute has elapsed. An outward arrow is replaced by an * while receive mode is active.

LS 8: Return (RTN). Returns COMM MODES 2/2 page display.

19.8.7 TNS CNU COMM PRESETS Page.

The COMM presets pages of TNS and CNU are identical in display and operation with the exception that:

TNS Each COMM 1 (or 2) PRESETS page provides access to 4 preset frequencies, with a total of 32 available presets.

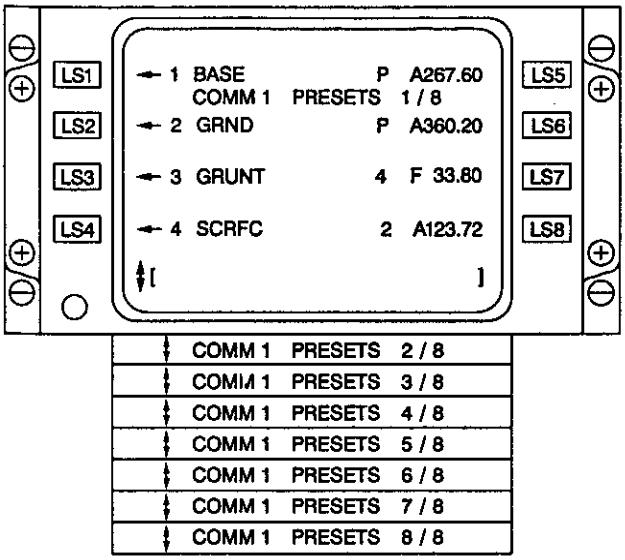
CNU A total of 27 presets for each individual radio are available on 7 pages. Twenty-five presets are for single channel frequencies, while preset positions 26 and 27 are dedicated to SINCGARS CUE and COLD start frequencies. Each radio is capable of individual preset lists, allowing two unique frequency lists to be developed.

Note

TNS COMM 1 PRESETS and COMM 2 PRESETS pages are the same list; COMM 1 PRESETS or COMM 2 PRESETS are displayed to eliminate confusion when using the preset list to tune the selected radio.

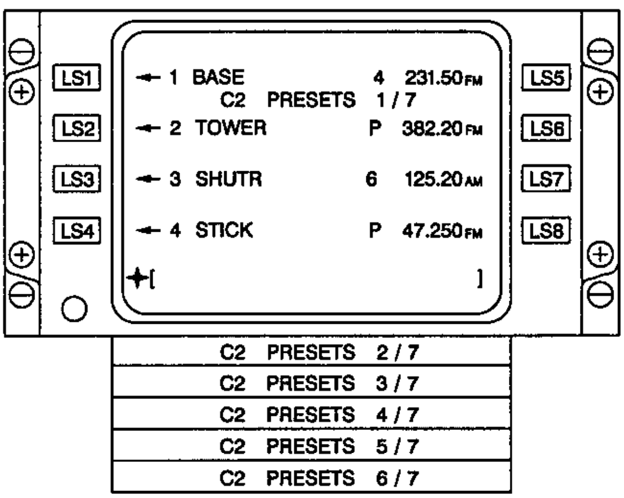
CNU C1 or C2 PRESETS pages will initially be accessed if the radio is tuned to a single channel frequency (manual or preset). If the radio is tuned to an AJ preset, the AJ PRESETS pages will be accessed initially. Selecting the ← or → keys will scroll from the particular radio's COMM PRESETS to the AJ PRESETS page.

COMM 1 or COMM 2 PRESETS pages are accessed by pressing LS 1 on either the COMM 1 or COMM 2 page.



TNS COMM 1 PRESETS PAGE

209000-46
J1413



CNU C2 PRESET PAGES

209000-163-14
J1411

Title Line: Displays COMM 1 PRESETS when the presets page is accessed from the COMM 1 page. When the presets page is accessed from the COMM 2 page, line 2 displays COMM 2 PRESETS.

Note

TNS COMM 1 PRESETS and COMM 2 PRESETS pages are the same list; COMM 1 PRESETS or COMM 2 PRESETS are displayed to eliminate confusion when using the preset list to tune the selected radio.

LS 1 through 4: The function of LS 1 through LS 4 depends on the contents of the scratchpad:

1. If the scratchpad is empty, the applicable COMM radio is tuned to the preset data corresponding to the line select key and the page display is changed to the COMM page.
2. If the scratchpad contains any string of one to five alphanumeric characters, the label for the corresponding change is changed to these characters.

LS 5 through 8: The function of LS 5 through LS 8 depends on the contents of the scratchpad:

1. If the scratchpad contains a valid frequency, the frequency of the corresponding channel is changed to the scratchpad contents. For UHF presets, the FM modulation (F) must be entered manually either preceding the UHF frequency or by just entering an F to an existing UHF frequency. **TNS** F or A is displayed followed by the frequency with two digits to the right of the decimal point. **CNU** Displays three digits to the right of the decimal point followed by half-height modulation selection.
2. If the scratchpad contains a net variable between 1 and 6 (inclusive), the net variable for the corresponding channel is changed.
3. If the scratchpad contains P, the frequency will be plain text.

4. If the scratchpad contains C, the KY mode will be changed to cipher text, defaulting to the last net variable.

Note

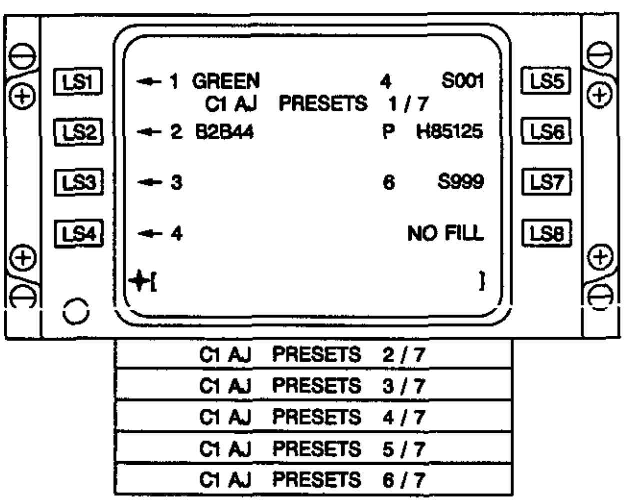
VHF-FM frequencies will result in modulation defaulting to F. For VHF-AM and UHF frequencies the default is A.

The COMM PRESETS page is scrollable up or down from the COMM PRESETS 1/8 page to COMM PRESETS 8/8 in a wraparound fashion. Accessing this page results in display of the page last viewed.

19.8.8 CNU AJ PRESETS Pages.

27 Anti-jam presets are available for each individual radio. AJ preset positions 26 and 27 are reserved for the SINCGARS CUE and COLD start functions.

The AJ PRESETS pages are accessed by scrolling left or right from the COMM PRESETS pages, or from the COMM page by selecting LS 1 or 2 with an AJ preset selected.



CNU C1 AJ PRESET PAGES

209000-163-16
J1411

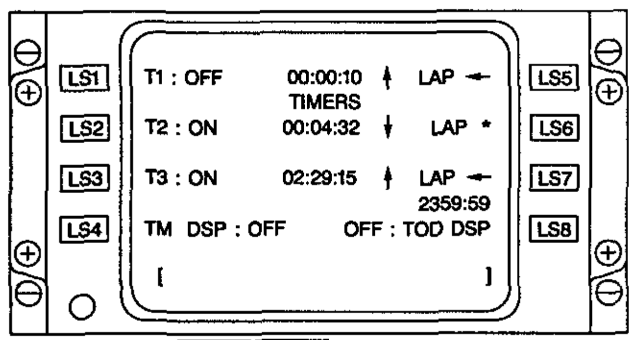
There are 7 scrollable AJ preset pages containing 25 hopsets. Preset labels and NVs are not included as part of the AN/CYZ-10 fill data, thus requiring the pilot to manually assign each as desired. Line select keys function similarly to those on the COMM PRESETS page.

HAVEQUICK hopset AJ preset positions may be manually modified by the pilot by entering HXXXXX (where XXXXX is the net identification number) in the scratchpad and pressing the appropriate left LS key.

19.8.9 TNS CNU TIMERS Page.

The TIMERS page is used to control the three event timers and to enable the Timer/Time-of-Day display for the CDU annunciation line and the HUD.

The TIMERS page is accessed by pressing LS 4 on the INDEX 1/2 page.



TNS CNU TIMERS PAGE

209000-49
J1413

LS 1 through 3: The function of these line select keys depends on the scratchpad contents:

1. Pressing with a blank scratchpad toggles the timer ON/OFF.

2. A zero in the scratchpad resets the timer to 00:00:00, turns the timer off, designates the up-counter arrow display, and resets the LAP function.

3. Pressing with a number in the scratchpad sets the timer, turns the timer on, designates the down arrow display and resets the LAP function. The format for time entry is: 100 = 1 hour; 1 = 1 minute; .01 = 1 second, with the range 0.01 to 959.59 (e.g., entering 20 in the scratchpad sets the timer to 20 minutes). The down-count to zero triggers a √ TIMER N annunciation (where N indicates timer 1, 2, or 3) on line 6 and a √ CDU annunciation on the HUD.

LS 4: Toggles the timer display (TM DSP) on the annunciation line ON/OFF. When selected ON, an active timer will have priority over TOD (if selected) for display on the CDU and HUD. For multiple active timers, the priority for display will go to the lower numbered timer 1, 2, 3.

LS 5 through 7: Enables/disables the timer T1, T2 and T3 (respectively) LAP freeze display. When the LAP display is frozen, an * is displayed next to LAP. Timers will continue to count up/down. When the LAP display is unfrozen, timer display will resume. This will not freeze HUD or CDU annunciation line display.

Annunciator: Timer or TOD is displayed on the annunciation line on all pages when DSP is toggled to ON from LS 4/LS 8. If a status message is presented when time display is selected, the annunciation and time display will alternate until the annunciation is cleared.

LS 8: Toggles the time of day DISP on the annunciation line between ON and OFF. TOD will also be displayed on HUD when no other timers are active with timer display on.

19.8.10 TNS CNU Zeroize Functions.

Data "externally" entered into the CCS, EGI, radios, KY-58, and MDL can be zeroized by CDU ZEROIZE pages and the INS ZEROIZE switch in the pilot cockpit. Zeroize can be used to erase COMSEC material to prevent capture, to quickly erase navigation or communication data which is no longer useful, and to initialize components which are not functioning properly.

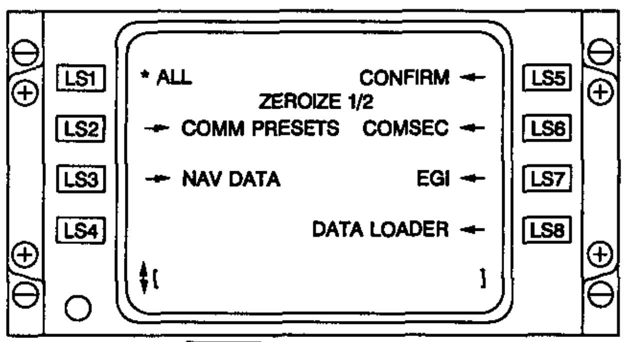
Note

> Use of the ZEROIZE switch or LS 1 on both ZEROIZE pages erases all externally entered data from the EGI NVM, radios, KYs and MDL. This is an emergency function that causes a complete lock-up of the CDU after data erasure. The CCS functions can be regained through execution of the recovery from zeroize procedures.
>
> ZEROIZING does not affect the ALMANAC data stored in the EGI NVM.

With the few exceptions listed below, display and operation of the ZEROIZE pages are identical in TNS and CNU .

19.8.10.1 TNS CNU ZEROIZE 1/2 Page.

The ZEROIZE pages are accessed by pressing LS 5 on the INDEX 1/2 page. The TNS and CNU displays are identical except EGI is not available on the TNS display. This page is scrollable up or down to the ZEROIZE 2/2 page.



CNU ZEROIZE 1/2 PAGE

209075-755-24
J1410

Pressing a line select key toggles the display of an asterisk beside the function selected to be zeroized and puts a * CONFIRM? message in the scratchpad until the selection is confirmed via LS 5 or is reset with the CLR key. Deselecting the asterisk is accomplished by pressing the LS again, leaving the page, or clearing the scratchpad. If no action is taken within 5 seconds, the scratchpad is cleared and the asterisk is changed to an in-arrow. Pressing LS 5 with the asterisk displayed next to a function will zeroize the selected data and ZEROIZED will appear in the scratchpad until cleared with the CLR key or overwritten with a new * CONFIRM? message.

LS 1: Selects zeroization of the entire CCS (waypoints, targets, routes, etc) as well as radios, KY-58s and CNU EGI CVs, if turned on. TNS This is intended to be an emergency function and the CCS will lock up after performing the erase.

Note

When ALL is selected, all COMM presets, secure net variables, and NAV data will be zeroized.

The system will default to the following default list:

- All Single Channel Presets: FM 33.00
- TIMERS: 00:00, tacan 126X, CNU WGS-84
- TNS DOPPLER - SEA
- CNU All A-J Presets to NO FILL
- CNU NTS : NOT INSTALLED.

LS 2: Selects single channel and CNU AJ preset data for both radios as well as other COMM data to be erased. This data includes labels, KY-58 text mode and NV, fill status, net number, waveform, frequency and modulation, currently and last tuned to anti-jam/single frequency/maritime/manual/guard mode selection, and scan channel data. This selection also sends a command to the radios to erase their NVM data, including fill data, CNU WODs, etc.

LS 3: Selects all navigation lists to be erased, including flight plan, waypoints, targets, routes, and PIM.

LS 4: Not used.

LS 5: Confirms the zeroization of a selected item.

LS 6: Selects KY-58 COMSEC data to be erased from the CCS, including single channel presets, frequency currently tuned to, and last tuned to text modes, mode, NVs, power, delay settings, and CNU AJ preset. This selection also sends a command to the KY-58s to erase their NVM data (i.e., keys).

LS 7: TNS Not used.

CNU Sends erase command to EGI.

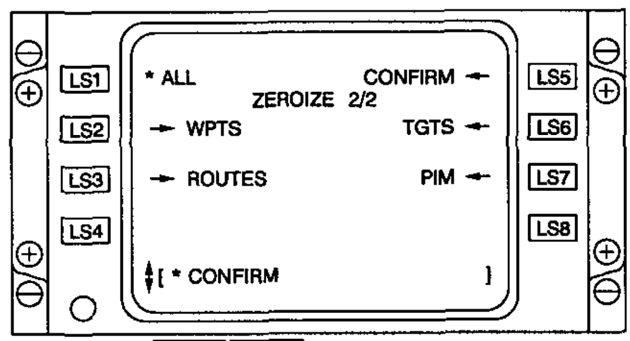
LS 8: Not operational.

Note

After confirming zeroize, ALL ZEROIZED cannot be cleared from the scratchpad using the CLR key.

19.8.10.2 TNS CNU ZEROIZE 2/2 Page.

The TNS and CNU displays are identical. This page is scrollable up or down to the ZEROIZE 1/2 page.



TNS CNU ZEROIZE 2/2 PAGE

209000-50
J1413

LS 1: Same as ZEROIZE 1/2 Page.

LS 2: Selects all WPTs to be zeroized when no waypoints are in use in the routes and/or flight plan lists. When waypoints are in use in the routes and/or flight plan lists, the waypoints will still be selected to be zeroized, but an annunciation IN USE BY ... message will appear in the scratchpad.

LS 3: Selects all ROUTES to be zeroized.

LS 4 and 8: Not used.

LS 5: Same as ZEROIZE 1/2.

LS 6: Same as LS 2 for TGTS.

LS 7: Same as LS 2 for PIM.

19.8.10.3 TNS CNU Emergency Zeroize Procedures.

This is an emergency function and will freeze keyboard functions which can only be reset by powering down and up again. The ZERO INS switch (Figure 19-2, sheet 2) erases all COMM presets, secure net variables, and NAV presets.

ZERO INS switch — ZERO INS, or ZEROIZE ALL on either Zeroize page (IDX, ZEROIZE (LS 5), ALL (LS 1) and within 5 seconds, CONFIRM (LS 5)).

Note

To fully ZEROIZE, the power to the CCS must remain on for approximately 30 seconds or until both CDU screens blank.

2. ICU NO. 2, ICU NO. 1, PLT CDU, and GNR CDU circuit breakers — OUT.
3. ICU NO. 2, ICU NO. 1, PLT CDU, and GNR CDU circuit breakers — IN.

Note

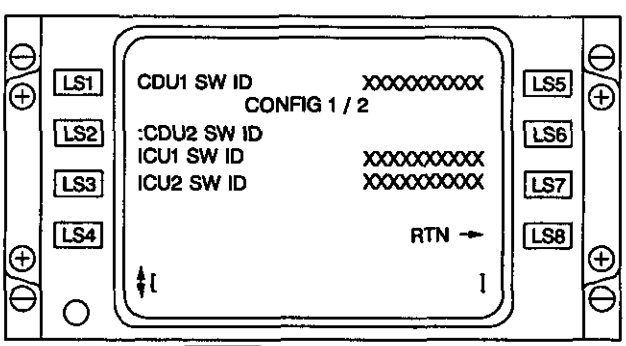
A 6 minute interval with power applied is required for microprocessors within the ICU No. 1, ICU No. 2, and CDU to reload the operating system after zeroize procedure has been completed. Do not use the CCS during this software reloading process.

4. Steps 2 and 3 — Repeat after 6 minutes.
5. CONFIG Page — Set up as required.
6. CCS and Comm/Nav data — Enter as required.

19.8.11 TNS CNU CONFIG Pages.

The CONFIG pages display the configuration for the software resident in the CDUs, ICUs, and CNU AN/ARC-210(V), and EGI. Two pages are used for each configuration.

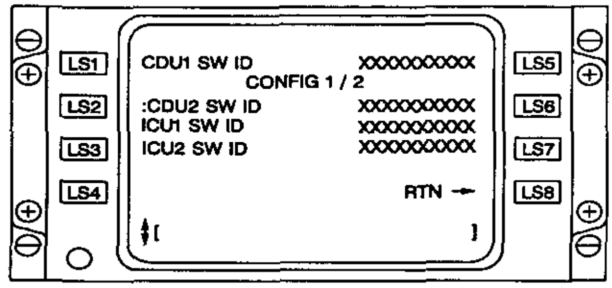
The CONFIG pages are accessed from LS 8 on the MAINT TEST. The CONFIG pages are scrollable up and down.



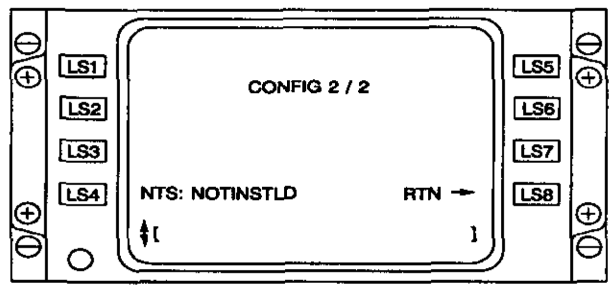
TNS CONFIG 1/2 PAGE

209000-163-9
J1411

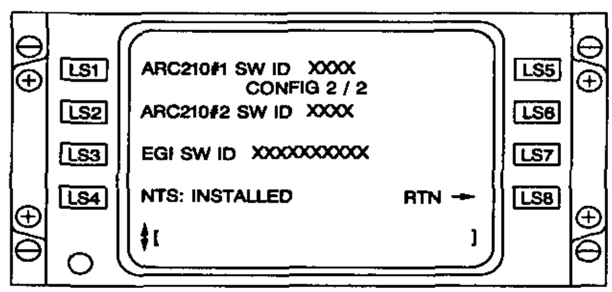
TNS CM LS 2 displays a colon (:), allowing selection of CDU2: NOT INSTALLED. This selection should be made on TNS configured aircraft.



CNU CONFIG 1/2 PAGE



TNS CONFIG 2/2 PAGE



CNU CONFIG 2/2 PAGE

209000-163-18
J1411

LS 4 selects NTS : INSTALLED or NOT INSTALLED. Incorrect configuration of NTS will prevent navigation information from being passed between the NTS and the CCS. Features such as target coordinates will not be available. TNS

NTS will be displayed and selectable, but will have no effect.

Note

Toggling LS 4 to the wrong configuration results in √ CONFIG on the CDU, or a BUS A/BUS B NOGO on the status 3/3 page.

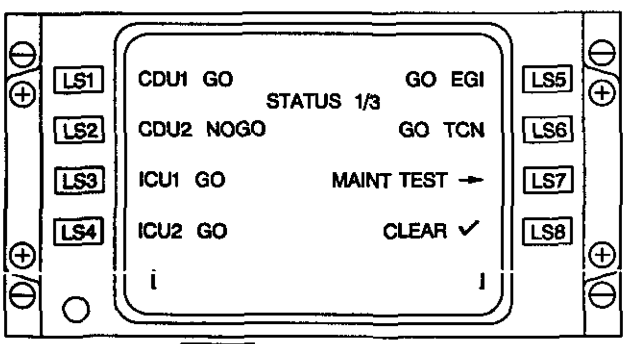
19.8.12 TNS CNU STATUS Pages and Functions.

The STATUS function displays avionic equipment status and provides access to maintenance test pages. Messages are displayed on the CDU line above the scratchpad. For a list of messages and CDU annunciations, refer to Table 19-3.

STATUS pages for TNS and CNU are identical, except where noted below.

19.8.12.1 TNS CNU STATUS 1/3 Page.

The STATUS pages are accessed by pressing the STAT function key, displaying the page which most recently had a status update. The STATUS pages are scrollable using the up and down arrow keys. The TNS and CNU displays are identical except where noted.



CNU STATUS 1/3 PAGE

209075-755-44
J1410

LS 1-6: Displays the status of each component as GO or NOGO. A √ STATUS annunciation is displayed on the scratchpad/annunciation line if any failure of the unit has occurred, which advises the pilot to check the status page for the cause of the message. A checkmark will be displayed next to the responsible component. The message may be cleared either by pressing the CLR key or LS 8. When a minus is entered, the √ STATUS annunciations are inhibited for future failures of that unit until reactivated by again entering a minus and selecting a line key. Selection of a line key with a blank scratch pad clears the checkmark for that unit.

LS 5: TNS Displays Doppler status.

CNU Displays EGI status.

LS 7: Accesses the maintenance test pages when the Ground/Air discrete is in Ground mode.

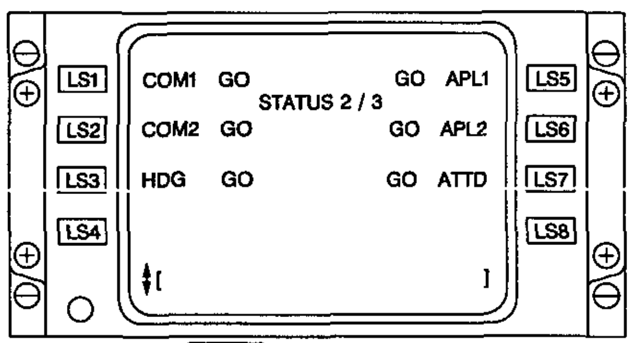
Note

MAINT TEST is not allowed when the helicopter is in flight and the GND/AIR/NORM switch is in the AIR or NORM position.

LS 8: Clears all checkmarks.

1. BAN — Blinks alternately with the timer display annunciation (for right justified annunciation except for timer display annunciation). Otherwise non-blinking.
2. BL — Blinks at an approximate 1 second rate.
3. BT — When time of day (TOD) display is on, blinks alternately with TOD. Otherwise blinks normally as BL type.
4. NOT — Non-blinking.

19.8.12.2 TNS CNU STATUS 2/3 Page.



CNU STATUS 2/3 PAGE

209000-163-7
J1411

LS 1, LS 2, LS 3, and LS 7: Displays status of each component as a GO or NOGO.

LS 5 and 6: TNS Not used.

CNU APL1 and APL2, refers to the ARC-210(V) radio anti-jam circuitry.

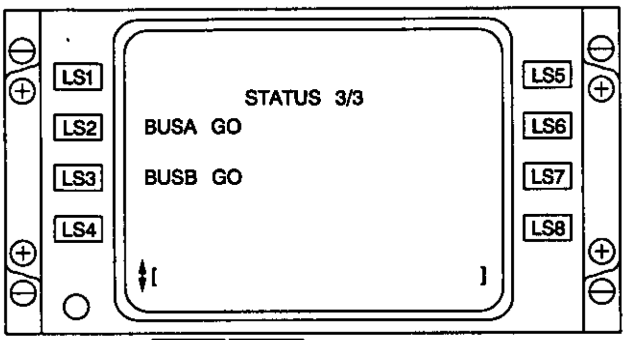
TABLE 19-3. CDU ANNUNCIATIONS

MESSAGE	TYPE	CONDITION
√ Config	BT	Configuration data does not match installed equipment.
√ NAV CNU	BT	When INS or GPS has failed with correct solution mode.
√ PSN IDX TNS	BT	Position index greater than 2 nmi.
√ POS FM CNU	BT	GPS/INS FM greater than 200 m; INS FM greater than 1000; or GPS FM greater than 8.
√ STATUS	BT	Detected failure of a component or interface signal. Reset with CLR key or valid status. Individually disabled by entry of a minus (-).
√ TIMER	BT	Down count to zero completed on one of the three timers.
CUE 1 (2) CNU	BT	Radio 1 (2) detects transmission on the CUE channel. Annunciation is associated with aural tone in headset.
DEAD RECKON	NOT	NAV mode has regressed to TAS/HDG.
ENTER TIME	NOT	Occurs after power interrupt or CNU if the time from GPS is valid.
ENTER WIND	NOT	Loss of groundspeed. Reset with entry of wind, regain ground velocity, or CLR.
EGI DIVERGE CNU	NOT	In blended solution, when INS fails to converge to GPS. Clearable by selection of GPS or INS-only solution or by performing INS realignment.
NAV FAIL	BAN	TNS No valid navigation data. CNU ICUs have failed, failure of INS and GPS, or failure of INS and GPS with incorrect solution mode.
NEXT CRS---°	BL	Appears 10 seconds prior to WPT. Resets at WPT passage.
NAV MEM TNS	BT	When Doppler goes to memory mode.
NAV STBY TNS	BT	Squat switch or GRD/AIR/NORM switch set to ground and valid navigation mode is possible.
T1 (2) (3) XX:XX:XX	NOT	Timer 1 (2) (3) DATA. Non-clearable except by disabling timer display on time page.
UPTD REJECT CNU	BT	Position update has been rejected by EGI because position error is greater than 1.0 nmi.

TABLE 19-3. CDU ANNUNCIATIONS (Cont)

MESSAGE	TYPE	CONDITION
UNK CNFG	BT	Detected an unknown avionics configuration.
XXXX:XX (TIME)	NOT	Time of day enabled.

19.8.12.3 CNU STATUS 3/3 page.



TNS CNU STATUS 3/3 PAGE 209000-86 J1413

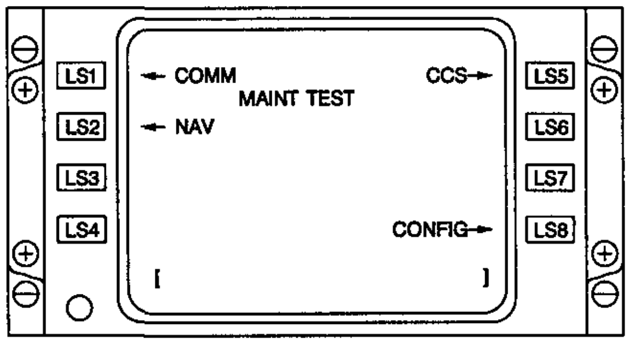
Displays status of avionics buses A and B as a GO or NOGO.

A NOGO can be generated by:

- Bus failure(s).
- One of the CDUs not installed.
- TACAN not installed.
- NTS Wrong configuration selected for NTS on CONFIG 2/2 page, LS 4.
- An open databus.

19.8.13 TNS CNU MAINT TEST Pages.

The MAINT (maintenance) TEST page is accessed from LS 7 on the STATUS 1/3 page.



TNS CNU MAINT TEST PAGE 209000-163-6 J1411

LS 1: Accesses the COMM TEST page.

LS 2: Accesses the NAV TEST page. Details are discussed in Chapter 20.

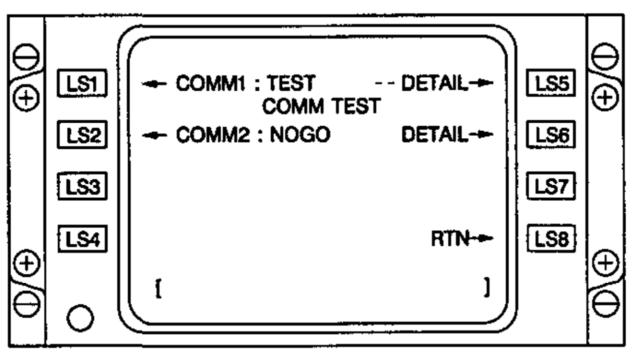
LS 3, 4, 6 & 7: Not used.

LS 5: Accesses the CCS TEST page.

LS 8: Accesses the CONFIG pages.

19.8.13.1 TNS CNU COMM Test Page.

The COMM TEST page is used to initiate and display results of command and tactical radio BIT. This page is accessed by pressing LS 1 on the MAINT TEST page.



CNU COMM TEST PAGE 209000-163-4 J1411

LS 1: Initiates BIT of the COMM1 (command) radio. "GO" will be displayed if COMM1 passes BIT. If COMM1 is unable to transmit/receive over the 1553 bus within 25 seconds, TEST will not display and a √ STATUS annunciation will appear.

TNS NOGO n-n-n will display when any WRA failure is detected. The n-n-n codes should be recorded for maintenance troubleshooting.

CNU NOGO will display when any WRA failure is detected. LS 5 may be selected to identify the specific WRA.

LS 2: Initiates BIT for COMM2 (tactical) radio. Status is displayed as for COMM1.

LS 3, 4, & 7: Not used.

LS 5: TNS Not used.

CNU Causes COMM1 DETAIL 1/2 page to be displayed.

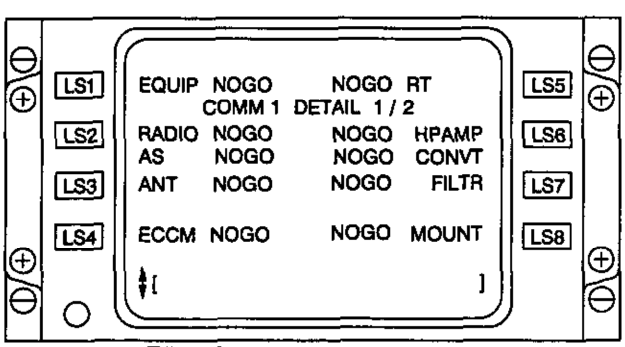
LS 6: TNS Not used.

CNU Causes COMM2 DETAIL 1/2 page to be displayed.

LS 8: Returns the display to the MAINT TEST page.

19.8.13.2 CNU COMM DETAIL Test Pages.

The COMM DETAIL pages are used to display the results of BIT of the command and tactical radio. These pages are accessed by pressing LS 5 on the COMM TEST page and are scrolled up and down from page 1/2 to page 2/2.



CNU COMM 1 DETAIL 1/2 PAGE

209000-163-2
J1411

Description of COMM DETAIL acronyms:

EQUIP — Indicates failure in the RT, antenna, or antenna converter unit.

RT — Indicates a receiver/transmitter fault.

RADIO — Indicates a fault in the RT, not including the ECCM module.

HPAMP — Indicates a failure in the high power amplifier.

AS — Indicates high VSWR or active antenna is not operational.

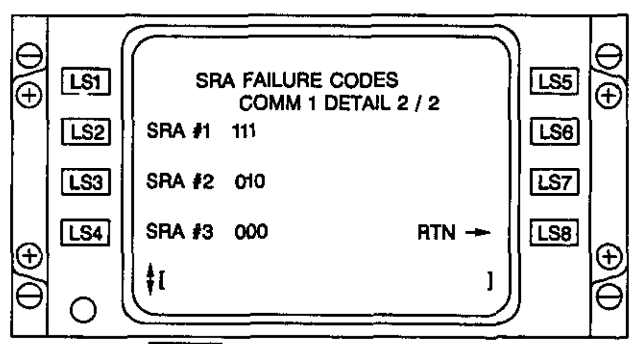
CONVT — Indicates a failure in the antenna converter unit.

ANT — Indicates a fault in the antenna system caused by high VSWR or antenna converter unit to antenna interface problem.

FILTR — Indicates failure in the filter.

ECCM — Indicates failure in the ECCM module.

MOUNT — Indicates failure in the mount.



CNU COMM 1 DETAIL 2/2 PAGE

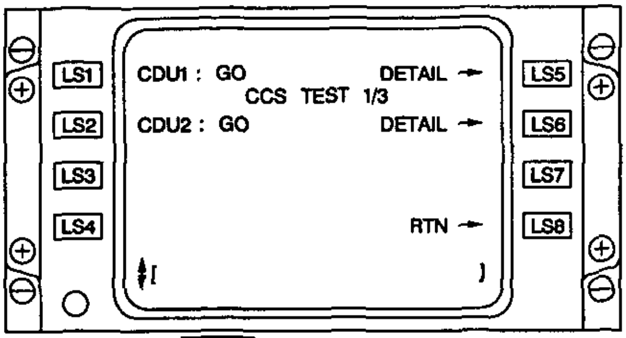
209000-163-5
J1411

LS 2, 3, & 4: Indicates the first, second, and third most probable failed SRA. Codes should be recorded for maintenance troubleshooting.

LS 8: Returns the display to the COMM TEST page.

19.8.13.3 TNS CNU CCS TEST 1/3 Page.

The CCS TEST 1/3 page is accessed by pressing LS 5 on the MAINT TEST page.



CNU CCS TEST 1/3 PAGE

209000-90
J1413

LS 1: Pressing LS 1 displays the last known test results as GO or NOGO. Pressing again displays dashes.

LS 2: TNS This will be blank on TNS aircraft with a single CDU when CONFIG 1/2 page *LS 2 has been activated.*

CM CNU Pressing LS 2 displays the last known test results as GO or NOGO. Pressing again displays dashes.

LS 3, 4, and 7: Not used.

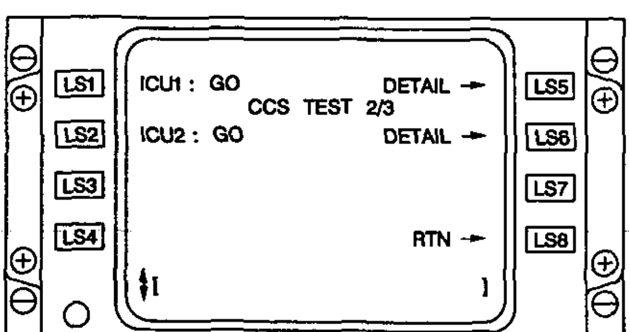
LS 5: Accesses the CDU 1 DETAIL page.

LS 6: CM CNU Accesses the CDU 2 DETAIL page.

LS 8: Returns the display to the MAINT TEST page.

19.8.13.4 TNS CNU CCS Test 2/3 Page.

The CCS TEST 2/3 page is accessed by scrolling down from the CCS TEST 1/3 page.



TNS CNU CCS TEST 2/3 PAGE

209000-91
J1413

LS 1: Initiates BIT for ICU 1 when toggled from dashes to TEST. A GO is displayed when BIT passes the test, and a NOGO is displayed when any failure is detected. If BIT cannot be initiated, the dashes will not toggle to TEST and a √ STATUS annunciation will be displayed.

LS 2: Initiates BIT for ICU 2 when toggled to TEST. Status is displayed as for ICU 1.

LS 3, 4, and 7: Not used.

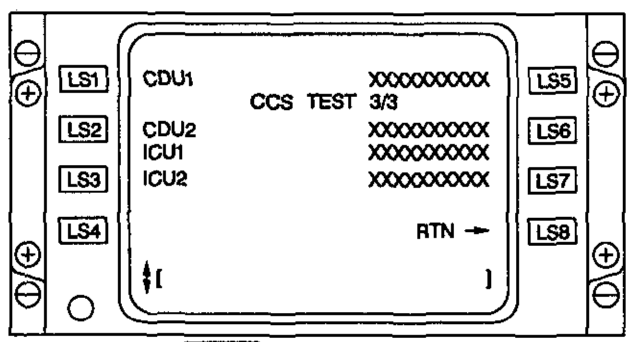
LS 5: Accesses the ICU 1 DETAIL page.

LS 6: Accesses the ICU 2 DETAIL page.

LS 8: Returns the display to the MAINT TEST page.

19.8.13.5 TNS CNU CCS Test 3/3 Page.

The CCS TEST 3/3 page is accessed by scrolling up from the CCS TEST 1/3 page or down from the CCS TEST 2/3 page.



CNU CCS TEST 3/3 PAGE

209000-92
J1413

Data Line 1: Displays the software version resident in the CDU.

Note

XXX represents the installed software version.

Data Line 2: TNS Not used. CDU 2 followed by dashes will be displayed.

CM CNU displays the software version resident in the CDU.

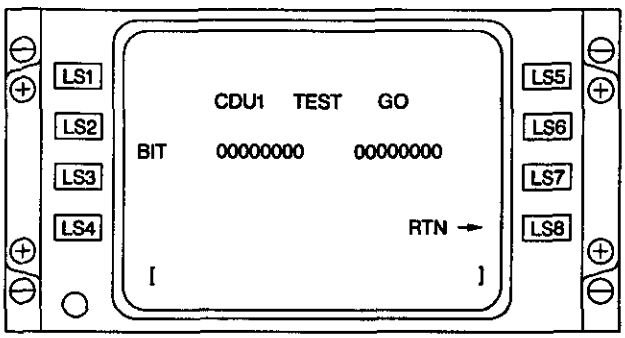
Information Line: Displays the software version resident in ICU 1.

Data Line 3: Displays the software version resident in ICU 2.

LS 8: Returns the display to the MAINT TEST page.

19.8.13.6 TNS CNU CDU Test Pages.

The CDU TEST pages are accessed by pressing LS 5 or LS 6 on the CCS TEST 1/3 page.



TNS CNU CDU TEST PAGE 209000-163-3 J1411

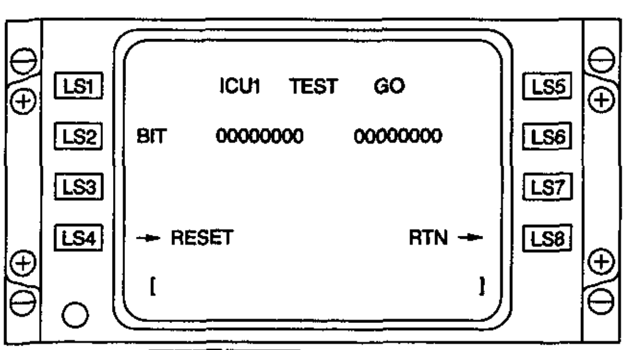
Information Line: Displays the CDU BIT acronym. A 1 displayed in any BIT position indicates fail. A 0 displayed in any BIT position indicates pass.

LS 1 through 7: Not used.

LS 8: Returns the display to the CCS TEST 1/3 page.

19.8.13.7 TNS CNU ICU Test Pages.

The ICU TEST pages are accessed by pressing LS 5 or LS 6 on the CCS TEST 2/3 page.



TNS CNU ICU 1 TEST PAGE 209000-60 J1413

Information line: Displays the ICU BIT acronym. A 1 displayed in any position indicates fail. A 0 displayed in any BIT position indicates pass.

LS 1 through 7: Not used.

LS 4: TNS Not used.

CNU Resets the applicable ICU fault ball and clears ICU BIT history.

LS 8: Returns the display to the CCS TEST 2/3 page.

19.8.14 TNS CNU CDU Screen Failure (and Anomalies).

Note

Radio communication remains enabled on the last CDU displayed frequency if the CDU screen goes blank.

1. PLT CDU circuit breaker — OUT.
2. PLT CDU circuit breaker — IN. Check for restoration of screen. If not restored, perform pilot emergency UHF switch method.
3. CM CNU If copilot/gunner has a screen failure, reset PLT CDU circuit breaker (pilot DC Panel).
4. CM CNU If pilot has a screen failure, reset GNR CDU circuit breaker (pilot DC Panel).
5. CM CNU If not restored, reset both PLT CDU and GNR CDU circuit breakers.
6. CM CNU If not restored, reset NO. 1 ICU then NO. 2 ICU and PLT CDU then GNR CDU circuit breakers.

CHAPTER 20

Navigation

20.1 SCOPE

This chapter presents information on the navigation systems. Chapter 19 presents information on the communication and identification systems.

In the following areas where communication and navigation functions are shared or overlap, the information is presented in chapter 19 only:

- Interface Control Unit (ICU)
- Control Display Unit (CDU)
- Squat Switch
- GND/AIR/NORM Override Switch
- CDU INDEX, POWER, TIMERS, ZEROIZE and TEST (other than navigation systems) pages.

20.2 NAVIGATION SYSTEMS INTRODUCTION

The USMC AH-1W is currently fielded in four primary avionics configurations:

- Baseline configuration B
- Tactical Navigation System TNS
- Canopy Mod CM
- Communication/Navigation Upgrade CNU .

Figure 20-1 lists the avionics systems applicable to each configuration. Figure 20-2 (Sheets 1 through 5) depicts the particulars for each configuration.

20.2.1 Baseline Configuration B .

Navigation equipment includes the navigation control panel, BDHI, AN/ARN-118(V) TACAN set, DF-301E DF set, DF feature of the AN/ARC-182(V) command radio, AN/ARN-89B ADF set, AN/ASN-75B compass system, AN/APN-194(V) radar altimeter, AN/APN-154(V) radar beacon set, and the FM homing feature of the AN/ARC-182(V) tactical radio. (The radar beacon set and the FM homing feature have been removed from most aircraft.) The primary navigation instrument, the BDHI, displays TACAN, DF, ADF, and compass system information. The pilot attitude indicator displays TACAN or FM homing information, and the HUD displays TACAN and ADF steering pointers. See Figure 19-3 (Sheet 1) for antenna locations and Figure 20-2 for navigation system controls and displays. Text specific to the Baseline Configuration is annotated with B .

20.2.2 Tactical Navigation System Configuration TNS .

The navigation system includes the navigation control panel, BDHI, AN/ARN-118(V) TACAN set, DF-301E DF set, DF feature of the AN/ARC-182(V) command radio, AN/ARC-89B ADF set, AN/ASN-75B compass system, AN/APN-194(V) radar altimeter, AN/APN-154(V) radar beacon set, APN-217(V)3 Doppler navigation set, the AN/ASQ-205(V) cockpit control system (CCS). The primary navigation flight instrument, the BDHI, displays TACAN, DF, ADF, and compass system information, and the pilot attitude indicator displays TACAN or horizontal deviation pointer information, depending on the NAV control switch position. The CDU and HUD display Doppler navigation steering information. See Figure 20-2 (Sheet 2) for navigation system controls and displays. Text specific to the Tactical Navigation Configuration is annotated with TNS .

See Figure 19-3 (Sheet 1) for the location of TNS antenna locations.

20.2.3 Canopy Modification Configuration CM.

The canopy modified aircraft has essentially the same navigation equipment configuration as the TNS with the addition of a radar altimeter and CDU in the front cockpit. CM aircraft may be fitted with either the NTS or the M-65 TSU. See Figure 20-2 (Sheets 3 and 4) for navigation system controls and displays. Text specific to Canopy Mod Configuration is annotated with CM.

20.2.4 Communication/Navigation Upgrade Configuration CNU .

The Comm/Nav Upgrade configuration is an enhancement to the CM configuration. Navigation system changes include:

- Addition of the CN-1689(V)2/ASN EGI system, AN/ARN-153 TACAN set, EGI and radio Code Load panel and provisions for ASQ-215 Mission Data Loader (MDL)
- Removal of the AN/ARN-89B ADF set, AN/ASN-75 Gyro-Compass system, AN/APN-217(V)3 Doppler Radar set, and AN/ARN-118 TACAN receiver/transmitter
- Changes to the NAV CONTROL switch functions.

See Figure 20-2 (Sheet 5) for navigation system controls and displays. Text specific to Comm/Nav Upgrade is annotated with CNU .

20.3 TNS CNU AN/ASQ-205(V) COCKPIT CONTROL SYSTEM (CCS)

The CCS provides centralized control for the communication and navigation systems. The CCS (navigational portion) consists of the ICU, CDU, squat switch (weight on skids sensor), and the pilot GND/AIR/NORM override switch. The CCS provides the following navigation functions:

1. Navigation based on operator and system inputs resulting in the following computed data:
   a. Present position (PPSN)
   b. Distance to or from selected waypoint or target
   c. Time to or from selected waypoint or target
   d. Course to next point
   e. Groundspeed
   f. Crosstrack error
   g. Track angle error
   h. Commanded heading
   i. Commanded true airspeed
   j. Position error
   k. Position index or position figure of merit
   l. Drift angle.

SYSTEMS	CONFIGURATION			
	B	TNS	CM	CNU
NTS			X	X
PLT CDU		X	X	X
CPLT CDU			X	X
ICU NO. 1 & NO. 2		X	X	X
DOPPLER		X	X	
EGI				X
ASN-75 COMPASS	X	X	X	
AN/ARC-182 RADIO	X	X	X	
AN/ARC-210 RADIO				X
THCDS	X	X	X	X
FFSP OR IFFSP	X	X	X	X
AN/ARN-118 TACAN	X	X	X	
AN/ARN-153 TACAN				X
AN/ARN-89 ADF	X	X	X	
DF-301 UHF/DF	X	X	X	X

209075-779
J1561

Figure 20-1. Avionics Configurations

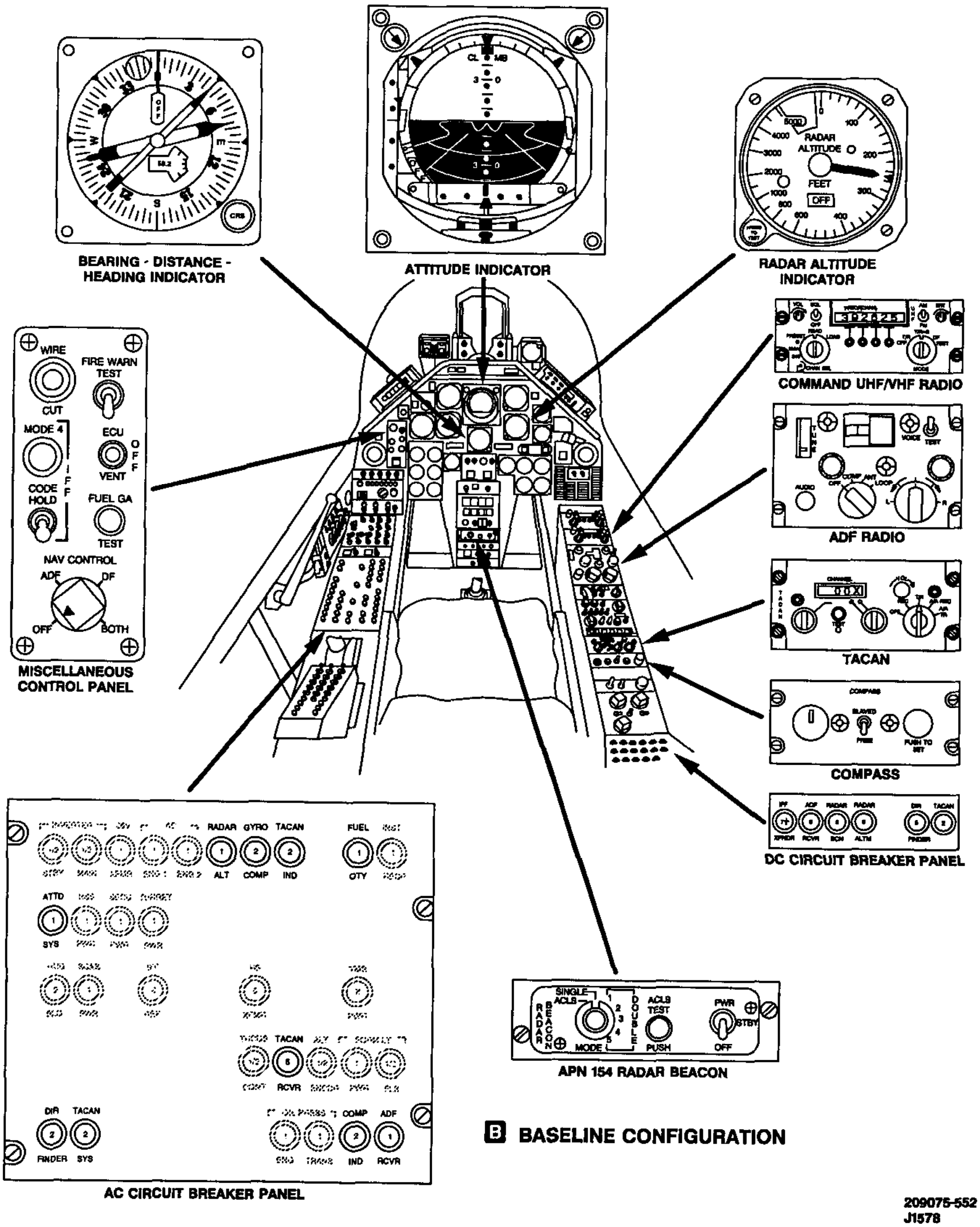


Figure 20-2. Navigation System Equipment (Sheet 1 of 5)

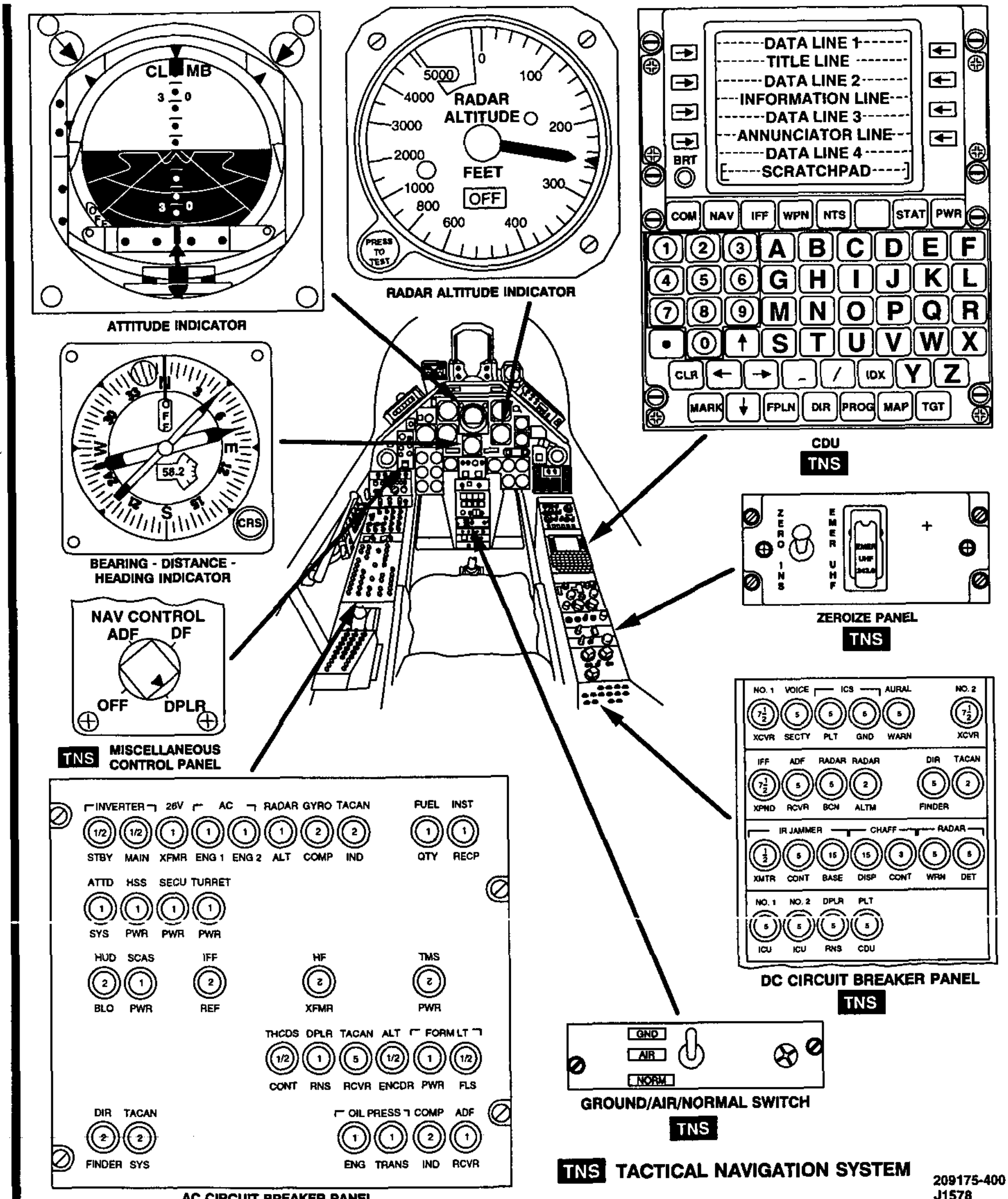


Figure 20-2. Navigation System Equipment (Sheet 2 of 5)

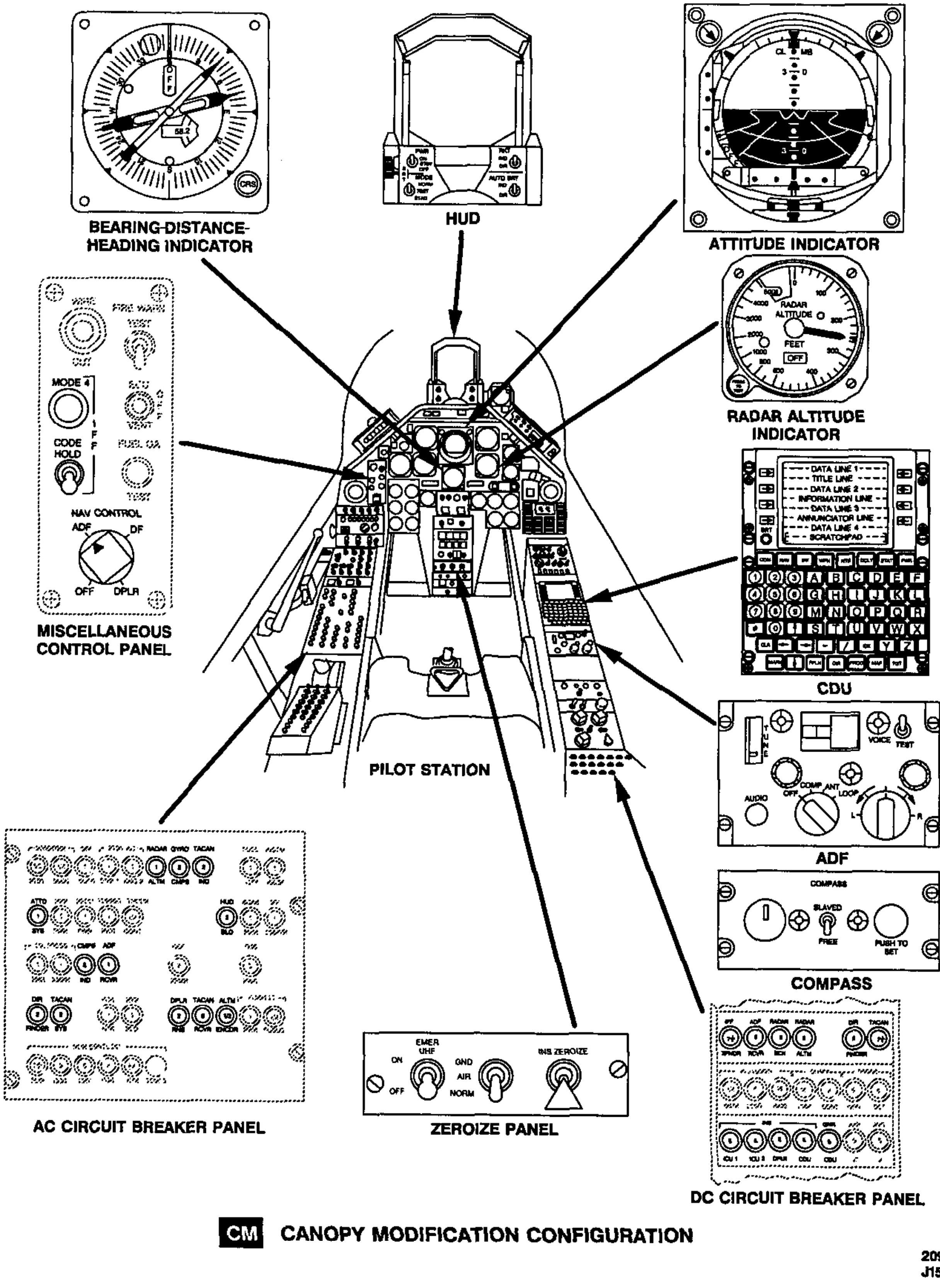


Figure 20-2. Navigation System Equipment (Sheet 3 of 5)

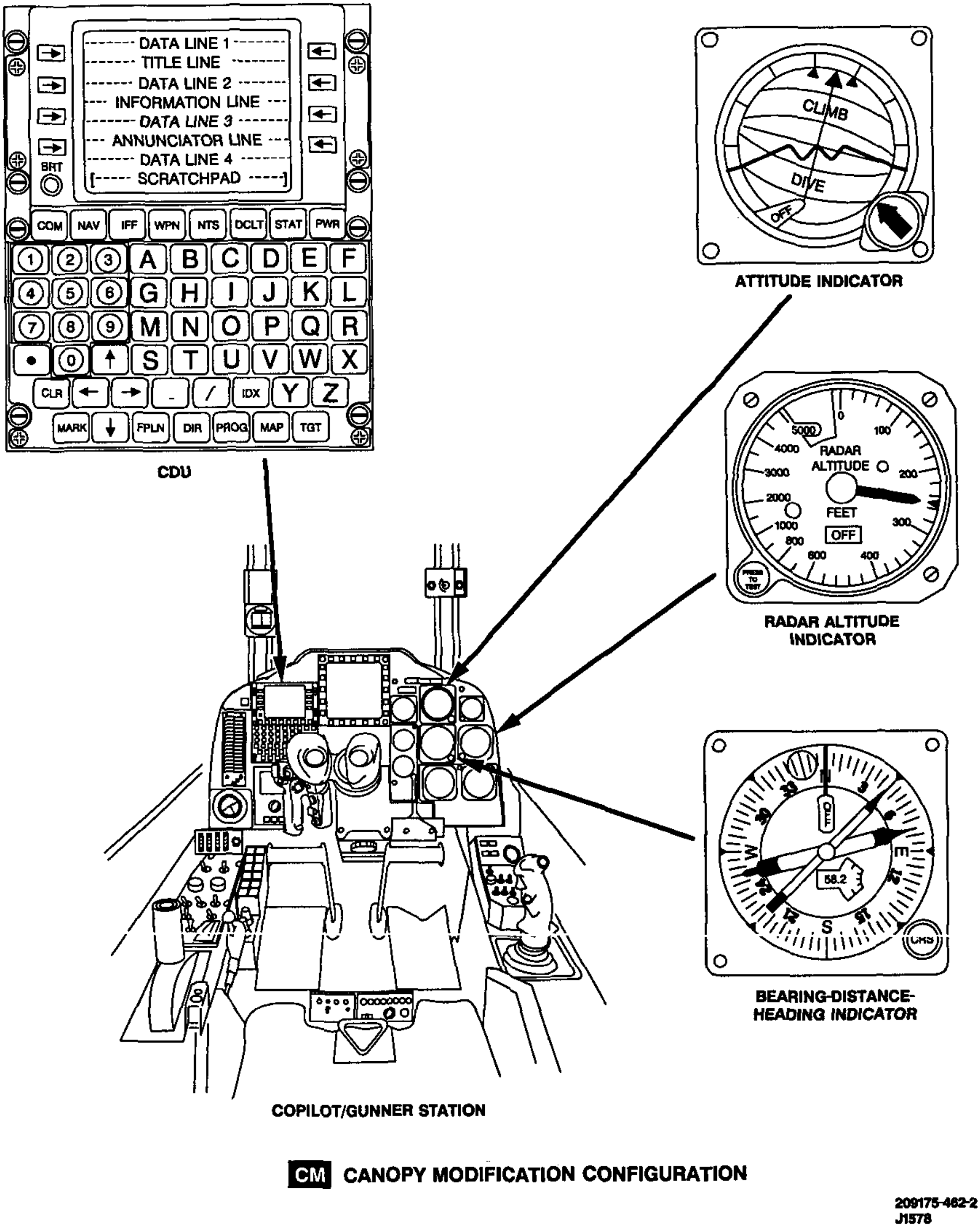


Figure 20-2. Navigation System Equipment (Sheet 4 of 5)

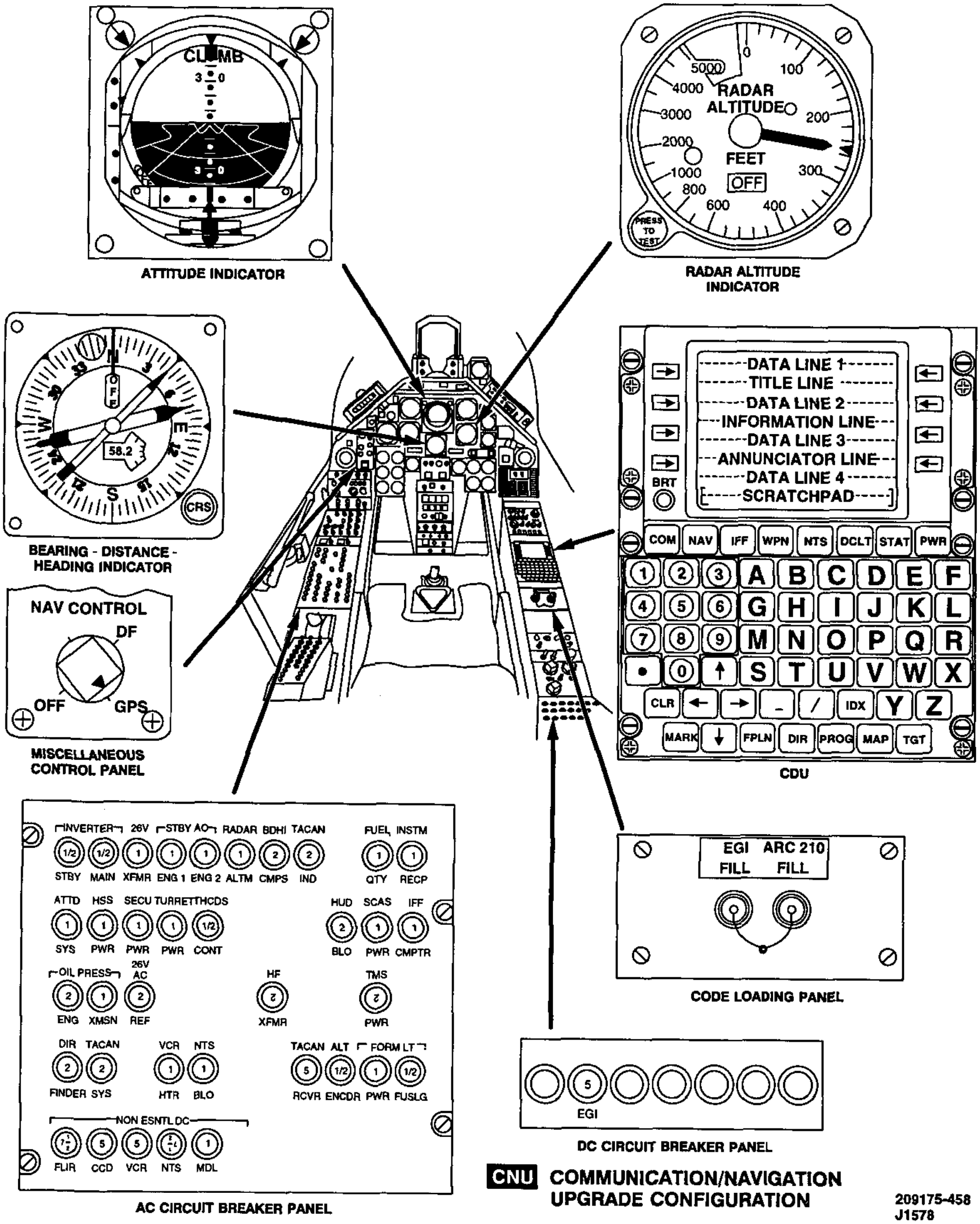


Figure 20-2. Navigation System Equipment (Sheet 5 of 5)

2. AN/ARN-118 or 153 TACAN channel, mode, and power control.
3. Displays of radar altitude from APN-194 altimeter system.
4. AN/APN-217(V)3 Doppler or H-764G EGI mode and power control.
5. Clock and timer function.
6. Zeroize control for navigation system.
7. Steering information to the HUD.
8. NTS Navigation bus interface to the NTS .
9. BIT initiating and status monitoring.

20.3.1 TNS CNU AN/ASQ-205(V) Cockpit Control System Operation.

The CCS is controlled by the pilots through the CDU. The mode entry pages are groups of closely related data presented on the CDU. Some functions require subordinate levels of pages to present further information. The information required most frequently and controls most likely to require immediate action are generally placed on the top level page.

20.3.2 TNS CNU Interface Control Unit.

Refer to Chapter 19.3.1.1.

20.3.3 TNS CNU Control Display Unit.

Refer to Chapter 19.3.1.2.

20.3.4 TNS CNU Squat Switch and GND/AIR/NORM Override Switch.

Refer to Chapter 19.3.1.3 and 19.3.1.4.

20.4 TNS AN/APN-217(V)3 DOPPLER NAVIGATION SYSTEM (DNS)

The DNS consists of a self-contained, independent, continuous-wave, Doppler radar, airborne navigation system that determines the three orthogonal components of helicopter velocity.

The DNS, in conjunction with the helicopter heading, vertical gyro reference system, and CCS computes position and steering information. The CCS provides the aircrew navigational progress and guidance data to preselected navigation points.

Note

TNS With the pilot GND/AIR/NORM override switch in the GND position, the CDU will stop updating the present position whether in flight or on the ground.

The DNS system is located on the underside of the helicopter fuselage, forward of the aft crosstube. The Doppler set requires 3 minutes to warm up.

A dehydrator unit is attached to the Doppler unit and contains a desiccant that changes color indicating when replacement is required. Normal replacement should not be required more frequently than once every 6 months. The Doppler is powered by the 28 vdc nonessential and 115 vac essential buses and is protected by the DC and AC DPLR RNS circuit breakers located on the dc and ac circuit breaker panels.

The Doppler navigation system is controlled from the NAV page of the CCS, the navigation control panel, and the pilot GND/AIR/NORM override switch (Figure 20-2, Sheet 2).

20.4.1 TNS AN/APN-217(V)3 Doppler Navigation System Operation.

1. NAV CONTROL panel switch — DPLR.
2. Pilot GND/AIR/NORM override switch — NORMAL.
3. DOP POWER — ON (PWR Key, or individually on Power page).

Note

Allow 3 minutes for system warmup.

4. NAV function key — PRESS.
5. DOP mode LS 7 key — PRESS to Select Sea or Land Mode as Required.

20.5 CNU H-764G EMBEDDED GPS/INS SYSTEM (EGI)

20.5.1 CNU EGI System Description.

The EGI system, located in the aft electrical compartment, combines a strapdown ring laser gyro (RLG)-type INS with a tightly coupled GPS in a single component. The EGI replaces both the AN/APN-217 Doppler and the AN/ASN-75B Compass System.

The EGI is a GPS-aided inertial navigation system that permits all-altitude operation, is independent of ground-based navigational aids, is not weather sensitive, and has an overall accuracy in the subnautical-mile/hr class.

The EGI also supplies UTC time to the CCS and to both ARC-210 radios for anti-jam (AJ) purposes. UTC time is displayed on START 1/2 page and can be converted to any local time zone, if desired.

20.5.2 CNU EGI Functional Components.

The main functional components are: Inertial Navigation System (INS), Global Positioning System (GPS) receiver, a GPS/INS integration filter, and a non-volatile memory (NVM) that retains INS and GPS data needed for initialization of the EGI. The NVM is sustained by two replaceable 3.5 vdc lithium batteries located in front of the EGI. Only one battery is required to retain the NVM to allow battery replacement without losing the almanac data. Batteries should last up to 6 months before replacement.

Note

The EGI batteries are not charged by the aircraft power. The drain on the batteries continues with EGI or aircraft power off.

20.5.3 CNU EGI Flight Instrument Interfaces.

The EGI interfaces with the CCS via avionics buses (Figure 20-3). The EGI is the sole source of heading to CCS, NTS , BDHI, HUD, and TACAN. The standby compass is retained as backup source of magnetic heading in the event of EGI failure.

With the MASTER ARM switch set to OFF, the EGI supplies attitude, attitude warning flag, and rate-of-turn signals to the attitude gyro and rate-of-turn indicator and attitude signals to the HUD (Figure 20-4). With the MASTER ARM switch set to ARM or STBY, attitude, attitude warning flag, and rate-of-turn signals are provided by the CN-1314 attitude gyro and by the rate-of-turn gyro.

In the event of an EGI failure with the MASTER ARM switch set to OFF:

- Attitude and rate of turn information to ADI and HUD are lost.
- Heading to BDHI, HUD, and TACAN is lost.
- BDHI OFF flag and the flag on the right side of the ADI appears in view.
- √ STATUS appears on CDU.

Note

Only attitude and rate of turn signals can be reclaimed by setting the MASTER ARM switch to STBY or ARM. Heading information must be derived from the wet compass.

The EGI fill receptacle on the code load panel is used to load EGI crypto-variables (CV) (Figure 20-2, Sheet 5). A similar receptacle on the EGI itself may also be used to load CVs.

EGI CV zeroizing is accomplished via the CDU if the EGI is not aligned and is in STBY mode, or by the INS ZEROIZE switch located on the pilot instrument panel.

The EGI ON/OFF control is accomplished from the CDU. Main power to the EGI is provided from the 28 vdc essential bus via the EGI circuit breaker. The XMSN OIL circuit breaker provides 28 vdc to the EGI to ensure an "orderly shutdown" (an orderly shutdown allows the EGI to store required information to accomplish an SHA during the next alignment) in the event 28 vdc essential power is lost. The EGI circuits that provide signals to the ADI, BDHI, and HUD are powered from the 26 vac REF circuit breaker.

20.5.3.1 CNU EGI Boresighting.

EGI mechanical boresighting is a factory process. Allowable boresight errors are driven primarily by armament datum line accuracy considerations (critical for precise laser derived coordinates) and have no effect on navigation performance. Software boresight adjustment capability is provided for O-level adjustment. See EGI CAL page description 20.14.19.

20.5.4 CNU INS Navigation Sensor Description.

The INS consists of three ring laser gyros (RLG), three accelerometers, and inertial electronics all located within the EGI housing. The INS does not require gyro spin-up or warmup time.

The EGI INS provides attitude, selectable magnetic or true heading, present position, EGI derived altitude, and accurate 3-dimensional linear/angular acceleration and velocity. It is also the source for the sideslip indicator on the HUD,

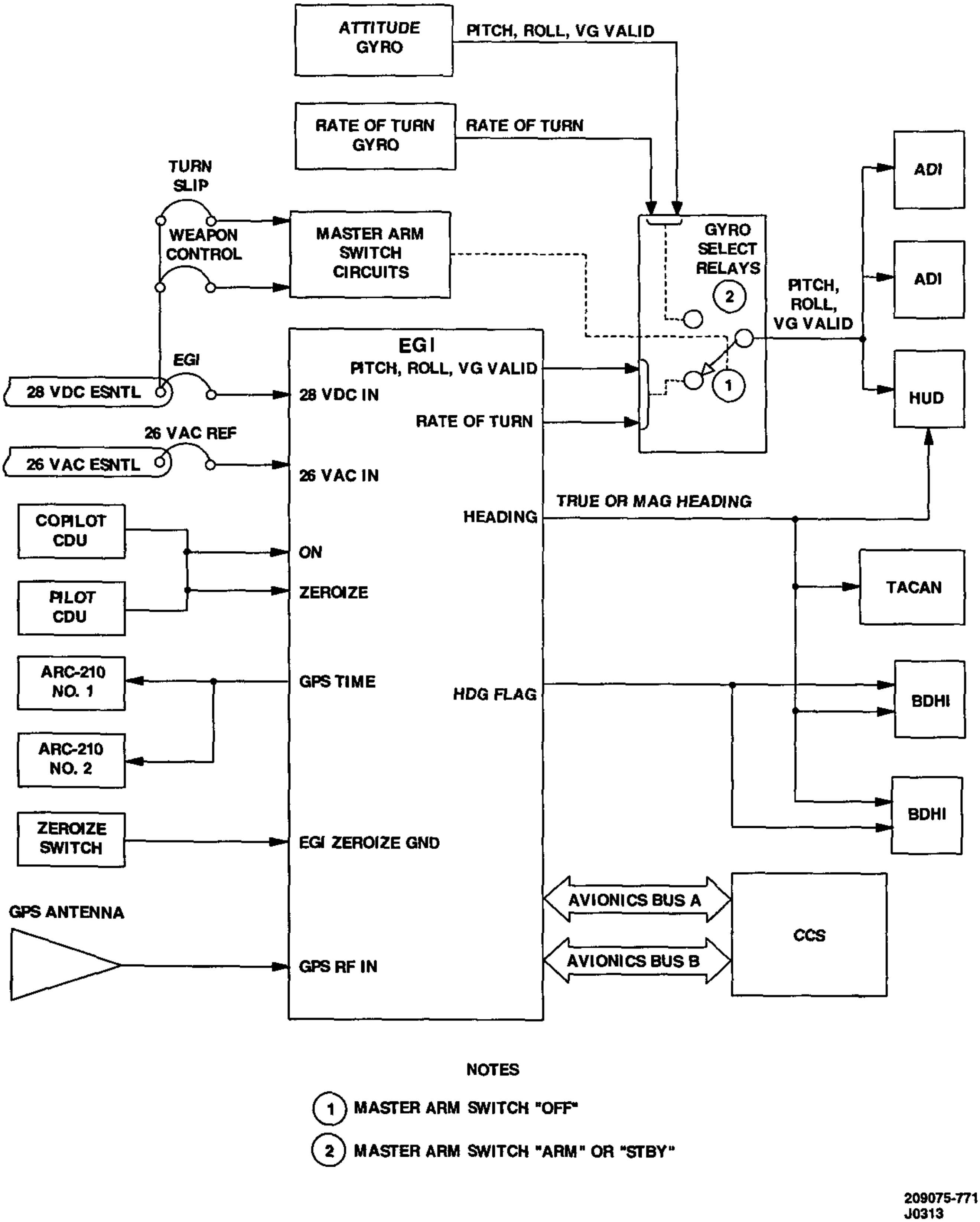


Figure 20-3. CNU EGI Interface Diagram

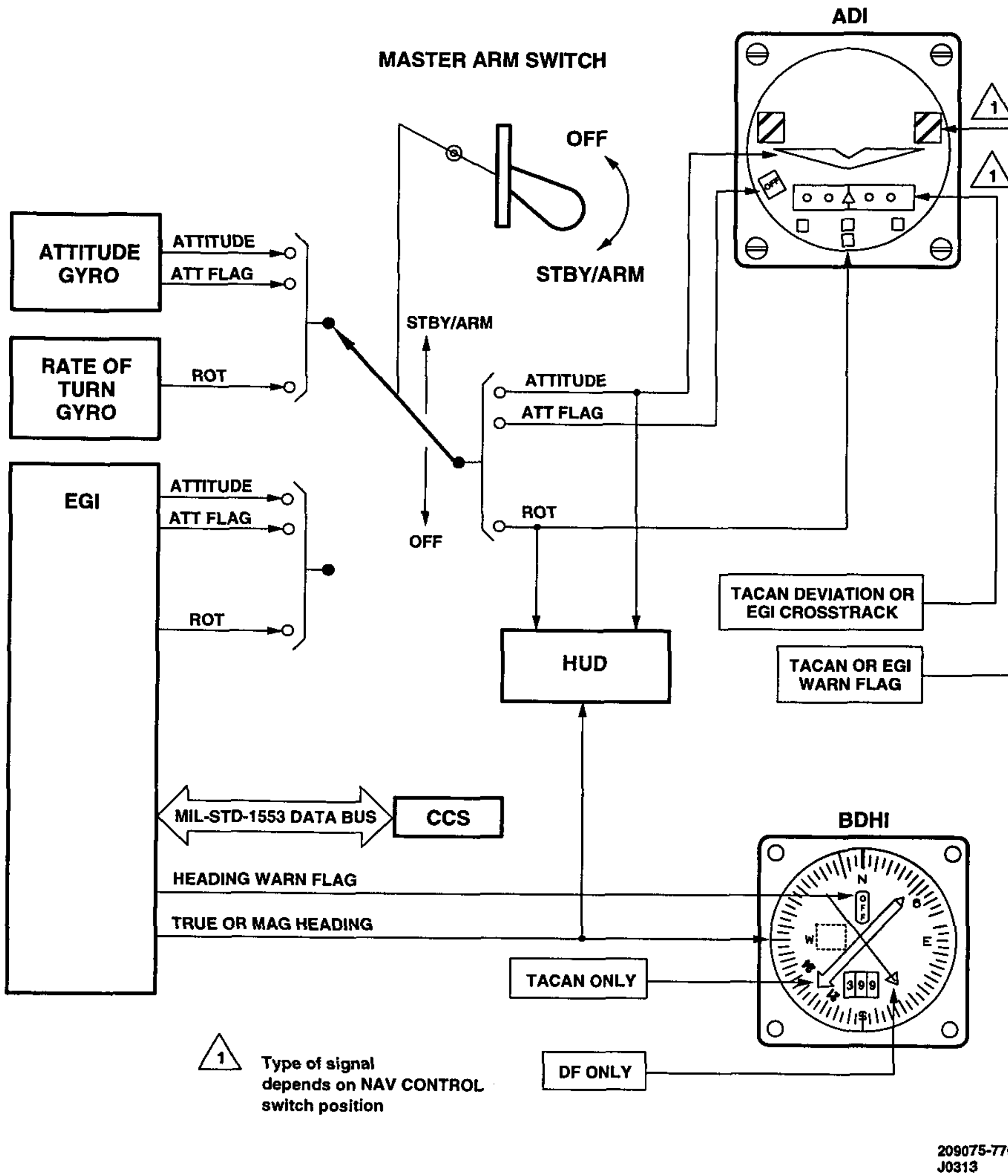


Figure 20-4. CNU ADI, BDHI and HUD Signal Sources

replacing the crosstrack symbol when fixed forward weapons are selected.

When an alignment is selected and a present position (PPSN) is provided either by (1) automatic GPS or (2) by manual entry on the START page, the INS will automatically align to true north. If magnetic north is selected, the CDU will automatically figure the declination and display correctly. A coarse INS alignment is indicated by the RMI locking in to the heading on the BDHI compass card and retraction of the OFF flag. When the EGI perceives the minimum requirements for navigation are met (general heading within 3° and INS drift less than nmi/h), NAV is displayed on the NAV 1/2 page next to LS 1.

The (aligned) INS produces true heading. Magnetic heading is derived from a table of magnetic variation using true heading, PPSN, and date. Alignment of the EGI requires entry/availability of accurate present position (PPSN), time and date.

EGI PPSN is provided by: manual entry on the START 1/2 page, automatically by the GPS module, or the last PPSN prior to shutdown from the EGI non-volatile memory (NVM).

INS altitude is initialized automatically with the altitude data from the pilot altimeter referenced to 29.92 in. Hg. This altitude is displayed on START 1/2 page as BARO ALT. This value can be manually overwritten with actual aircraft MSL altitude to reflect current barometric pressure conditions. Upon entry of actual altitude, BARO ALT display changes to MSL ALT. Using the altitude reference on START 1/2 page, the INS provides EGI derived altitude display on PROGRESS 2/3 page LS 1, as desired.

Note

Once the EGI has aligned, reselect BAROALT on START 1/2 (if MSLALT was selected) to allow EGI to calculate and display updated altitude information.

GPS position data is used to update INS PPSN and to limit the inherent drift of the INS sensor. When GPS data is not available, the INS position error will drift at a rate proportional to time and alignment status.

When in INS-only mode, depending on INS status and alignment status, the INS will drift between 0.8 nmi/h and 5 nmi/h. The expected INS accuracy is indicated on the NAV 1/2 page by the INS Figure of Merit (FM). The FM, a number between 1 and 9, indicates a qualitative index of INS accuracy. The best FM is 1 indicating the INS has aligned itself (to true north and level).

20.5.5 CNU GPS Navigation Sensor Description.

The GPS receiver module consists of a five channel dual-frequency Y/P/CA code receiver with augmented anti-jam (AJ), and anti-spoofing (AS) features. A passive GPS antenna is mounted on top of the 90° gearbox.

The GPS can provide a typical position accuracy of approximately 100 meters when using CA code, 30 meters when using P code, and 16 meters when using Y code.

Note

Y code can only be used if the appropriate cryptovariables (CV) key is loaded.

Expected GPS accuracy is displayed on the NAV 1/2 page as GPS FM (Table 20-1).

TABLE 20-1. GPS FIGURE OF MERIT

GPS FM	Position Error (Meters)
1	≤25
2	>25 up to 50
3	>50 up to 75
4	>75 up to 100
5	>100 up to 200
6	>200 up to 500
7	>500 up to 1000
8	>1000 up to 5000
9	>5000

20.5.6 CNU GPS Navigation Sensor Initialization.

GPS acquisition starts with the activation of any one of the INS alignment modes.

Initialization of the GPS requires reception of at least four satellites. Once initialized, reception of three satellites plus altitude (from pilot altimeter) will cover the minimum requirements for GPS operation.

The initialization and operation of the GPS also requires that the receiver possesses specific knowledge about the satellite constellation and satellite operational status/modes. This information is continuously transmitted by the GPS satellites, and parts of this message are stored in the receiver's non-volatile memory (NVM). The most important parts of this message are called the "Almanac" and "Ephemeris" data.

20.5.6.1 CNU Almanac Information.

Each satellite in the constellation transmits the Almanac.

The Almanac tells the receiver the approximate location of all of the satellites in the GPS constellation at a certain time and date. All satellite locations are referenced to the center of the earth.

Almanac with date, time, and approximate location, enables GPS to use the Almanac data to predict which satellites will be visible at that moment. (It lets the receiver know which satellites are above the horizon and where to search for them when attempting to establish a fix.)

Upon initial reception of the Almanac, the receiver stores the information in its memory. When the receiver already has almanac data from a previous power cycle, the EGI uses that stored information to aid in the satellite acquisition process. Almanac data is constantly updated when the receiver is tracking satellites.

Once the receiver has stored an Almanac, it remains valid for up to 180 days as long as the EGI memory batteries are not drained or interrupted.

If the receiver is turned on within 180 days, the Almanac will be useable enough for the receiver to find a satellite and download an updated Almanac.

Note

If the aircraft or EGI has been moved by more than 600 nmi from the position stored in its memory, acquisition of satellites and determination of a fix may take as long as 45 minutes.

20.5.6.2 CNU Ephemeris Data.

The GPS receiver needs ephemeris data to obtain the exact location of each satellite that it is tracking at that particular moment.

The ephemeris data tells the receiver exactly where the satellite is in space, so when the receiver calculates distance, it also knows the exact position of the signal source. Each satellite broadcasts its own ephemeris data. Satellites are updated and uploaded at least once a day along with clock correction data from ground based stations.

Ephemeris data contains:

- The information necessary to compensate for the satellite's normal orbital perturbations
- Information relative to the individual satellite's health
- The handover word that enables the use of cryptovariables needed to offset the SA.

20.5.6.3 CNU GPS-Time.

A part of the satellite navigation message contains a GPS time referenced to UTC. Depending upon the receiver's mode of operation, time is accurate to within 155 nanoseconds (for authorized users) and to within 350 nanoseconds for users subjected to the non-precise selective availability (SA) mode. GPS-time is used only during the initial satellite acquisition phase as a "coarse time". For accurate triangulation the GPS receiver clock needs to be exactly synchronized with the satellite clock. The internal clock of the GPS receiver can only synchronize with the satellite clock if four or more satellites are received. Without receiver clock synchronization it would be impossible to perform an accurate position determination.

The GPS module provides UTC time to the CCS and to the radios.

20.5.6.4 CNU GPS Receiver Initialization.

The GPS receiver can initialize either through "COLD start" which can take 15 minutes to 2 hours, or a "Warm start" which typically takes 2 to 4 minutes.

A receiver COLD start is defined as a condition where the EGI NVM cannot provide a valid GPS Almanac, PPSN, and TOD.

The Almanac stored in the EGI NVM becomes invalid when any of the following occurs:

- EGI NVM power has been interrupted by removing or draining the batteries
- Almanac is older than 180 days
- EGI has been moved more than 600 nmi with power off.

PPSN, Date and TOD can be entered manually on START 1/2 page. Entry of PPSN and TOD can reduce the time to accomplish COLD start considerably.

Note

PPSN, Date and TOD should only be entered if not supplied by the GPS. If data is initially entered manually and GPS is acquired, the GPS data will take precedence over manual inputs.

A receiver Warm Start is defined as a condition where the EGI NVM can provide a GPS Almanac, PPSN, and TOD.

20.5.6.5 CNU COLD start Sequence.

The following outlines the steps and approximate time the EGI takes when sequencing through a COLD start:

1. The receiver has to scan all available satellite codes (36) until it can lock on to one satellite. (5 to 45 minutes). When one satellite has been acquired, downloading of the Almanac can start.
2. Downloading GPS time (approximately 6 seconds).
3. Downloading the Almanac and Ephemeris data (12.5 minutes).
4. With Almanac data, correlated with PPSN and TOD, the receiver can lock on to the predicted satellite constellation (approximately 2 minutes).
5. Updating of Ephemeris data (approximately 1 1/2 minutes).
6. Receiver clock synchronizes with satellite clock (only if at least four satellites are received) which is a prerequisite to start triangulation calculations (approximately 6 seconds).

20.5.6.6 CNU Warm Start Sequence.

The following outlines the steps and approximate time the EGI takes when sequencing through a Warm Start:

1. Almanac data from the NVM allows the EGI to skip steps 1 through 3 of COLD start, and the receiver can scan to predicted satellite constellations immediately (approximately 2 to 3 minutes)
2. Updating of Ephemeris data (approximately 30 seconds).
3. Receiver clock synchronizes with satellite clock (only if at least four satellites are received) which is a prerequisite to start triangulation calculations (approximately 1 minute).

20.5.7 CNU EGI Navigation Solution Modes.

The EGI's, GPS and INS navigation sensors can be used independently or simultaneously (blended solution). Navigation mode can be selected on NAV 1/2 page LS 4. GPS/INS mode is the preferred operating mode for the EGI.

20.5.7.1 CNU INS-Only Mode.

No GPS data is used for the INS-only navigation solution. The magnitude of INS position error is proportional to time, alignment status/mode, and inflight updates. INS expected accuracy is displayed on the NAV 1/2 page as an FM (Table 20-1).

20.5.7.2 CNU GPS-Only Mode.

When GPS-only mode is selected, INS data will not be used for the navigation solution. However, the information will be used to aid the GPS receiver satellite tracking information. A GPS-only navigation solution can only be accomplished with a minimum of four satellite tracks. Once initialization is accomplished, and in the event only three satellites are available, the ambiguity (fourth satellite requirement) will be resolved by the barometric altimeter reading. In the event this is required for a navigation solution, the navigation accuracy will be degraded.

GPS performance in this mode is determined mainly by factors such as satellite constellation, number of satellites received, availability of INS aiding, Selective Availability (S/A) offset, and use of the Y Code. GPS expected accuracy is displayed on the NAV 1/2 page as an FM (Table 20-1).

20.5.8 CNU GPS and INS Data Blending.

The EGI blended solution GPS/INS provides the best estimate of PPSN, altitude, velocity, and time based on a combination of GPS and INS data.

In this mode inertial data as well as any other sensor inputs will not degrade available GPS performance, nor does incorporation of GPS data cause the system performance to be degraded below INS-only specifications.

Initial application of GPS data into the blended solution requires that the GPS track four satellites and that the GPS FM value is equal or less than 5 in C/A mode or equal to or less than 3 for Y-only mode.

Note

If the GPS is tracking with Y code only selected, and without valid CVs loaded, GPS updates will not be applied to the blended solution and INS only navigation mode is being utilized.

Viewing and selecting the EGI GPS automatic updating mode (AIDING) and viewing the validity of the cryptovariables is accomplished on NAV 2/2 page (LS 3, 4 and 7). Y/P/CA is the preferred mode selection for INS AIDING. This will allow for the best possible available navigation solution to be accomplished.

Overall EGI Performance is indicated as EGI FM, expressed in meters, and displayed on the NAV 1/2 page and on the PROGRESS 1/3 page.

20.5.8.1 CNU GPS Complement to INS Operation.

The GPS automatically provides PPSN to initialize and update the INS. For practical purposes GPS position error can be considered constant. This constant position error constitutes a boundary for INS position error accumulation. Throughout operation with GPS aiding, the INS alignment is continually refined and will result in improved INS only navigation accuracy.

20.5.8.2 CNU Complement to GPS Operation.

INS velocity and present position are used to steer the GPS. As a result the GPS receiver is more spoof-resistant and reacquires the satellite constellation faster after temporary loss of GPS signal.

The characteristics of the INS enable correlation with data produced by GPS. It will detect sudden present position changes caused by GPS signal reception anomalies. The result is reduced vulnerability to spoofing or other GPS signal anomalies.

20.5.9 CNU Figure of Merit Relationship.

EGI performance is determined through interpretation of GPS FM and INS FM for the individual NAV sensors, and with the EGI FM for overall EGI performance. Useable GPS FM for INS updating is equal to or less than 6. Best unkeyed GPS FM is 3. Best GPS FM with CVs is 1. A typical value for INS FM is 2 or better.

EGI FM is a Figure of Merit, i.e., it displays an EGI-calculated estimate of position accuracy; it does not necessarily depict actual position error.

A typical EGI FM after initial EGI coarse alignment is 427 meters. After obtaining a GPS and an INS FM of 1, EGI FM can go below 20 meters.

20.6 TACAN

20.6.1 B TNS CM AN/ARN-118(V) TACAN.

20.6.1.1 TACAN System Description.

The TACAN set is a tactical air navigation system that transmits to and receives radio frequency signals from a TACAN beacon. The received signals are decoded to compute slant range and relative bearing to the TACAN beacon and deviation from the selected radial. The bearing information is displayed by the No. 2 pointer on the BDHI, while the line-of-sight distance range is displayed in nmi on the range indicator of the BDHI. The course deviations R-L are presented to the pilot on the attitude indicator. When the AN/ARC-182(V) tactical radio is not in the FM homing mode, TACAN course deviation and warning flag signals will be presented on the pilot attitude indicator. TNS NAV flag right-side comes into view in the pilot attitude indicator when the TACAN beacon is lost.

TACAN receives/transmits on 252 channels with (126)X or (126)Y coding.

The AN/ARC-118(V) TACAN set contains an automatic self-test function that causes the system to be tested automatically whenever the TACAN beacon signal is lost. The automatic self-test checks the system for proper operation to determine if the signal loss was caused by a system malfunction. If there is a system malfunction, the TEST indicator on the TACAN control panel illuminates upon completion of the automatic self-test cycle.

To provide an in-flight confidence test, a manual self-test can be initiated by momentarily pressing the TEST switch on the TACAN control panel. When initiating a system test, observe the control TEST indicator. If the indicator illuminates during the test and remains illuminated, there is a malfunction in the system and the information displayed on the BDHI should be disregarded. If the TEST light extinguishes, the system is checked and provides an 85-percent confidence level.

TNS The AN/ARN-118(V) TACAN set performs a BIT function that causes the system to be tested automatically whenever the TACAN beacon signal is lost. The BIT checks the system for proper operation to determine if the signal was lost because of a system malfunction. If there is a system malfunction, an error message (√ STATUS) will be displayed in the CDU scratchpad and the TACAN warning flag on the ADI will appear upon completion of the BIT cycle.

TNS To provide an in-flight confidence test, a manual self-test can be initiated by setting the pilot GND/AIR/NORM override switch to GND and momentarily pressing the LS 2 when the NAV TEST 1/2 page is displayed. If a GO is displayed on the NAV TEST 1/2 page, the system is checked and provides an 85-percent confidence level. After the test is complete, set the GND/AIR/NORM override switch to NORM.

Table 20-2 represents the ideal operating range over level terrain.

TABLE 20-2. IDEAL TACAN RANGE

AGL Alt (Feet)	Max DME Range (Nm)
100	12
250	19
500	27
750	34
1000	39
2000	55
3000	67
4000	78
5000	87

The AN/ARN-118(V) TACAN set may also provide both bearing and distance information in the air-to-air mode (Figures 20-5 and TNS 20-6). AH-1W helicopters are equipped to transmit and receive air-to-air distance only. No bearing transmitting capability exists.

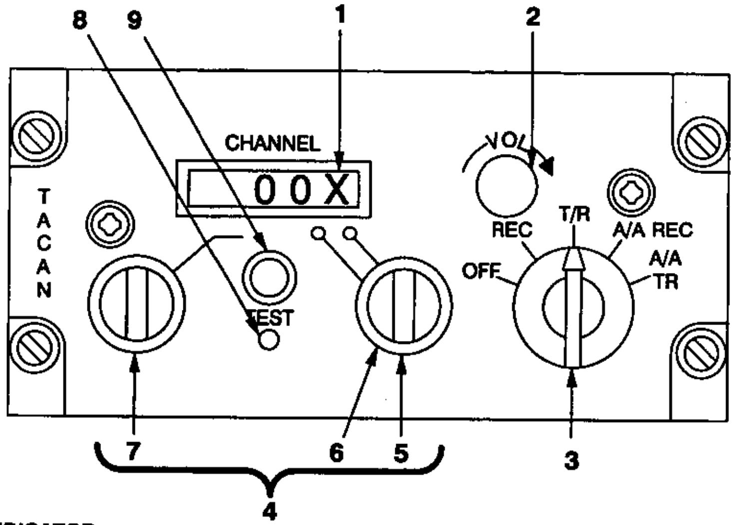
20.6.1.2 AN/ARN-118(V) TACAN Controls and Functions (Figures 20-5 and TNS 20-6).

20.6.1.3 B AN/ARN-118(V) TACAN Operating Procedures.

1. ICS PLT and ICS GNR circuit breakers - IN.
2. COMP IND, ADF RCVR (ac), and ADF RCVR (dc) circuit breakers - IN.
3. DC TACAN and AC TACAN SYS, TACAN IND, and TACAN RCVR circuit breakers - IN.
4. GYRO COMP circuit breaker - IN.
5. INVERTER MAIN and INVERTER STBY circuit breakers - IN.
6. BATT NO. 1 and/or BATT NO. 2 switches - ON.
7. INV switch - MAIN.
8. TACAN VOL control - CLOCKWISE (to audible level).
9. CSC control panel NAV A audio switch - ON (in and rotated clockwise).
10. TACAN mode selector - AS REQUIRED.
11. TACAN CHANNEL selectors - AS REQUIRED.

20.6.1.4 TNS AN/ARN-118(V) TACAN Operating Procedures.

1. ICS PLT and ICS GNR circuit breakers - IN.
2. COMP IND, ADF RCVR (ac), and ADF RCVR (dc) circuit breakers - IN.
3. DC TACAN and AC TACAN SYS, TACAN IND, and TACAN RCVR circuit breakers - IN.
4. GYRO COMP circuit breaker - IN.
5. INVERTER MAIN and INVERTER STBY circuit breakers - IN.
6. ICU NO. 1, ICU NO. 2, and PLT CDU circuit breakers - IN.
7. BATT NO. 1 and/or BATT NO. 2 switches - ON.
8. INV switch - MAIN.



CONTROL/INDICATOR	FUNCTION
1. CHANNEL digital display	Displays TACAN channel
2. VOL control	Varies level of audio signal
3. Mode selector switch	
OFF	Off switch for TACAN system.
REC	Receive Mode: Provides bearing information.
T/R	Transmit-Receive Mode: Provides bearing and distance information.
A/A REC	Air-to-air receive mode: Provides bearing information from suitably equipped, cooperating aircraft. A 63 channel separation is required between cooperating aircraft.
A/A T/R	Air-to-air transmit-receive mode: Provides bearing and distance information from a suitably equipped, cooperating aircraft. If the cooperating aircraft is not equipped with bearing transmitting capability, only slant range distance is provided.
4. CHANNEL selectors	Selects any of 126 channels.
5. Units selector	Selects units digit of desired channel.
6. X-Y selector	Selects either X or Y TACAN operating mode.
7. Tens/hundreds selector	Selects tens and/or hundreds digit of desired channel.
8. TEST switch	Initiates system self-test.
9. TEST indicator	Illuminates when a malfunction has occurred.

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Figure 20-5. AN/ARN-118(V) TACAN Controls and Indicators

9. CDU IDX function key - PRESS.

10. POWER LS 8 key - PRESS.

11. OFF: TACAN LS 6 key - PRESS TO TOGGLE TACAN SET ON.

12. CSC control panel NAV A audio switch - ON (in and rotated clockwise).

13. CDU NAV function key - PRESS.

14. TCN MODE: LS 2 key - PRESS TO SELECT TACAN MODE.

Note

TACAN AAR mode selection will only provide bearing information. To allow the air-to-air mode function, cooperating aircraft must have 63 channel frequency separation (e.g., 29 and 92).

15. LS 6 - PRESS TO SELECT TACAN CHANNEL.

20.7 CNU AN/ARN-153 (V)4 TACAN

The Comm/Nav Upgrade replaces the AN/ARN-118(V) TACAN receiver/transmitter with a new fully digital AN/ARN-153(V)4 TACAN receiver/transmitter.

20.7.1 CNU ARN-153 TACAN System Description.

The ARN-153(V)4 TACAN system provides the following:

- A 1350 Hz station identification signal to the ICS (NAV A)
- Slant range in nautical miles (nmi) to TACAN beacon displayed in the BDHI range window.

Note

A range warning flag is not provided. Loss of range signal will reset the BDHI range counter to 000.

- Relative magnetic bearing to TACAN station on BDHI No. 2 pointer (Figure 20-7) (double needle) and HUD.

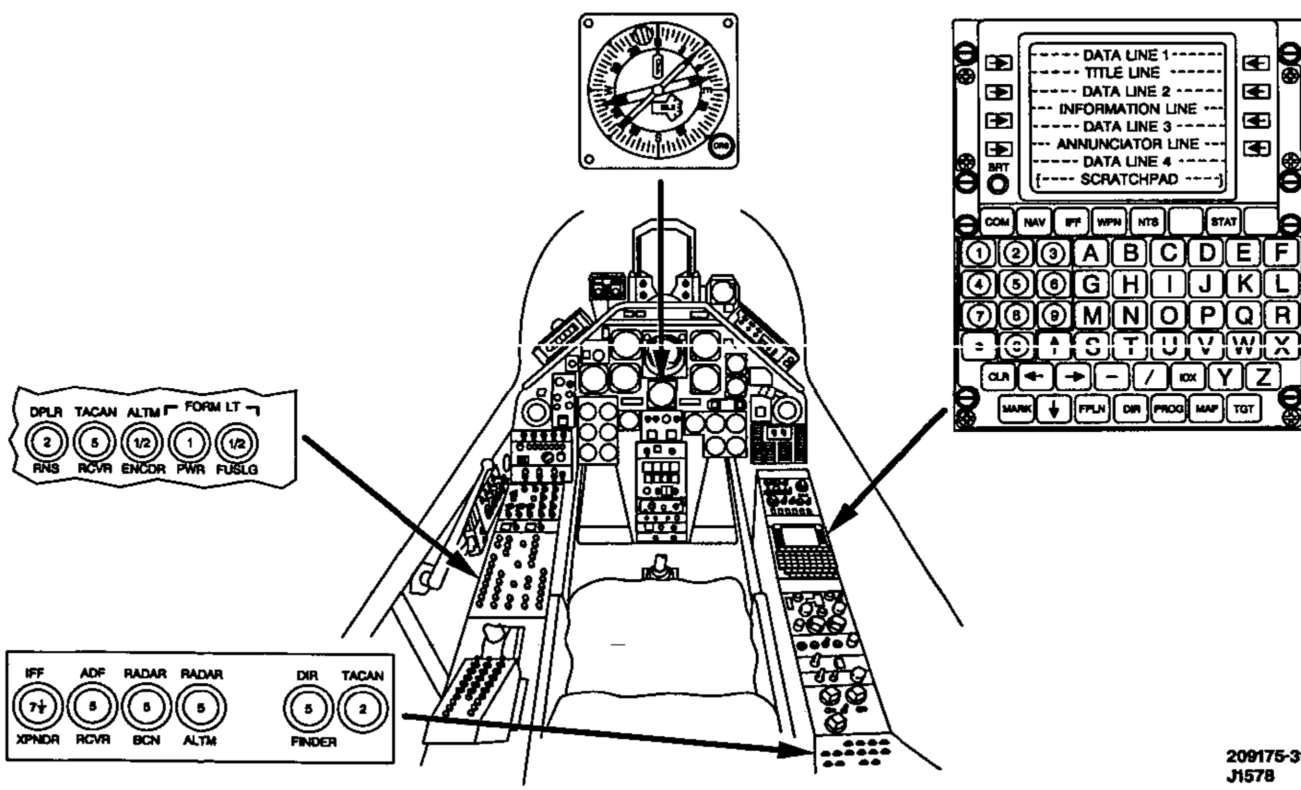


Figure 20-6. TNS AN/ARN-118(V) TACAN Controls and Indicators

TACAN relative bearing on the BDHI and HUD requires availability of EGI heading. The compass card on the BDHI and HUD heading tape displays true (T) or magnetic (M) heading depending upon selection on NAV 2/2 page.

Note

TACAN radials are always presented referenced to magnetic north, regardless of the HDG default selection on NAV 2/2 page. Relative bearing to the TACAN station display on the ADI is affected by the selection of either T or M on NAV 2/2 page.

When the NAV CTRL switch is set to any position other than GPS:

- The ADI deviation indicator pointer indicates the angular deviation from the radial selected with CRS knob on the BDHI. Full scale represents 10° deviation.
- The warning flag on the right side of the ADI indicates TACAN signal validity.

Operating range is limited to line-of-sight. Refer to Table 20-2 for maximum range data.

The TACAN set is powered from the 28 vdc non-essential bus via the TACAN circuit breaker, and from the 26 vac non-essential bus via the TACAN SYS circuit breaker.

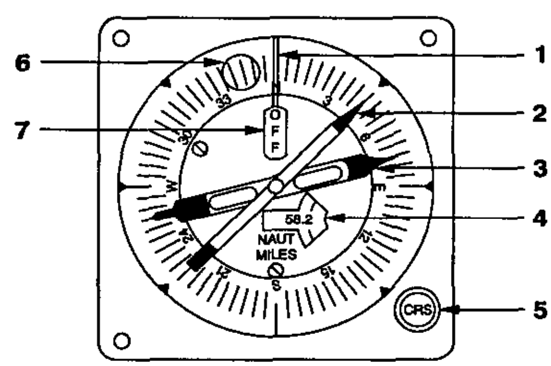
Note

Presentation of TACAN information on the BDHI requires 115 Vac (essential and non-essential) applied to the BDHI via the TACAN IND, TACAN RCVR, and BDHI circuit breakers.

In the event of an EGI failure all TACAN operations will become nonfunctional.

20.7.1.1 CNU AN/ARN-153(V)4 TACAN Controls and Functions.

1. Power: CDU POWER page LS 8 or CDU PWR key (power on only).
2. Channel selection: Entering desired channel and mode in scratchpad and selecting NAV 2/2 page LS 5 or PROGRESS 1/3 page LS 8. Toggling either LS key with a blank



CONTROL/INDICATOR	FUNCTION
1. Fixed Index	Gyromagnetic compass heading on compass card under lubber line.
2. Pointer No. 1 (single bar)	Indicates B TNS ADF or UHF/VHF-DF bearing.
3. Pointer No. 2 (double bar)	Indicates TACAN bearing.
4. Distance Range Indicator	Line-of-sight distance (nautical miles) to TACAN station.
5. Course (CRS) control knob	Positions the course index and selects course selected by the attitude indicator deviation pointer when the deviation pointer is connected to the TACAN system.
6. Course Selector Index (BUG)	Reference for course deviation pointer on attitude indicator.
7. Power OFF Flag	Disappears when gyromagnetic compass is energized.

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Figure 20-7. Bearing-Distance-Heading Indicator scratchpad displays the previous tuned channel.

Note

In the event of ICU No. 2 failure, the TACAN remains tuned to the last entered channel.

3. NAV 2/2 page LS 1 cycles through REC, T/R, A/A REC, and A/AT/R to provide the following:
   a. REC: Bearing only to TACAN beacon.
   b. T/R: Bearing and range to TACAN beacon.
   c. A/A REC: Bearing to other aircraft equipped with airborne TACAN beacon.
   d. A/AT/R: Bearing and range to other aircraft with airborne TACAN beacon.

Note

Use of A/AT/R and A/A REC require TACANs being tuned 63 channels apart. The flag on the right side of the ADI will remain in view.

4. Status: STATUS 1/3 page LS 6 and NAV TEST page LS 3.
5. Self-Test: NAV TEST page LS 3.

20.7.1.2 CNU AN/ARN-153(V)4 TACAN Operating Procedures.

Refer to section 20.14 for CDU page descriptions.

1. ICS PLT and ICS GNR circuit breakers - IN.
2. TACAN, TACAN SYS (dc) circuit breakers - IN.
3. TACAN IND, and TACAN RCVR, and BDHI (ac) circuit breakers - IN.
4. INVERTER MAIN and INVERTER STBY circuit breakers - IN.
5. ICU NO. 1, ICU NO 2, CPLT and PLT CDU breakers - IN.
6. BATT NO. 1 and/or BATT NO. 2 switches - ON (non-essential bus must be energized).
7. INV switch - MAIN.

Note

Steps 8, 9, and 10 can be skipped if the CDU PWR function key has been used.

8. CDU IDX function key - PRESS
9. POWER LS 8 key - PRESS
10. TACAN LS 8 key - PRESS to toggle TACAN SET on.
11. STAT function key - PRESS to verify TACAN status on display line 3.
12. CSC control panel NAV A audio switch - ON (in and rotated clockwise).
13. CDU NAV function key - PRESS, scroll to NAV 2/2 page.
14. TCN MODE: LS 1 key - PRESS to select TACAN mode (TR is normal mode).
15. LS 5 - ENTER desired TACAN channel.

Note

TACAN channel can also be entered/changed on PROGRESS 1/3 page LS 8.

20.7.1.3 CNU TACAN Manual Self-Test.

Manual self-test is initiated by pressing LS 3 on the NAV TEST page. The following displays are observed:

- ADI deviation pointer and BDHI No. 2 needle move between extremes during self-test.
- Audio tones are produced.
- The flag on the right side of the ADI cycles in and out of view.

Note

TACAN indications may be inaccurate when less than 50 feet from HF radio transmitters.

20.8 BDHI

There are two BDHIs mounted in the helicopter: one on the pilot instrument panel (Figure 20-7) and one on the copilot/gunner instrument panel. They are connected in parallel and display the following information:

1. Compass card - Provides an accurate indication of the helicopter heading and is controlled by the TNS AN/ASN-75B gyro compass system or CNU EGI.

CNU The BDHI Compass Card displays either true or magnetic heading depending on the selection on the NAV 1/2 page.

2. Pointer No. 1 (single bar) - Displays either ADF bearing from the B TNS CM AN/ARN-89B system or UHF/VHF DF bearing from the DF-301E system. B TNS CM The ADF signal is removed from the pointer and the DF signal displays when the NAV CONTROL panel switch is set to DF or BOTH/TNS DF and the AN/ARC-182 or AN/ARC-210 command radio is tuned to DF frequencies. Keying the microphone switch will interrupt DF inputs.

3. Pointer No. 2 (double bar) - Displays the TACAN bearing from the AN/ARN-118(V) or AN/ARN-153(V)4 system.

4. NAUT MILES window - Displays the slant range in nmi to the selected TACAN station.

Note

For the AN/ARN-118 TACAN the BDHI DME will lock on the last known distance. For the AN/ARN-153 TACAN the BDHI DME will reset at 000. This information will let the pilot know the TACAN signal has been lost.

20.9 DF-301E UHF/VHF DIRECTION FINDER SET

20.9.1 DF-301E Controls and Indicators.

The direction finder set is enabled by the NAV CONTROL switch set to DF, and frequencies are selected on the command radio set. The set is operable in the frequency range of 108 to 400 MHz. When the NAV CONTROL switch is set to DF or BOTH/TNS DPLR and frequencies between 108 to 155.975 MHz and 225 to 399.975 MHz are tuned on the command radio set, the receiver is coupled to the DF set and bearing information is presented on the No. 1 pointer of the BDHI. See figure B TNS CNU 20-9 (Sheets 1 and 2).

20.9.2 B DF-301E Operating Procedures.

1. DIR FINDER circuit breakers - IN.

2. NAV CONTROL panel switch - BOTH OR DF AS REQUIRED.

Note

When the NAV CONTROL panel switch is in the DF or BOTH position, keying the microphone switch will disable the DF and ADF bearing information will be displayed on the BDHI. DF displays when the microphone switch is released.

3. AN/ARC-182(V) command radio set - FREQUENCY SET AS DESIRED.

4. AN/ARC-182(V) operational MODE selector - SET T/R or T/R+G AS DESIRED.

Note

If the DF mode is selected on the AN/ARC-182(V) command radio set, FM homing, DF, and any audio reception will be inoperative.

5. BDHI - MONITOR NO. 1 POINTER FOR NAVIGATION.

20.9.3 TNS CNU DF-301E Operating Procedures.

1. DIR FINDER circuit breakers - IN.

2. ICU NO. 1, ICU NO. 2, and PLT CDU circuit breakers - IN.

Note

When the NAV CONTROL panel switch is in the DF position, keying the microphone switch will disable the DF. TNS ADF bearing information will be displayed on the BDHI. DF displays when the microphone switch is released.

The DF ON/OFF on the COMM 2 page is inoperative and may result in poor audio reception if used.

3. NAV CONTROL panel switch - DF.

4. CDU COM function key - PRESS.

5. COMM page - DISPLAYED.

6. Enter desired preset into scratchpad.

7. LS 1 (command radio) key - PRESS.

The following alternate method may also be used:

1. CDU COM function key - PRESS.

2. COMM page - DISPLAYED.

3. C1 (command radio) - PRESS TO SELECT AS REQUIRED.
4. COMM 1 - DISPLAYED.
5. LS 1 PRESETS key - PRESS.
6. COMM 1 - DISPLAYED.
7. Desired frequency - SELECT BY SCROLLING AND PRESSING APPROPRIATE LINE SELECT KEY (LS 1 THROUGH LS 4) WITH AN EMPTY SCRATCHPAD.
8. BDHI - MONITOR NO. 1 POINTER FOR POSITION AND STEERING.

20.10 NAVIGATION CONTROL PANEL

20.10.1 NAV CONTROL Switch Functions.

The navigation control panel (Figure 20-9) incorporates a four-position switch for selection and control of bearing and distance information presented on the pilot and copilot/gunner BDHI and the pilot attitude indicator. The control switch interfaces with the DF-301E (DF set), B TNS CM AN/ARN-89B (ADF set), TACAN, TNS AN/APN-217(V)3 (Doppler set), and the radios.

Nav control switch functions are summarized in Figure 20-8.

Note

Set the NAV CONTROL switch to OFF if communication reception is marginal. Because of the avionics configuration, degraded communications may occur during radio navigation using DF mode.

1. OFF position.
   a. FM homing and DF disabled. TNS CNU DF disabled.
   b. ADF bearing indicated on BDHI pointer No. 1.
   c. TACAN bearing indicated on BDHI pointer No. 2.
   d. TACAN distance indicated on BDHI.
   e. TACAN course deviation indicated on pilot attitude indicator.
   f. TNS CNU TACAN CDI on attitude indicator.
   g. TACAN steering data on attitude indicator if tactical radio is not tuned to and receiving FM station.
2. B TNS CM ADF position.
   a. ADF bearing position indicated on BDHI pointer No. 1.
   b. DF disabled.
   c. FM homing and course deviation are enabled and indicated on the pilot attitude indicator. TNS CNU FM homing removed.
   d. TACAN bearing indicated on BDHI pointer No. 2.
   e. TACAN distance indicated on BDHI.
   f. TNS TACAN CDI on attitude indicator.
   g. TACAN steering data on attitude indicator if tactical radio is not tuned to and receiving FM station.
3. DF position.
   a. FM homing disabled.
   b. DF indicated on BDHI pointer No. 1 when the command radio is tuned to DF frequencies (108.000 to 155.975 and 225.000 to 399.975 MHz).
   c. TACAN bearing indicated on BDHI pointer No. 2.
   d. TACAN distance indicated on BDHI.
   e. TACAN course deviation indicated on the pilot attitude indicator.
4. BOTH position/TNS DPLR position/CNU GPS position.
   a. DF indicated on BDHI pointer No. 1 with command radio tuned to DF frequencies. B TNS CM ADF indicated on BDHI pointer No. 1 with AN/ARN-89B ADF set tuned to ADF frequencies and command radio not tuned to DF frequencies. If the command radio is tuned to a DF frequency, DF has priority over ADF; however, the No. 1 pointer will indicate ADF bearing when the command radio is keyed.
   b. TNS CNU FM homing and course deviation enabled and indicated on pilot

EQUIP/ SWITCH POSITION	TACAN	ADF	FM HOMING	DF	TNS DOPPLER	CNU GPS
OFF	BDHI-Pointer No. 2 Attitude Indicator-Steering Data	BDHI-Pointer No. 1				
ADF	BDHI-Pointer No. 2 Attitude Indicator - Steering data if tactical radio is not tuned to and receiving FM station	BDHI-Pointer No. 1	Attitude Indicator - Steering data if tactical radio is tuned to and receiving FM station			
DF	BDHI-Pointer No. 2 Attitude Indicator - Steering Data			BDHI-Pointer No. 1		
BOTH	BDHI-Pointer No. 2 Attitude Indicator - Steering data if tactical radio is not tuned to and receiving FM station		Attitude Indicator - Steering data if tactical radio is tuned to and receiving FM station	BDHI-Pointer No. 1		
TNS DPLR	BDHI-Pointer No. 2 Attitude Indicator - Steering data if tactical radio is not tuned to and receiving FM station	BDHI-Pointer No. 1		BDHI-Pointer No. 1	Attitude Steering Steering data on course deviation pointer	
CNU GPS	BDHI-Pointer No. 2 Attitude Indicator - Steering data if tactical radio is not tuned to and receiving FM station			BDHI-Pointer No. 1		Attitude Steering Steering data on course deviation pointer

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Figure 20-8. NAV CONTROL Switch Functions

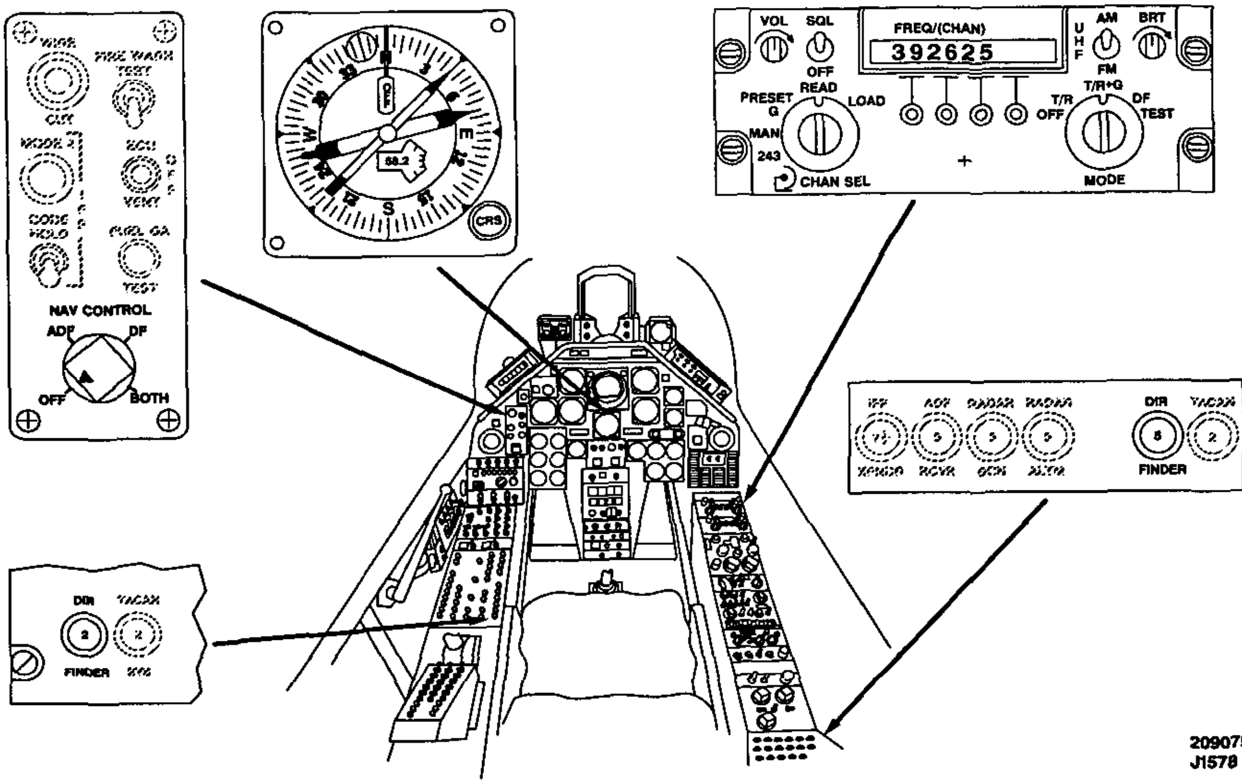


Figure 20-9. DF-301E Direction Finder Controls and Indicators (Sheet 1 of 2)

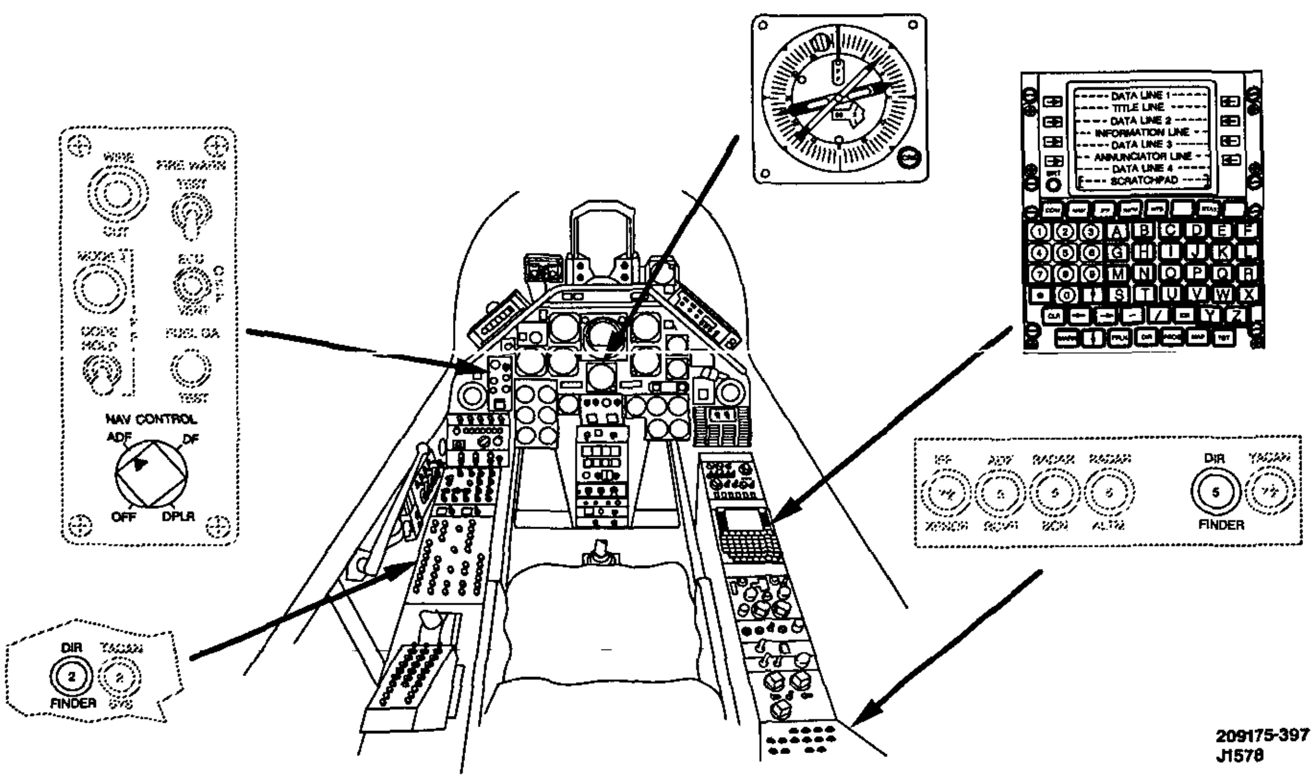


Figure 20-9. DF-301E Direction Finder Controls and Indicators (Sheet 2 of 2)

attitude indicator when AN/ARC-182(V) tactical radio is tuned to FM homing frequencies. TNS FM homing disabled.

c. TACAN bearing indicated on BDHI pointer No. 2.

d. TACAN distance indicated on BDHI.

e. TACAN CDI on attitude indicator if tactical radio is not tuned to and receiving FM station.

f. TNS CNU Doppler/EGI crosstrack data on attitude indicator.

20.11 B TNS CM AN/ARN-89B AUTOMATIC DIRECTION FINDER SET

The AN/ARN-89B ADF set, located in the pilot right console is used in conjunction with the BDHI and CSC. The set supplies bearing information to the BDHI No. 1 (single bar) pointer when the NAV CONTROL panel switch is positioned to OFF or ADF. The AN/ARN-89B receiver operates in the 100 to 3000 kHz frequency range and is used to receive continuous wave (CW) or amplitude modulated (AM/VOICE) radio frequency signals. The three modes of operation for the ADF set include automatic homing in the COMP mode, manual homing in the LOOP mode, and as a communication receiver in the ANT mode. A beat frequency oscillator is included to provide an audible indication for identification and tuning to CW stations, and is activated by the CW/VOICE/TEST switch set to CW. The ADF system is powered by the 26 vac essential bus and 28 vdc nonessential bus. Circuit protection is provided by two ADF RCVR circuit breakers located on the ac and dc circuit breaker panels.

20.11.1 B TNS CM AN/ARN-89B ADF Controls and Functions (Figure 20-10).

Note

CNU AN/ARN-89B ADF is removed as part of the COMM/NAV Upgrade.

20.11.2 B TNS CM AN/ARN-89B ADF Operating Procedures.

ADF Operation:

1. CSC control panel receiving NAV B switch - ON.
2. Function selector - COMP.
3. Frequency - SELECT.
4. AUDIO - ADJUST.
5. TUNE meter - TUNE FOR MAXIMUM UP NEEDLE DEFLECTION.
6. NAV CONTROL panel switch - ADF or OFF AS REQUIRED.

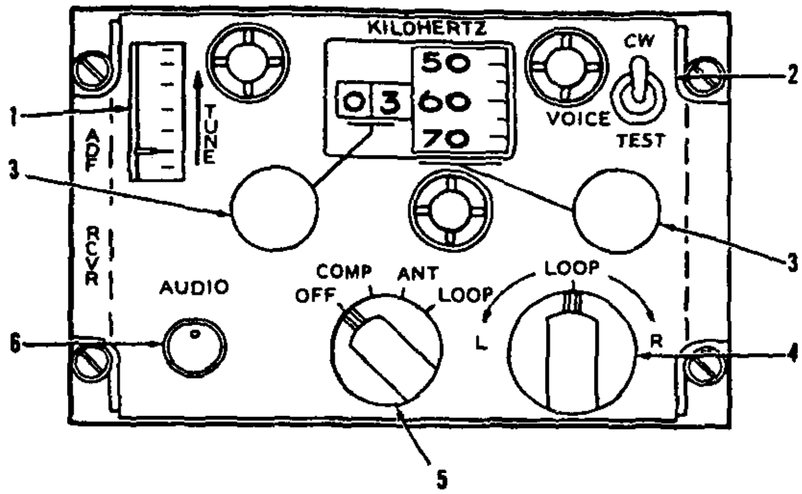
ADF Manual Operation:

1. CSC control panel receiving NAV B switch - ON.
2. Function selector - LOOP.
3. CW/VOICE/TEST switch - CW.
4. Rotate loop for maximum reception - RETUNE.
5. Rotate loop to find audible null position - ADJUST VOLUME FOR A 5 TO 8 DEGREE NULL WIDTH.
6. Check for ambiguity - THE ADF BEARING POINTER WILL EITHER READ THE MAGNETIC BEARING TO THE STATION OR BE 180 DEGREES OUT.
7. Function selector - OFF.

20.12 B TNS CM AN/ASN-75B COMPASS SET

The AN/ASN-75B compass set provides an accurate indication of helicopter heading. The AN/ASN-75B is capable of operating as a magnetically slaved directional gyro in the SLAVED mode or as a free directional gyro with latitude correction in the FREE gyro mode. Mode selection facilities are provided by a toggle switch on the panel of the C-8021 AN/ASN-75B compass set control. The AN/ASN-75B heading output is presented on the rotating compass card of the BDHI on the pilot and copilot/gunner instrument panel. The LATITUDE degree selector and LATITUDE N-S switch are located on the AM-4606/ASN-75 amplifier-power supply in the radio compartment and must be placed in the desired position before flight.

A control panel located on the pilot right console is used to set the AN/ASN-75B compass system. A knob marked PUSH to SET provides for synchronization of the gyro to the magnetic heading of the helicopter. The synchronization indicator (annunciator) is a zero-center meter marked + on the left and • on the right. When the indicator reads +, the ASN-75B may be synchronized by pressing the PUSH TO SET knob located on the C-8021 ASN-



CONTROL/INDICATOR	FUNCTION
1. TUNE indicator	Up deflection of the needle indicates most accurate tuning of the receiver.
2. CW/VOICE/TEST switch	
CW	Provides tone that may be used for identification, tuning, or CW station.
VOICE	Permits normal aural reception.
TEST	Rotates ADF bearing pointer to provide a check of pointer accuracy with function selector in the COMP position, inoperative in LOOP and ANT positions. The switch is spring loaded away from TEST position.
3. Frequency selectors	
Left (coarse tune)	Selects first two digits of desired frequency.
Right (fine tune)	Selects third and fourth digits of desired frequency.
4. LOOP control	Manual positioning of loop antenna when ADF is operating in manual direction finding mode.
5. Function selector	
OFF	Power off.
COMP	ADF operation as an automatic direction finder.
ANT	Receiver provides aural information only.
LOOP	ADF operation as a manual direction finder using the loop antenna only.
6. AUDIO control	Adjusts receiver volume.

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Figure 20-10. AN/ARN-89B Automatic Direction Finder Set

75B and rotating it in the + direction until the indicator centers. Similarly, when the indicators read •, the knob should be rotated in the • direction. This ensures that the heading presented on the compass card of the BDHI is correct. The PUSH TO SET knob is also used to set the desired helicopter heading while operating in the FREE gyro mode. Exercise care to prevent setting the compass 180° out of phase; in this situation the synchronization indicator will center. However, synchronization pointer movement will be opposite to the direction of rotation of the control knob. The synchronization indicator continues to provide a visual check on the slaving operation. The AN/ASN-75B compass system receives power from the 26 vac bus and the 115 vac bus. Circuit protection is provided by circuit breakers in the ac circuit breaker panel labeled GYRO COMP and COMP IND.

20.12.1 B TNS CM AN/ASN-75B Controls and Functions.

See Figure 20-11 for controls and functions.

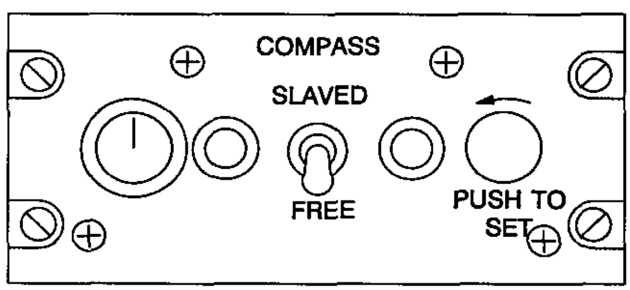
Note

When the SLAVED mode is selected, the AN/ASN-75B will automatically slave to the correct heading at a rate of 2.5° ± 1.25° per minute. The correct heading may be immediately selected with the PUSH TO SET knob as explained above. Once the correct heading is selected, the AN/ASN-75B will maintain the correct magnetic heading on the BDHI compass card.

When operating in areas of high latitude or during shipboard operations, the gyro may be unslaved to reduce unreliable readings.

20.12.1.1 B TNS CM Slaved Gyro Operating Procedures.

1. Allow approximately 2 minutes for the gyro to reach operating speed.
2. Mode - SLAVED.
3. Synchronize gyro and magnetic heading by pushing in on the PUSH TO SET knob and rotating until the synchronizing indicator is centered.



CONTROL/INDICATOR	FUNCTION
PUSH TO SET knob	Provides synchronization of gyro to magnetic heading of helicopter.
SLAVED mode	Will produce an output from transmitter synchro which agrees with remote compass transmitter Type ML-1 magnetic heading.
FREE gyro mode	Provides correction for earth's rate of drift by amplifier-power supply AM-4606/ASN-75.

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Figure 20-11. B TNS CM AN/ASN-75B Compass Set Control Panel

20.12.1.2 B TNS CM Free Gyro Operating Procedures.

1. Check LATITUDE selectors and N-S switch before flight.
2. Allow approximately 2 minutes for gyro to reach operating speed.
3. Mode - FREE.

20.13 AN/APN-194(V) RADAR ALTIMETER

B TNS CM have only a single radar altimeter on the pilot instrument panel and CM CNU have a radar altimeter on each pilot instrument panel.

The AN/APN-194(V) is a pulse-modulated radar altimeter system and provides absolute altitude information between 0 and 5000 feet. Absolute altitude is displayed on a dial face with a single pointer. An OFF flag appears when the system loses electrical power or when the altitude signal becomes unreliable. The system may become unreliable when the helicopter is maneuvered through unusual attitudes or at altitudes greater than 5000 feet. The PUSH TO TEST knob on the indicator functions as the power on/off switch, the PUSH TO TEST switch for system self-test, and the altitude DH index adjustment. When indicated altitude drops below the DH index setting in the rear cockpit only, a 3 to 5 beep aural warning signal sounds through the ICS. CM CNU *Only the rear cockpit DH index will set* the aural warning altitude.

Note

The system automatically resets once the aircraft climbs above the preset altitude.

The radar altimeter is powered by the 115 vac essential bus and 28 vdc essential bus. The circuits are protected by the RADAR ALT ac circuit breaker and the RADAR ALTM dc circuit breaker.

20.13.1 AN/APN-194(V) Controls and Functions. See Figure 20-12.

20.13.2 AN/APN-194(V) Operating Procedures.

1. RADAR ALTM and RADAR ALT circuit breakers - IN.
2. PUSH TO TEST knob - ROTATE CLOCKWISE FOR POWER ON AND SET DH INDEX AT 50 feet. (Allowing 3 minutes for warmup and verify 3 to 5 beep aural warning signal is heard).

Note

CM CNU Turning either RAD ALT on results in the system powering up and both indicators will indicate normally. Only the rear cockpit DH index will set the aural warning altitude.

3. Radar altimeter - CHECK:
   a. OFF flag not displayed.
   b. Altitude pointer indicates 0 - 3 feet.
4. PUSH TO TEST knob - PUSH AND HOLD (10 seconds).

Check for the following indications:

   a. Altitude pointer indicates 100 ± 15 feet.
   b. Self-test light illuminates green.
   c. OFF flag not displayed.

5. PUSH TO TEST knob - RELEASE.

Check for the following indications:

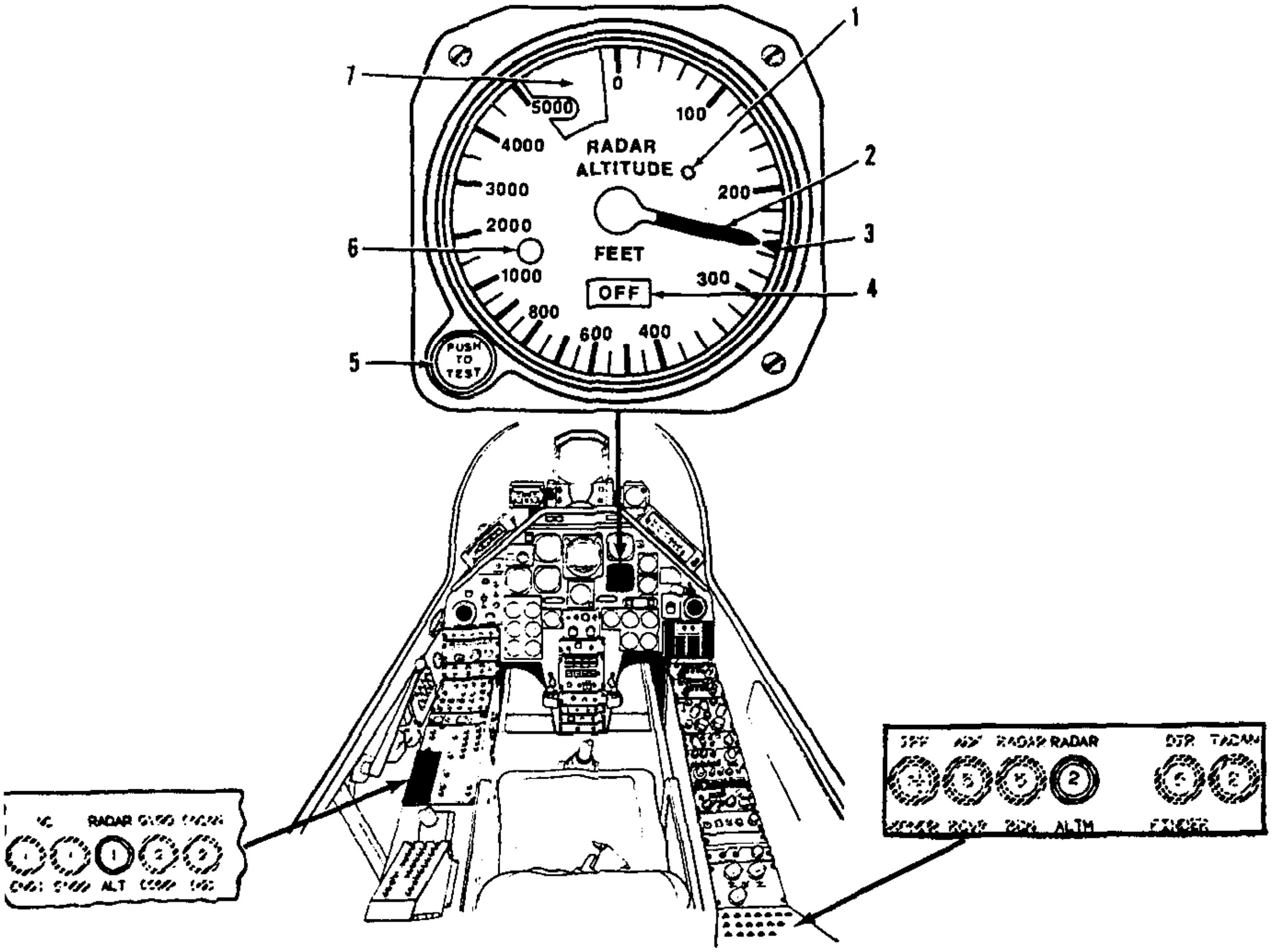
   a. Altitude pointer returns to 0 ± 3 feet.
   b. Three to five beep aural warning signal heard.

6. Set DH index pointer - AS REQUIRED.

Note

Allow approximately 3 minutes for the system to reach operating temperature; otherwise, the radar signal may not be reliable. Altitude information displayed on the CDU (PROG 2/3) and HUD should match the indications of the radar altimeter during turn-on and self-test procedures.

In the event of loss of track because of helicopter attitude (30° PITCH or 45° ROLL) or operation beyond the range of the altimeter, the altitude pointer swings behind the no-track mask and the HUD digital readout is totally blanked. In addition, the OFF flag comes into view.



CONTROL/INDICATOR	FUNCTION
1. Self-test light	Illuminates green if system is operational in self-test (light may not be visible in daytime).
2. Altitude pointer	Indicates altitude of helicopter above ground level.
3. Decision height (DH) index pointer	Indicates selected DH altitude.
4. OFF flag	Indicates power removed from altimeter, radar signal is unreliable, or helicopter above 5000 feet.
5. PUSH TO TEST	Turns altimeter on and off. Energizes self-test circuit in the altimeter. Adjusts DH index pointer setting.
6. Low altitude warning light	Disconnected.
7. Mask	Indicates altimeter unreliable or helicopter altitude above 5000 feet AGL. (Altitude pointer goes behind mask.)

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Figure 20-12. Radar Altimeter

20.14 TNS CNU CDU DISPLAYS AND FUNCTIONS

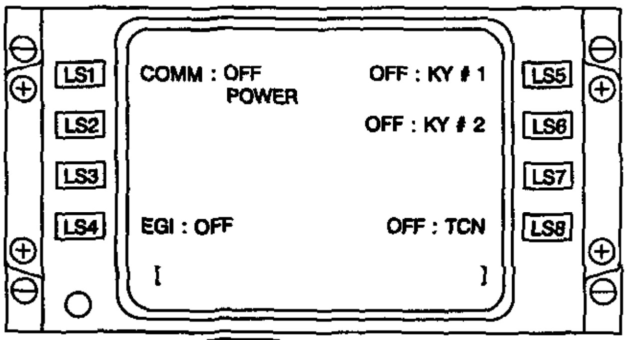
20.14.1 TNS CNU INDEX Pages.

Refer to Chapter 19.

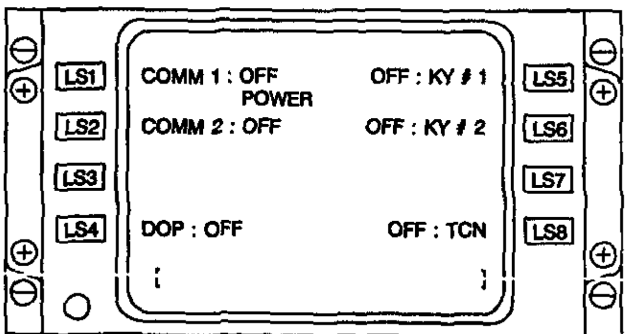
20.14.2 TNS CNU CDU POWER Page.

Power pages are provided to allow power control of CCS controlled avionics.

Power page is accessed via LS 8 key in the INDEX 1/2 page.



CNU POWER PAGE



TNS POWER PAGE

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Power can be applied either simultaneously to all avionics equipment by pressing the CDU PWR key (power-on only), or individually by pressing applicable LS 1 through LS 8 on the POWER page.

A normal shutdown is performed by powering off all avionics on the POWER page, then waiting for approximately 7 to 10 seconds prior to powering down the aircraft.

CNU It is imperative to perform an orderly shutdown in order to save the last INS and GPS computed PPSN, GPS Almanac, time, aircraft heading and other critical data into the EGI NVM. The completion of power down of the EGI is indicated by appearance the BDHI "OFF" flag. Power for the radios and EGI default to off on CCS power up.

Note

Backup power is provided to the EGI from the battery bus via the XMSN OIL circuit breaker to allow an orderly shutdown for inadvertent power down/ power transients.

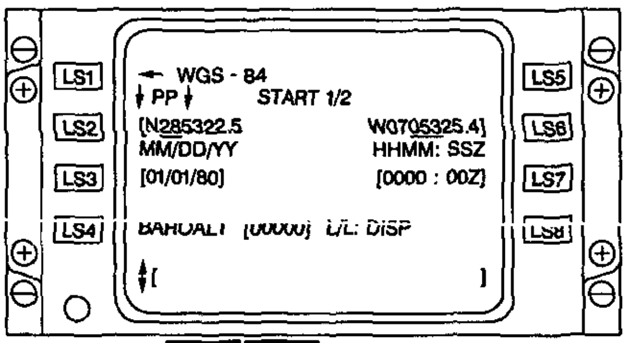
Refer to Chapter 19 for detailed information on the POWER page operations.

20.14.3 TNS CNU START Pages.

The START pages are provided to allow initialization of the aircraft navigation parameters. START page allows manual entry of time (local or Zulu), date and present position. START pages also allow selection of Horizontal Datum and coordinate display format (UTM or latitude/longitude).

20.14.3.1 TNS CNU START 1/2 Page.

The START 1/2 page is accessed via the LS 1 key on the INDEX 1/2 page.



TNS CNU START 1/2 PAGE

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LS 1: Displays the currently selected datum. Pressing the line select key calls the HORIZ (horizontal) DATUMS page displaying the current selection.

Note

Accessing the HORIZ DATUMS pages from the START page results in display of the currently selected datum.

Points are stored as a lat/long coordinate with a horizontal datum assigned to it. The UTM grid versus L/L relationship is defined by the horizontal datum (on the START 1/2 page) in use when the coordinates are initially entered. Previously stored coordinates will not change if another horizontal datum is selected.

CNU Correct alignment of the INS and conversion from true to magnetic heading requires a correct PPSN. L/L or UTM default must be selected prior to entry of PPSN data.

LS 2: Initially displays the CCS present position (labeled as ↓ PP ↓ directly above) from CCS memory or CNU EGI stored memory at previous power down. Pressing the LS 2 key with a blank scratchpad has no effect. Pressing the line select key with a valid latitude/longitude (L/L) or universal transverse mercator (UTM) in the scratchpad will enter that parameter into the system. CNU Valid GPS PPSN will always overwrite the position displayed on LS 2 unless the GPS sensor is deselected.

Note

L/L inputs may be entered in degrees, minutes, or seconds (example: DDMMSS for latitude, DDDMMSS for longitude) or degrees, minutes, seconds, and tenths of seconds (DDMMSS.S for latitude, DDDMMSS.S for longitude). UTM positions are entered as 4 or 5 digits each for easting and northing, and displayed as 5 digits each. If zone and/or 100,000 meter square is omitted, prior entry values are assumed.

Datum default must be chosen prior to entry of the position on line 3.

CNU PPSN manually entered must be within 1 nmi to allow INS position to be updated upon acquisition of GPS data.

LS 3: Displays the DATE. Pressing the LS 3 key with a blank scratchpad has no effect. Pressing the line select key with a valid date in the scratchpad will enter that parameter into the system. Slashes need not be used. All month, day, and year (MM/DD/YY) input must be in a two-digit format. The date will default at power up to the date stored in memory. CNU The date will be updated with GPS date when available.

Note

Date entry is necessary for correct magnetic heading conversion.

LS 4: CNU Displays barometric altitude in feet (referenced to 29.92 in. Hg) for use in altitude-initialization of EGI. Pilot may override the displayed value by entering the actual altitude, in feet, and pressing LS 4. Upon entry, the value will be displayed at LS 4 in the following format: MSLALT [00000]. Pressing of LS 4 with a blank scratchpad will toggle between the MSLALT and BAROALT display (if pilot has entered a valid altitude). The pilot-entered altitude may be removed by entering a dash (minus) in the scratchpad and pressing LS 4 with MSLALT displayed.

Note

CNU Once the EGI has aligned, reselect BAROALT on START 1/2 (if MSLALT was selected) to allow the EGI to calculate and display updated altitude information.

LS 5 and 6: Not used.

LS 7: Displays local clock time, CNU from GPS if available. Pressing with a blank scratchpad has no effect. Pressing LS 7 with a valid time in the scratchpad inserts that time into the system and sets the clock; pressing LS 7 with a valid time-zone letter in the scratchpad will reset local time to the indicated time-zone. Entry of time is in hours, minutes, and time zone letter; seconds are display only. Time will be set to whole minutes at the moment LS 7 is pushed. Coordinated Universal Time (ZULU) will be the default if time zone letter is omitted.

Note

CNU Manual entry of time must be within 10 seconds of UTC or GPS may not initialize. Normal shore based operations do not require manual entries on the START page. Once GPS has acquired satellites, the START page date and time will be automatically updated.

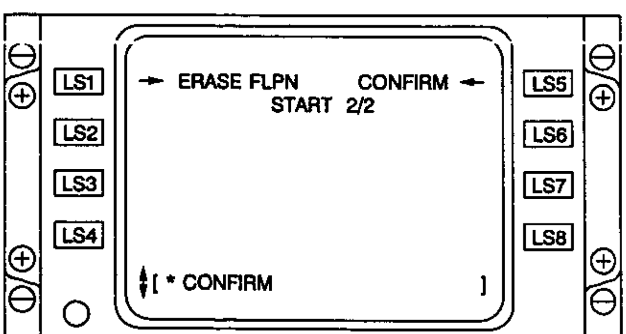
LS 8: Toggles the DISP between UTM and L/L for the system default on the FPLN and PROG pages and MARKed or laser coordinates in the scratchpad. UTM selection displays distances in kilometers. L/L selection displays distance in nautical miles. The selection also affects display formats for system-generated targets and marks distance and crosstrack deviation on the PROGRESS 1/3 page, track space on the LADDER and EXP SQUARE pattern pages, and present and checkpoint positions on the UPDATE page.

Note

Only the CDU, and not the HUD or BDHI, is affected by this default.

20.14.3.2 TNS CNU START 2/2 Page.

The START 2/2 page is accessed by pressing LS 1 on the INDEX 1/2 page and scrolling down from the START 1/2 page.



TNS CNU START 2/2 PAGE

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J1340

LS 1: Selects/deselects the display of an * beside ERASE FPLN and writes * CONFIRM in the scratchpad when the asterisk is selected. Erasing the flight plan clears the previous flight plan and history points allowing the new flight plan and steering calculation to be computed from the current aircraft present position.

LS 2 through 4: Not used.

LS 5: When an asterisk is displayed next to LS 1, pressing LS 5 erases the current flight plan and removes the * CONFIRM message from the scratchpad. Pressing LS 5 when the arrow is displayed next to LS 1 has no effect.

LS 6 through 8: Not used.

The START 2/2 page is scrollable up or down to the START 1/2 page.

20.14.3.3 TNS CNU START Page Procedures.

1. Horizontal Datum - Select (IDX, Start 1/2, LS 1, scroll to desired datum, select using appropriate left LS).

Note

Points are stored as a lat/long coordinate with a horizontal datum assigned to it. The UTM grid versus L/L relationship will be predefined by the horizontal datum (on the START 1/2 page) in use when the coordinates were initially entered. Previously stored coordinates will not change if another horizontal datum is selected.

2. Present Position - Enter (IDX, Start 1/2, type coordinates in scratchpad, load using LS 2).

Note

CNU PPSN must be updated to within 500 nmi to adequately acquire satellites.

3. Date - Enter, if required (IDX, Start 1/2, type date in scratchpad, load using LS 3).

4. Time - Enter, if required (IDX, Start 1/2, type time in scratchpad, load using LS 7).

5. MSL Altitude - Enter, if required (IDX, Start 1/2, type current altitude in scratchpad, load using LS 4).

6. Coordinate display style - Select UTM or L/L (IDX, Start 1/2, LS 8).

7. Old Flight Plan - Erase (IDX, Start 2/2, LS 1 then LS 3).

Note

Old flightplan should be erased to allow steering information (i.e., CMD HDG and crosstrack) to be calculated from current aircraft present position rather than the last waypoint in the flight plan history.

CNU Once the EGI has aligned, reselect BAROALT on START 1/2 (if MSLALT was selected) to allow the EGI to calculate and display updated altitude information.

20.14.4 TNS CNU HORIZ (horizontal) DATUMS.

Table 20-3. HORIZONTAL DATUMS

CDU PAGE NO	HORIZ DATUMS
1/12	ADINDAN
	ARC 1950
	AUSTRALIAN GEODETIC
	BUKIT RIMPAH
2/12	CAMP AREA ASTRO
	DJARTA
	EUROPEAN
	GEODETIC DATUM 1949
3/12	GHANA
	GUAM 1963
	G. SEGARA
	G. SERINDUNG
4/12	HERAT NORTH
	HJORSEY 1955
	HU-TZU-SHAN
	INDIAN
5/12	IRELAND 1965
	KRARTAU (MALAYAN REV.)
	LIBERIA 1964
	LUZON
6/12	MERCHICH
	MONT JONG LOWE
	NIGERIA
	N AMER 1927 CONUS
7/12	N AMER ALASKA CANADA
	OLD HAWAIIAN MAUI
	OLD HAWAIIAN OAHU
	OLD HAWAIIAN KAUAI
8/12	ORDINANCE SURVEY GB36
	QORNOQ
	SIERRA LEONE 1960
	S AMER PROV 1956
9/12	S AMER CORREGO ALEGRE
	S AMER CAMPOINCHAUSPE
	S AMER CHUA ASTRO
	S SMER YACARE
10/12	TANANARIVE OBSV 1925
	TIMBALAI
	TOKYO
	VOIROL
11/12	SPECIAL INDIAN
	SPECIAL LUZON
	SPECIAL TOKYO
	SPECIAL WGS-84
12/12	WGS-72
	WGA-84

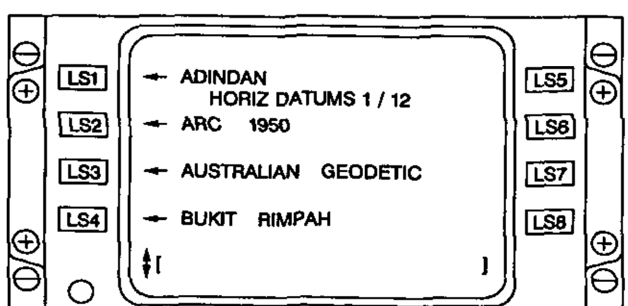
(TABLE I.D. 922048)

Note

If the zeroize ALL function is used, the default datum will be WGS-84. If the zeroize NAV function is used, the default datum will be WGS-72.

Horizontal Datum pages are provided to select the applicable map datum for maps in use that will allow for proper data input and grid to lat/long conversions. It is imperative that close attention be paid to the map datums of the maps and charts in use for both in-aircraft navigation and coordination with other agencies, both air and ground. Waypoint and target position data are stored as a latitude/longitude with the horizontal datum as selected on the start page at the time of entry and will be accurate for only that datum. See Table 20-3 for the list of horizontal datums.

Pages are accessed via LS 1 on the START 1/2 page. Datums are used to calculate UTM grid coordinate relationships from L/L. Horizontal datum to be used is identified in the marginal information of the UTM grid or the sectional map.



TNS CNU HORIZ DATUMS PAGE

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J1340

LS 1 through 4: Displays the menu of datums. Pressing a left line select key selects that datum for entry and calls the START 1/2 page with a selected datum on the display line.

LS 5 through 8: Not used. Pressing a right line select key has no effect.

Note

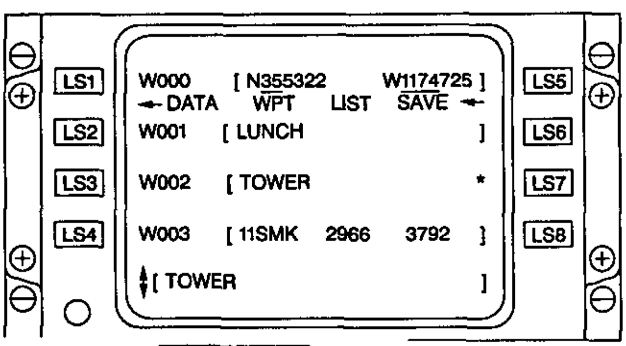
> It is essential that the proper datum is selected prior to entering waypoint and target data. Changing the datum will not change the stored waypoint or the target L/L versus UTM calculated relationship previously loaded using a different horizontal datum.

The HORIZ DATUMS pages are scrollable in a wraparound fashion. Accessing the HORIZ DATUMS pages from the START pages results in display of the currently selected datum.

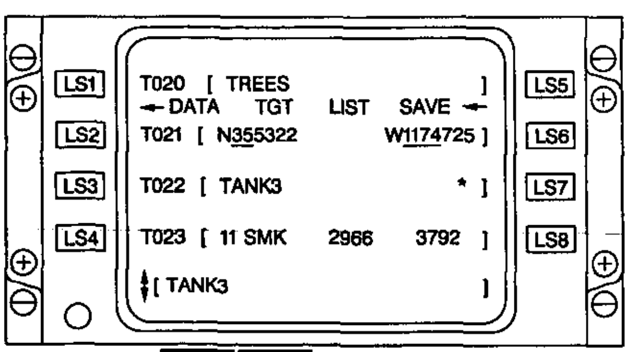
20.14.5 TNS CNU WPT/TGT LIST Page.

Waypoint list pages are provided for entry and display of stored navigation points. All manually entered points and labels (names) must be input on the WPT/TGT LIST pages.

The WPT (waypoint) LIST page is accessed via LS 7 on the INDEX 1/2 page.



TNS CNU WPT LIST PAGE



TNS CNU TGT LIST PAGE

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J1381

The waypoint list contains up to 100 points, numbered W000 to W099, consisting of any type of point except list numbers or computer-generated (pattern or PIM) points. The target list contains up to 50 points, numbered T000 to T049, consisting of any type of point except list numbers or computer-generated (pattern or PIM) points. These points may be L/L, UTM coordinates, or a name. Attempting to use a duplicate name will result in a NAME IN USE displayed in the scratchpad. Attempting to enter an undefined list number results in a NOT STORED annunciation. When accessed from the INDEX 1/2 page, the list will appear in the scrolled position from which it was last exited. Following power-up the top of the list will be displayed.

Note

> PIM is a reserved name. Attempting to use PIM to name a WPT results in an ERROR message.

Waypoint/target entries are made to a blank slot in the applicable list. First enter the desired coordinates in the scratchpad and press the appropriate line select key. Enter the desired name, consisting of no more than five alphanumeric characters, then press the same left LS key. A coordinate to be entered as a waypoint or target must be manually entered in any open slot in the waypoint list. When the last location on the list is filled, a WPT/TGT LIST FULL annunciation displays in the scratchpad indicating unnecessary points may have to be deleted. If this is not done, the annunciation will continue to be displayed for each additional attempt to insert new points. A waypoint/target cannot be deleted if it is currently in use as part of one or more routes; an IN USE RTE N annunciation in the scratchpad will result. A waypoint cannot be deleted from the list if it is in the active flight plan. An IN USE FPLN message will display. Deletion of a waypoint results in that waypoint being erased. The following points in the list will not fill.

In flight, pressing the TGT function key also inserts present position in the first open location in the target list, marking the new entry (with an underline) as TXXX and displaying it by LS 3. When the pilot GND/AIR/NORM override switch is in the GND position or NORM position (and helicopter on ground), the TGT key accesses the list but does not enter a position.

The CCS will calculate and display on the scratchpad target coordinates when a valid return is received during lasing. Lased target coordinates will be displayed in UTM or Lat/Long depending on selection on START 1/2 page. If no valid return is received the scratchpad contents will be cleared. Coordinates will be calculated in rangefinding and designating modes. The lased coordinates may be inserted into target list or any other waypoint location.

Note

It is essential that the proper datum is selected prior to entering waypoint and target data. Points are stored as a L/L coordinate with a horizontal datum assigned to it. The UTM grid versus L/L relationship will be predefined by the horizontal datum (on the START 1/2 page) in use when the coordinates were initially entered. Previously stored coordinates will not change if another horizontal datum is selected.

Changing datum will not change the stored waypoint or the target L/L versus UTM calculated relationship previously loaded using a different horizontal datum.

LS 1 through 4: The function of these line select keys depends on the scratchpad contents. When the scratchpad is empty, the waypoint data page for that waypoint is accessed. When a valid coordinate or a name associated with valid coordinates is entered into the scratchpad, pressing the left line select key will place that entry on the associated line. Also, points may be renamed in this manner by entering a new, unique name. Entry of a waypoint or target list number will result in the display of the associated coordinates on the display line. Pressing these line select keys with a minus sign in the scratchpad will delete that waypoint from the list, unless it is in use as a part of a route or active flight plan. In this case, the point must first be deleted from use in the flight plan or route before it can be deleted from the list.

Note

To load a waypoint or target, the L/L or UTM grid must be entered first, then the waypoint may be named.

UTM grid inputs must be 8 or 10 digit grid coordinates (example: 11STT58492345). Once a UTM grid reference (i.e., 11STT) is used, additional grid coordinate entries can be input using only the 8 or 10 digit grid format.

L/L inputs may be entered in degrees, minutes, and seconds (example: DDMMSS for latitude, DDDMMSS for longitude) or in degrees, minutes, seconds, and tenths of seconds (DDMMSS.S for latitude, DDDMMSS.S for longitude).

DOD FLIP publications provide locations in degrees, minutes and tenths of minutes. To obtain seconds from tenths of minutes, multiply tenths of minutes by 60 (example: 0.7 minutes x 60 = 42 seconds). L/L hemisphere reference (i.e., N, E, S, W) and leading zeros are required for all L/L inputs. Longitude degree entries must fill three places.

LS 5 through 8: The right line select keys on the WPT/TGT LIST page are used to select or deselect waypoints/targets for insertion into the flight plan. When a point is selected by pressing the right line select key, the right bracket is changed to an asterisk and the point is stored in the scratchpad. Deselection is accomplished by pressing a line select key next to an asterisk, resulting in removal of the point from the internal selection list. When points are selected, the scratchpad will display INSERT PTS AT ?. When the FPLN function key is pressed or a ROUTES points list is accessed, this prompt asks the operator in what position to load the desired points. Selected points are ordered for insertion sequentially as they were designated. A point can be included in a sequence only once. Reaccessing the WPT/TGT LIST page after insertion into a flight plan or route clears the asterisk designators. Points may be selected in any selected order from both lists.

Title Line: DATA indicates the left line select keys access the data page (when pressed with a blank scratchpad) associated with that waypoint or target. The SAVE function (LS 5) indicates the right line select keys save the waypoint or target in the scratchpad.

Note

The up and down arrow keys scroll through the entire list (blank slots included) line-by-line.

The list wraps around in a scrolling manner (e.g., when scrolling down to the last waypoint W099, the next waypoint to be displayed will be W000).

20.14.5.1 TNS CNU Entering Waypoints and Targets.

A. Manual Scratchpad Entry

1. Access WPT or TGT list (IDX, LS 7 or LS 3).
2. Coordinates - Enter (into scratchpad, then desired left LS key).
3. WPT/TGT label - Enter (into scratchpad, then desired left LS key).

Note

Names may be up to 5 characters long and may include letters, numbers, -, and/or/.

B. CNU /LDRS Coordinate Entry

1. Desired TGT/WPT location - Lase (DES or LRF).

Note

NTS If the NTS receives a valid range, CCS will calculate target location and display into the scratchpads. If no valid range is received (dashes on NTS - MFD and HUD laser range displays), the CCS will erase the scratchpads if old coordinates are present.

2. Coordinates - Load into TGT list (depressing TGT key) or into WPT list (IDX, LS 7, desired left LS key).
3. WPT/TGT Label - As desired.

C. MARK Key Coordinate Entry

1. Fly over desired position - Depress MARK key.

Note

Accuracy of a mark-on-top is a function of navigation system accuracy, height above mark point and aircraft ground speed. The most accurate mark would be obtained in a low hover over the desired point.

2. Coordinates - Load into target list (depressing TGT key) or into WPT list (IDX, LS 7, desired left LS key).
3. WPT/TGT Label - As desired.

D. TGT Key Coordinate Entry

1. Fly over desired position - depress TGT key. Target will automatically load into the first available TGT list location, TGT list page will be displayed and entered TGT location will be shown adjacent to LS 3 with the target list number underlined.

Note

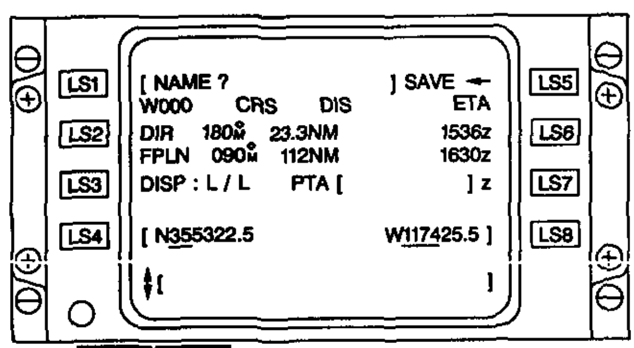
This present position is stored in L/L ONLY even if the start page is selected to UTM.

2. WPT/TGT label - As desired.

20.14.6 TNS CNU Waypoint/Target Data Pages.

Data pages are provided for viewing steering information from the aircraft present position to the selected point either directly (DIR) or along the flight plan track (FPLN) if used in the flight plan. Data page is also used for offset calculation from an existing position.

The data pages are accessed via the left line select keys on the WPT LIST page, TGT LIST page, FPLN page, route points page, or PIM page when the scratchpad is empty.



TNS CNU WAYPOINT/TARGET DATA PAGE
209000-75
J1340

Dashes and labels will be displayed for parameters until they become available. If accessed from the line select key next to a blank slot, the resultant page displays only labels with dashed fields.

LS 1: Displays the name (up to five characters) of the point, if a name has not been entered NAME? is displayed. Naming/renaming is not allowed on this page; entry of a defined name via the scratchpad causes the displayed parameters to be referenced to that point. The name may include an optional offset (/radial/distance) from an existing point.

Title Line: Displays the WPT/TGT list number and the labels for CRS (course), DIS (distance), and ETA (estimated time of arrival) to that point for each DIR and FPLN calculation on 3 lines and 4. These parameters are based on present position and speed.

Note

ETA is always displayed referenced to GMT (Z) regardless of start page local time zone selection.

Data Line 2: Displays the DIR (direct-to) parameters that are calculated for the course, distance, and estimated time of arrival based on present position and speed.

Note

Distance will display/enter in kilometers if parameters were initially entered in UTM or nautical miles if entered in L/L.

Information Line: Displays the FPLN parameters that are calculated for the course to the TO point in the flight plan and the distance and estimated time to arrive at this waypoint along the flight plan route. If the referenced waypoint is not currently in the flight plan, these fields will be dashed.

Note

Direct heading is the heading from the present position. FPLN heading is the heading into the waypoint along the FPLN course and may differ slightly from the direct heading for long legs.

LS 3: Toggles the coordinate DISP between UTM and L/L for this display only. When UTM coordinates are displayed, the distance parameter changes from nmi to km.

Note

The UTM grid or L/L relationship is defined by the horizontal datum (on the START page) in use when coordinates were initially entered. They will not change if another horizontal datum is selected.

CDU calculated conversion between L/L and UTM may result in position errors.

LS 4: The function of this line select key depends on the scratchpad contents. When the scratchpad is blank, pressing the line select key will have no effect. Pressing with valid coordinates in the scratchpad inserts that location and the name and label fields will be dashed. The parameters displayed on the page will be referenced to the newly entered location. Pressing LS 4 with a /radial/distance in the scratchpad causes the system to calculate the coordinates of that point and display them in the scratchpad, dashing the name and label fields.

LS 5: SAVE will copy the displayed (LS 4) coordinates to the scratchpad.

LS 6: Not used.

LS 7: Enters the PTA (planned time of arrival) in hours and minutes referenced to GMT (Z) from the scratchpad. The PTA will result in a CMD TAS being displayed on PROG 2/3 when the point becomes the current TO point in the flight plan. Displays the command true airspeed (CMD TAS) needed to arrive at a designated PTA point. Pressing this line select key with a blank scratchpad has no effect. Only one point may have a PTA associated with it; defining a PTA for another point cancels the previous one.

Note

If no winds are entered, CMD TAS is the ground speed required to reach waypoint at desired PTA.

LS 8: Returns the display to the list page which the DATA page was accessed, in the scrolled position.

Note

The DATA pages are scrollable, a page at a time, through the points list from which it was accessed. The data pages wrap around when accessed from the list pages, but not when accessed from the FPLN or Route pages. Scrolling and scroll arrows are inhibited whenever new coordinates are entered via the scratchpad or from an offset calculation.

Any data page may be used for trial calculations (offset waypoints) by changing parameters on the screen via the scratchpad without affecting the original entries to the system. When reaccessed, the page will appear unchanged.

20.14.6.1 TNS CNU Offset Point Procedures.

1. IDX key - Press.
2. WPT LIST - Press.
3. *Left LS Key - Press (select desired waypoint* data page to conduct offset calculation).
4. /radial/distance from the waypoint - Enter (e.g., /180/3) into the scratchpad.

Note

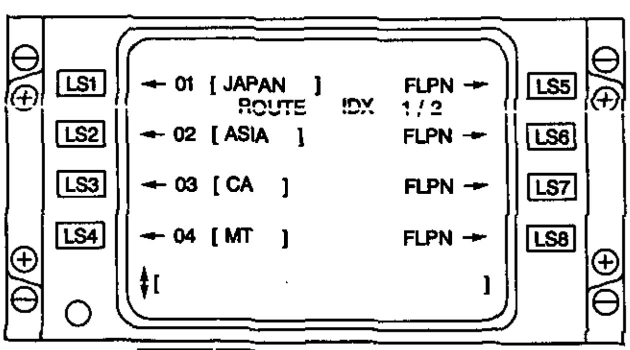
Radial inputs are entered in degrees magnetic. Distance entries may be entered to the nearest tenth nmi/km.

5. LS 4 - PRESS (offset coordinates will be displayed in the scratchpad).
6. Scratchpad entry - Save into an available WPT, TGT or FPLN position, as desired.

20.14.7 TNS CNU ROUTE IDX 1/2 and 2/2 Pages.

Route pages are provided for creating and storing frequently used flight plan routes consisting of up to 50 waypoints, targets and/or manually entered coordinates in any desired order. Routes can be inserted in the flight plan in normal and reverse order allowing ingress and egress from a single route.

The ROUTE IDX (index) 1/2 page is accessed via LS 2 on the INDEX 1/2 page. ROUTE IDX 2/2 is accessed by scrolling from ROUTE IDX 1/2.



TNS CNU ROUTE INDEX PAGE

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LS 1 through 4: The function of the left line select keys depends on the scratchpad contents. When the scratchpad is blank, pressing a left line select key *will access the route points (RTE) page for that* route, if it has been named. Pressing a line select key next to a blank slot has no effect. When a route name is entered in the scratchpad, pressing a left line select key will change the name of that route. If the name duplicates that of an existing route, a NAME IN USE message will display. If a unique name is entered to a blank, the left line select key will subsequently access a blank route points page. Pressing a left line select key with a minus in the scratchpad will delete that route and name.

Note

Unlike Waypoints and Targets, Routes must be named prior to selecting and entering route points.

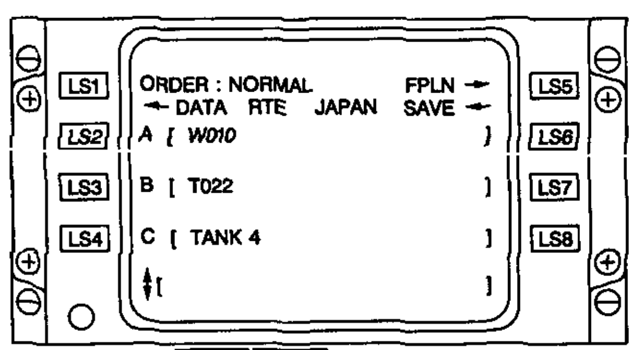
LS 5 through 8: Access the FPLN page with the prompt INSERT RTE AT ? displayed in the scratchpad. The route is loaded into the desired flight plan location by pressing the line select key next to the desired insertion position. Attempting to access the *FPLN* page with an empty route (containing no points) displays a NOT STORED message.

The *ROUTE IDX 1/2* and *2/2* pages are scrollable up or down to the other ROUTE IDX page.

20.14.8 TNS CNU RTE Page.

Route pages are provided to allow loading, modifying and viewing stored routes.

The RTE page is accessed via the left line select keys on the ROUTE IDX page.



TNS CNU ROUTE PAGE

209000-79
J1340

LS 1: Toggles the order of the route between NORMAL and REVERSE. Selecting REVERSE causes the route to be displayed in reverse order, with the prior last point (normal order) in the A *position. Order reverts to NORMAL upon re-*accessing the page.

Title Line: The DATA page for displayed point. SAVE copies the adjacent point data into the scratchpad as INSERT POINTS AT?.

LS 2 through 4: The function of the left line select keys depends on the contents of the scratchpad. When the scratchpad is blank, pressing a left line select key will access the DATA page. Selection with a valid point name or list number will insert that point, moving any existing or subsequent points down the list. Selection with INSERTS PTS AT ? in the scratchpad inserts the point(s) as the next route point(s), causing the designated and subsequent route points to move down in the route. Selection with a minus in the scratchpad will delete that point and subsequent route points will move up.

LS 5: Accesses the FPLN page with the prompt INSERT RTE AT ? displayed in the scratchpad. The route (NORMAL or REVERSE) is loaded into the desired flight plan location by pressing the line select key next to the desired insertion position on the FPLN page.

LS 6 through 8: Pressing a right line select key will select or deselect route points for inclusion in the flight plan and save them into the scratchpad. An asterisk will replace the right bracket when a point has been selected. Multiple points may be selected, in any order, for inclusion in the flight plan.

Note

The RTE page scrolls up or down through the list, a point at a time.

20.14.8.1 TNS CNU Route Building Procedures.

1. Routes Page-Access (IDX, Routes/LS 2).
2. Enter route name into scratchpad.
3. Enter name of route using left LS key.

Note

Routes must be named prior to inserting WPTs, TGTs or coordinates.

4. Select WPTs, and TGTs in the desired order by using the appropriate right LS key.

Note

Points can only be selected once until inserted into the route. If a point is inadvertently selected it can be deselected by depressing the appropriate right LS key to remove the asterisk.

5. Access desired Route data page (IDX, routes/LS 2, desired left LS key).
6. Insert points into the desired location using the left LS key.

Note

Points can be inserted anywhere into an existing route.

7. Repeat steps 4-6 above if required, or insert manually entered scratchpad coordinates as desired.

20.14.9 TNS CNU Flight Plan Page.

The flight plan allows the pilot to designate a group of navigation points that the CCS will use to compute steering information for display on the CDUs, HUD, and NTS MFD.

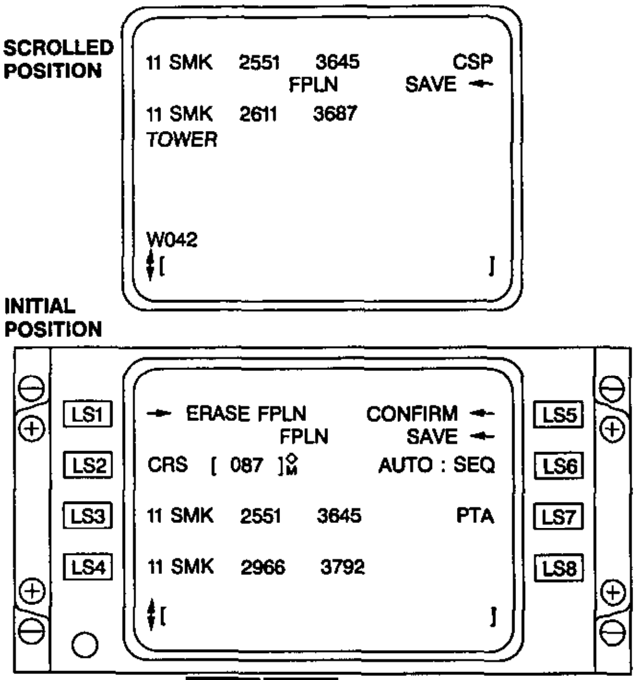
Flight plans may contain a series of up to 50 geographic points, including waypoints, targets, manually entered coordinates, one PIM, pattern points, one PTA, and/or routes. Attempts to insert a point or route that would result in more than 50 points will result in an FPLN FULL annunciation in the scratchpad. Points may be keyed in directly by name, list number, or coordinates or be selected from a waypoint, target, or route list or be computer-generated, as for patterns and PIM.

The FPLN page is always accessed in its initial position, with the TO point displayed on the line 3. At least one point and a course into that point must be designated to create a flight plan. Accessing the page when no flight plan has been designated (e.g., following ERASE FPLN on the START 2/2 page) results in:

The FROM and TO designations coming together on the FPLN page.

CNU The FPLN pages being identical in display and operation to TNS with the exception of a display of M (magnetic) or T (true heading) (as selected on the NAV 2/2 page).

The FPLN page being accessed via the FPLN function key, the DIR key, any right LS key on the Route Index pages, LS 5 on the PIM pages and LS 8 on any pattern page.



TNS CNU FPLN PAGE

209000-80
J1381

The display labels PTA, commence search point (CSP), and DIR being displayed on the right when applicable to that point. There can be only one rendezvous point (PTA) and one pattern commence search point (CSP) in the flight plan at a time. The pattern CSP cannot be the moving point PIM.

A typical flight plan page may display history points, a TO point, and a future point. Four past (history) points are retained in the flight plan, and are accessed by scrolling up with the arrow key. Past points cannot be edited; attempts to do so result in a scratchpad ERROR message. When in a scrolled position, course and sequencing information (line 1) is overwritten with a point, and the ↓ TO ↓ (on line 2) is blanked.

LS 1: When in the initial position (TO point on line 3), the system-generated CRS (course) in to the current TO point is displayed. This is typically the course between a prior (history) point and the current TO point. Selection with a blank scratchpad has no effect. Selecting an angle in degrees from 000° to 359° results in overwriting that angle with a preferred course in to the TO point. Course entries that exceed ± 90° difference from the currently displayed course will result in an ERROR message in the scratchpad. When in a scrolled position, the associated data page is accessed with this line select key.

LS 2: In the initial position, displays the current TO point. Selection with a blank scratchpad changes the page to the DATA page, which provides detailed information on the TO point. Selection with a valid point location, waypoint list number (W003), waypoint name (SNAKE), target list number (T001), target name (TANK2), L/L or UTM grid in the scratchpad causes that point to become the new TO point and moves the existing and subsequent points to the next position in the flight plan. Selection with a minus in a scratchpad deletes that entry from the flight plan and moves the next waypoint to the TO position.

LS 3 and 4: Display the subsequent points in the flight plan. Selection with a blank scratchpad changes the page to the DATA page, which provides detailed information on that point. Selection with a valid location in the scratchpad inserts that position as the next TO point and causes the existing point to move to the next position. Selection with a minus in the scratchpad deletes the point from the flight plan and subsequent points move up.

Note

Care must be taken when inserting a named point into the flight plan to prevent renaming the existing flight plan point with a name that is not a currently stored point.

↑ DEST ↑ marks the end of the active flight plan. Insertion of a point or route in to this position causes the marker to move down to the final position of the flight plan. ↑ DEST ↑ cannot be deleted, nor can points be entered below it.

Note

The "NEXT COURSE" steering cue displayed after passing the last waypoint in the flight plan will be a repeat of the previous course.

LS 5: When in the initial position (TO point on line 3), the flight plan SEQ mode toggles between AUTO and MAN regardless of the scratchpad contents. When in the scrolled position, the point in the scratchpad is saved, as for LS 6, LS 7, and LS 8.

Note

Automatic sequencing will sequence the FPLN points and display steering information to the subsequent FPLN point. Manual sequencing will retain the FPLN "TO" point and all steering information will be to the selected "TO" point when manual mode was selected.

LS 6, 7, and 8: Selection of the right line select keys causes the formatted point in the scratchpad to be saved. Pattern generated points are presented as coordinates.

Title Line: ↓ TO ↓ indicates the point directly below is the current TO point. Also displayed is page title: FPLN. SAVE indicates selection of the right line select key that saves the point in the scratchpad.

The FPLN page is scrollable up through the last four FROM points or down through subsequent flight plan points.

20.14.9.1 TNS CNU Flight Plan Building Procedures.

1. Route (normal order) - Select as desired (IDX, ROUTES/LS 2, desired right LS key, left LS key on FPLN page adjacent to desired location).

Note

When inserting routes and points to a desired location in the flight plan, select the left LS key adjacent to the location. Inserted point(s) will move the previously displayed point and all subsequent points down the list.

2. Route (reverse order) - Select as desired (IDX, ROUTES/LS 2, desired left LS key, LS 1, LS 5, left LS key on FPLN page adjacent to desired location).
3. Select WPTs and TGTs in the order desired order by using the appropriate right LS key.

Note

Points can only be selected once until inserted into the route. If a point is inadvertently selected it can be deselected by depressing the appropriate right LS key to remove the asterisk.

4. Manually entered coordinates - Insert (into scratchpad, then into flight plan in the desired location using left LS key).
5. Repeat steps 1-4 as desired.

Note

Flight plans can consist of a maximum of 50 waypoints.

20.14.9.2 TNS CNU Flight Plan Modification Procedures.

There are two basic methods to modify the flight plan. The first is inserting points into the flight plan using the same procedures used in building the flight plan. The second is using the direct to (DIR) function; this is the only way to change the current TO point.

1. Direct to - Select (DIR).
2. Direct to point - Enter (into scratchpad, then LS 1). Scratchpad entry can be manually entered coordinates, TGT/WPT list number, TGT/WPT name, or tagged points/routes selected prior to selecting direct to function.

Note

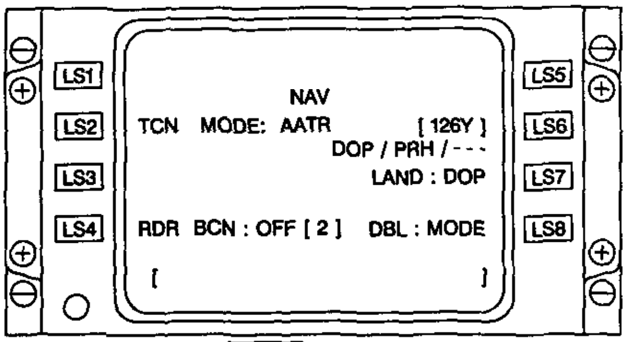
A new leg will be constructed by the CCS from the aircraft current position when LS 1 is depressed to the first point entered as direct to. Previous points will be moved down the flight plan list.

20.14.10 TNS CNU NAV Pages.

20.14.10.1 TNS NAV Page.

NAV page is provided to allow operator control of TACAN and Doppler modes and channel selection. TACAN channel selection is also provided on PROG 1/3 page.

NAV page is accessed by pressing the NAV function key.



TNS NAV PAGE

209000-61
J1340

LS 2: Toggles the TCN MODE (TACAN) between receive (R), transmit/receive (TR), air-to-air receive (AAR), and air-to-air transmit/receive (A/AT/R).

Information Line: Navigation modes are displayed as follows: DOP/PRH/---(GPS has failed or no data); ---/---/--- (no navigation sensors are available).

Note

> DOP/PRH will only be displayed with the pilot GND/AIR/NORM override switch set to AIR or when the squat switch senses the helicopter is in flight when the switch is set to NORM. PRH (pitch, roll, and heading) displays as a status of attitude gyro and RMI navigation signals received by the Doppler system.

LS 3: Not used.

LS 4: Toggles radar beacon system On/Off. Most aircraft have this system removed.

LS 5: Not used.

LS 6: The two functions of LS 6 are to recall the last tuned channel and/or to enter channels manually. To recall the last tuned channel, press LS 6 with the scratchpad empty. The previous channel is displayed and the TACAN is tuned to this channel. To enter a new channel, enter the number into the scratchpad and press LS 6. If an invalid channel is detected, no action will be taken and the scratchpad will alternate between ERROR and the scratchpad entered data. All TACAN channels will default to the X mode unless a Y is entered in the scratchpad after the channel number.

Note

> While line select keystrokes will affect a change in the CDU display immediately, there is a 2 to 3 second delay before command signals are received by the respective avionic component.

LS 7: Toggles the DOP mode between LAND and SEA.

Note

> The SEA mode for Doppler navigation is designed to reduce error caused by extended over-water Doppler operation.

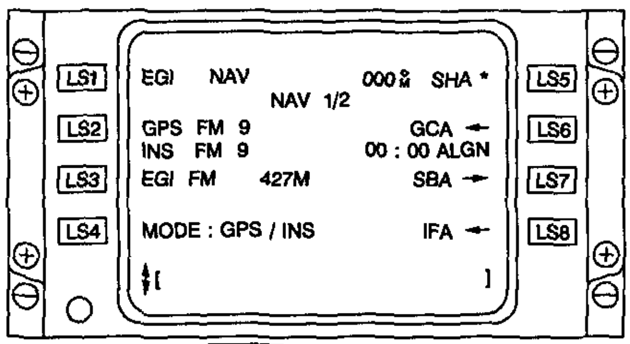
LS 8: Toggles radar beacon system mode between DBL/SNGL. Most aircraft have this system removed.

The NAV page is not scrollable.

20.14.10.2 CNU NAV 1/2 Page.

CNU NAV pages are provided to allow the operator to initiate EGI alignment, operating modes and status. The pages also allow TACAN mode and channel selection. TACAN channel selection is also provided on PROG 1/3 page.

NAV page is accessed by pressing NAV function key.



CNU NAV 1/2 PAGE

209000-162-2
J1379

LS 1: Displays current alignment status/mode of the EGI. When optionally pressed after coarse alignment, commands the EGI to transition to NAV mode. Coarse alignment is indicated by the heading status (Status 2/3) changing to GO and RMI off flag being pulled out of view (approximately 1 minute for a gyrocompass alignment (GCA). An asterisk will appear to the left (indicating the alignment selection) until the transition is complete. NAV is displayed when EGI minimum requirements (heading within 3° and INS-drift less than 5 nmi/h) for navigation in the selected mode are met. For a GCA, this is typically 4 minutes, and for SHA, it is approximately 21 seconds. EGI will automatically transition to NAV when the aircraft is launched after a coarse alignment (squat switch in normal).

LS 2: Displays status or FM of GPS.

Display Line 4: Displays status or FM of the INS. The right side of display line 4 contains alignment time. This will advance from zero during alignment, and freeze upon transition to NAV mode. Advancement of the alignment time is an indication that an active INS alignment is in progress.

Note

An IFA or SBA/GPS will not commence until adequate GPS position information is obtained.

SBA/MAN alignment will not commence until a present position is entered on START 1/2 page and ship's speed and BRC are entered on the SBA page.

LS 3: Displays EGI position figure of merit (FM) IN METERS.

LS 4: Cycles EGI to next navigation solution (GPS, INS or GPS/INS) each time it is pressed. During normal operations, select GPS/INS mode to obtain optimum navigation solution and allow automatic INS position updating.

LS 5: Heading from the EGI. On start this is the heading used for a Stored Heading Alignment (SHA) provided the orientation of the aircraft has not changed. The degree symbol will be displayed with a T or M beneath it to indicate whether the heading is referenced to true north or magnetic north. Actuation of this key will command the EGI to commence a stored-heading alignment or if the squat switch senses the aircraft is on the deck.

LS 6: Commands the EGI to perform Gyro-Compass Alignment. Allowed only if the squat switch senses the aircraft is on the deck.

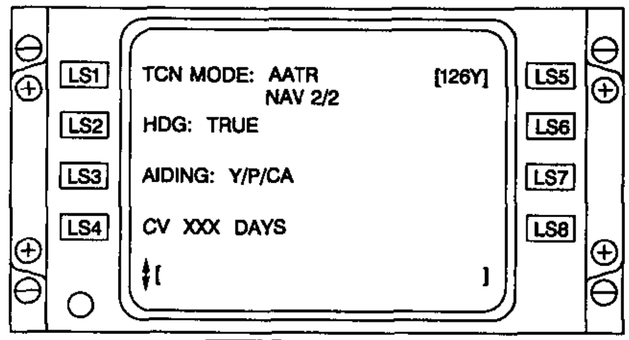
LS 7: Accesses the Shipboard Alignment options page.

LS 8: Commands the EGI to perform In-Flight Alignment (IFA). IFA will not commence until GPS has obtained an adequate position solution and the weight on wheels switch senses the aircraft is in flight.

This page is scrollable up or down to the NAV 1/2 page.

20.14.10.3 CNU NAV 2/2 Page.

NAV 2/2 page is accessed by pressing the NAV function key and scrolling up or down from the NAV 1/2 page.



CNU NAV 2/2 PAGE

209000-182-5
J1379

LS 1: Toggles the TCN MODE (TACAN) between receive (R), transmit/receive (TR), air-to-air receive (AAR), and air-to-air transmit/receive (AATR). When pressed, the display changes immediately, but there is a 2-second delay before the mode is sent to the TACAN.

LS 2: Toggles the heading display mode between TRUE and MAG. This affects all heading displays on the HUD, RMI (except TACAN radial), NTS - MFD and CDU (except FPLN Data pages). The display defaults to MAG on initial power on.

CAUTION

Magnetic shall be selected for instrument flight.

TACAN radial position information (#2 needle on RMI) is always displayed referenced to magnetic north; however, if true heading reference is selected, bearing to the station will be incorrect.

LS 3: Toggles automatic position GPS update AIDING accuracy between Y and Y/P/CA code. This mode controls what GPS accuracy mode is required for automatic INS position updating in blended (GPS/INS) navigation mode.

Note

If GPS aiding is selected in Y Code and valid cryptovariables (CV) are not loaded (see LS 7 NAV 2/2 page), GPS updates will not be applied to the navigation solution.

LS 4: Displays the number of consecutive days/ hours for which the GPS receiver has valid and verified keys:

CV---; Displays dashes if ICUs have failed.

CV XX; Displays number of days if days are greater than one.

CVN XXX Days /UNVERF/; CV 1 day; If mission duration is 1 day but the Time is not valid. Nothing is displayed if ICU and CDU are on but EGI is off.

< XX HOURS; If time is valid.

< XX HOURS/GUV/; If it has group unique variable (GUV) loaded (long term cryptovariables).

Expired, Unkeyed Failed, Incorrect.

LS 5: The two functions of LS 5 are to recall the last tuned channel and/or to enter channels manually. To recall the last tuned channel, press LS 5 with the scratchpad empty. The previous channel is displayed and the TACAN is tuned to this channel. To enter a new channel, enter the number into the scratchpad and press LS 5. If an invalid channel is detected, no action will be taken and the scratchpad will alternate between ERROR and the scratchpad entered data. All TACAN channels will default to the X mode unless a Y is entered in the scratchpad after the channel number.

LS 6 through 8: Not Used.

This page is scrollable up or down to the NAV 1/2 page.

20.14.10.4 CNU NAV Page Setup *Procedures.*

1. EGI Mode - Select GPS/INS or as required (NAV 1/2 LS 4).
2. TACAN Mode - Select TR or as required (NAV 2/2, LS 1).
3. EGI-AIDING Mode - Select Y/P/CA (NAV 2/2, LS 3).

Note

This will allow the INS to be automatically updated by any valid GPS nav solution (SPS or PPS). If Y is selected, INS will not automatically update if Y code signals (PPS) are not available.

20.14.11 CNU EGI Alignment.

EGI alignment is designed to initiate GPS acquisition and align the INS. GPS acquisition times may vary greatly from the normal 2-3 minutes with current stored almanac data up to 45 min for cold start. The different modes are provided to allow pilots to obtain adequate alignments under most conditions of environment and time constraints expected to be encountered. EGI will continue to refine its alignment throughout the flight with continual GPS update inputs.

EGI alignment is an INS-platform leveling, heading alignment, and altitude-initialization function. EGI alignment modes are: Gyro Compass Align (GCA), Stored Heading Align (SHA), and In Motion Align (IMA) and its submodes such as Shipboard Alignment (SBA) and In-Flight Alignment (IFA).

A prerequisite for INS heading alignment is PPSN. PPSN is provided to the EGI by either PPSN stored in the EGI NVM, the EGI GPS module, or manual entry on the START 1/2 page.

Note

Manual entry/update of PPSN is only possible in INS-only mode, or if adequate GPS fix is not yet attained.

PPSN is updated continuously by the GPS provided the initial INS-drift has not exceeded 1 nmi at the time of GPS PPSN acquisition.

The amount of time needed for INS alignment mainly depends upon: type of alignment selected, navigation solution used (INS, GPS, or blended), status of navigation sensors, and availability of data in NVM.

INS-only performance and navigation solution drift rates vary with the type and duration of the alignment. The expected EGI performance is presented in Figure 20-13.

In-motion alignment modes depend upon entry of position (manual or GPS) and aircraft movement (manual inputs for SBA/MAN or GPS provided for IFA and SBA/GPS).

Initial navigation is possible with partial EGI alignment (coarse alignment) with degraded accuracy. An accurate PPSN (GPS or manual) entry should be entered within a reasonable time to avoid the INS drifting beyond the update window).

Even without GPS aiding, the drift rates resulting from a partial alignment will improve throughout flight by conducting accurate position updates.

If the INS position solution is greater than 1 nmi from the GPS position fix, the EGI will not execute automatic updating. If this occurs the EGI must be re-aligned.

20.14.11.1 CNU Ground Alignments.

20.14.11.1.1 CNU Gyrocompass Align (GCA) Mode.

GCA is the most accurate INS-alignment mode and takes 4 minutes to complete. Prerequisites for GCA alignment are: PPSN entered, and helicopter not in motion. PPSN is provided by the GPS module, the EGI NVM, or manually via the START 1/2 page. A GCA is commanded by pressing LS 6. (GCA-alignment, and the arrow will be replaced by an *. LS 1 will display GCA.) Alignment in progress is indicated by advancement of the alignment-time on display line 4 (XX:XX ALGN).

Completed alignment will be indicated by NAV adjacent to LS 1. A completed GCA provides the 1 nmi/h INS-only accuracy of the EGI (lowest drift rate).

An interruption of GCA due to helicopter movement will prolong the alignment by a period equal to the suspension plus 20 seconds.

EXPECTED INS-ONLY PERFORMANCE				
ALIGNMENT MODE	POSITION DRIFT RATE (CEP)	ALIGN TIME	MAG HDG	TRUE HDG
GCA	1.0 nm/hr	3 min	0.5°	0.1°
	0.8 nm/hr	4 min	Data not available	
SHA	3-5 nm/hr	21 sec		
	3.0 nm/hr	2 min		
	1.0 nm/hr	4 min		
SBA/GPS	5.0 nm/hr	5.5 min		
	3.0 nm/hr	7 min		
	1.0 nm/hr	10 min		
SBA/MAN	5.0 nm/hr	5 min		
	3.0 nm/hr	10 min		
IFA	1.0 nm/hr	10 min without prior coarse alignment and GPS FM $\leq$5		
		5 min without prior coarse alignment and GPS FM $\leq$5		

NOTE

Values given for alignment performed at latitudes South of 45° N and North of 45° S. Alignment performance numbers deterioate at higher latitudes.

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J1387

Figure 20-13. CNU EGI Alignment Performance Table

Pressing LS 1 after a coarse alignment (approximately 1 minute into GCA) commands NAV to be displayed.

Note

If LS 1 is depressed as stated above, the navigation solution will result in an increased INS-only drift rate.

20.14.11.1.2 CNU Stored Heading Aligned (SHA) Mode.

SHA implements a fast INS alignment mode. An SHA is performed in 30 seconds or less when certain conditions are met:

1. The EGI internal checks indicate adequate alignment prior to previous power down, and the helicopter has not been moved after the orderly shutdown.
2. PPSN and HDG values are stored in the EGI during a (normal) shutdown.

Initial INS-only performance in this mode is degraded to about 3 - 5 nmi/h (CEP). If the EGI determines the helicopter has been moved or other prerequisites are not met, it will automatically transition to GCA.

SHA is commanded by pressing LS 5 SHA. (Arrow will be replaced by an *. LS 1 displays SHA.)

20.14.11.2 CNU In Motion Alignment (IMA).

The EGI can execute and complete INS alignment with the aircraft in motion. IMA modes depend on availability of PPSN, and GPS or manual navigation inputs. The In-Motion Alignment modes are:

In-flight Alignment (IFA). IFA requires GPS data available.

Shipboard Alignment (SBA) either:

- With GPS data available (SBA/GPS)
- Without GPS data available (SBA/MAN).

20.14.11.2.1 CNU In-Flight Alignment (IFA) Mode.

IFA is a GPS-aided alignment mode. IFA can be performed in flight in order to initially align or realign the system:

- Without prior alignment
- After partial GCA (minimum 30-second coarse alignment)
- After a complete alignment.

IFA can be performed with the helicopter in motion or stationary. The system will take advantage of aircraft maneuvers to improve speed and quality of IFA. Best maneuvers to speed up IFA are climbing or descending turns which include course changes of greater than 70°, with occasional 180° heading changes.

IFA is commanded by pressing LS 8 IFA. (The arrow will be replaced by an *. LS 1 displays IFA.)

Without the benefit of coarse alignment, the EGI will normally complete IFA in approximately 10 minutes after GPS FM of 5 or less is obtained, provided GPS FM is continuously 5 or less.

Following a 30-second coarse alignment on ground or shipboard, the EGI completes IFA within 5 minutes, provided GPS FM is continuously 5 or less.

If during IFA, GPS FM is higher than 5, IFA will be interrupted until GPS FM is again 5 or lower.

IFA is complete when INS-only accuracy is equivalent to or better than that achieved with GCA.

20.14.11.2.2 CNU IFA Procedures.

This alignment may be used when EGI is suspected of erroneous output, when INS derived position is beyond 1 nmi when GPS navigation solution is acquired (no automatic update), or when response time is critical and delays for other alignment modes are considered excessive.

CAUTION

Launching prior to a coarse alignment will result in unreliable EGI attitude (Master Arm - Off) and RMI heading indications. Coarse alignment takes approximately 3 minutes after GPS navigation solution acquisition.

1. NAV Page - Access (NAV 1/2).
2. IFA - Select (LS 8).

Note

IFA will not commence alignment until after obtaining adequate GPS navigation data (indicated by EGI-SBY to EGI-IFA and align counter counting up). Normal IFA takes less than 10 minutes after INS alignment has initiated.

20.14.11.2.3 CNU Ship Board Alignment (SBA) Modes.

Alignment with GPS (SBA AUTO): this is the same as IFA NAV 1/2 page. LS 1 will display SBA/GPS during alignment.

SBA/MAN alignment mode is primarily provided to obtain an alignment that provides reasonable heading and attitude displays to the pilot. This mode may have to be selected when GPS is not available or GPS almanac data is invalid and time to obtain a GPS fix is not feasible. INS-only navigation accuracy is extremely sensitive to accuracy of all manually input data and the ship maintaining its track and speed throughout the alignment period. Once commanded, the SBA/MAN alignment will complete prior to accepting GPS navigation solution update (provided INS position solution is within 1 nmi of GPS position solution).

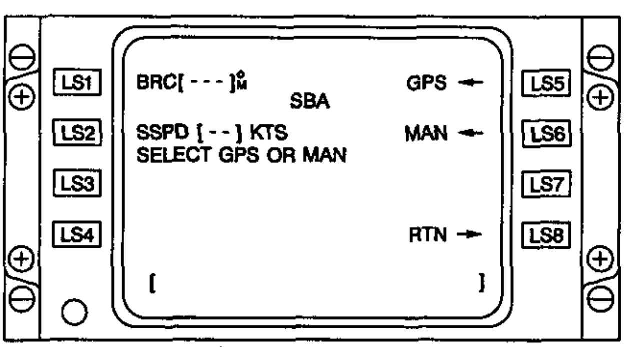
When aligning without GPS data (SBA/MAN), present position entries must be made on the START 1/2 page. LS 1 will display SBA/MAN during alignment. Additionally, manual entries on the SBA page must be made for:

- Ship speed (SSPD)
- Base recovery course (BRC) (ship's heading).

Note

SBA/MAN alignment is very sensitive to the ship speed and must remain constant within 1 knot throughout the alignment.

SBA page is accessed from NAV 1/2 using the LS 7 key.



CNU SBA PAGE

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For an SBA/GPS to be successful, the following conditions must exist: a valid almanac for the actual present position of the ship must be available in the EGI NVM (Almanac not more than 180 days old) and the START page position must be within 500 nmi of actual position.

Pressing LS 7 on the NAV 1/2 page accesses the SBA page.

LS 1: Displays and allows entry of the base recovery course (BRC)/ship heading (ideally ship's track) required for shipboard alignment, in degrees, in the range [0-359], true or magnetic. When SBA is initiated, the BDHI and heading on NAV 1/2 page will initially indicate the input BRC. Note that the displayed value is the last entered value (or --- if no entry was made); this value is not automatically updated. BRC is required for SBA/MAN.

Note

The EGI will automatically determine aircraft spotting angle. Do not use aircraft heading on the ship for BRC entry.

LS 2: Displays, and allows entry of, the ship speed in knots, in the range [0-60]. Note that the displayed value is the last entered value (or --- if no entry was made); this value is not automatically updated. SPD is required for SBA/MAN.

Note

The ship speed must remain constant within 1 knot throughout this alignment. The difference in ship's actual speed and the SSPD entered will result in EGI navigation errors of the same magnitude.

Display Line 4: When GPS or MAN align option has been selected and required data has been entered, the legend RTN TO START ALIGN will be displayed. When MAN has been selected and BRC and SSPD have not been entered, the legend ENTER BRC AND SSPD will be displayed. Otherwise, the legend SELECT GPS OR MAN will appear, unless alignment is in progress. In that case the legend ALIGN IN PROGRESS will appear.

Note

NAV mode selections are indicated by an asterisk displayed next to the LS key until selected alignment is complete. Once alignment is complete NAV is displayed next to LS 1.

LS 3 and 4: Not Used.

LS 5: Selects and deselects GPS-aided INS alignment; selection is indicated by an asterisk replacing the arrow.

Note

For an SBA/GPS to be valid, Almanac for the actual present position of the ship must be available in the EGI NVM (Almanac not more than 180 days old) and START page position must be within 500 nmi of actual position.

For SBA/GPS, alignment will not commence until after valid GPS data is received (GPS FM less than or equal to 5).

LS 6: Selects and deselects manual shipboard EGI INS alignment; selection is indicated by an asterisk replacing the arrow.

LS 7: Returns the display to the NAV 1/2 page, and starts a shipboard alignment if GPS or MAN is selected.

20.14.11.2.4 CNU SBA/GPS Alignment Procedures.

This mode is provided as the primary shipboard alignment method. A reasonable start present position (within 500 nmi) is required for timely GPS satellite acquisition.

1. NAV Page - Access (NAV 1/2).
2. SBA - Access SBA Page (LS 7).
3. GPS - Mode Select (LS 5).
4. Command Alignment - RTN (LS 8).

SBA/GPS will not commence alignment until after obtaining adequate GPS navigation data (align counter counting up). Normal SBA/GPS takes approximately 10 min after INS alignment has initiated.

20.14.11.2.5 CNU SBA/MAN Alignment Procedures.

This mode is provided to allow INS-only alignment to be commenced before GPS has acquired an adequate navigation solution and time to launch is critical. SBA/MAN produces a navigation accuracy solution of poor accuracy; however, adequate attitude and heading indications can be obtained. Only after INS is aligned will the position be automatically updated by GPS.

1. SBA Page - Access (NAV 1/2, LS 7).
2. BRC - Enter (into scratchpad, then LS 1).

Note

BRC must be entered in MAG or TRUE depending on HDG mode selected on NAV 1/2 (mode indicated next to bracket by LS 1). Ideally the BRC should be the ship's track, not the heading.

3. SSPD - Enter (into scratchpad, then LS 2).

Note

Ship speed accuracy is very critical to obtain an adequate INS only alignment. Entered speed should be accurate to within 1 kt and held constant throughout the alignment.

4. MAN - Mode Select (LS 6).
5. Select SBA/MAN alignment - RTN (LS 8).
6. Start Page PPSN - Enter (into scratchpad, then IDX, LS 1, LS 2).

Note

SBA/MAN will commence once updated PPSN is entered. PPSN must be accurate to within 2 nmi to ensure navigation solution will be automatically updated once GPS has acquired adequate data. Automatic position update will not occur until INS alignment is completed. Normal SBA/MAN align time is over 10 min.

20.14.12 TNS CNU PROGRESS Pages.

The progress pages are provided to control and display navigation, steering, and status information to the pilot (figure 20-14). An optional PROGRESS/Comm page may be selected on PROG 1/3 to allow ready access to primary navigation and communication information and control.

20.14.12.1 TNS CNU PROGRESS 1/3 Page.

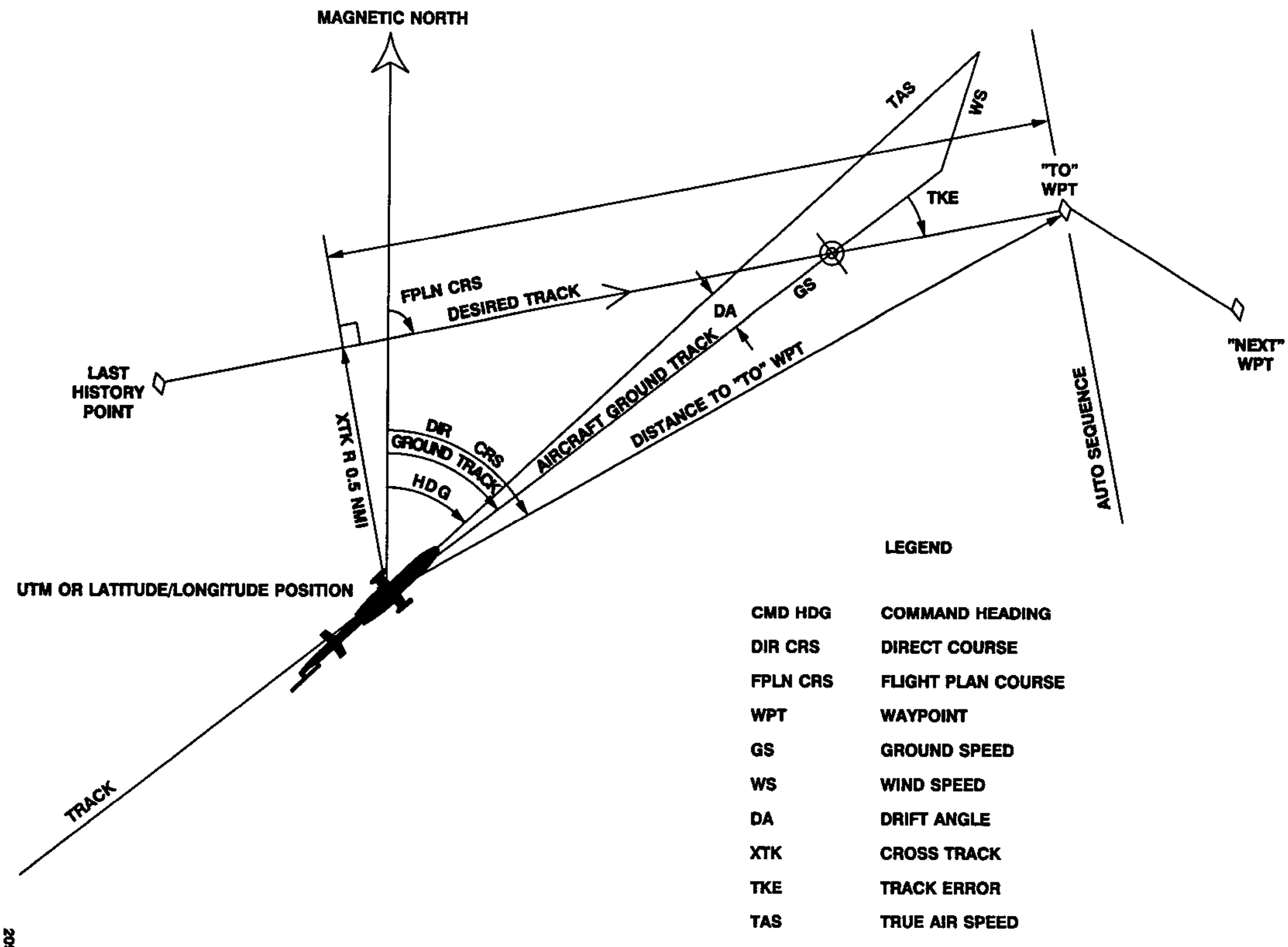
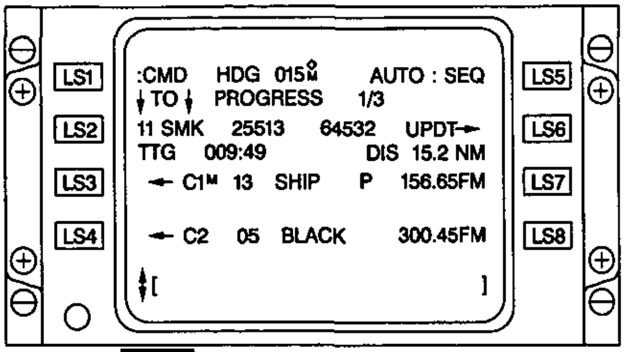
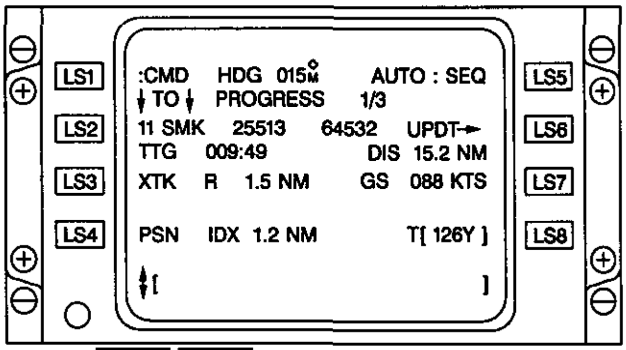


Figure 20-14. PROGRESS Page Information

The PROGRESS 1/3 page is accessed via the PROG function key. The page displays navigation progress along the flight plan.



CNU PROGRESS 1/3 PAGE (COMM)



TNS CNU PROGRESS 1/3 PAGE (NAV)

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J1381

LS 1: Toggles between commanded heading (CMD HDG), direct-to course (DIR CRS), and flight plan course (FPLN CRS). CNU A subscript T or M will indicate true or magnetic heading and course (as selected on NAV 2/2 page).

Note

The command heading will correct for course deviation at a 10° intercept when 0.1 to 0.5 nmi from the course track and 30° intercept when greater than 0.5 nmi from the course track.

Title Line: The ↓TO↓ indicates that the "TO" point is displayed directly below on line select 2.

LS 2: Displays the current "TO" point as it appears on the flight plan page. (Selection of LS 2 is not operational.) This can be displayed as an L/L, UTM, or up to five alphanumerics (name).

Information Line: Displays the time-to-go (TTG) to the "TO" point in minutes and seconds. Displays the distance to the "TO" point in nmi if the default at startup was defined as L/L or in km if the default is UTM.

LS 3: Has two functions depending upon the scrolled state of the page:

Displays crosstrack (XTK) deviation left or right (L or R) in nmi if the default at startup was defined as L/L; km if the default is UTM. Selection of LS 4 is not operational in this scrolled state.

Note

The course deviation pointer on the pilot attitude indicator displays 0.5 nmi deviation (left or right of course) for each dot of needle deflection. Fly to the course needle to correct the course. Crosstrack deviation on the HUD uses a different (variable) scaling than the ADI deviation. Refer to Chapter 21 for depiction of HUD crosstrack deviation.

When the page is optionally scrolled left or right, it displays a part of the COMM radio control page. Using the respective LS keys allows access to various functions of the COMM page.

LS 4: Has two functions depending upon the scrolled state of the page:

TNS Displays the estimated position index (PSN IDX) in nmi.

CNU Displays the EGI figure of merit (EGI FM) of the EGI in meters. Selection of LS 4 is non-operational in this scrolled state.

When the page is optionally scrolled left or right, it displays a part of the COMM radio control page. Using the respective LS keys allows access to various functions of the COMM page.

LS 5: Toggles waypoint sequencing mode between AUTO or MAN.

LS 6: Accesses the Update page and inserts "TO" point in the checkpoint position.

LS 7: Has two functions depending upon the scrolled state of the page:

Displays groundspeed (GS) in knots (KTS). Selection of LS 4 is non-operational in this scrolled state.

When the page is optionally scrolled left or right, it displays a part of the COMM radio control page. Using the respective LS keys allow access to various functions of the COMM page.

LS 8: Has two functions depending upon the scrolled state of the page:

Displays and controls the TACAN channel selection. LS 8 can toggle between current and previously tuned TACAN channel and also a manually entered channel/mode.

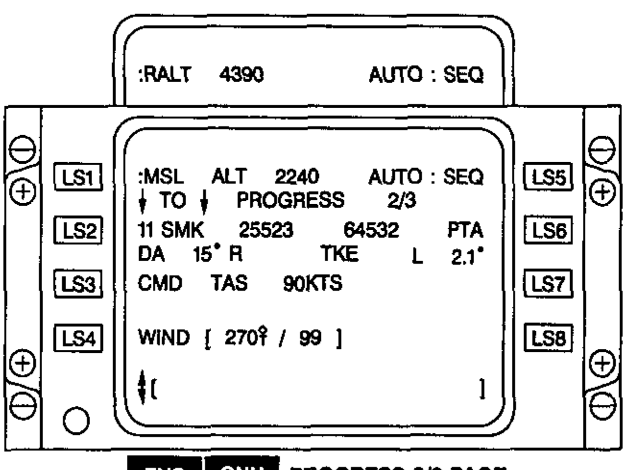
When the page is optionally scrolled left or right, it displays a part of the COMM radio control page. Using the respective LS keys allows access to various functions of the COMM page.

The PROGRESS 1/3 page is scrollable down to the PROGRESS 2/3 page and up to the GPS PROGRESS 3/3 page.

20.14.12.2 TNS CNU PROGRESS 2/3 Page.

Progress 2/3 page provides additional steering information as described below.

The PROGRESS 2/3 page is accessed by scrolling down from the PROGRESS 1/3 page.



TNS CNU PROGRESS 2/3 PAGE

209000-82
J1381

LS 1: TNS Displays the radar altitude (RALT) in feet above ground level (AGL). Display range is from 0 to 5000 feet. NO TRACK is displayed when the radar altimeter signal is unreliable. The display is by 1-foot increments between 0 and 400 feet; by 10-foot increments from 410 to 5000 feet. CNU Displays either the mean-sea-level altitude (MSL ALT) derived from EGI or RALT from the radar altimeter. EGI MSL referenced altitude display ranges from -300 to 15,000 ft. LS 1 toggles alternately between RALT and MSL.

Note

> Displayed radar altimeter information is updated approximately once per second and will lag behind RADALT indicator during rapid changes in radar altitude.

Title Line: The down arrows indicate that the "TO" point is displayed on LS 2.

LS 2: Displays the current "TO" point. LS 2 is not operational.

Information Line: Displays the drift angle (DA) in degrees left and right (L or R). This indicates the aircraft ground track is left or right of the aircraft heading.

Note

> DA may be used to determine initial crab angle to maintain a desired ground track in crosswind conditions.

LS 3: Displays the commanded true air speed (CMD TAS) needed to arrive at a designated PTA point. If no PTA point exists in the active flight plan, dashes will be displayed for the commanded airspeed. LS 3 is not operational.

Note

> If true wind entry has not been input, the displayed CMD TAS is the groundspeed that should be flown to arrive at the PTA point at the entered time. If input true winds are inaccurate, the CMD TAS will be inaccurate.

LS 4: Displays manually entered true WIND direction and speed. Selection of LS 4 with a valid wind direction/speed entry (XXX/XX) in the scratchpad will overwrite the current direction/ speed.

Note

> Manually entered winds are only used in calculating command headings to compensate for wind drift and calculating a CMD TAS (TAS is not computed or displayed in the AH-1W).

LS 5: Displays the flight plan sequencing (SEQ) mode as either AUTO or MAN. LS 5 is used to toggle between AUTO and MAN sequencing. The sequencing mode can also be changed from the flight plan page.

LS 6 through 7: Not used.

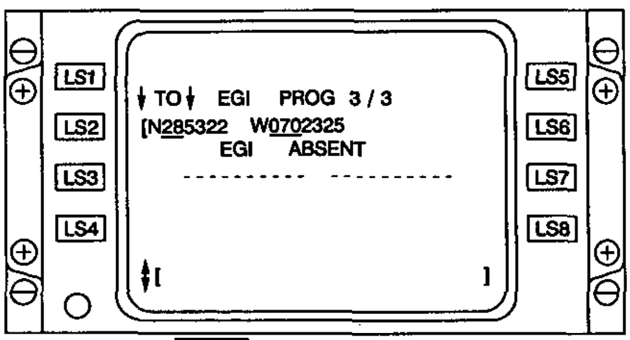
LS 8: Displays TAS in knots. Selection of LS 8 is not operational. TAS entry is not operational in the AH-1W and will be dashed.

The PROGRESS 2/3 page is scrollable down to the GPS PROGRESS 3/3 page and up to the PROGRESS 1/3 page.

20.14.12.3 TNS CNU GPS PROGRESS 3/3 Page.

Progress 3/3 page CNU provides backup GPS position display only when both ICUs have failed. TNS *The page is displayed but is not functional.*

The PROGRESS 3/3 page is accessed by scrolling up from the PROGRESS 1/3 page.



CNU PROGRESS 3/3 PAGE

209000-83
J1340

This page is the navigation backup page when both ICUs fail. It provides GPS position only. The waypoint name under ↓ TO ↓ will not update (it will continue to display "TO" waypoint displayed at the time of the failure).

LS 1: Not used.

LS 2: Displays the current "TO" point as it appeared on the FPLN page prior to ICU failure. It displays the "TO" point with name, label, or L/L coordinates. It doesn't update as a waypoint is passed.

Note

This page displays coordinates in latitude/ longitude only.

Display Line 4: The EGI ↓ PPSN ↓ indicates the GPS present position displayed directly below when both ICUs have failed (backup mode). When no EGI is installed, EGI ABSENT is displayed here.

Note

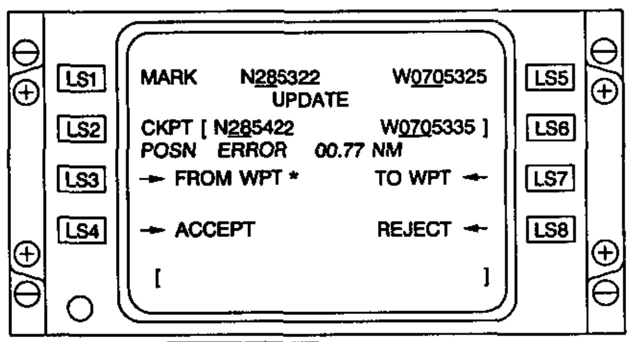
TGT and MARK function keys are nonfunctional in the backup navigation mode. Actuation of these keys results in a √ STATUS message.

LS 6: Accesses the UPDATE page.

20.14.13 TNS CNU UPDATE Page.

The UPDATE page is provided to allow manual position updating of the Doppler or EGI operating in an INS only mode.

The UPDATE page is accessed via the LS 6 key on PROG 1/3.



TNS CNU UPDATE PAGE

209000-84
J1340

When the MARK key is depressed, the following information is frozen on update page until MARK key is depressed again to update the mark or until "ACCEPT/REJECT" is selected on the update page. The clear key will also clear this information.

- EGI or Doppler calculated MARK POSITION (Update page PPSN on LS 1 is changed to MARK and the coordinated are frozen.)
- *TO and FROM waypoints at the time of the mark are stored in memory.*

On the UPDATE page TO WPT or FROM WPT may be selected using LS 3 or LS 7 to allow selection of the checkpoint for position error. The waypoint selected will be indicated by an asterisk *and the applicable coordinates will be displayed on* LS 2.

Manual checkpoint coordinates may be entered via the scratchpad, but the currently stored TO and FROM checkpoint data will be erased.

When in Doppler TNS or an INS-only mode CNU , accurate manual updates are critical for updating present position as well as improved navigation performance on subsequent legs. Accurate Mark on Top is a function of geographic location accuracy, accuracy of aircraft position over geographic point, and flyover airspeed. The most accurate Mark on Top is obtained by a low hover over the known geographic point.

Note

> TNS Once the Doppler is updated, the present position will not be frozen when the aircraft is on the ground. The rate of position drift is proportional to the accepted position error.

CNU The EGI will not accept a position update that results in a calculated position error of greater than 1.0 nmi in the first hour of flight since alignment or since last update. Allowable maximum position error for acceptable EGI manual update increases above 1.0 nmi at a rate of 1.0 nmi/h after the first hour since alignment or last manual update.

Note

> If position error is outside the maximum allowable, the only method of updating the EGI is by commanding some form of a re-alignment.

Data Line 1: Displays the CCS calculation of present position (PPSN) in whole seconds (although tenths of seconds are used in the update calculation). LS 1 and LS 5 are not operational. Pressing the MARK function key causes the dynamic present position display to freeze (regardless of page displayed), changes the PPSN label to MARK, enters the present position into the scratchpad, writes the TO and FROM waypoint coordinates at the time of the MARK to non-volatile memory, and computes position error.

Data Line 2: Displays the checkpoint (CKPT) position from the PROGRESS page. The checkpoint position may be overwritten by entering a valid location in the scratchpad and pressing LS 2. Entry of a new checkpoint with an existing MARK POSITION recalculates the position error. TO and FROM checkpoints are cleared when a manually entered CKPT is input.

Data Line 3: POS ERROR (position error) represents the offset between present position and the checkpoint position in nmi or km, depending on the coordinate system default (L/L or UTM).

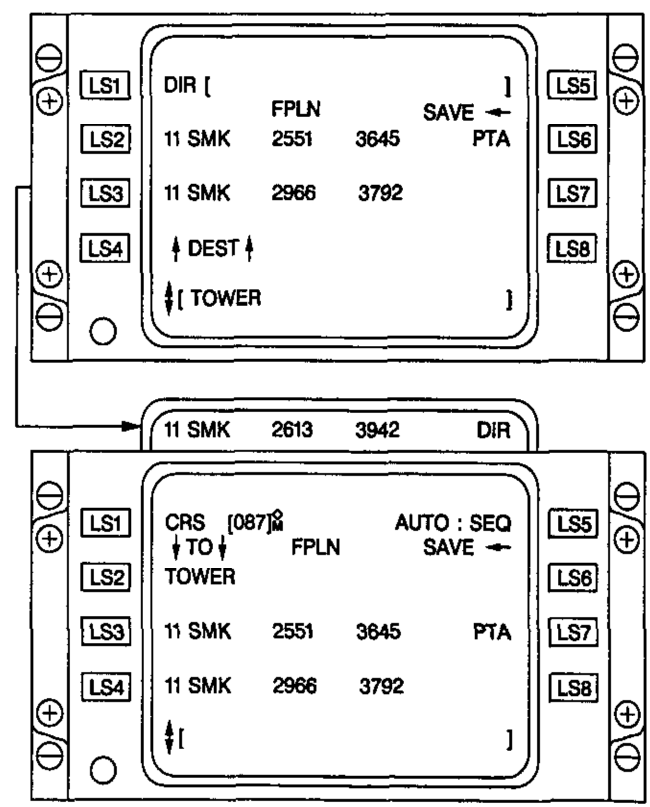
LS 3 or 7: Is used to select TO or FROM WPTs for POSN error calculation and update acceptance/ rejection.

LS 4: Selection of LS 4 with a valid MARK position and checkpoint position accepts the updated position, changing the CCS estimate of present position by the amount of the position error. Upon pressing, present position unfreezes and the position error is dashed.

LS 8: No update will be applied if LS 8 is pressed. Upon pressing, present position unfreezes and the position error is dashed.

20.14.14 TNS CNU DIRECT-TO Page.

The DIRECT TO page is accessed via the DIR function key. The prompt DIR is displayed on line 1 of the flight plan (FPLN) page, regardless of scrolled position.



DIRECT (TO) PAGE

209000-85
J1381

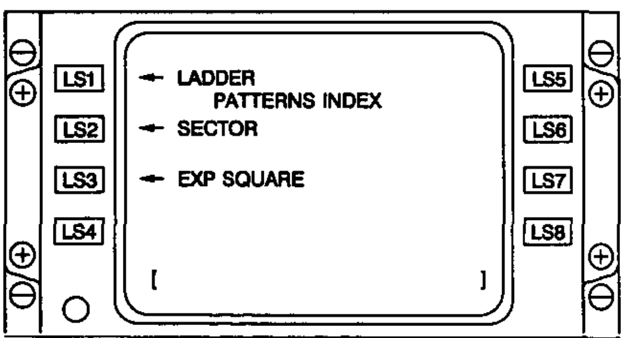
LS 1: Entering a point name, list number, or coordinate in the scratchpad and pressing causes the system to compute a DIR course from present position to that point. The new point becomes the TO point on the display and all existing flight plan points (including the prior TO point) move down.

Alternately, pressing the left line select key next to an existing flight plan point causes the point to become the new TO point. Intermediate points are deleted. Pressing the right line select key saves the point in the scratchpad, which can then be entered as the direct-to point while retaining the intermediate points.

20.14.15 TNS CNU PATTERNS INDEX Page.

Patterns provide the capability to automatically compute waypoints and steering information for three search patterns. Pattern dimensions can be modified on the individual pattern pages. A single pattern can be inserted into the flight plan, and when the aircraft arrives at the CSP the CCS will automatically calculate turn waypoints and steering information.

The PATTERNS INDEX page is accessed via LS 6 on the INDEX 1/2 page.



PATTERNS INDEX PAGE

209000-99
J1340

LS 1: Accesses the LADDER pattern setup page.

LS 2: Accesses the SECTOR pattern setup page.

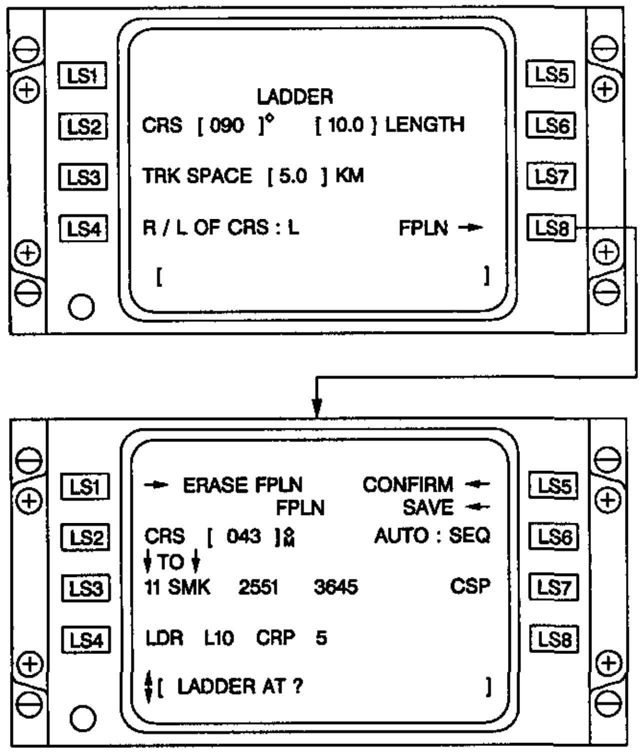
LS 3: Accesses the expanding (EXP) SQUARE pattern setup page.

LS 4 through 8: Not used.

The PATTERNS INDEX page is not scrollable.

20.14.15.1 TNS CNU LADDER Page.

The LADDER page (Figure 20-15) is accessed via LS 1 on the PATTERNS INDEX page.



LADDER PAGE

209000-100
J1381

LS 1: Not used.

LS 2: Angle in degrees from 000 to 359 in the scratchpad specifies that angle as the ladder course (CRS). Pressing LS 2 with a blank scratchpad has no effect.

LS 3: A distance of 0.1 to 53.9 nmi (0.1 to 99.9 km) in the scratchpad specifies that distance as the ladder TRK SPACE (entry of tenths is optional). Track space will be displayed either in nmi (L/L) or km (UTM), depending on the default condition defined at startup. Pressing LS 3 with a blank scratchpad has no effect.

LS 5: Not used.

LS 6: A distance of 01. to 53.9 nmi (0.1 to 99.9 km) in the scratchpad specifies that distance as the ladder length (entry of tenths is optional). Length will be displayed in either nmi (L/L) or km (UTM), depending on the default condition defined at startup and displayed on line 5. Pressing LS 6 with a blank scratchpad has no effect.

LS 7: Not used.

LS 8: Accesses the FPLN page with LADDER AT ? displayed in the scratchpad. The pattern is activated by selecting a line select key adjacent to the desired FPLN waypoint. Commence search point (CSP) will be displayed to the right of the FPLN waypoint.

Note

The system calculates and displays four pattern points ahead until the normal flight plan is resumed, either by deleting the CSP (if the pattern is inactive) or commanding a direct to past the last pattern point (if the pattern is active). CSP remains in the flight plan until the pattern is exited. Parameters defined in tenths will be truncated and displayed as whole numbers. All parameters are displayed as two digits without leading zeros.

Preset values and entered pattern parameters remain displayed on the LADDER page until overwritten with a new parameter. Pattern edits require reinsertion of the pattern at CSP.

If the CSP is the TO point, editing the course on the FPLN page will modify only the course into the CSP. To change only the pattern course line, the course must be changed on the LADDER pattern setup page and reinserted.

The LADDER page is not scrollable.

20.14.15.2 TNS CNU SECTOR Page.

The SECTOR page (Figure 20-16) is accessed via LS 2 on the PATTERNS INDEX page.

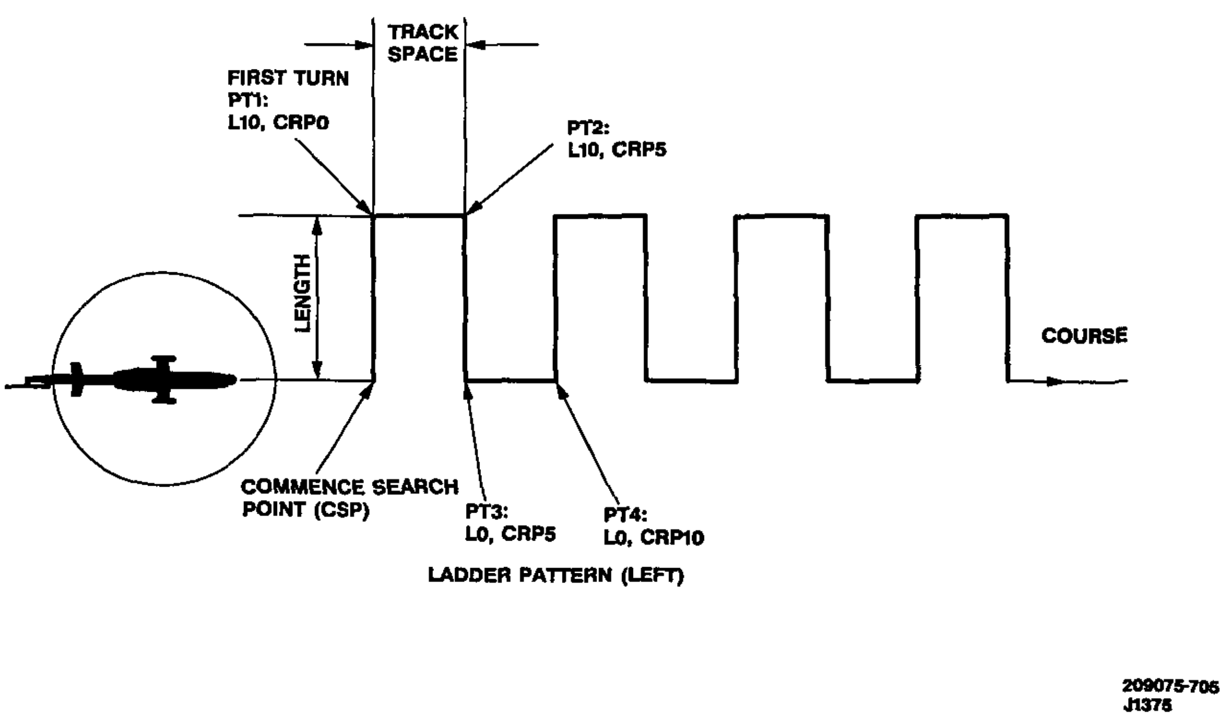
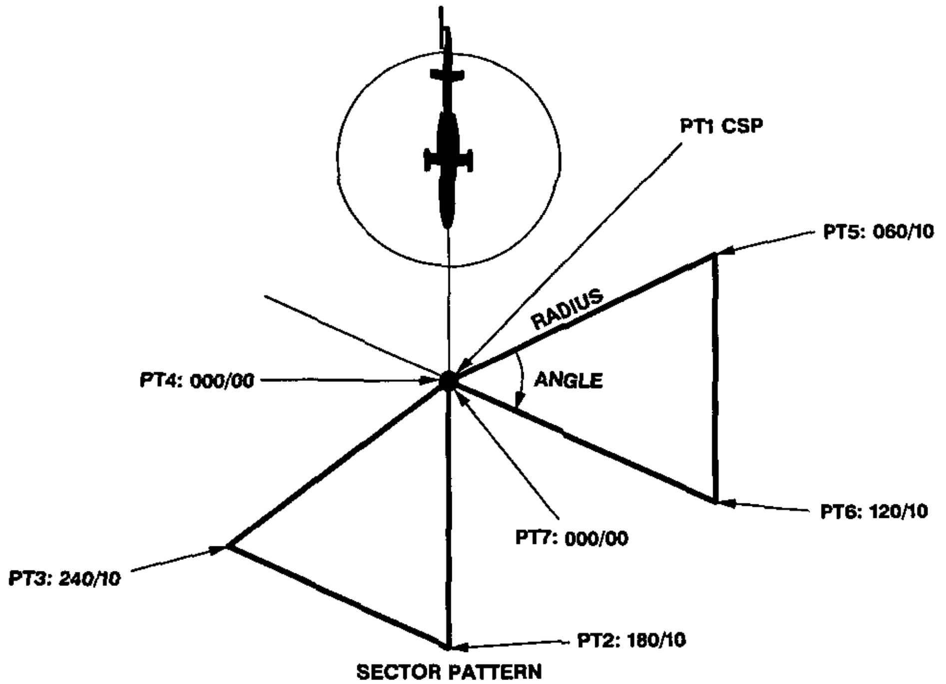
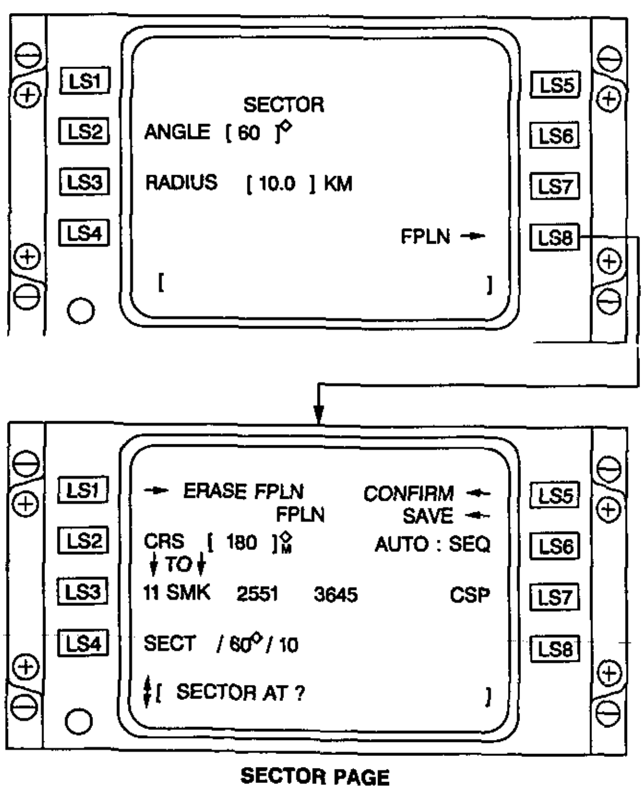


Figure 20-15. LADDER Pattern



209075-706
J1375

Figure 20-16. SECTOR Pattern



SECTOR PAGE

209000-101
J1381

LS 1: Not used.

LS 2: An angle, in degrees, from 1° to 90° in the scratchpad specifies the angle between the lines connecting generated pattern points and the CSP. Pressing LS 1 with a blank scratchpad has no effect.

LS 3: A radius of 0.1 to 53.9 nmi (0.1 to 99.9 km) in the scratchpad specifies the distance from the CSP to generated pattern points (entry of tenths is optional). The radius will be displayed in either nmi (L/L) or km (UTM), depending on the default condition defined at startup. Pressing LS 3 with a blank scratchpad has no effect.

LS 4 through 7: Not used.

LS 8: Accesses the FPLN page with SECTOR AT ? displayed in the scratchpad. The pattern is activated by selecting a line select key adjacent to the desired FPLN waypoint. CSP will be displayed to the right of the CSP.

Note

The system calculates and displays four pattern points ahead until the normal flight plan is resumed, either by deleting the CSP (if the pattern in inactive) or commanding a direct to past the last pattern point (if the pattern is active). CSP remains in the flight plan until the pattern is exited. Parameters defined in tenths will be truncated and displayed as whole numbers. All parameters are displayed as two digits without leading zeros.

Preset values and entered pattern parameters remain displayed on the SECTOR page until overwritten with a new parameter. Pattern edits require reinsertion of the pattern at CSP.

The course of the first leg after CSP is normally the course into CSP. If the CSP is a past event, course edit only changes the course into the current TO point and DIR also must be selected prior to selecting CSP.

The SECTOR page is not scrollable.

20.14.15.3 TNS CNU EXP SQUARE Page.

The EXP SQUARE pattern page (Figure 20-17) is accessed via LS 3 on the PATTERNS INDEX page.

LS 1 and 2: Not used.

LS 3: A distance of 0.1 to 53.9 nmi (0.1 to 99.9 km) in the scratchpad specifies that distance as the ladder TRK SPACE (entry of tenths is optional). Track space will be displayed either in nmi (L/L) or km (UTM), depending on the default condition defined at startup. Pressing LS 3 with a blank scratchpad has no effect.

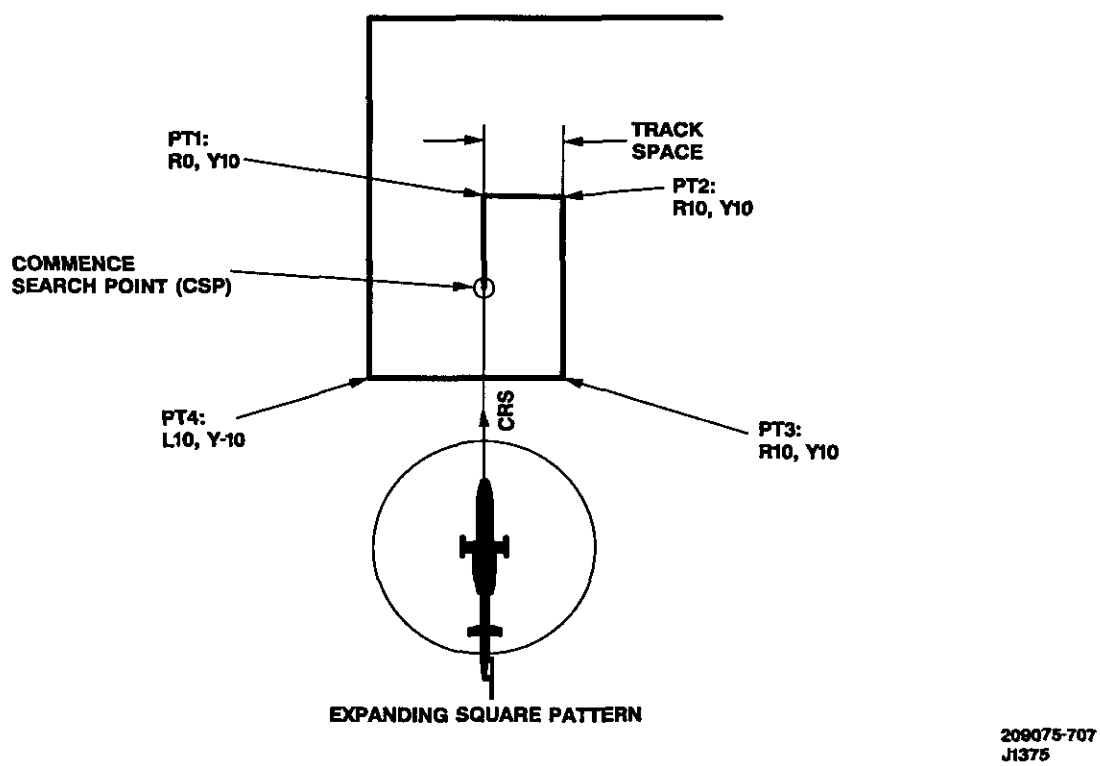
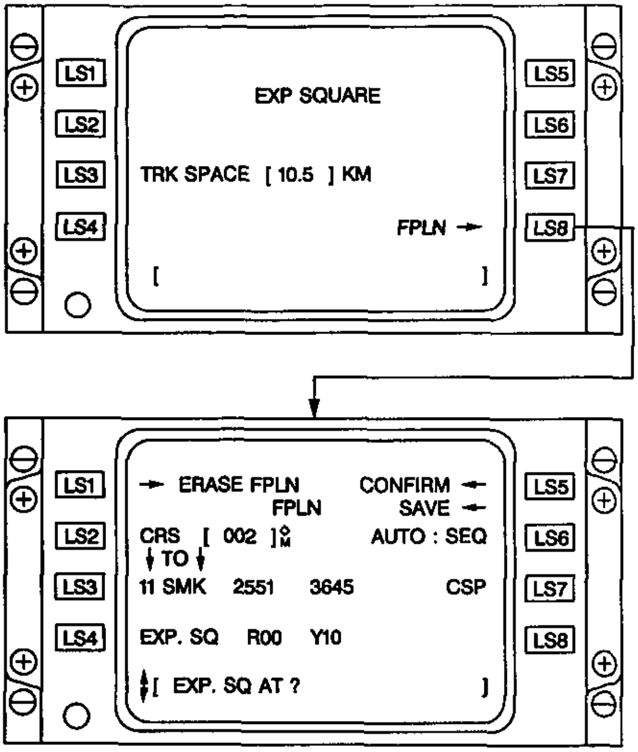


Figure 20-17. EXPANDING SQUARE Pattern

LS 4 through 7: Not used.



EXPANDING SQUARE PAGE

209000-102
J1381

LS 8: Accesses the FPLN page with EXP SQ AT ? displayed in the scratchpad. The pattern is activated by selecting a line key adjacent to the desired FPLN waypoint. CSP will be displayed to the right of the CSP point.

Note

The system calculates and displays four pattern points ahead until the normal flight plan is resumed, either by deleting the CSP (if the pattern is inactive) or commanding a direct to past the last pattern point (if the pattern is active). CSP remains in the flight plan until the pattern is exited. Parameters defined in tenths will be truncated and displayed as whole numbers. All parameters are displayed as two digits without leading zeros.

The course of the first leg, after CSP, shall normally be the flight plan course into the CSP.

Preset values and entered pattern parameters remain displayed on the EXP SQUARE page until overwritten with a new parameter.

Pattern edits require reinsertion of the pattern at the CSP point. If the CSP is a past event, *DIR also must be selected* prior to selecting CSP.

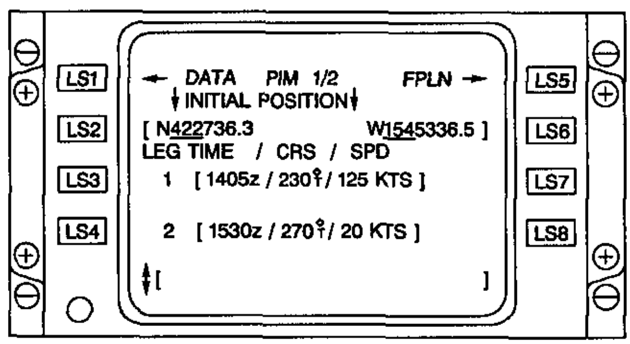
The EXP SQUARE page is not scrollable.

20.14.15.4 TNS CNU Position and Intended Movement (PIM) Pages.

20.14.15.4.1 TNS CNU PIM 1/2 Page.

The PIM page is used to load the initial position and relative track of a predictably moving vehicle or surface vessel for post mission recovery. The page is used to store up to five ship/vehicle course legs. For depiction of PIM refer to figure 20-18.

The PIM 1/2 page is accessed via LS 1 on the INDEX 2/2 page.



PIM 1/2 PAGE

209000-96
J1340

LS 1: Accesses the DATA page for the current PIM position.

Title Line: The down arrows indicate INITIAL POSITION of PIM displays directly below on the data line 2.

LS 2: Displays the initial position of the PIM. Selection of LS 2 with a valid latitude/longitude (only) in the scratchpad will enter the position. *Selection with a minus in the scratchpad deletes the* initial position from the system.

Information Line: Displays the labels for the LEG number, start TIME of leg, CRS (true course), and SPD (speed) entries for the columns directly below.

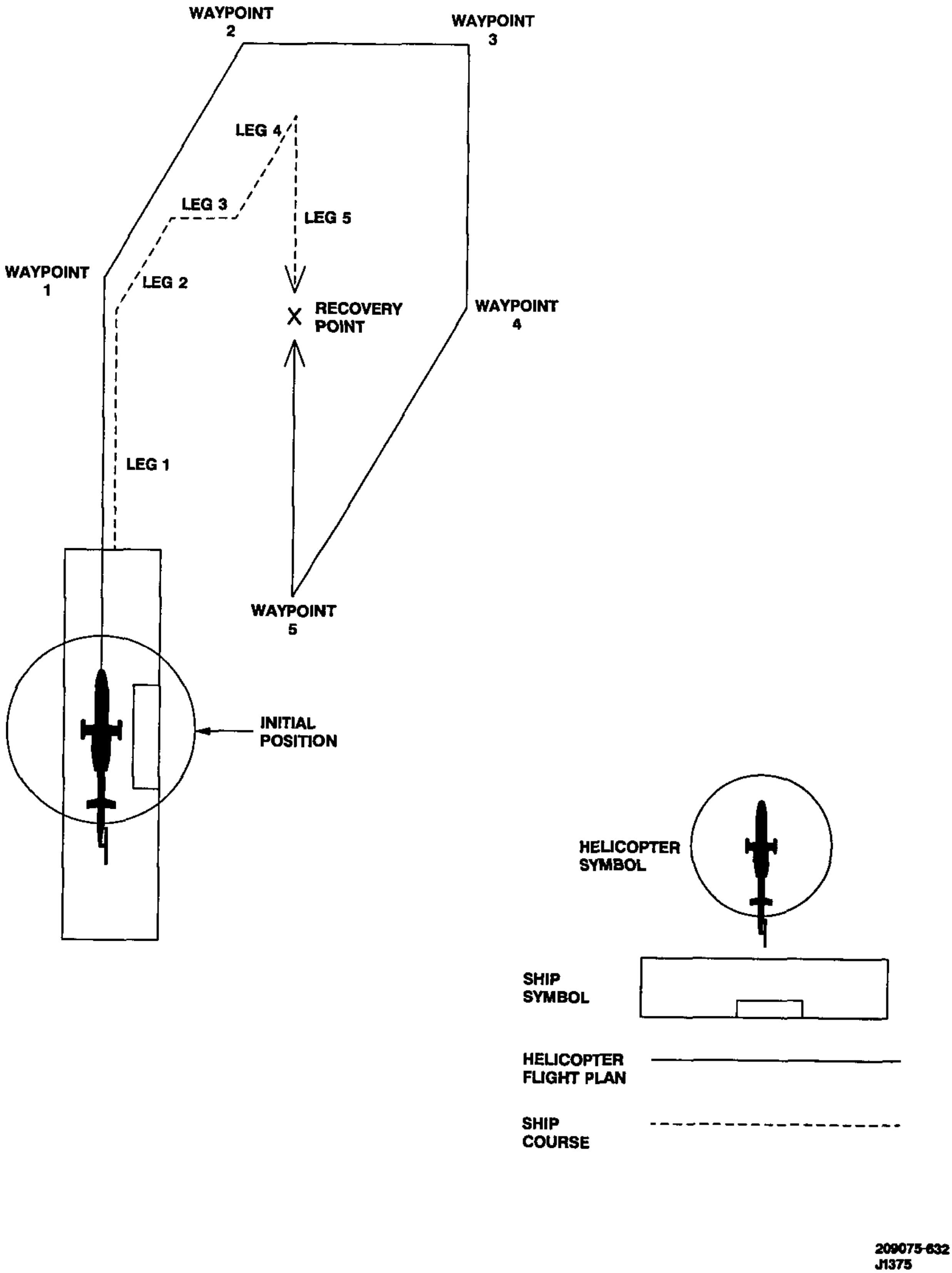


Figure 20-18. Position and Intended Movement, Flight Plan/Course

LS 3: *Displays the start time, course, and speed of* the first leg. Pressing the line select key with a valid time/CRS/SPD in the scratchpad enters/alters the parameters for the leg. Selection with a minus in the scratchpad deletes the leg if no legs follow. If it is not the last leg, an ERROR-INVALID TIME is displayed upon attempt to insert a time of day that is less than the time for the prior leg or greater than 6 hours. Selection with no initial position results in an ERROR message in the scratchpad.

Note

> Entries may be made to a leg only if the previous leg is defined. Slashes must be used to separate the parameters, but KTS label is not a required entry. Time must be entered referenced to UTC/GMT (Zulu). Course (track) must be entered in true north degrees.

LS 4: Displays time, course, and speed of the next leg. Pressing the line select key with a valid TIME/CRS/SPD in the scratchpad enter/alters the parameters for the LEG. Selection with a minus in the scratchpad delete the leg if no legs follow. If it is not the last leg, an error message is displayed.

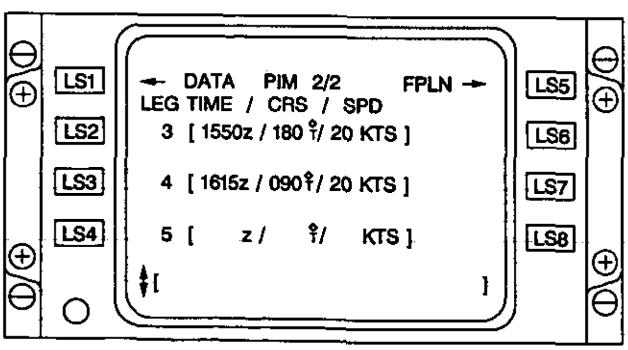
LS 5: Accesses the FPLN page with PIM at ? displayed in the scratchpad. Designating a position, within the flight plan, results in entry of the name PIM as that point.

LS 6 through 8: Not used.

The PIM 1/2 page is scrollable up or down to the DATA PIM 2/2 page.

20.14.15.4.2 TNS CNU PIM 2/2 Page.

The PIM 2/2 page is scrollable up or down to the DATA PIM 1/2 page.



PIM 2/2 PAGE

209000-97
J1340

LS 1: Accesses the DATA page for the PIM current position.

Title Line: Displays the labels for the course LEG number, TIME or leg change CRS (course), and SPD (speed) entries for the column directly below.

LS 2, 3, and 4: Display the time, course, and speed of each successive leg. Pressing a line select key with a valid TIME/CRS/SPD in the scratchpad enters/alters the parameters for that leg. Selection with a minus in the scratchpad deletes the leg if no legs follow. If it is not the last leg, an error message is displayed.

Note

> Entries may be made to a leg only if the previous leg is defined. Slashes must be used the separate parameters, but KTS is not a required entry. Time must be entered referenced to UTC/GMT (Zulu). Course (track) must be entered in true north degrees.

The PIM 2/2 page is scrolled up or down using the arrow keys to the PIM 1/2 page.

20.14.16 TNS CNU ZEROIZE Page.

Refer to Chapter 19.

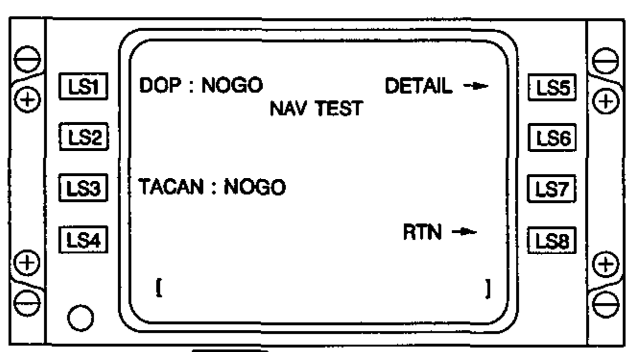
20.14.17 TNS CNU STATUS Functions.

Refer to Chapter 19.

20.14.18 TNS CNU NAV TEST Pages.

20.14.18.1 TNS NAV TEST Page.

The NAV TEST 1/2 page is accessed by pressing LS 2 on the MAINT TEST page.



TNS NAV TEST PAGE

209000-88
J1340

LS 1: Initiates BIT of the Doppler. During BIT, TEST is displayed; when BIT is complete, GO or NOGO will appear.

LS 2: Not used.

LS 3: Initiates BIT of the TACAN when toggled from dashes to TEST. The time to complete BIT is 29 to 31 seconds to GO. A GO is displayed when BIT passes the test, and a NOGO is displayed when any failure is detected. If BIT cannot be initiated, then the dashes will not toggle to TEST and a √ STATUS annunciation will be displayed.

LS 4, 6, and 7: Not used.

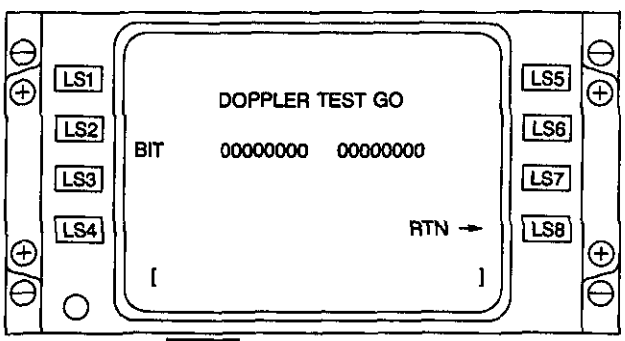
LS 5: Accesses the DOPPLER TEST page.

LS 8: Returns the display to the MAINT TEST page.

The NAV TEST page is not scrollable.

20.14.18.1.1 TNS DOPPLER TEST Page.

The DOPPLER TEST page is accessed by pressing LS 2 on the NAV TEST page.



TNS DOPPLER TEST PAGE

209000-95
J1340

Information Line: Displays the Doppler (radar navigation system) BIT acronym. A 1 displayed in any BIT position indicates fail. A 0 displayed in any BIT position indicates pass.

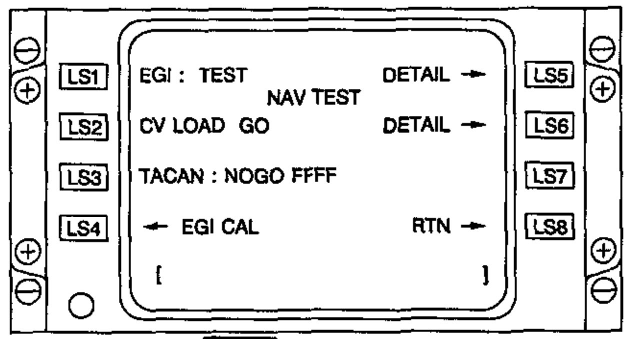
LS 1 through 7: Not used.

LS 8: Returns the display to the NAV TEST 1/2 page.

The DOPPLER TEST page is not scrollable.

20.14.18.1.2 CNU NAV TEST Page.

MAINT TEST page functions are identical to the TNS with the exception of:



CNU NAV TEST PAGE

209000-89
J1340

LS 1: Initiates BIT of the EGI. During BIT, TEST appears in the status field; when BIT is complete, GO or NOGO will appear in the status field. NOGO is displayed when any BIT failure occurs. Dashes are displayed when BIT results are not available.

Note

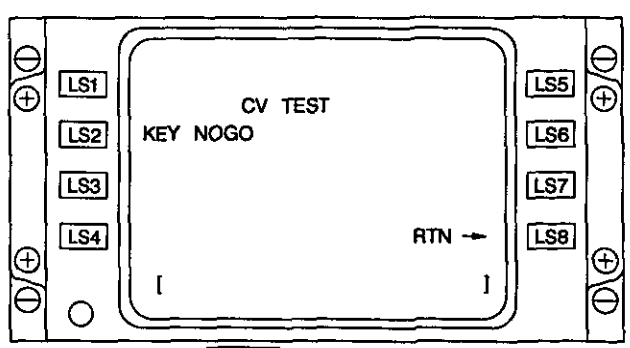
EGI test can only be initiated on initial power on of the EGI and prior to selection of an alignment.

LS 2: Displays the status of the GPS CV, either GO or NOGO. Dashes are displayed when CV status is not available.

LS 4: Accesses the EGI Calibration page.

LS 6: Accesses the CV TEST page.

20.14.18.1.3 CNU CV TEST Page.



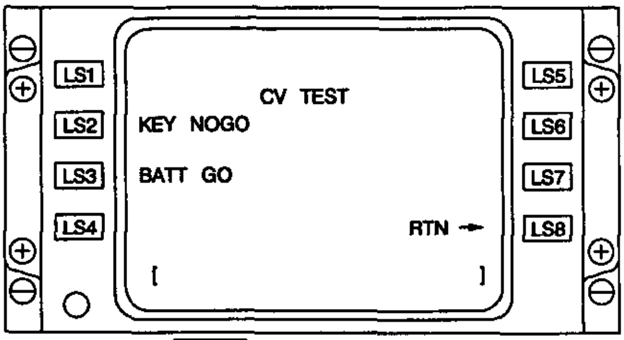
CNU CV TEST PAGE

209000-162-4
J1379

LS 2: Displays a GO if the GPS receiver module is loaded with the GPS cryptovariables.

20.14.18.1.4 CNU EGI TEST Pages.

The EGI TEST 1/2 detail page is accessed by pressing LS 5 on the NAV TEST page.



CNU EGI TEST 1/2 PAGE

209000-162-1
J1379

LS 1: Displays the status of the EGI INS. LS 1 is not functional.

Display Line 2: In addition to the page title, the overall BIT results for EGI are displayed.

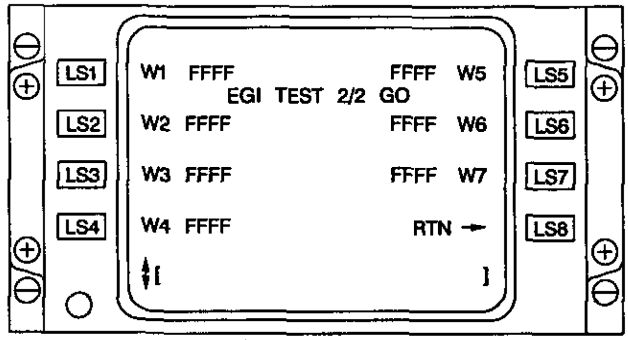
LS 2: Displays the status of the EGI GPS. LS 2 is not functional.

LS 3: Displays the status of the EGI NVM battery. LS 3 is not functional.

Note

EGI alignment with respect to NTS - TSU boresight is critical for accurate calculation of lased target coordinates. Installation of a replacement EGI or NTS -TSU will require calibration of the EGI. Aircraft logbooks will be the primary source for obtaining the boresight corrections for the EGI calibrations. An alternate shore based procedure allows for heading (BSZ) corrections (the primary source of boresight errors).

EGI TEST 2/2 Page, shown below, presents EGI status messages and is used for maintenance troubleshooting.



CNU EGI TEST 2/2 PAGE

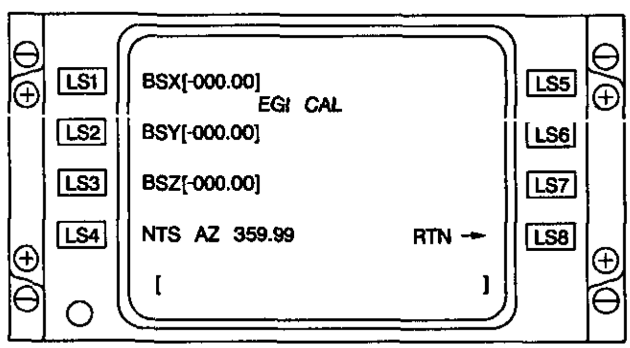
209000-162-3
J1379

20.14.19 CNU EGI Calibration Page.

EGI mechanical boresighting is a factory process. Allowable boresight errors are driven primarily by armament-datum line accuracy considerations and have no effect on navigation performance. Software boresight capability is provided for O-level adjustment. EGI calibration must be accomplished whenever the EGI is replaced. The EGI calibration values are retained in the memory and are not cleared by zeroizing.

EGI calibration page is provided to allow software boresight adjustments to fine tune pitch, roll, and yaw alignment to the aircraft and/or armament datums. The primary method of boresighting the EGI is input of depot-level measurements entered in the aircraft logbooks.

EGI calibration page is accessed by LS 4 on the NAV TEST page.



CNU EGI CALIBRATION PAGE

209075-782
J1340

LS 1-3: Display currently loaded boresight values. When actuated with a non-blank scratchpad, valid numbers are copied into the corresponding data field, and transmit them to the EGI; when actuated with a blank scratchpad no actions occur. The numbers define the alignment installation of the EGI with respect to the aircraft body coordinate system. Range of data is [-180.00 ... +180.00].

Note

Entering a boresight calibration value will delete the previously entered value.

BSX: Roll calibration input: Positive entries roll gyro horizon to the right.

BSY: Pitch calibration input: Positive entries move gyro horizon up.

BSZ: Yaw (heading) calibration input: Positive entries decrease RMI headings (rotates RMI card clockwise).

LS 4: The turret Azimuth is displayed on this line. The range is 0 to 359.99 degrees.

LS 5-7: Not used.

LS 8: Returns the display to the NAV Test page.

20.14.19.1 CNU EGI Calibration Procedures.

The following procedures are provided to allow insertion of aircraft EGI Calibration values provided in the specific aircraft logbook. EGI must be calibrated whenever the EGI has been replaced. EGI may be recalibrated when erroneous previous entries are suspected.

1. Complete an entire GCA.
2. Load boresight correction into BSX, BSY, and BSZ using line select 1, 2, and 3, respectively (need to enter minus sign if negative).

Note

The calibration values may have to be entered twice to ensure the EGI successfully received the correction (EGI receipt of the calibration value will be indicated by bracketed display).

If an error is made during input, the only way to correct the value is by re-entering the correct value.

3. Boresight correction will take effect after the EGI's next GCA.

20.14.19.1.1 CNU Alternate EGI Calibration Procedures.

This procedure is provided for shore based operation when logbook calibration values are not available or calibration values are suspected to be inaccurate.

Pitch and Roll Calibration:

1. Level the aircraft.
2. Complete an entire GCA.
3. Determine calibration estimates using HUD pitch ladder with Master Arm - Off.
4. Load boresight correction into BSX (roll) and BSY (pitch) using line select 1 and 2, respectively (need to enter minus sign if negative).

Note

Positive roll calibration entries roll gyro horizon to the right. Positive pitch calibration entries move gyro horizon up.

5. Boresight correction will take effect after EGI is realigned by completing an entire GCA.
6. Verify calibration adequacy; repeat steps 3 through 6 as necessary.

Yaw Calibration:

1. Accurately survey two points (aircraft position and target).
2. Calculate actual heading from surveyed aircraft position to surveyed target in degrees True to the nearest one hundredth of a degree.
3. Complete an entire GCA.
4. Complete an NTS boresight.
5. Park aircraft over surveyed position with nose pointing toward surveyed target (within 5 degrees).
6. Select Hdg: True on NAV 2/2.
7. TRACK or AUTOTRACK a surveyed target (preferably using FLIR Narrow Zoom FOV) and note NTS AZ on the EGI Cal page.
8. Determine boresight correction required by: NTS AZ - actual calculated heading (example actual heading 070.35 - NTS AZ 70.50 = boresight correction minus .15).

9. Load boresight correction into BSZ using LS 3 (need to enter minus sign if negative).

Note

The calibration value may have to be entered twice to ensure the EGI successfully received the correction (EGI receipt of the calibration value will be indicated by BSZ (LS 3) display).

10. Boresight correction will take effect after EGI is realigned by completing an entire GCA.

PART VIII

Weapon Systems

CHAPTER 21
Armament Systems

21.1 SCOPE

This chapter provides information on the armament systems, fire control systems, NTS, ANVIS, HUD, and armament operational checklists for the AH-1W helicopter. Descriptive data and operational procedures are provided on the following systems and controls.

SYSTEM	PARA
1. Helmet Sight Subsystem (HSS)	21.5
2. A/A49E-7(V4) Turret System	21.6
3. TOW Missile System (TMS)	21.7
4. Hellfire Missile System (HMS)	21.8
5. AIM-9/AGM-122 Missile System	21.9
6. Wing Stores Armament System	21.10
7. Pilot Armament Controls and Indicators	21.11
8. Cyclic Stick Armament Switches	21.12
9. Gunner Armament Controls and Indicators	21.13
10. Night Targeting System	21.14
11. ANVIS HUD Sysytem	21.18

(TABLE I.D. 922125)

21.2 ARMAMENT CONFIGURATION

Refer to the AH-1 ATTACK HELICOPTER TACTICAL MANUAL, NWP 3-21.5-AH1, for all authorized stores loading.

21.3 INTERRELATION OF ARMAMENT

The armament subsystems are interfaced with one another. Figure 21-1 shows pilot and copilot/gunner control components including NTS and ANVIS HUD in relationship to each armament subsystem.

21.4 ARMAMENT FIRING MODES

Figure 21-2 shows switch position for principal firing modes including NTS.

21.5 HELMET SIGHT SUBSYSTEM

The HSS (Figure 21-3) permits the pilot or gunner to rapidly acquire visible targets and to direct turret fire onto those targets. The HSS also provides a means of cueing from the pilot to gunner via the TSU for target location. The HSS consists of two HS assemblies mounted on the pilot and gunner helmets, two linkage assemblies mounted on the cockpit top left canopy frame, and an electronic interface assembly mounted on the rear cockpit bulkhead.

Aiming the turret is accomplished by superimposing the reticle image on the target while depressing the appropriate TRIGGER ACTION switch. Error signals will cause the turret to move until aligned with the viewer sight line. The reticle image is projected by a reflex sight in front of the operator's right eye, and appears as a yellow/white pattern focused at the target range.

Each linkage assembly (pilot and gunner) is stowed by sliding the respective linkage arm into a spring-loaded stow bracket at the forward end of the linkage. In operation, the linkage arm is connected to the pilot and gunner helmet by means of a magnet on top of the helmet. This attachment is for quick breakaway in the event of an accident. Breakaway requires approximately 20 pounds of pull. Each linkage has a built-in test (BIT) magnet, to which the steel fastener at the end of the linkage arms (both pilot and gunner) are connected when performing BIT. The respective linkage arm must be connected to the helmet magnet to obtain a viewing reticle. The turret weapon cannot be fired with the HS if this linkup has not been accomplished.

CONTROL COMPONENTS	TURRET	TOW MISSILE	HELLFIRE MISSILE	SIDEWINDER MISSILE	WING STORES: ROCKETS	WING STORES: GUN POD	TARGET ACQUIRE-TSU	WING STORES JETTISON
PILOT STATION:								
ARMAMENT CONTROL PANEL	X	X	X	X	X	X		
STORE CONTROL PANEL					X	X		
WING STORES JETTISON BUTTON								X
HELLFIRE PILOT CONTROL PANEL			X					
AIM-9 COCKPIT CONTROL UNIT				X				
HEAD-UP DISPLAY	X	X	X	X	X	X		
ANVIS HUD	X	X	X	X	X	X		
HELMET SIGHT	X						X	
CYCLIC SWITCHES	X		X		X	X		
AIM-9 COLLECTIVE SWITCH				X				
EMERGENCY JETTISON SELECT PANEL								X
GUNNER STATION:								
CYCLIC SWITCHES	X		X		X	X		
HELMET SIGHT	X						X	
TELESCOPIC SIGHT UNIT	X	X					X	
LEFT HAND GRIP	X	X						
SIGHT HAND CONTROL	X	X					X	
ARMAMENT CONTROL PANEL	X				X	X		X
TOW/HELLFIRE CONTROL PANEL	X	X	X				X	
WING STORES JETTISON SWITCH								X

209900-1273-1
J1974

Figure 21-1. Interrelation of Armament (Sheet 1 of 2)

CONTROL COMPONENTS	TURRET	TOW MISSILE	HELLFIRE MISSILE	SIDEWINDER MISSILE	WING STORES: ROCKETS	WING STORES: GUN POD	TARGET ACQUIRE-TSU	WING STORES JETTISON
GUNNER STATION:								
NIGHT TARGETING SYSTEM	X	X	X				X	
MULTIFUNCTION DISPLAY (MFD)	X	X	X					
NTS TELESCOPIC SIGHT UNIT	X	X	X					
NTS LEFT HAND GRIP	X	X	X		X	X		

209900-1273-2
H5322

Figure 21-1. Interrelation of Armament (Sheet 2 of 2)

The HS reticle is supplied with light from any one of three lamps to ensure reliability through redundancy. After linkage arm linkup with the helmet, the HSS RTCL TEST switch indicates failure of any of the three lamps. If one lamp is inoperative, no reticle will appear when the HSS RTCL TEST switch is activated. Each HS assembly has a cable terminating in an eight-pin connector. This connector must be attached to the mating jack located on the seat armor in the same clip as the communications connector. After the HS assembly has been connected and the linkage attached, the sight eyepiece must be positioned in front of the eye. To adjust the eyepiece vertically, compress the ends of the spring lock with the left hand and move the eyepiece up or down with the right hand. To adjust the sight laterally, grasp the sight housing firmly and apply enough lateral force to overcome the effect of the friction disc and cause the housing to move.

The HS assembly can be retracted (rotated out of the FOV) manually. To retract the sight manually, push the small button located to the right of the bulb cover. The sight will rotate counterclockwise out of the FOV. The signal for retracting the gunner sight electronically occurs when the gunner moves the ACQ/TRK/STOW switch from the ACQ position to the TRK position or when the switch is in the TRK position and the PHS ACQ switch is depressed. The signal moves the sight out of the way automatically before the gunner looks into the TSU. The sight, once retracted, must be manually returned to the FOV by rotating the sight clockwise until it latches in front of the eye.

The turret is positioned in azimuth and elevation by moving the HS with the linkage attached while the appropriate TRIGGER ACTION switch is depressed; vertical movement of the head will produce elevation movement of the turret, and horizontal movement of the head will produce azimuth movement of the turret. If the HSS assembly is in the retracted position, positioning and firing circuits are not interrupted. Release of the TRIGGER ACTION switch will cause the turret to return to the stow position regardless of the HS position. If the TRIGGER ACTION switch is depressed and the sight is moved at a speed greater than the maximum angular velocity of the turret, the firing circuit is interrupted and the sight reticle flashes until the gun is coincident within 4.5° of the HS line of sight. The sight reticle also flashes when the turret is moved to azimuth or elevation travel limits. HSS reticle OFF-BRT knobs and TEST switches are located on the pilot and gunner armament control panels. An HSS BIT switch on the

PILOT SWITCHES			GUNNER SWITCHES					CREWMEMBER	CAN		USING	
MASTER ARM	WEAPON CONT	STATION SELECT	PILOT OVER-RIDE	WING STORES SELECT	THCDP MODE SELECT	ACQ TRK STOW	PHS ACQ		FIRE	ACQ TGT FOR TSU	SIGHT	WEAPON SWITCH ON
ARM	GUNNER	1/2/3/4	OFF		HF STBY	STOW		GUNNER	TUR		HS	LHG
											NVG HUD	LHG
								PILOT	WS		HUD	CYC
					TSU/ GUN	STOW		GUNNER	TUR		HS	LHG
											NVG HUD	LHG
								PILOT	WS		HUD	CYC
						TRK		GUNNER	TUR		TSU	LHG
											MFD	LHG
								PILOT	WS		HUD	CYC
						ACQ		GUNNER		ACQ	HS	
											NVG HUD	
						TRK	PRESS	PILOT		ACQ	HS	
											NVG HUD	
					TOW STBY			PILOT	TUR		HS	CYC
											NVG HUD	CYC
									WS		HUD	CYC
					ARM MAN/ AUTO			PILOT	TUR		HS	CYC
											NVG	CYC
									WS		HUD	CYC
	PILOT	1/2/3/4	OFF					PILOT	TUR		HS	CYC
											NVG HUD	CYC
									WS		HUD	CYC
	FIXED	1/2/3/4	OFF					PILOT	TUR		HUD	CYC
											NVG HUD	CYC
									WS		HUD	CYC
ARM OR STBY			PILOT OVER-RIDE	INBD/ OUTBD				GUNNER	TUR		HS	CYC
											NVG HUD	CYC
									WS		NONE	CYC

209900-1275-1
J1478

Figure 21-2. Armament Firing Modes (Sheet 1 of 6)

PILOT SWITCHES			GUNNER SWITCHES					CREWMEMBER	CAN		USING	
MASTER ARM	WEAPON CONT	STATION SELECT	PILOT OVER-RIDE	WING STORES SELECT	THCDP MODE SELECT	ACQ TRK STOW	PHS ACQ		FIRE	ACQ TGT FOR TSU	SIGHT	WEAPON SWITCH ON
ARM	GUNNER	1/2/3/4	OFF		HF STBY	STOW		GUNNER	TUR		HS	LHG
											NVG HUD	LHG
								PILOT	WS		HUD	CYC
					TSU/ GUN	STOW		GUNNER	TUR		HS	LHG
											NVG HUD	LHG
								PILOT	WS		HUD	CYC
						TRK		GUNNER	TUR		TSU	LHG
											MFD	LHG
								PILOT	WS		HUD	CYC
						ACQ		GUNNER		ACQ	HS	
											NVG HUD	
						TRK	PRESS	PILOT		ACQ	HS	
											NVG HUD	
					TOW STBY			PILOT	TUR		HS	CYC
											NVG HUD	CYC
									WS		HUD	CYC
					ARM MAN/ AUTO			PILOT	TUR		HS	CYC
											NVG	CYC
									WS		HUD	CYC
	PILOT	1/2/3/4	OFF					PILOT	TUR		HS	CYC
											NVG HUD	CYC
									WS		HUD	CYC
	FIXED	1/2/3/4	OFF					PILOT	TUR		HUD	CYC
											NVG HUD	CYC
									WS		HUD	CYC
ARM OR STBY			PILOT OVER-RIDE	INBD				GUNNER	TUR		HS	CYC
											NVG HUD	CYC
									INBD		NONE	CYC

209900-1275-2
J1920

Figure 21-2. Armament Firing Modes (Sheet 2 of 6)

PILOT SWITCHES			GUNNER SWITCHES					CREWMEMBER	CAN		USING	
MASTER ARM	WEAPON CONT	STATION SELECT	PILOT OVER-RIDE	WING STORES SELECT	THCDP MODE SELECT	ACQ TRK STOW	PHS ACQ		FIRE	ACQ TGT FOR TSU	SIGHT	WEAPON SWITCH ON
ARM	GUNNER	2/3	OFF		HF STBY	STOW		GUNNER	TUR		HS	LHG
											NVG HUD	LHG
								PILOT	WS		HUD	CYC
					TSU/ GUN	STOW		GUNNER	TUR		HS	LHG
											NVG HUD	LHG
								PILOT	WS		HUD	CYC
						TRK		GUNNER	TUR		TSU	LHG
											MFD	LHG
								PILOT	WS		HUD	CYC
						ACQ		GUNNER		ACQ	HS	
											NVG HUD	
						TRK	PRESS	PILOT		ACQ	HS	
											NVG HUD	
					TOW STBY	STOW		PILOT	TUR		HS	CYC
											NVG HUD	CYC
									WS		HUD	CYC
						TRK		PILOT	TUR		HS	CYC
											NVG HUD	CYC
									WS		HUD	CYC
						ACQ		GUNNER		ACQ	HS	
											NVG HUD	
						TRK	PRESS	PILOT		ACQ	HS	
											NVG HUD	
					ARM MAN/ AUTO	STOW		PILOT	TUR		HS	CYC
											NVG HUD	CYC
									WS		HUD	CYC
						TRK		GUNNER	TOW		TSU	LHG
											NVG HUD	LHG
								PILOT	TUR		HS	CYC
											NVG HUD	CYC

209900-1275-3
J1478

Figure 21-2. Armament Firing Modes (Sheet 3 of 6)

PILOT SWITCHES			GUNNER SWITCHES					CREWMEMBER	CAN		USING	
MASTER ARM	WEAPON CONT	STATION SELECT	PILOT OVER-RIDE	WING STORES SELECT	THCDP MODE SELECT	ACQ TRK STOW	PHS ACQ		FIRE	ACQ TGT FOR TSU	SIGHT	WEAPON SWITCH ON
ARM	GUNNER	2/3	OFF		ARM MAN/ AUTO	TRK		PILOT	WS		HUD	CYC
											NVG HUD	CYC
						ACQ		GUNNER		ACQ	HS	
											NVG HUD	
						TRK	PRESS	PILOT		ACQ	HS	
											NVG HUD	
	PILOT	2/3	OFF					PILOT	TUR		HS	CYC
											NVG HUD	CYC
									WS		HUD	CYC
											NVG HUD	CYC
	FIXED	2/3	OFF					PILOT	TUR		HUD	CYC
											NVG HUD	CYC
									WS		NONE	CYC

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Figure 21-2. Armament Firing Modes (Sheet 4 of 6)

PILOT SWITCHES			GUNNER SWITCHES					CREWMEMBER	CAN		USING	
MASTER ARM	WEAPON CONT	STATION SELECT	PILOT OVER-RIDE	WING STORES SELECT	THCDP MODE SELECT	ACQ TRK STOW	PHS ACQ		FIRE	ACQ TGT FOR TSU	SIGHT	WEAPON SWITCH ON
ARM	GUNNER	OFF	OFF		HF STBY	STOW		GUNNER	TUR		HS	LHG
											NVG HUD	LHG
					TSU/ GUN	STOW		GUNNER	TUR		HS	LHG
											NVG HUD	LHG
						TRK		GUNNER	TUR		TSU	LHG
											MFD	LHG
						ACQ		GUNNER		ACQ	HS	
											NVG HUD	
						TRK	PRESS	PILOT		ACQ	HS	
											NVG HUD	
					TOW STBY	STOW		PILOT	TUR		HS	CYC
											NVG HUD	CYC
						TRK		PILOT	TUR		HS	CYC
											NVG HUD	CYC
						ACQ		GUNNER		ACQ	HS	
											NVG HUD	
						TRK	PRESS	PILOT		ACQ	HS	
											NVG HUD	
					ARM MAN/ AUTO	STOW		PILOT	TUR		HS	CYC
											NVG HUD	CYC
						TRK		GUNNER	TOW		TSU	LHG
								PILOT	TUR		HS	CYC
											NVG HUD	CYC
						ACQ		GUNNER		ACQ	HS	
											NVG HUD	
						TRK	PRESS	PILOT		ACQ	HS	
											NVG HUD	
	PILOT		OFF					PILOT	TUR		HS	CYC
											NVG HUD	CYC
	FIXED		OFF					PILOT	TUR		HUD	CYC
											NVG HUD	CYC
ARM OR STBY			PILOT OVER-RIDE					GUNNER	TUR		HS	CYC
											NVG HUD	CYC

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Figure 21-2. Armament Firing Modes (Sheet 5 of 6)

PILOT SWITCHES				GUNNER SWITCHES					CREWMEMBER	CAN		USING	
MASTER ARM	WEAPON CONT	AIM-9 CONT	HPCP MODE	PILOT OVER-RIDE	WING STORES SELECT	THCDP MODE SELECT	ACQ TRK STOW	PHS ACQ		FIRE	ACQ TGT FOR TSU	SIGHT	WEAPON SWITCH ON
ARM			LOAL OR LOBL			ANY ACTIVE HF MODE			PILOT	HF MSL		HUD	CYC
ARM			GNR CONT						GUNNER	HF MSL		THCDP	CYC
													LHG
ARM		ARM							PILOT	AIM-9 MSL/ AGM-122		HUD	COLL

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Figure 21-2. Armament Firing Modes (Sheet 6 of 6)

gunner armament control panel tests the pilot and gunner HSS and the electronic interface assembly (EIA). Failure indicator lights plus a GO light (indicates proper HSS operation) are also located on the gunner armament control panel. The 115 vac REF XFMR bus powers the HSS. The HSS PWR circuit breaker in the ac circuit breaker panel protects the HSS.

21.6 A/A49E-7(V4) TURRET SYSTEM

The A/A49E-7(V4) turret system (Figure 21-4) is chin-mounted on the helicopter and provides the capability to position, feed, and fire the M197 20-mm automatic gun. Major components of the turret system are the turret assembly, turret control assembly, M197 gun, torque box assembly, coincidence control unit, pressure system transducer, recoil compensation system, M89/M89E1 feeder, gun drive assembly, gun control system, and the 20-mm feed system. The turret system is interfaced with the head-up display, HSS, TSU, CDS, THCDP, and armament circuits.

The recoil compensation system interfaces with the SCAS, with the SCAS turned on, providing weapon recoil damping of helicopter movement when the weapon is fired.

The turret system is electrically operated and requires 28 vdc and 115 vac, 400 Hz power from the helicopter electrical system. Application of power to the turret system is supplied through circuit breakers on the pilot ac and armament circuit breaker panels. If normal electrical power is removed from the turret system, emergency 28 vdc power is applied directly to the emergency stow control unit in the turret assembly. This unit automatically drives the gun to the stow position to prevent ground contact by the gun barrels upon landing. The TURRET STOW light will illuminate when the turret is stowed. Stow position for the gun is 0° azimuth, 11° to 14° up elevation.

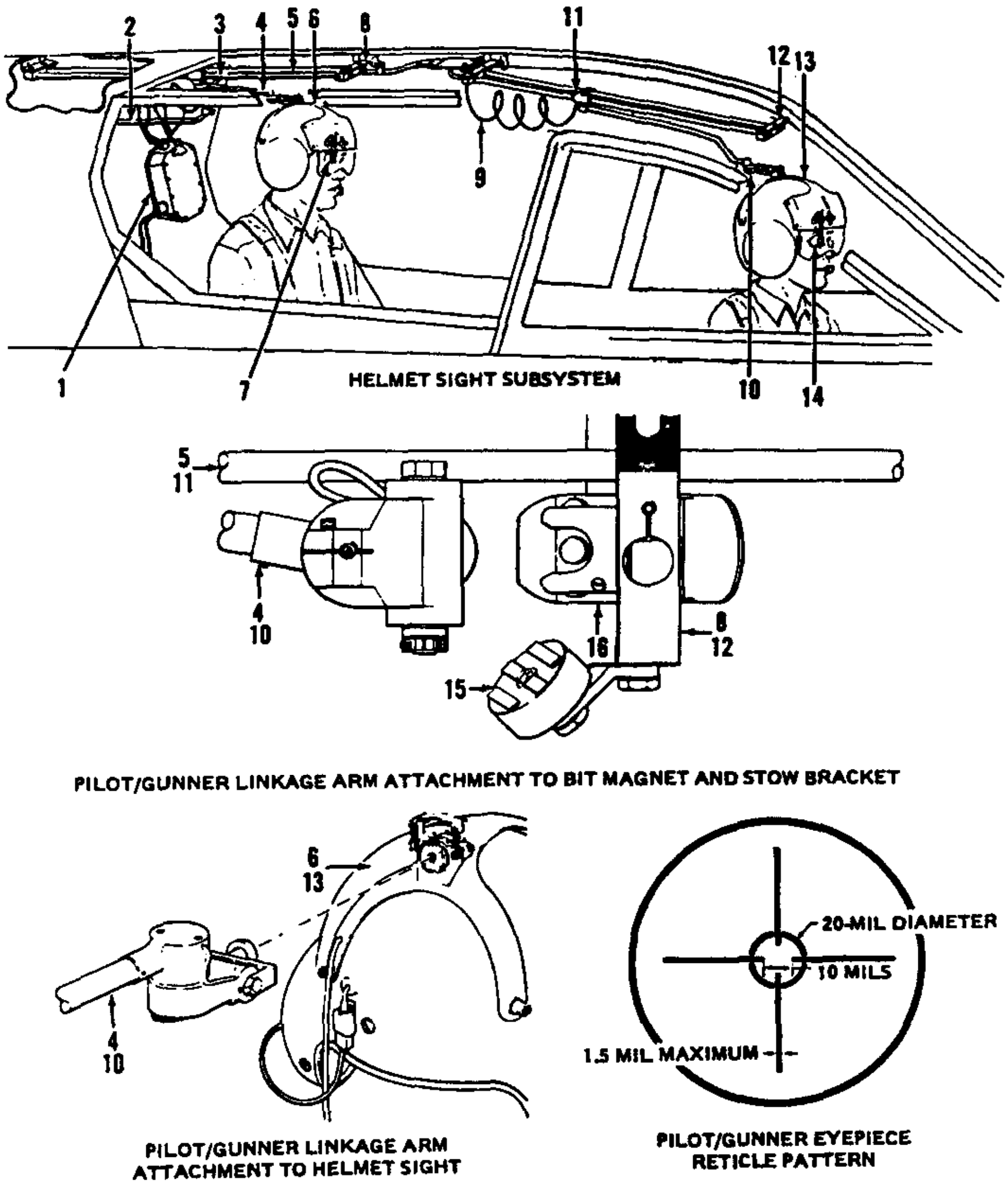
21.6.1 Turret Functions. Electrical circuits provide remote control for the azimuth and elevation drive system in the turret. The azimuth drive system rotates the turret through a range of 110° either side of 0° azimuth. The gun can be lowered 50° below 0° and raised 30° above 0° elevation. The gun control assembly controls operation of the gun and operation of the ammunition system. The M-65 TSU azimuth and elevation range of the night targeting system TSU is not the same as the standard M-65 TSU. The azimuth range for the NTS TSU is 90° right and 95° left. The elevation range is 25° up and 50° down. The HSS turret limits are not affected by the addition of NTS. Refer to paragraph 21.14 for additional information about the night targeting system TSU. The gun control assembly also supplies firing voltage to the gun when gun drive power is applied. The gun drive assembly rotates the gun barrels at a firing rate of approximately 650 rounds per minute. The ammunition feed system contains 750 rounds of belted 20-mm ammunition. The gun is fired for the duration of the trigger command signal plus clearing cycle or in limited 16 ±4 round bursts. The first detent on the cyclic TRIGGER TURRET FIRE switch and LHG TRIGGER switch allows the gun control assembly to automatically terminate each trigger command signal after 16 ±4 rounds are fired. The second detent allows continuous firing.

CAUTION

The M197 automatic gun is restricted to a firing schedule not to exceed a 450 round burst with a minimum of 6 minutes cooling time prior to firing the remaining 300 rounds.

The gun control assembly also terminates the trigger command signal when the gun reaches azimuth or elevation limits and when the gun position disagrees in azimuth or elevation more than 4.5° from the sight position command signal. The flow of ammunition to the gun stops immediately upon termination of the trigger command signal.

Time delay circuits in the gun control assembly continue the gun drive power and firing voltage long enough for the gun to fire ammunition remaining in the gun unless the trigger command signal is terminated by position error. Should the trigger command signal be terminated by position error in excess of 4.5°, firing voltage is terminated simultaneously; however, the gun drive power is continued to clear live ammunition from the gun.



1. Electronic interface assembly
2. Gunner extension cable
3. Pilot linkage cable
4. Pilot linkage arm
5. Pilot linkage rails
6. Pilot helmet sight
7. Pilot eyepiece
8. Pilot linkage front support
9. Gunner linkage cable
10. Gunner linkage arm
11. Gunner linkage rails
12. Gunner linkage front support
13. Gunner helmet sight
14. Gunner eyepiece
15. BIT magnet
16. Stow bracket

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Figure 21-3. Helmet Sight Subsystem

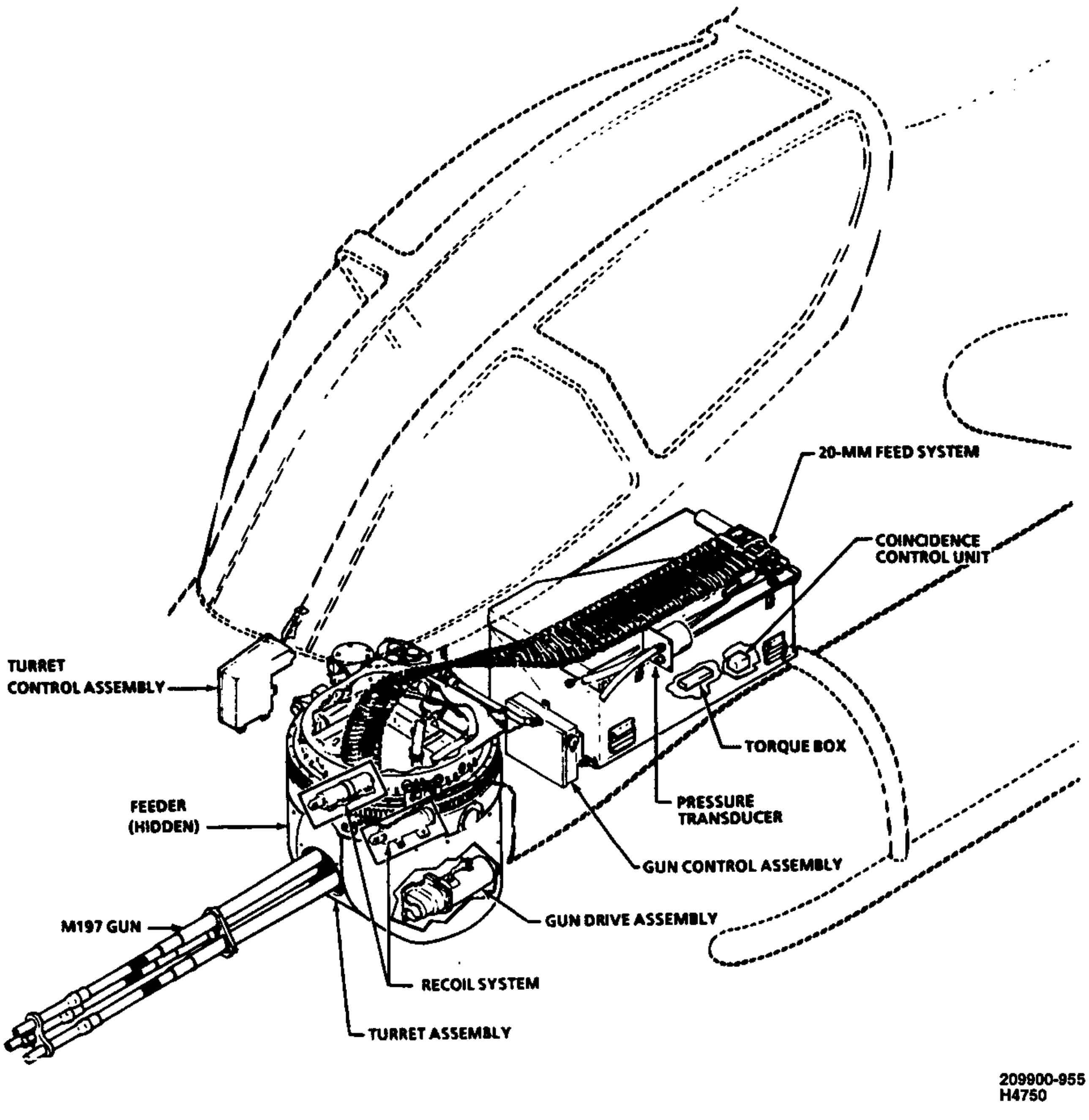

Figure 21-4. A/A49E-7(V4) Turret System

21.6.2 Turret Modes of Operation. The turret system can be operated in one of the five modes of operation depending upon switch setup. The pilot controls the turret system in pilot FIXED or PILOT HSS mode. The gunner controls the system in gunner HSS, TSU/GUN, or PILOT OVERRIDE. Turret and wing stores cannot be fired simultaneously.

Note

Ammunition is cleared and the gun will stow during turret operation when the pilot WING ARM FIRE switch is pressed or the AIM-9 UNCAGE/FIRE switch is set to FIRE.

21.6.2.1 Pilot FIXED Mode. In the pilot FIXED mode of operation, the turret system remains stationary in a fixed forward position at 0° azimuth and 0° elevation. The pilot aims the weapon by maneuvering the helicopter in such a manner as to superimpose the reticle image of the HUD sight on the selected target. The pilot TRIGGER ACTION switch must be depressed to display the gun reticle. The gun is fired by pressing the TRIGGER TURRET FIRE switch on the cyclic grip. The pilot FIXED mode is selected by positioning switches as follows:

1. WEAPON CONT — FIXED
2. RECOIL COMP ON-OFF — ON
3. RECOIL COMP rate — ANY POSITION
4. GUN RANGE — As Desired
5. PILOT OVERRIDE — OFF
6. AIRSPEED COMP — COMP
7. TURRET DEPR LIMIT — OFF
8. MASTER ARM — ARM
9. TRIGGER ACTION — DEPRESSED
10. TRIGGER TURRET FIRE — DEPRESSED.

21.6.2.2 Pilot HSS Mode. In the pilot HSS mode, movement and positioning of the turret system is controlled by the pilot HS. Within azimuth and elevation limits of the system, the turret is positioned to the pilot LOS. That is, the gun barrels are aimed to the same point as the pilot helmet sight reticle. Pilot HSS mode is selected by positioning switches as follows:

1. WEAPON CONT — PILOT
2. RECOIL COMP ON/OFF — ON
3. RECOIL COMP rate — ANY POSITION
4. GUN RANGE — As Desired
5. PILOT OVERRIDE — OFF
6. AIRSPEED COMP — COMP
7. TURRET DEPR LIMIT — OFF
8. MASTER ARM — ARM
9. TRIGGER ACTION — DEPRESSED
10. TRIGGER TURRET FIRE — DEPRESSED.

21.6.2.3 Gunner HSS Mode. In gunner HSS mode, movement and positioning of the turret system is controlled by the gunner HS. The gunner aims the turret by superimposing the reticle image of his HS on a selected target while depressing the LHG ACTION switch. Gunner HSS mode is selected by positioning switches as follows:

1. WEAPON CONT — GUNNER
2. RECOIL COMP ON/OFF — ON
3. RECOIL COMP rate — ANY POSITION
4. PILOT OVERRIDE — OFF
5. RANGE — As Desired
6. AIRSPEED COMP — COMP
7. TURRET DEPR LIMIT — OFF
8. ACQ/TRK/STOW switch — STOW
9. THCDP — ANY POSITION EXCEPT TOW FUNCTION

Note

When the THCDP is in any TOW function, control of the turret reverts to the pilot HS.

10. MASTER ARM — ARM
11. LHG ACTION — DEPRESSED
12. LHG TRIGGER — DEPRESSED.

The turret slews to gunner helmet LOS when LHG ACTION is depressed.

21.6.2.4 TSU/GUN Mode. In the TSU/GUN mode, aiming of the turret is accomplished by superimposing the reticle image of the TSU on a selected target. The gunner may employ several methods of acquiring and tracking targets with the TSU. By placing the ACQ/TRK/STOW switch to the TRK position, the TSU may be directed to the desired target by using the track control stick on the SHC. The MFD may be used to perform tracking in place of the TSU. The quickest method, however, uses either the pilot or gunner HS to direct the TSU. The pilot superimposes his HS reticle on a target and the gunner directs the TSU to that target by placing the ACQ/TRK/STOW switch on the SHC to TRK and depressing the PHS ACQ button. The gunner may direct the TSU with his own HS by superimposing his HS reticle on the desired target and positioning the ACQ/TRK/STOW switch to ACQ. The TSU/GUN mode is selected by positioning switches as follows:

1. WEAPON CONT — GUNNER
2. RECOIL COMP ON/OFF — ON
3. RECOIL COMP rate — ANY POSITION
4. PILOT OVERRIDE — OFF
5. RANGE selector — As Desired
6. AIRSPEED COMP — COMP
7. TURRET DEPR LIMIT — OFF

Note

TURRET DEPR LIMIT switch has been modified and is a part of the laser interlock system.

8. THCDP BRT/OFF switch — ON
9. THCDP system mode switch — TSU/GUN
10. ACQ/TRK/STOW — TRK
11. MASTER ARM — ARM
12. LHG ACTION — DEPRESSED
13. LHG TRIGGER switch — DEPRESSED.

21.6.2.5 Pilot Override Mode. In the PILOT OVERRIDE mode, the gunner controls movement of the gun with his HS and fires the weapon using the TRIGGER TURRET FIRE switch on the gunner cyclic grip. When this mode is selected by the gunner, all circuits on the pilot armament control panel are bypassed except when the MASTER ARM switch is in the OFF position. The PILOT OVERRIDE mode is selected by positioning the switches as follows:

CAUTION

NTS Selection of Pilot Override will disable and deenergize NTS, which may result in damaging the NTS TSU

1. PILOT OVERRIDE — OVERRIDE
2. TRIGGER ACTION — DEPRESSED
3. TRIGGER TURRET FIRE — DEPRESSED.

21.7 TOW MISSILE SYSTEM

The TOW missile system is designed to launch and guide the TOW missile. The system utilizes optical and IR means to track a target and guide the missile. Six functional elements (Figure 21-5) provide for the launching and guiding capabilities of the TMS. The six functional elements are:

1. Stabilized sight
2. Controls and displays
3. Infrared
4. Missile command
5. Launcher
6. Night targeting system.

The first element, the stabilized sight, provides the capability for sighting and tracking a target using commands generated by the gunner. This element consists of the TSU and SCA. The MFD can be used in place of the TSU.

The second element, the controls and displays, provides positioning commands to the TSU, system turn-on, missile selection, steering direction for the pilot, system status to the gunner and pilot, self-test commands, and operational mode selections. This element consists of the SHC, THCDP, CDS, status annunciators and an LHG.

The third element, IR, provides the capability of detecting the angular displacement of the missile from the optical LOS by tracking an IR beacon that is located on the aft end of the TOW missile. The direction and amplitude of the angular displacement of the missile from the TSU LOS is used to generate missile position error signals. This element is located in the TSU and consists of the IR tracker and error detector.

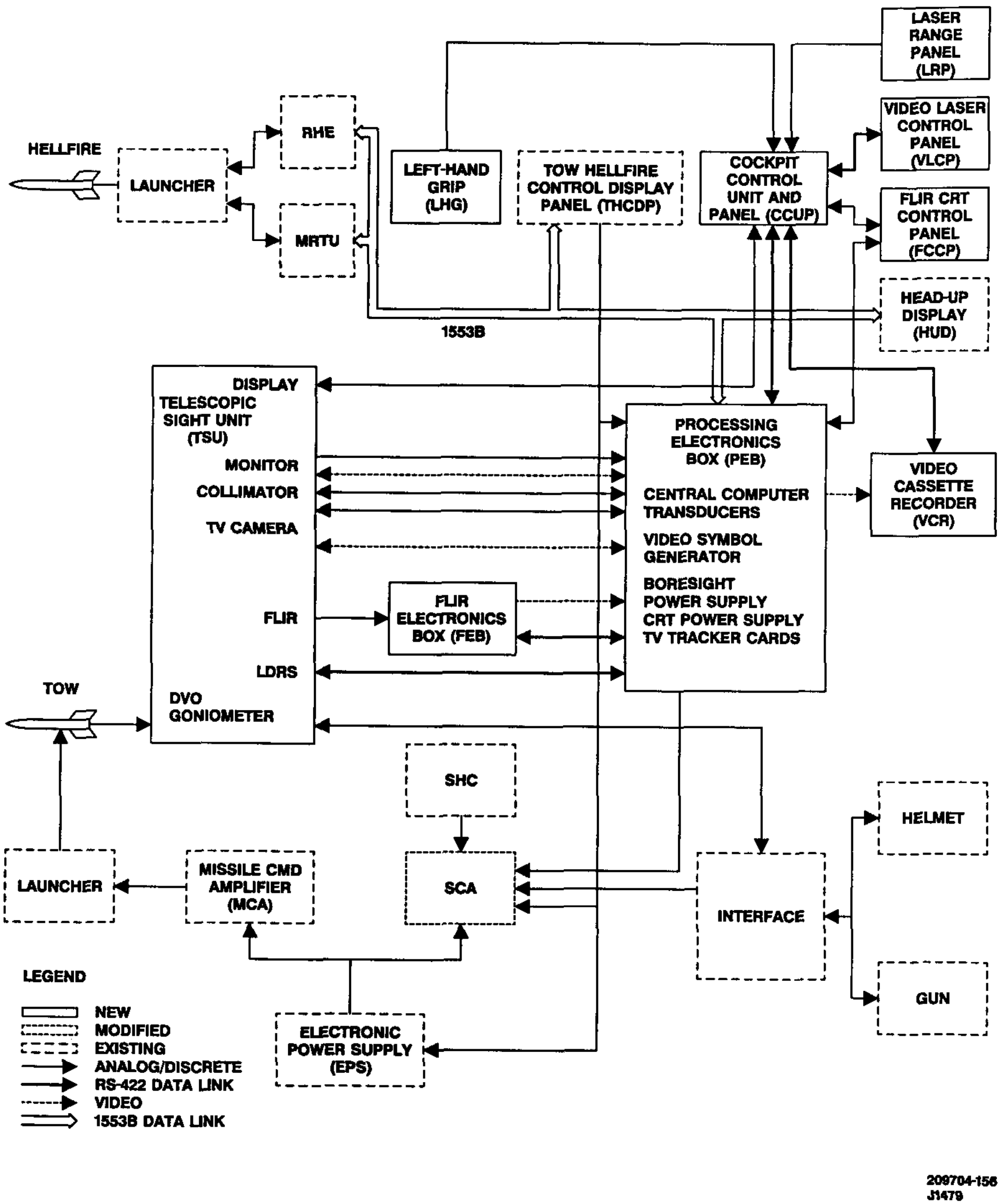

Figure 21-5. TMS Functional Block Diagram

The fourth element, missile command, processes the missile position error signals that are generated by the IR element into FM multiplexed signals. These signals are transmitted over the missile command wires as commands that are used to direct the missile back to the TSU optical LOS. This element consists of the MCA.

The fifth element, the launchers, consists of the TML attached to the outboard wing stations. The launchers are designed so that either two or four missiles can be loaded on each outboard wing station.

The sixth element, the NTS, consists of FEB, PEB, CRT, TVC, VCR, CCUP, LCP, LRP, NTS LHG, LDRS MFD, and a modified TSU. The NTS allows for viewing and recording the TSU image under day and night conditions using the VCR and viewing the TVC or FLIR image as presented on the CRT. The LDRS provides the capability of ranging and designating a target using a 1064 nanometer neodymium YAG solid state laser for guidance of laser guided munitions. The LRP provides the ability to select a minimum laser return range. The LCP provides the ability to automatically/manually set RFTDL designation codes and diagnostic/ maintenance codes. The NTS LHG incorporates controls for the HELLFIRE, FLIR, TVC, laser, autotrack mode, image source selection, FOV selection and FLIR polarity, focus, automatic/ manual gain/level control, declutter, offset, and TSU slew rate (action). The CCUP provides controls for the VCR, boresight, CRT ORT brightness and contrast, system clock adjustment, caution lights and controls, and diagnostic pages. The M-65 TSU was modified to accept the TVC and CRT and to facilitate the integration of NTS components. For additional information about the NTS, refer to paragraph 21.14.

21.7.1 TOW Missile System Abbreviations and Acronyms.

21.7.1.1 NTS Abbreviations and Acronyms (Figure 21-6).

21.7.2 TMS Built-In Test. The TMS has an automatic BIT, consisting of 10 distinct tests designed to verify system operational integrity and to indicate a failure of one of four WRAs (TSU, SCA, MCA, and EPS). The EPS is the only WRA in the system that maintains a continuous operating integrity check but is only read out by the THCDS during BIT. BIT is initiated whenever the TMS is initially powered, and is immediately sequenced automatically to each test. When the TMS is armed, BIT is interrupted and the system is immediately ready for use. BIT cannot be performed if the ACQ/ TRK/STOW switch is in any position other than STOW. An indication appears on the THCDP that shows whether BIT is in-test (test), pass (power on), or fail (OFF). If the system fails BIT, an indicator will appear to isolate the failure to one of the previously mentioned four WRAs. The BIT switch resets the BIT fail indicators and recycles the BIT sequence. The following units are not checked via this BIT operation: SHC, HUD, and launchers. When the manual BIT button on the THCDP is pressed, all annunciators in the TSU will be displayed. When the BIT button is released, the annunciators will disappear from view and the BIT checks are initiated as in the automatic BIT operation. TMS BIT may take up to 100 seconds. NTS will perform its BIT in conjunction with the TMS BIT. Upon completion of TMS BIT, the NTS will continue the laser energy test for up to 10 seconds.

21.7.3 Telescopic Sight Unit and Left-Hand Grip.

21.7.3.1 TSU. The TSU (Figure 21-7) contains the optical system necessary for firing the TOW missile. Visually, the TSU has an angular coverage of ±110° in azimuth and +30° to +60° in elevation. The TSU is mounted on the nose of the helicopter and extends into the front cockpit. The night targeting system TSU has an azimuth range between 90° right and 95° left. The elevation of the night targeting system TSU has a range between 25° up and 50° down. The SHC is mounted on the right side of the TSU and the LHG is mounted on the left. The IR tracker and error detector are located in the front part of the TSU. The TVC and the CRT of the NTS are attached to the lower aft surface of the ORT in the cockpit.

WARNING

- Laser operation is involved in performing the following tests. Standard laser precautions in ANSI Z136.1-1986 must be followed. Wear appropriate goggles during laser threat environment operation.
- Laser light energy is intensified when viewed through an optically aided viewing device. A laser protective filter for the TSU shall be selected when conducting flight operations in a laser threat environment. Laser protective filters may not be installed on all aircraft.

ABBREVIATIONS & ACRONYMS	DEFINITIONS
ADL	ARMAMENT DATUM LINE
BIT	BUILT-IN TEST
CAM	CAMERA
CCM	COUNTER-COUNTERMEASURES
CCU	COCKPIT CONTROL UNIT
CDS	CONTROL DISPLAY SUBSYSTEM
EIA	ELECTRONIC INTERFACE ASSEMBLY
EPS	ELECTRONIC POWER SUPPLY
FOV	FIELD OF VIEW
GHS	GUNNER HELMET SIGHT
HF	HELLFIRE
HMS	HELLFIRE MISSILE SYSTEM
HPCP	HELLFIRE PILOT CONTROL PANEL
HSS	HELMET SIGHT SUBSYSTEM
HUD	HEAD-UP DISPLAY
IR	INFRARED
LHG	LEFT HAND GRIP
LOAL	LOCK-ON AFTER LAUNCH
LOBL	LOCK-ON BEFORE LAUNCH
LOS	LINE OF SIGHT
MAN	MANUAL
MCA	MISSILE COMMAND AMPLIFIER
MRTU	MULTIPLEX REMOTE TERMINAL UNIT
PHS	PILOT HELMET SIGHT
PRU	POWER RELAY UNIT
RHE	REMOTE HELLFIRE ELECTRONICS
RIPL	RIPPLE
RTCL	RETICLE (TSU)
SCA	STABILIZATION CONTROL AMPLIFIER
SECU	SERVO ELECTRONIC CONTROL UNIT
SHC	SIGHT HAND CONTROL
THCDP	TOW/HELLFIRE CONTROL DISPLAY PANEL
THCDS	TOW/HELLFIRE CONTROL DISPLAY SYSTEM
TML	TOW MISSILE LAUNCHER
TMS	TOW MISSILE SYSTEM
TOW	TUBE-LAUNCHED OPTICALLY-TRACKED WIRE-GUIDED
TSU	TELESCOPIC SIGHT UNIT
WRA	WEAPON REPLACEABLE ASSEMBLY

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Figure 21-6. NTS TOW/HELLFIRE and AIM-9/AGM-122 Missile Abbreviations and Acronyms (Sheet 1 of 2)

ABBREVIATIONS & ACRONYMS	DEFINITIONS
ANVIS HUD	AVIATORS NIGHT VISION IMAGING SYSTEM HEAD-UP DISPLAY
CCUP	COCKPIT CONTROL UNIT PANEL
CRT	CATHODE RAY TUBE
CPU	CENTRAL PROCESSOR UNIT
DES	DESIGNATOR
DET	DETECTOR
DVO	DIRECT VIEW OPTICS
FEB	FLIR ELECTRONICS BOX
FLIR	FORWARD LOOKING INFRARED
LCP	LASER CODE PANEL
LDRS	LASER DESIGNATING AND RANGING SYSTEM
LED	LIGHT EMITTING DIODE
LHG	LEFT HAND GRIP
LRP	LASER RANGE PANEL
LRU	LINE REPLACEABLE UNIT
LSR	LASER
NTS	NIGHT TARGETING SYSTEM
ORT	OPTICAL RELAY TUBE
PEB	PROCESSOR ELECTRONICS BOX
RAM	RANDOM ACCESS MEMORY
RFTDL	RANGE FINDER TARGET DESIGNATOR LASER
SRA	SHOP REPLACEABLE ASSEMBLY
TIS	THERMAL IMAGING SYSTEM (SENSOR)
TNS	TACTICAL NAVIGATION SYSTEM
TVC	TELEVISION CAMERA
TVT	TV TRACKER
VCR	VIDEO CASSETTE RECORDER
YAG	YTTRIUM ALUMINUM GARNET

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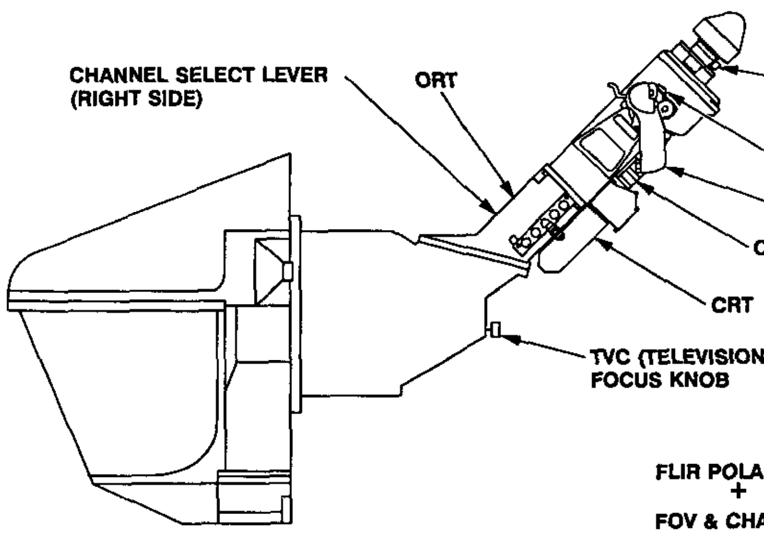
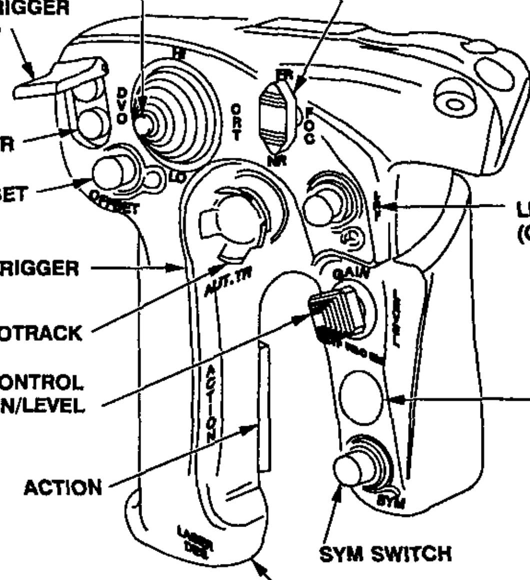
Figure 21-6. NTS TOW/HELLFIRE and AIM-9/AGM-122 Missile Abbreviations and Acronyms (Sheet 2 of 2)





LEFT HAND GRIP

LHG NOMENCLATURE	POSITION/ ACTION	FUNCTION
LASER DES switch	Press	- Activates laser rangefinder. - Activates laser designator. - Activates VCR. - Places event mark on tape if VCR is recording.
TRIGGER switch	First detent Second detent Either detent	- Fires turret 16 ± 4 round burst. - Fires turret continuously. - Fires TOW missile. - Activates VCR. - Places event mark on tape if VCR is recording.

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Figure 21-7. Gunner Telescopic Sight Unit (Sheet 1 of 3)

LHG NOMENCLATURE	POSITION/ACTION	FUNCTION
FLIR POLARITY/FOV/ CHANNEL SELECT	Press	- Selects FLIR polarity (black hot/white hot).
	DVO	- Selects direct view optics.
	CRT	- Pushing right from DVO initially selects TVC mode. - Subsequent pushes select FLIR and TVC alternately.
	In DVO mode:	
	HI	- Selects 4.6° FOV (13 power).
	LO	- Selects 30° FOV (2 power).
	In TVC mode:	
	HI	- Selects 1.6° x 1.2° FOV (34 power).
	LO	- Selects 10° x 7.5° FOV (5.3 power).
	In FLIR mode From medium FOV (7.1° Horizontal x 5.3° Vertical, 7.0 Power):	
	HI	- Pushing up once selects narrow FOV (2.0° x 1.5° FOV, 25 power). - Pushing up twice selects narrow FOV zoom (50 power).
	LO	- Selects wide FOV (24.3° x 18.4° FOV, 2.0 power).
ACTION switch	Press in FLIR mode medium FOV only:	
	Press	- Changes TSU track rate to slow.
	Press in CCD, DVO and FLIR modes:	- Activates TOW launchers in THCDP TOW mode. - Activates motion compensation circuits in THCDP TOW mode. - Activates attack logic in THCDP TOW mode. - Slaves turret to TSU or gunner helmet sight in THCDP TSU/GUN mode.
FOC switch	FR	- Pushing up focuses FLIR toward objects in far range.
	NR	- Pushing down focuses FLIR toward objects in near range.
	Press	- Activates automatic focus feature when momentarily pressed.
LRF switch	Press	- Activates laser rangefinder.
FLIR MAN/AUTO GAIN/ LEVEL switch	In FLIR mode:	
	Press	- Selects manual or automatic mode for GAIN and LEVEL functions.
	In TVC mode:	
	Press	- Right or left selects manual or automatic light level control for TVC.
	In MAN mode:	
	LEVEL	- Pushing to the left reduces LEVEL. Pushing to the right increases LEVEL.
	GAIN	- Pushing up increases GAIN. Pushing down decreases GAIN in FLIR mode.
	In CCD mode:	
	Press	- Toggles manual light level control.
	LEVEL	- Pushing left darkens filter, pushing right lightens filter.
SYM switch	Press	- When pressed while system is in FLIR channel and held for 3 seconds, will display gray scale. - Momentary activation of this switch will clear CRT image of the laser range, target coordinates, and range and bearing information. Updated information will be displayed when valid laser signal is received.
AUT TR switch	Press	- Engages and disengages automatic tracking feature.
	UP/DOWN/ LEFT/RIGHT	- Adjusts LOS in automatic tracking mode one pixel at a time.

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Figure 21-7. Gunner Telescopic Sight Unit (Sheet 2 of 3)

LHG NOMENCLATURE	POSITION/ ACTION	FUNCTION
OFFSET switch	Press and hold	- In autotrack mode, allows LOS to be adjusted off target using SHC. Pressing again will eliminate selected offset.
MSL trigger guard	Raise Lower	- Enables Hellfire missile to be fired. - Enables gunner cyclic wing arm fire switch.
MSL trigger	Press	- Fires Hellfire missile and activates VCR.

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Figure 21-7. Gunner Telescopic Sight Unit (Sheet 3 of 3)

In operation, the IR tracker and error detector receives IR energy from the missile during flight and senses any missile displacement from the optical LOS. This information is used to generate the command signals that direct the missile back to the LOS. During system self-test, the IR tracker is automatically boresighted to the optical LOS. The stabilization system isolates the optical system from helicopter motion.

The direct view optical FOVs offer a 30° FOV in LO MAG (2× magnification) and a 4.6° FOV in HI MAG (13× magnification). In FLIR mode, additional FOVs as seen in Figure 21-7 are used. The gunner LHG is mounted on the TSU optical relay tube in a location that allows the gunner to operate necessary controls. The LHG controls are used to select a number of functions including ACTION and TRIGGER switches for firing the TOW missile and 20-mm turret, and to control many of the components of the NTS. Annunciators within the TSU provide the gunner with system status information. A focus knob is located on the underside of the TSU relay tube. The eyepiece is monocular and has been modified to allow the use of the AR-5 gasmask. It can be rotated so that either eye can be used to view through the optics.

21.7.3.2 Left-Hand Grip. The LHG (Figure 21-7), located in the gunner station on the TSU, contains the LHG ACTION and TRIGGER switches. LHG ACTION and LHG TRIGGER are used for activating and firing the TOW missile system as well as the turret in normal gunner modes. The LHG ACTION switch allows interface of the turret to gunner helmet sight, turret to TSU, and TSU to TOW missile launcher. The LHG TRIGGER is used to fire TOW missiles or turret. The LHG TRIGGER has two detents.

In addition to the basic M-65 TSU LHG buttons and switches, the NTS LHG contains controls for the NTS components. These controls and their functions (Figure 21-7) are as follows:

SWITCH	FUNCTION
FOV and CHANNEL SELECT	FLIR POLARITY/FIELD OF VIEW AND CHANNEL SELECT
FOC	FLIR MANUAL/AUTO FOCUS
LASER DES	ACTIVATES LASER DESIGNATOR/RANGEFINDER

(Cont)

SWITCH	FUNCTION
LRF	LASER RANGEFINDING
GAIN LEVEL	FLIR MANUAL/AUTO GAIN LEVEL TVC-LIGHT LEVEL CONTROL
SYM	SELECTS FLIR GRAY SCALE WHEN DEPRESSED FOR 3 SECONDS CLEARS LASED TARGET INFORMATION FROM CRT WHEN PRESSED MOMENTARILY
AUT TR	AUTOTRACKING
OFFSET	ENGAGE/DISENGAGE OFFSET IN AUTOTRACKING MODE
MSL TRIGGER GUARD	ENABLES GUNNER TO FIRE HF MISSILE FROM LHG
MSL TRIGGER	FIRES HF MISSILE

21.7.4 Sight Hand Control. The SHC (Figure 21-8) is mounted on the right side of the TSU in the gunner station and contains the track control stick that is a force transducer device. This stick provides track commands that position the TSU optics to enable target locating and tracking. The SHC also selects different modes of operation for the TSU. In autotrack mode, the SHC is used to go to manual mode by depressing it in any direction. In autotrack with offset, the SHC aligns the direction and magnitude of the offset. In FLIR mode, depressing the SHC disables the averaging process for FLIR video. The CONST OVRD button allows the gunner to initiate the TOW fire sequence even though the helicopter is not aligned within valid constraints. This function is normally only used by maintenance personnel. The probability of missile capture is greatly reduced utilizing constraints override.

21.7.5 TOW/HELLFIRE Control Display Panel. The THCDP (Figure 21-9) provides the gunner with controls and visual status indication for the TMS. The THCDP provides commands to the TMS for missile selection, BIT, and wire cut when the system mode switch is positioned to a TOW mode. The panel is the primary control panel for the THCDS. The THCDS interfaces with the TMS and performs the computations and data transfers necessary for controlling the TMS. Figure 21-10 illustrates the primary TOW displays on the THCDP. The displays appear in four major groupings: missile status, armed status, system status, and scratchpad display.

21.7.5.1 System Mode Switch. The system mode switch (Figure 21-9) in a TOW mode position allows the gunner to select firing of a TOW missile. When the system mode switch is set to any TOW mode, the HMS is in standby mode.

21.7.5.1.1 TSU/GUN Mode Switch Position. With the system mode switch in the TSU/GUN position, the gun turret is enabled, TSU/GUN is displayed and the missile status display shows TOW missile and launcher status (Figure 21-11, detail C).

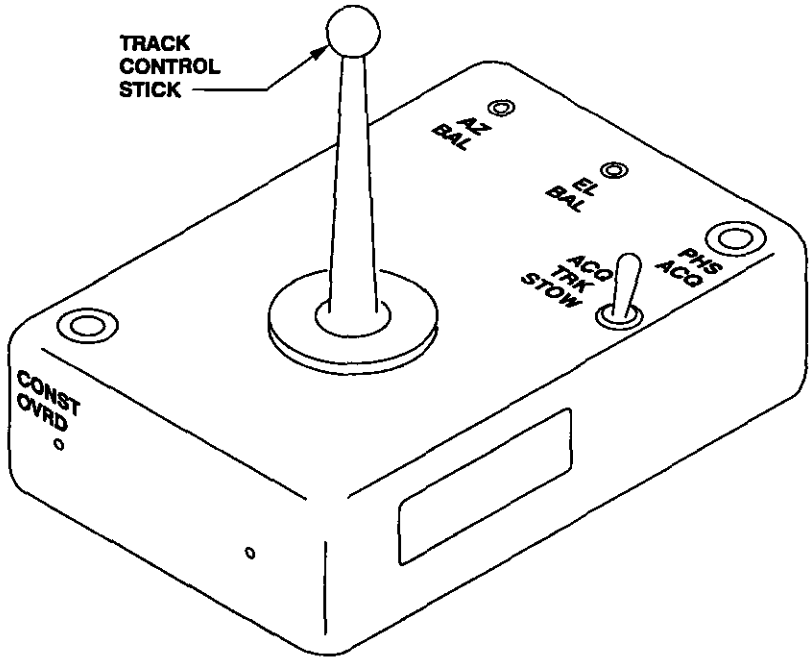
21.7.5.1.2 STBY Mode Switch Position. With the system mode switch set to TOW STBY, the TMS is in standby mode. A missile cannot be launched in this mode. TOW-STBY is displayed and the TOW missile and launcher status is shown. Missile present is indicated by TOW and the missile number. An empty launcher or launched missile is indicated by a shaded area in place of TOW (Figure 21-11, detail A). When a launcher is not present, the area for TOW and number is blank.

21.7.5.1.3 MAN Mode Switch Position. With the system mode switch to ARM MAN mode and the MASTER ARM switch in ARM, the TOW missile to be fired may be manually selected and ARM-MAN is displayed (Figure 21-11, detail D). Selection of the missile is made on keyboard (1, 2, 3, 4, 5, 6, 7, or 8) and the display reads MSL-SEL. The selected missile number will appear. When ENTR is pressed, the missile is selected. The selected missile is indicated with brackets around the missile number. After a missile is launched, a shaded area will appear where TOW was indicated.

Note

If the TOW trigger jams or is held down more than 10 seconds, advisory message TRIGGER STUCK is displayed in the scratchpad.

21.7.5.1.4 AUTO Mode Switch Position. With the system mode switch set to ARM AUTO mode,



LOCATION: GUNNER INSTRUMENT PANEL

NOMENCLATURE	FUNCTION
Track Control Stick	Move - Positions TSU in azimuth and elevation.
ACQ/TRK/STOW Switch	ACQ - Slaves TSU to gunner HS for target acquisition. TRK - Permits track control handle to position TSU. - Permits pilot to perform target acquisition. STOW - Stows TSU at 0° azimuth and 0° elevation.
PHS ACQ Switch	Press - Slaves TSU to pilot HS for target acquisition.
EL BAL Screw	- Used during maintenance.
AZ BAL Screw	- Used during maintenance.
CONST OVRD Switch	Press - Permits TOW firing when helicopter is not aligned within the attack envelope.

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Figure 21-8. Gunner Sight Hand Control

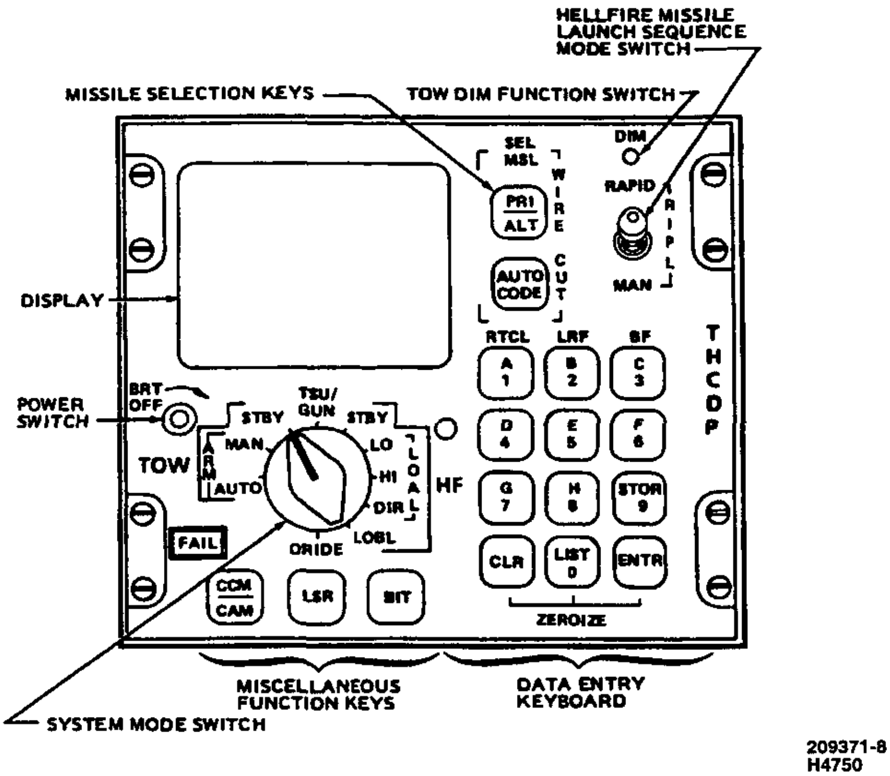
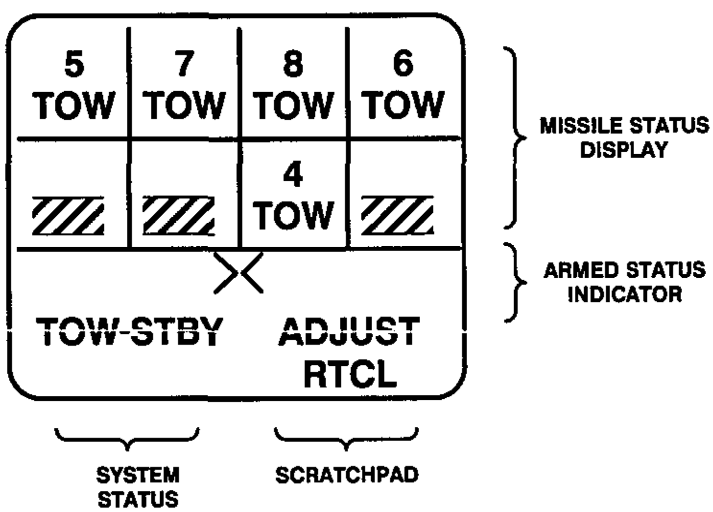


Figure 21-9. Gunner TOW/HELLFIRE Control Display Panel



DISPLAY	MEANING
Blank	Neither TOW system nor launcher present
TOW	TOW missile present
ZZ	TOW missile station empty
><	When the MASTER ARM is not ARMED (i.e., in standby), "><" appears below the missile status display.

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Figure 21-10. Primary TOW Displays

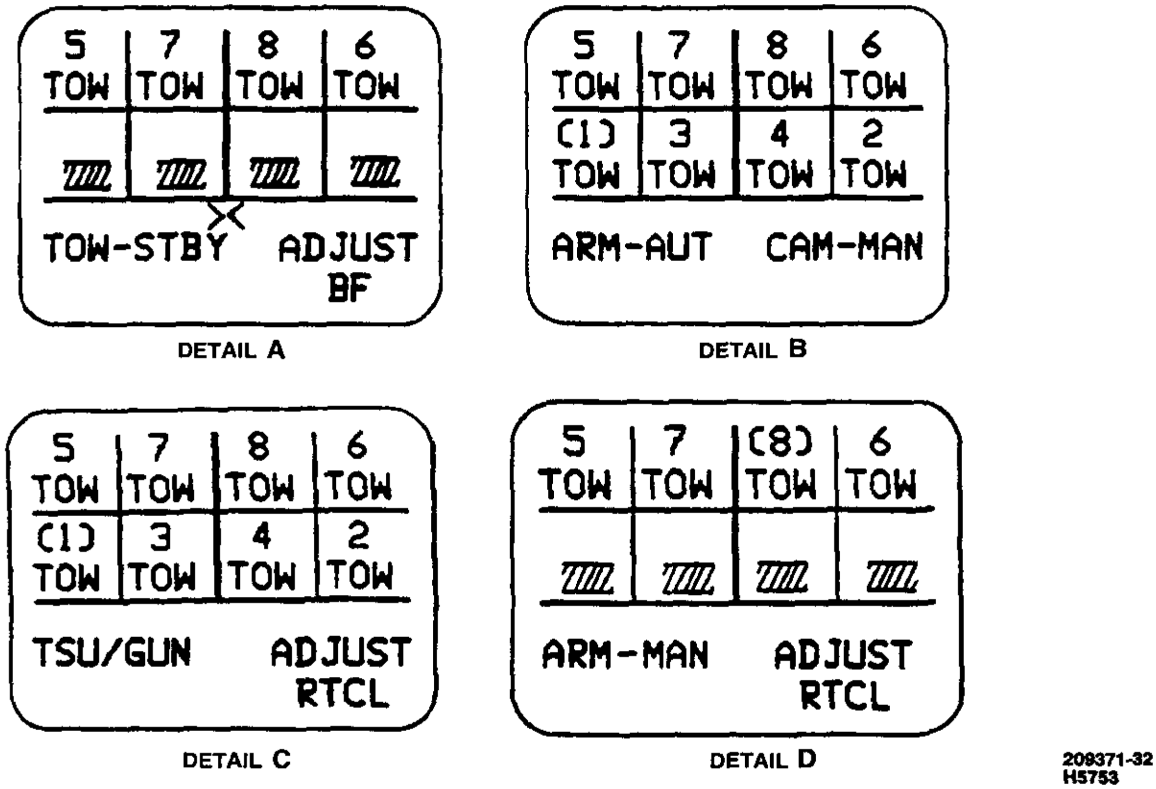


Figure 21-11. THCDP Display for TOW

the THCDS selects the TOW missile to be launched starting in numerical sequence from missile No. 1. The automatic selection and arming process may take up to 3 seconds. ARM-AUT is displayed (Figure 21-11, detail B).

21.7.5.2 Power (BRT/OFF) Switch.

21.7.5.2.1 OFF Position. In the OFF position, primary power is removed from the TMS and HMS.

21.7.5.2.2 BRT Position. Applies power to the TMS, HMS, and the NTS. Allows adjustment of brightness on THCDP display screen. When switching the THCDP on while the mode selection switch is either in TOW STBY or TSU/GUN, a full system BIT is performed on TMS and NTS components.

21.7.5.3 CCM/CAM Key. The CCM/CAM pushbutton changes the camera status from off, to manual, to auto, to off with successive presses. The display shows CAM/MAN for manual (Figure 21-11, detail B) CAM-AUT for automatic, and CAM-OFF (for 5 seconds) then blank for off. RUN indicates that camera start is active. (CAM function is not used.)

21.7.5.4 RTCL, LRF, and BF Keys. The RTCL key controls the dimming of the TSU reticle in both DVO and TVC modes. The BF key is pressed to adjust dimming of the BATTLE FLAG LED display. Display is dimmed when gunner CAUTION panel is placed in the DIM position.

21.7.5.5 NTS CNU LSR Key. The LSR key selects the laser rangefinder first or last pulse logic and engages one of the laser arm interlocks for the NTS RFTDL. The LSR key cycles the laser mode from laser off, to laser first, to laser last, with successive presses. The display shows LSR OFF for laser off, LSR FST for laser first, and LSR LST for laser last. When in the TOW mode, the display appears in the lower left hand corner of the scratchpad. When in HELLFIRE mode the display appears in the lower right hand corner of the scratchpad. The current laser mode is displayed for 5 seconds when the LSR pushbutton is first depressed, or when the THCDP mode has changed between TOW and HELLFIRE. Laser mode changes can only be made while the current state is displayed by pushing the LSR key. The laser mode will initially default to laser off at power-up.

21.7.5.6 BIT Key. The BIT pushbutton initiates the built-in test of the TOW and NTS components with a press. All TMS LRA faults are displayed in the scratchpad area on the display. If multiple faults exist, each fault will be displayed until acknowledged (with a press of the CLEAR button), then the display returns to the normal display. All NTS-related failures will be displayed on both the CRT and the MFD.

21.7.5.7 WIRE CUT Keys. The PRI/ALT and the AUTO CODE pushbuttons initiate wire cut when pressed simultaneously. WIRECUT is displayed for 5 seconds. The pilot WIRE CUT pushbutton is located on the pilot miscellaneous control panel.

21.7.5.8 DIM Switch. The DIM pushbutton enables dimming of the TSU reticle and the annunciator flags. The DIM pushbutton enables dimming of the TSU reticle. When the DIM pushbutton is pressed, the scratchpad displays ADJUST and the system holds for further input. Pressing and holding the RTCL A1 pushbutton increases the TSU reticle illumination, and ADJUST RTCL (Figure 21-11, detail D) is displayed. The RTCL A1 pushbutton may be released when the desired illumination is achieved. Pressing the RTCL A1 pushbutton a second time decreases the illumination until the button is released. After the illumination is adjusted, the DIM pushbutton may be pressed to exit and the scratchpad display returns to normal. The battle flags are adjusted in the same way using the BF C3 pushbutton.

21.7.6 Pilot Head-up Display. The HUD interfaces with the THCDP and TMS and visually presents symbology for flight and TMS firing. The HUD provides the pilot steering indications for meeting the helicopter constraints during prelaunch and postlaunch of the TOW missile. Refer to paragraph 21.11.4.

21.7.7 TOW Missile Launcher. The TML (Figure 21-12) provides support and electrical interface with the TMS. The launchers are designed so that two or four TOW missiles can be loaded on wing stations 1 and 4.

21.7.8 TOW Missile System Function.

21.7.8.1 Target Acquisition. The gunner has several methods of acquiring a target through the TSU. By placing the ACQ/TRK/STOW switch in the TRK position, the TSU may be directed toward the target utilizing the SHC stick. This method will take more time than other methods and will require the gunner to search with the TSU. As the FOV is restricted to 30 in LO MAG and 4.6 in HI Mag, some difficulty may be encountered. The quickest method is to utilize either the PHS or GHS to direct the TSU optics. If the pilot places the PHS reticle on a target, the gunner can direct the TSU to that target by placing the ACQ/TRK/STOW switch on the SHC to TRK and depressing the PHS ACQ button, also located on the SHC. When the PHS ACQ button is depressed, the GHS reticle automatically retracts enabling the gunner to view through the TSU. The TSU will continue to align with the pilot LOS until the gunner releases the PHS ACQ button.

If the gunner desires to direct the TSU to a target using the GHS, he proceeds as follows:

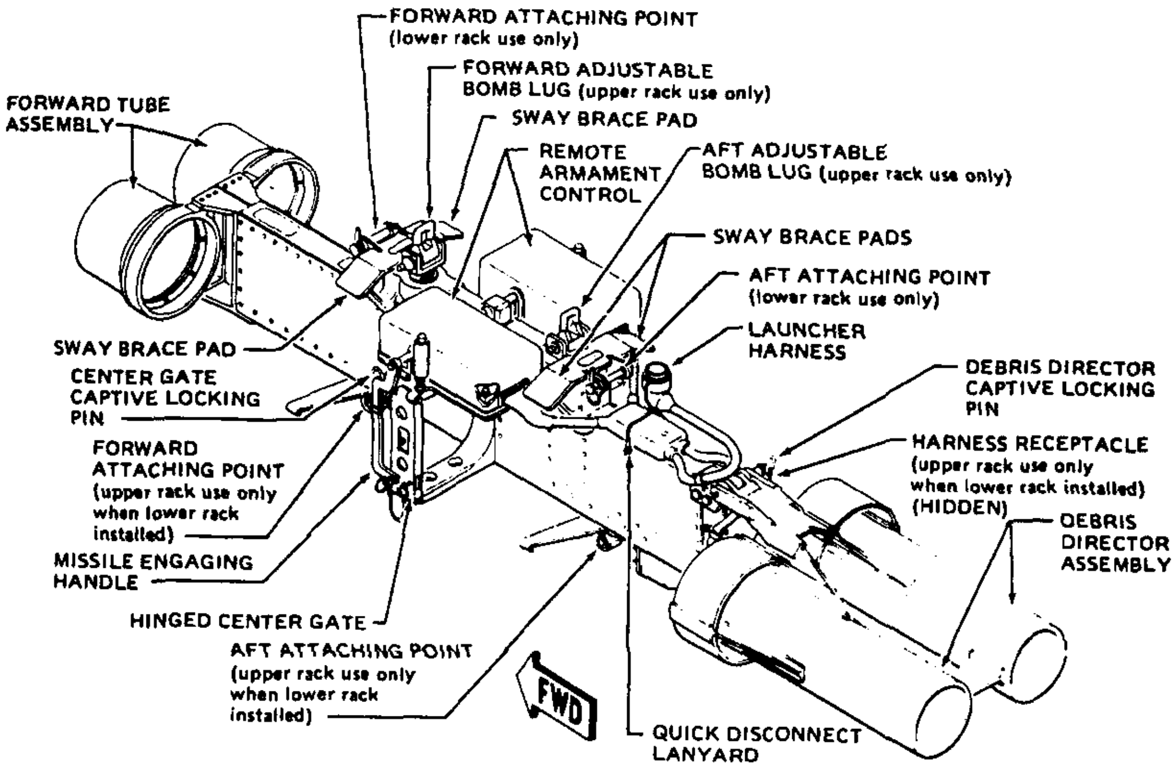
1. Superimpose the GHS reticle on the target.
2. Move the ACQ/TRK/STOW switch to ACQ.

The ACQ/TRK/STOW switch is spring-loaded from ACQ to TRK so it will be necessary to hold it in the ACQ position. As long as the switch is held in the ACQ position, the TSU will continue to align itself with the GHS LOS. When the switch is released, it will spring back to the TRK position and the GHS eyepiece will automatically retract. The gunner then views through the TSU to acquire the target. The acquisition functions will operate for any TOW or TSU/GUN mode switch position on the THCDP while the THCDP power switch is on.

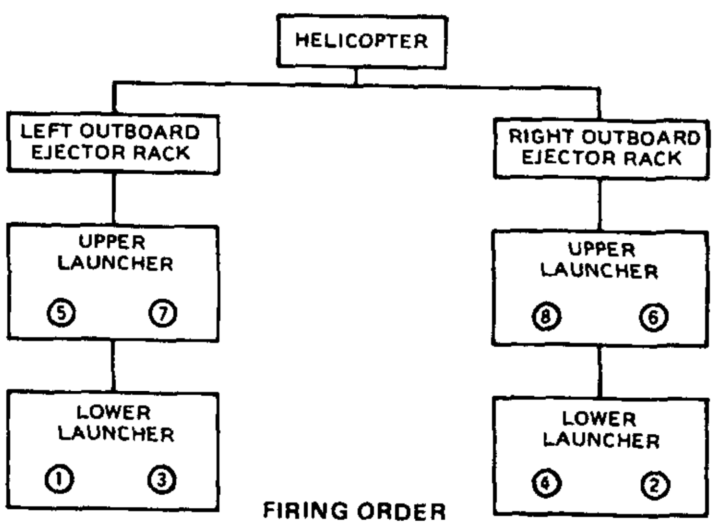
The TSU (LO MAG) may be directed onto a target by the pilot pointing the nose of the helicopter at the target by placing the ACQ/TRK/STOW switch in the STOW position. The pilot needs to have a wing store selected (an empty store will suffice) to obtain the TSU indicator in the HUD. This may be the fastest way to acquire a target that is off the nose.

21.7.8.2 TOW Missile Firing. Once the gunner has acquired a target in LO MAG, he switches to the HI MAG position on the LHG. The small circle in the LO MAG reticle of the TSU represents the limits of the HI MAG FOV. If the target appears in the small circle of the LO MAG reticle, the target will appear within the HI MAG FOV. When in HI MAG, the gunner should depress the LHG ACTION switch to get motion compensation and to initiate the attack logic necessary to launch the TOW missile.

1. WPN CONT — Gunner.



LAUNCHER



FIRING ORDER

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Figure 21-12. TOW Missile Launcher

2. LHG ACTION switch — DEPRESSED (motion compensation).

3. CHANNEL SELECT switch — Channel as Desired (DVO/TVC/FLIR). FOV — HI for DVO; MEDIUM, NARROW, or NARROW ZOOM FOV for FLIR.

4. ACQ/TRK/STOW switch — TRK.

5. Missile — PRESENT AND SELECTED.

6. THCDP system mode switch — ARMED, MAN, or AUTO.

7. MASTER ARM switch — ARM.

With these conditions met, the ATTK will appear in the TSU FOV and the HUD displays a prelaunch rectangle with a flashing reticle if the reticle is outside the prelaunch rectangle. The HUD gives the pilot steering information to align the helicopter within predetermined prelaunch constraints. As the helicopter comes into a prelaunch constraints, the HUD reticle stops flashing and RDY appears within the TSU FOV. The pilot should strive to give the gunner as stable a platform as possible for the actual firing.

With the attack and ready annunciators present, the firing sequence can be initiated by the gunner utilizing the TRIGGER on the LHG. By pulling the LHG TRIGGER and initiating the fire sequence, the HUD displays an X over the missile shown adjacent to the upper window area. This indicates that an irreversible sequence of operations has begun, leading to missile launch. During this phase of operation, the pilot should refrain from causing sudden motions of the helicopter. As the missile exits the launch tube, the HUD displays a postlaunch constraints rectangle and the attack and ready annunciators in the TSU disappear. An approximate 1.5 second delay occurs between the trigger pull and the missile exit from the launch tube. The 1.5 second delay is necessary for the following:

1. Missile battery charge-up

2. Missile gyro spin-up

3. Missile guidance set self-balance.

One and one-half seconds after initiation of the fire sequence, the launch motor ignites. The launch motor shears the missile holdback pin and accelerates the missile to 225 FPS, allowing the missile to exit the launch container. The launch motor burns out before the missile exits the launch tube and the missile coasts approximately 7 to 12 meters before the flight motor ignites. At this point, the wing and flight surfaces have snapped out into position and the flight motor ignites, accelerating the missile to just under Mach 1. When the flight motor ignites, the acceleration of the missile causes a g-sensing device to complete the missile arming. At this point, nose crush is all that is necessary to detonate the warhead. The flight motor quickly burns out and the missile coasts for the duration of the flight. Ignition of the flight motor will cause target obscuration because of smoke and gases for a short period of time. As target obscuration occurs, the gunner should release his control inputs with the SHC and allow motion compensation to keep the TSU reticle on the target. As obscuration decreases, if the reticle has drifted off the target, the gunner should make a smooth, positive correction back to the target avoiding jerky SHC movement.

The NTS TSU has different azimuth and elevation restraints from the standard M-65 TSU. The new limits are 90° right, 95° left, 25° up, and 50° down.

Note

> The NTS SCA scales the HUD gunner TSU reticle to indicate postlaunch constraint limits of the **NTS** modified TSU.

The gunner continues to track the target until missile impact or wire cut. Wire cut will be automatically initiated by missile impact, the missile timer (25 seconds after TRIGGER pull), or if the IR tracker loses the missile IR source for more than 0.5 second. Manual wire cut can be initiated by either the gunner or pilot at any time, utilizing the respective WIRE CUT switches. If the pilot moves the WEAPON CONT switch from GUNNER to PILOT, wire cut will occur. Wire cut will also occur if the copilot/gunner goes to LO MAG, switches from an active TOW mode, or stows the TSU.

WARNING

> Because of the nature of the missile flight control, when wire cut occurs, missile flight will be extremely erratic.

The pilot retains control of the turret through the pilot HSS with the THCDP in the active TOW mode and the WEAPON CONT switch in the GUNNER position. Ammunition will be cleared (if firing) and the gun will stow for 3.5 seconds upon TOW missile trigger initiation. The pilot may fire the turret again, at the end of 3.5 seconds, using the pilot HSS.

21.8 HELLFIRE MISSILE SYSTEM

The HMS is capable of launching eight HELLFIRE missiles at targets designated by ground, other airborne units, or autonomously. This can be accomplished while the helicopter is at airspeeds from zero to V_{ne} (velocity never exceed). The missile is a laser-guided, point-target weapon designed to destroy armored or reinforced targets.

WARNING

Laser operation is involved in performing the following tests. Standard laser precautions in ANSI Z136.1-1986 must be followed. Wear appropriate goggles during laser operation.

The system consists of a THCDS, RHE, MRTU, and two launchers mounted on the outboard stores position of each wing. Figure 21-13 illustrates the interrelationship of the HMS components. See Figure 21-6 for abbreviations and acronyms used with the HMS.

21.8.1 TOW/HELLFIRE Control Display System. The THCDS performs the computations and data transfers necessary for controlling the HMS. The major components consist of the THCDP and the HPCP. Refer to Figure 21-14 for THCDP interface with HMS and TMS.

21.8.1.1 TOW/HELLFIRE Control Display Panel. The THCDP (Figure 21-15) provides the gunner with controls and visual status indication for the HMS. The THCDP communicates with the HMS, TMS, HUD, HPCP, TSU, NTS, and turret. Helicopter pitch attitude information is received from the pitch and roll (vertical) gyro. The functions of the THCDP are as follows:

1. Display of TOW missile system and HMS data.
2. Display of steering data for proper helicopter orientation for missile launch.
3. Display of laser code assignment, status, etc., of each HMS missile.
4. Synchro-to-digital conversion of the helicopter attitude gyro pitch output for subsequent transmission on the multiplex data bus.
5. Data bus control.
6. Data communication to and from the MRTU, the RHE, TMS, and CDS.
7. Initiates BIT for the TOW and HMS and performs BIT on the THCDS.
8. Codes the NTS LDRS when LCP is in AUTO.

21.8.1.2 HELLFIRE Pilot Control Panel. The HPCP (Figure 21-16) is located on the pilot instrument panel. The HPCP interfaces with the THCDP and provides the pilot control of the HMS. The panel consists of one rotary mode select switch and a pushbutton switch for designating laser codes for missile launch.

The HPCP is not active when the THCDP system mode switch (Figure 21-15) is set to HF STBY, TSU/GUN, or TOW. However, when the THCDP is set to an HF active mode, the HPCP has functional priority over the equivalent THCDP switch setting.

21.8.1.2.1 GNR CONT Mode. In this position the THCDP rotary switch and PRI/ALT pushbutton have priority for mode selection and primary/alternate laser code channels.

21.8.1.2.2 LOAL Modes. Any one of three LOAL modes may be selected by the rotary switch. A missile may be launched after being selected and given a laser code for designation in any LOAL mode.

1. LOAL LO — When this mode has been selected, the missile will climb at a low altitude after launch and search for a laser designated target.
2. LOAL HI — When this mode has been selected, the missile will climb to a higher altitude after launch and search for a laser designated target.
3. LOAL DIR — When this mode has been selected, the missile will pursue a more direct trajectory after launch and search for a laser designated target.

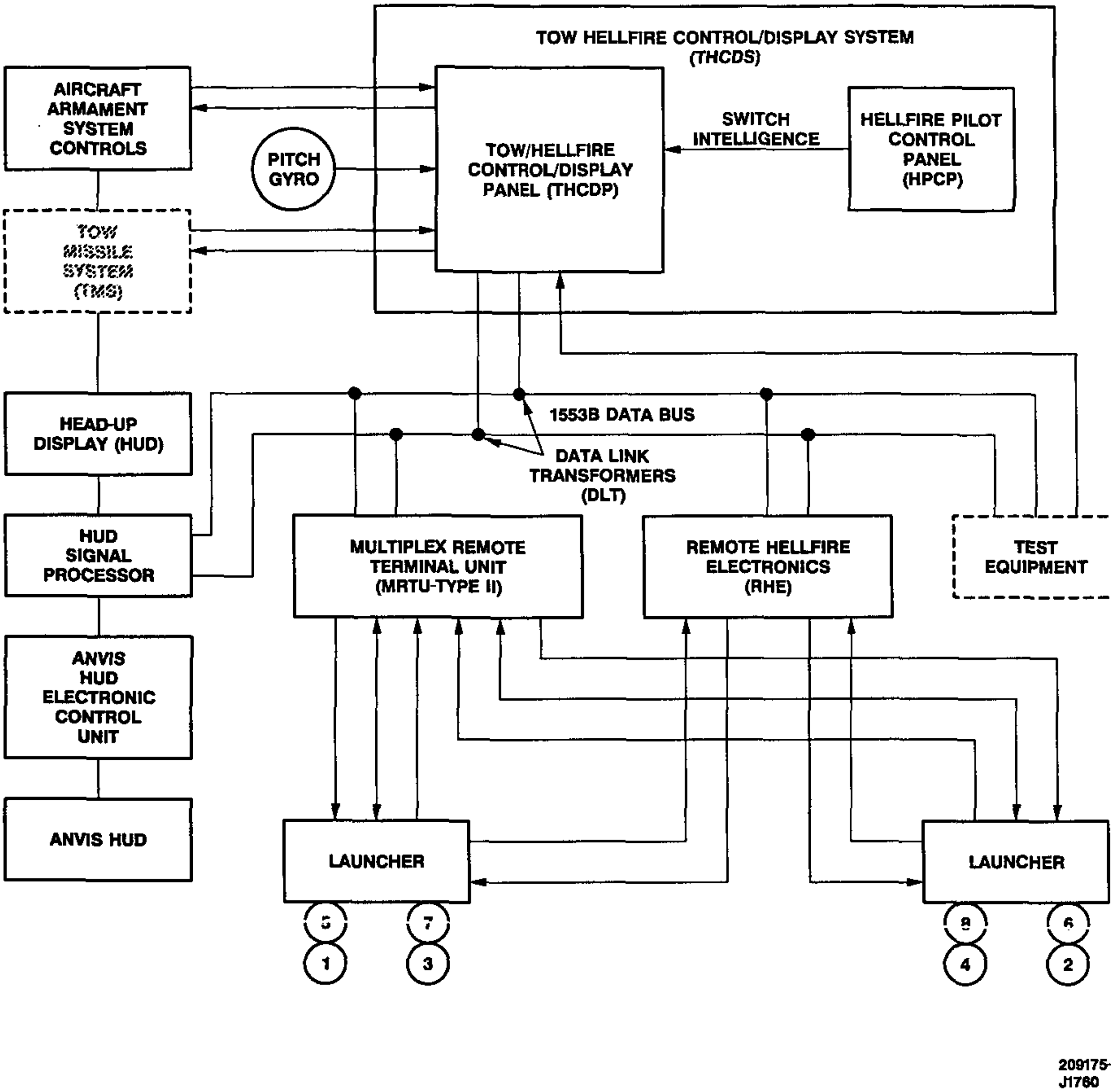


Figure 21-13. HMS Functional Block Diagram

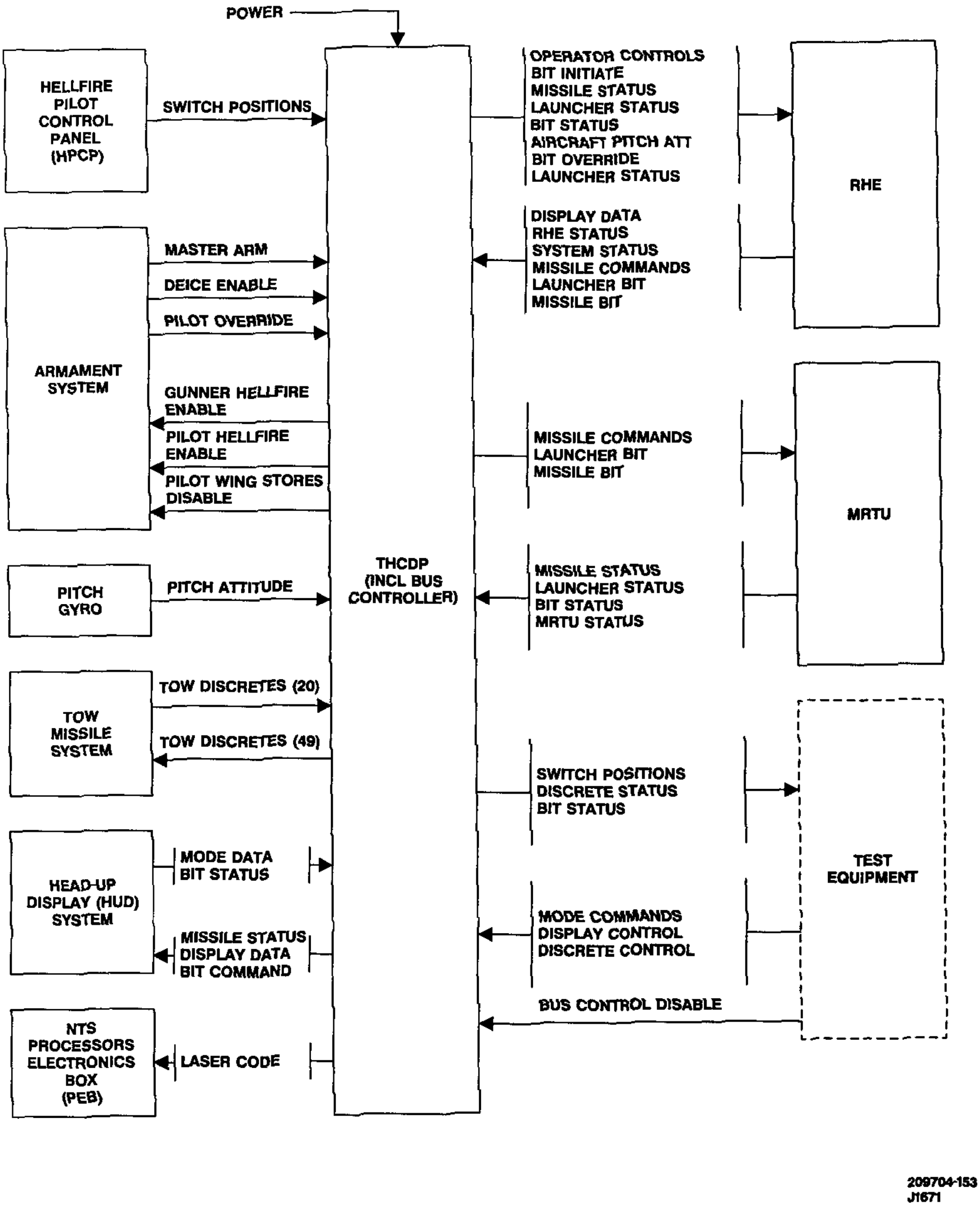
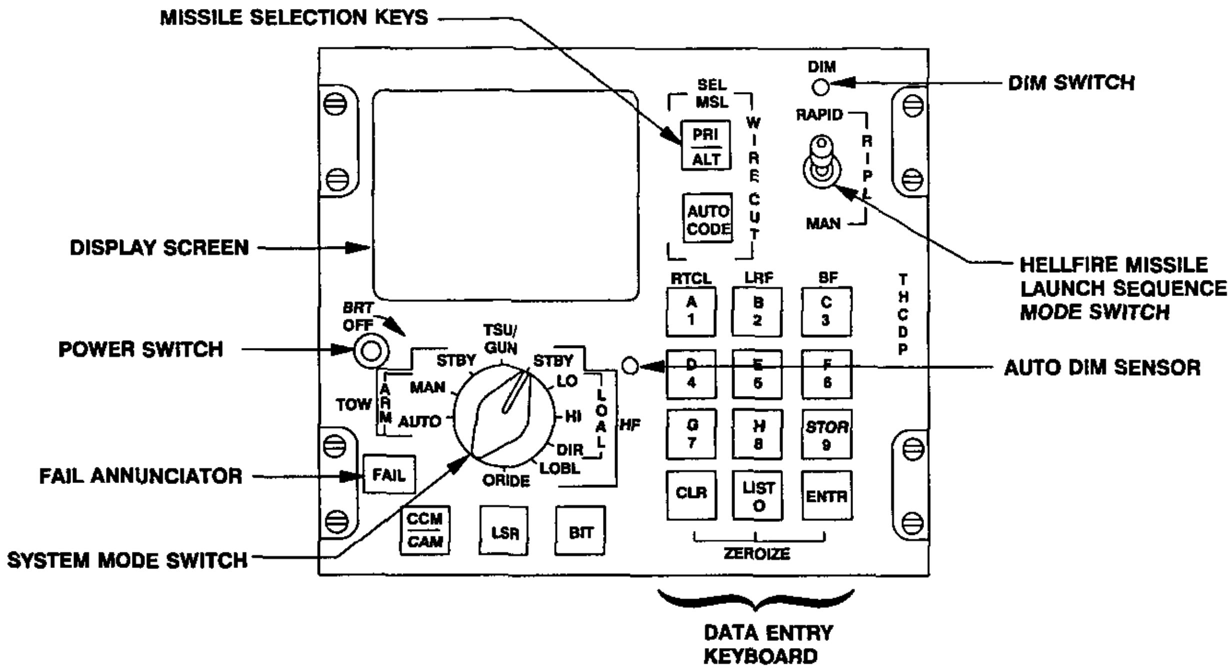


Figure 21-14. THCDP Interface



NOMENCLATURE	FUNCTION
Display Screen	Display BIT, system status, launch mode, missile status, launch constraints, missile selection and a scratchpad display for BIT and other messages.
BRT/OFF switch	Applies power to THCDP/HMS/TMS and allows adjustments of display screen brightness.
SEL MSL keys	PRI/ALT key designates either primary or alternate laser code as one used for next priority missile launch.
	AUTO CODE key selects automatic laser code assignment to missile.
WIRE CUT	TOW function - Pressing PRI/ALT and AUTO CODE keys simultaneously cuts TOW missile guidance wire.
DIM SWITCH	TOW function - Press to activate TSU symbology dimming.
RTCL KEY	*Press to adjust TSU reticle dimming when DIM switch is activated.*
LRF KEY	No function.
BF KEY	Varies intensity of battle flags.

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Figure 21-15. TOW/HELLFIRE Control Display Panel (Sheet 1 of 3)

NOMENCLATURE	FUNCTION
Auto Dim Sensor	Photocell that senses ambient light levels to automatically adjust display screen intensity.
FAIL annunciator	Illuminates when essential 28 vdc bus fails, video input or output fails, controller processor fails (internal).
RAPID/RIPL/MAN switch	Determines code utilization sequence which is selected for launch and manual override of selected missile.
Keyboard	Keys A1 through H8 used to enter laser codes and select missiles to be launched.
	STOR 9 key stores data entered on keyboard in memory.
	LIST 0 key initiates laser code listing assignment sequences and is used to assign missile quantity of zero.
	CLR key aborts data entry sequence.
	ENTR key is used to complete the listing request. During LIST operations, if ENTR key is pressed within 5 seconds of the last ENTR operation, the numeric code assignment for the next alpha character is displayed.
	ZEROIZE clears laser codes in memory when CLR, LIST, ENTR keys are pressed simultaneously.
System Mode Switch - HF	Provides selection of test/standby mode and five launch modes. Launch modes effective only when GNR CONT position is selected on HPCP.
	STBY - enables BIT and status display and allows access to failure code for maintenance.
	LOAL LO/HI/DIR - selects lock-on-after-launch mode (missile laser seeker will lock onto laser designator after launch from helicopter). LO/HI/DIR selects trajectory of missile after launch (low, high or direct).
	LOBL - selects lock-on-before-launch mode (missile laser seeker will lock onto laser designator before launch from helicopter).
	ORIDE - Allows manual launch of missile when outside of LOBL launch constraints.
Mode switch - TOW	TSU/GUN-TSU is used to aim and direct turret. Gunner may fire 20MM turret gun using TSU optics.
	TOW STBY - TMS is in standby. Turret control transferred to pilot. TOW missile and launcher status displays.
	MAN - TOW missile selection is manual through data entry keyboard numbers 1 through 8.
	AUTO - TOW missile selection is automatic starting in sequence from missile No. 1.

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Figure 21-15. TOW/HELLFIRE Control Display Panel (Sheet 2 of 3)

21.8.1.2.3 LOBL Mode. In the LOBL mode, a missile must have been given and have accepted a laser code for designation. It then begins searching for a laser designated target by employing a box-scan pattern. After acquiring a target, the seeker will lock on and pass along steering LOS information to other scanning missiles on the same laser code to assist those missiles to lock on. The missile will continue to track the target until the seeker gimbal limits have been reached or the laser return energy falls below the seeker threshold. If the azimuth and elevation positions of the target relative to the missile centerline are within the constraints window, and if the missile has been selected for the next launch, the missile can be launched.

21.8.1.2.4 CONSTR ORIDE Mode. This mode operates the same way as the LOBL mode, except that the requirement for the target to be within the launch constraints window is overridden. The rotary switch is spring-loaded for this position, thus its action is momentary.

21.8.1.2.5 PRI/ALT Mode. This pushbutton switch is used to designate either the primary or the alternate laser code as the one to be used for the next missile launch (i.e., the priority missile channel).

21.8.2 HELLFIRE Missile LAUNCHER ARM Switch. The LAUNCHER ARM switch (Figure 21-36) is located above the pilot left console. The switch is a two-position momentary switch, powered by the HELLFIRE CONTR circuit breaker. If the HML has not been armed prior to takeoff, the pilot can arm the launcher from the cockpit by positioning the LAUNCHER ARM switch to ON. When switched to ON, all launchers are armed (Figure 21-17).

21.8.3 Remote HELLFIRE Electronics Unit. The RHE is a microcomputer interfaced with the THCDS to operate/control the HMS. The RHE performs BIT procedures and testing for itself, other HMS electronics, and the launchers and missiles. The BIT go/no-go status is displayed on the THCDP.

NOMENCLATURE	FUNCTION
BIT key	In HF STBY mode, initiates BIT on all Hellfire missiles. When in a Hellfire active mode and launch mode set to MAN. BIT is initiated only on the selected missile. In TOW STBY or TSU/GUN mode, initiates BIT on the entire TOW system and NTS.
LSR key (activated upon removal of FIRST/ LAST/OFF switch)	FIRST Enables Laser when all other interlocks are closed. Causes LRF to compute target distance by looking at the first Laser pulse received from the target. LAST Enables Laser when all other interlocks are closed. Causes LRF to compute target distance by looking at the last Laser pulse received from the target. OFF Laser system is disabled.
CCM/CAM key	Dual function key - Initiates missile counter-countermeasures function in HF mode, and selects camera status in TOW mode.

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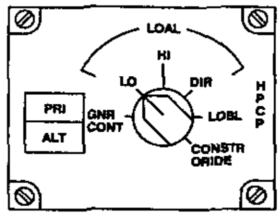
Figure 21-15. TOW/HELLFIRE Control Display Panel (Sheet 3 of 3)



NOMENCLATURE	FUNCTION
PRI/ALT KEY	Designates either primary or alternate laser code as one used for next missile launch.
MODE SELECT	Provides selection of five launch modes and permits pilot to assign launch mode selection to gunner THCDP.
GNR CONT	Enables launch modes to be selected by THCDP. Only gunner can launch missile.
* LOAL LO/HI/DIR	Selects lock-on-after-launch mode (missile laser seeker will lock on to laser designator after launch from helicopter). LO/HI/DIR selects trajectory of missile after launch (low, high or direct).
* LOBL	Selects lock-on-before-launch mode (missile laser seeker will lock on to laser designator before launch from helicopter).
CONSTR ORIDE	Same as LOBL position except missile launch is not inhibited by launch constraints.

* Active only when THCDP mode switch is in an active HF mode.

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Figure 21-16. HELLFIRE Pilot Control Panel

21.8.4 Multiplex Remote Terminal Unit. The MRTU performs the function of accepting, transferring, and outputting signals to and from the multiplex bus, THCDS, and HMS launchers under control of the THCDP. The signal flow on the data buses consists of command, data, and status messages.

21.8.5 HMS Lightweight Launchers. One HMS lightweight launcher (Figure 21-17) is mounted on each outboard ejector rack. Each launcher can carry up to four missiles. The launchers contain internal electronics and circuitry which interface with the RHE, MRTU, and a special serial data bus. Arming and firing the missiles are accomplished by the pilot or gunner through the HMS and wing stores armament system circuitry controls.

21.8.6 HMS Operational Modes. The missile preferred firing order is shown in Figure 21-18. Numbers shown within the missiles correspond to the missile station inventory displayed on the THCDP. Numbers shown in parentheses represent the preferred firing order. Firing order is determined by the THCDS depending on launch sequence mode switch position and missile channel selection. The system has three modes of operation: standby, active, and diagnostic.

WARNING

HELLFIRE 28 vdc fire power and launcher power are applied directly to the launchers from the helicopter circuit breakers (Figure 21-36).

21.8.6.1 Standby Mode. In the standby mode, primary power is supplied to the THCDS, RHE, MRTU, and HELLFIRE missiles and launchers. System testing, diagnostics, and laser code storage are accomplished in this mode.

21.8.6.2 Active Mode. The active mode has five launch modes grouped into two seeker acquisition modes (LOAL and LOBL). In the active mode, missiles are selected, armed, and launched.

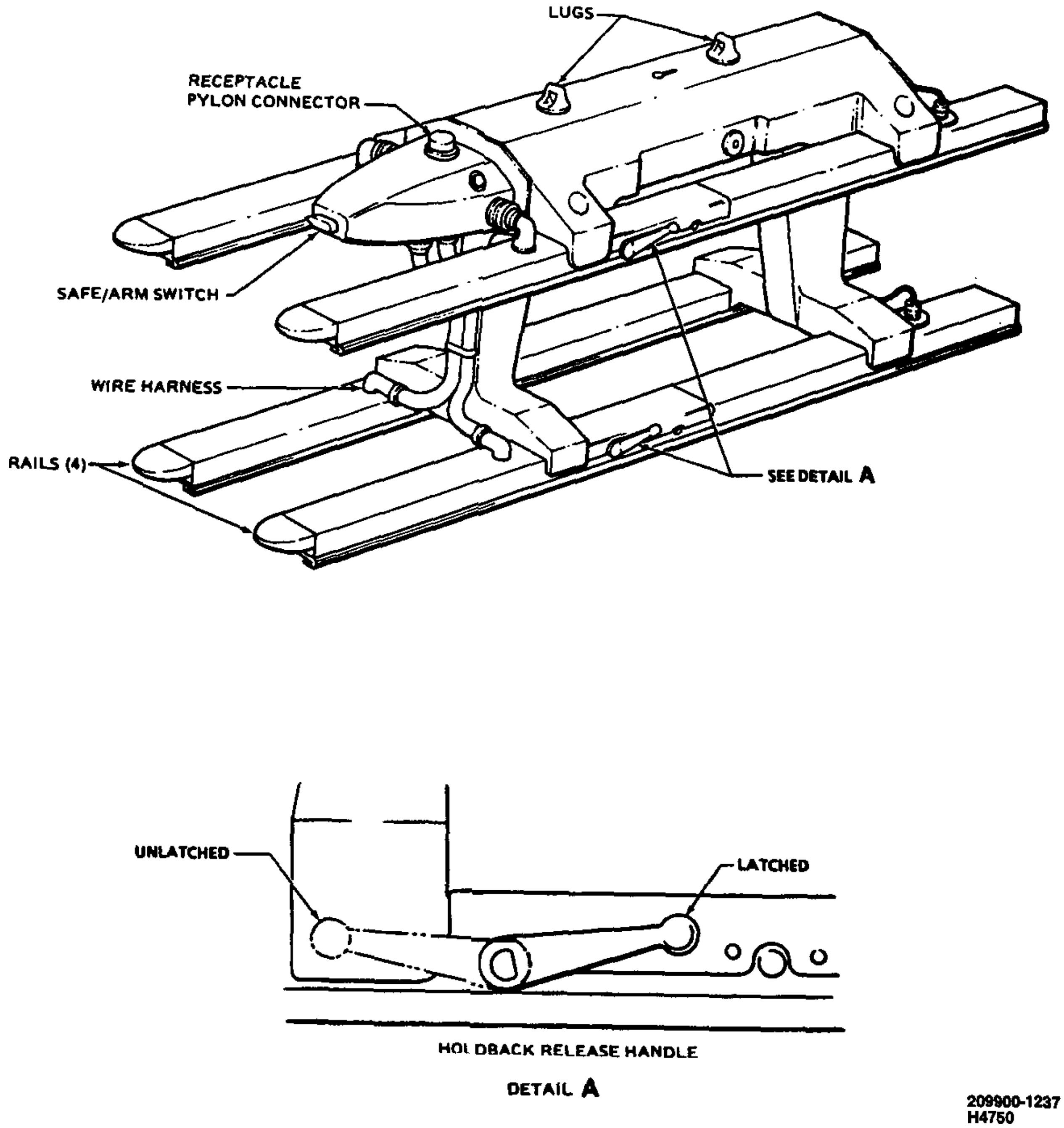


Figure 21-17. HELLFIRE Missile Launcher

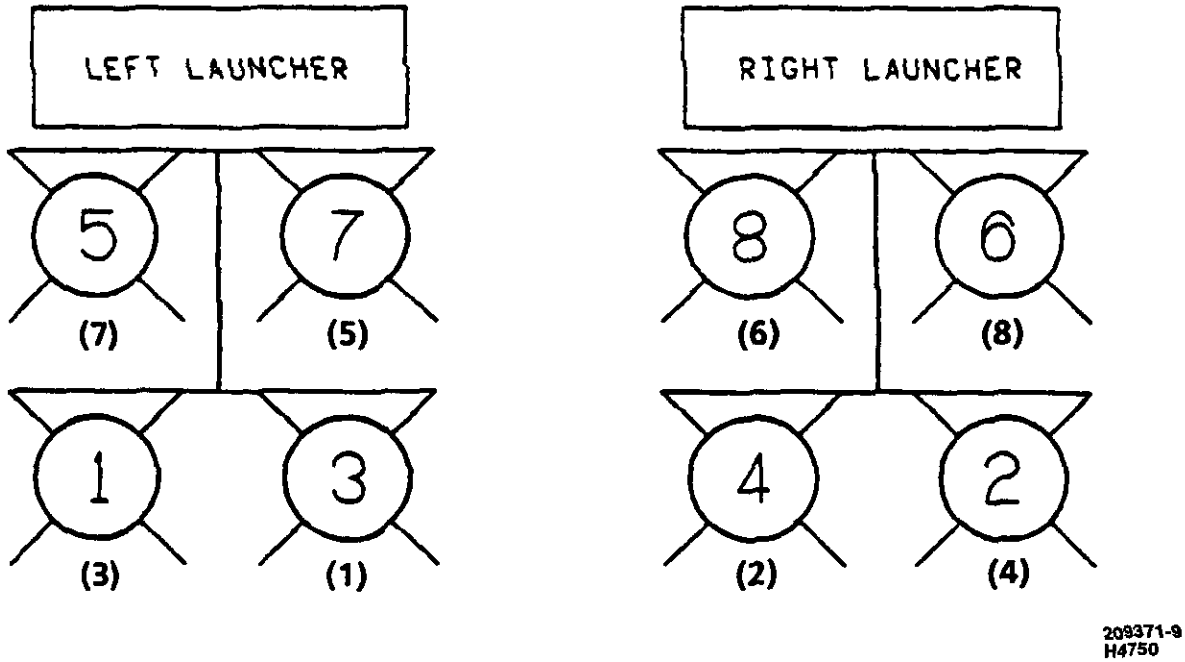


Figure 21-18. Missile Preferred Firing Order (Viewed From Aft of Helicopter)

21.8.6.3 Diagnostic Mode. The diagnostic mode provides for fault isolation when failure messages appear on the THCDP displays. This mode can only be entered from the standby mode.

21.8.7 THCDS Displays. THCDS has two types of displays for operational use: primary (Figure 21-19) and steering (Figure 21-20). The steering display will not appear if the HELLFIRE missiles are not locked onto laser energy.

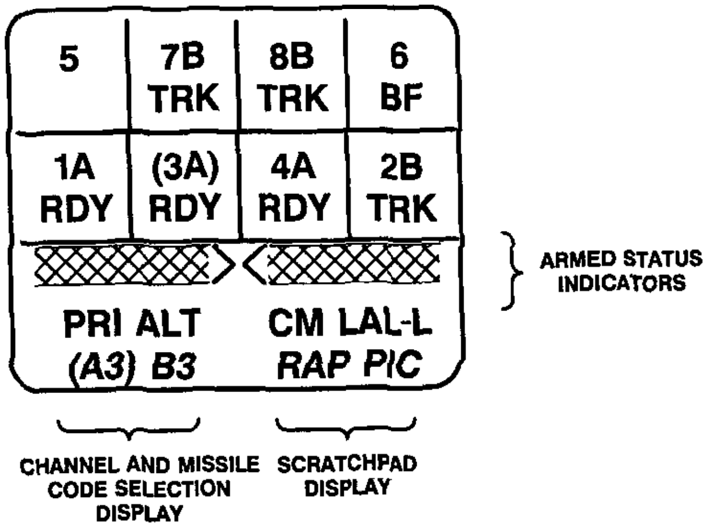
21.8.7.1 Primary Display (Figure 21-19). The primary display will be present during most operating modes except during portions of the test/ standby and lock-on-before-launch modes. The display can be divided into four major groupings: missile status display, armed status indicators display, missile channel and code selection display, and scratchpad display.

21.8.7.1.1 Missile Status Display. A separate status display is maintained for each of the eight possible missiles that could be loaded on the helicopter. Missiles 1, 3, 5, and 7 are on the left launcher and missiles 2, 4, 6, and 8 are on the right launcher. The display for each missile launcher consists of two rows of four fields each.

If a missile is present on the launcher, its corresponding number will appear in the middle of the field along the top row of its corresponding display position. If a missile is not present (not loaded or successfully fired) but the launcher is present, then a dash (-) will appear where the missile number would normally be. If the launcher is not present, both rows of four fields for all of the launcher's missiles will be blanked.

If a missile has been sent a designated laser code and has accepted that code (for tracking purposes), the letter corresponding to the code (A through H) will appear to the right of the missile number.

When a missile is designated as the priority missile (next missile to be launched), the brackets will appear around the missile number/letter code.



NOTE:

LAST, FRST, or OFF will be displayed for 5 seconds, depending on the THCDP LSR key.

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Figure 21-19. Primary Display

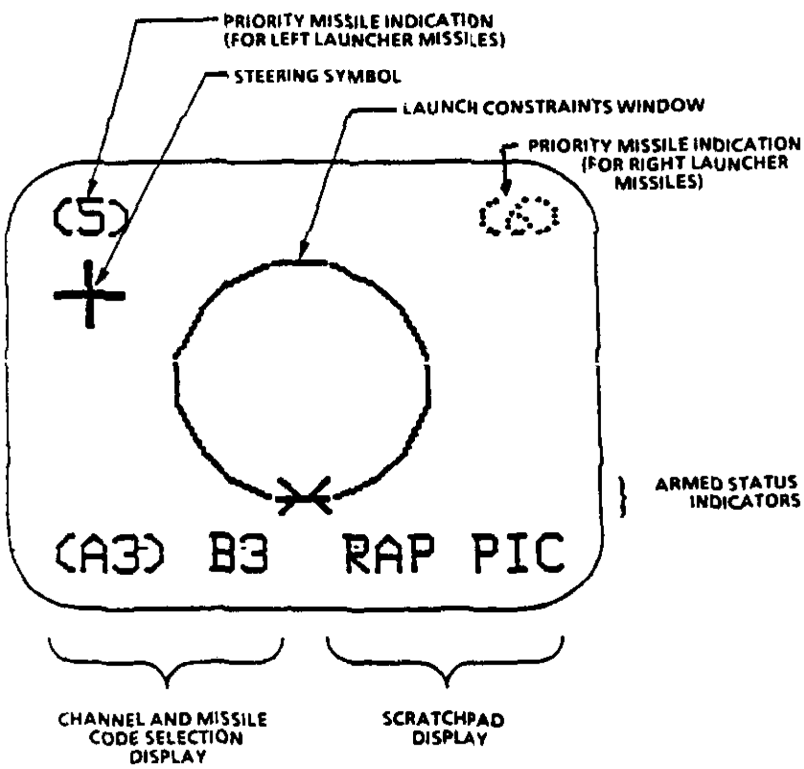

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Figure 21-20. Steering Display

The bottom row of each missile display field is used to convey the current status of the missile. The displays in this area are described as follows:

Display	Meaning
Blank	Missile not selected or no missile present.
BIT	BIT in progress on missile.
BF	Missile has failed BIT.
MF	Missile has failed (other than BIT).
SEL	Missile has been selected; laser code is being sent to missile.
RDY	Ready — Missile is powered. The seeker has accepted the laser code that appears next to the missile number and the seeker spins up and is uncaged. In LOAL modes, the priority missile could now be launched; in LOBL modes, the missile seeker begins search pattern.
TRK	Tracking — Missile seeker has acquired and locked onto a target; seeker will continue to track target until gimbal limits are reached or received laser energy is lost; in LOBL, the priority missile could now be launched if the launch constraints window is satisfied.
HF	Hangfire — Missile completed launch sequence to leave the launcher rail. HF flashes in all four squares until launch motor burnout, then displays continuously.
SF	Station failed.
UNL	Unlatched — Launcher is present but not properly latched or the latch handle is not properly seated/latched.

(TABLE I.D. 922126)

21.8.7.1.2 Laser Status Display.

The display shows LSR OFF for laser off. LSR FST for laser first, and LSR LST for laser last. When in the TOW mode, the display appears in the lower left hand corner of the scratchpad. When in HELLFIRE mode the display appears in the lower right corner of the scratchpad. The current laser mode is displayed for 5 seconds when the LSR key is first depressed, or when the THCDP mode has changed between TOW and HELLFIRE. Laser mode changes can only be made while the current state is displayed by subsequent presses of the LSR key. The laser mode will initially default to laser off at power-up.

21.8.7.1.3 Armed Status Indicators. A display when the MASTER ARM is not armed is indicated by arrows > < below the missile status displays (Figure 21-19). Both the left and right launchers are safed as indicated by the cross-hatched bar below the respective launcher.

21.8.7.1.4 Missile Channel and Code Selection Display. The display shows the laser codes and missile quantities assigned to the two active laser channels: primary and alternate. The abbreviations PRI and ALT always appear on the display as shown. Below each abbreviation is a display of the laser code (A through H) and missile quantity (0 through 3) assigned to each of the channels. The brackets indicate under which of the two laser channels the next missile will be launched. These brackets can be toggled between the primary and alternate designations through manual action of the missile channel selection (PRI/ALT) switch, or they will be toggled automatically after each successful missile launch in the RIPL mode.

21.8.7.1.5 Scratchpad Display. The scratchpad display will be used for a variety of applications and miscellaneous functions. The contents, duration, and priorities for this display are preprogrammed. In general, the contents for this display will be derived from the following areas:

1. BIT messages (BIT in progress, BIT failures, etc.)
2. Laser code display
3. Data entry sequences (for laser codes, etc.)
4. Launch sequence mode display
5. Seeker acquisition mode display
6. Whether the gunner (GIC), pilot (PIC), or gunner in pilot override (POR) is in control of the system
7. Laser mode state either OFF, FST (first) or LST (last).

8. Miscellaneous functions (CCM on, etc.).

21.8.7.2 Steering Display. This display (Figure 21-20) occurs only when the priority missile (next missile to be launched) is tracking a laser target. The channel and missile code selection and scratchpad displays are the same as for the primary display except that they have been reduced to one row of display information.

21.8.7.2.1 Priority Missile Indicators. The priority missile indication consists of the number for the next missile to be launched (1 through 8) enclosed in brackets. Missiles 1, 3, 5, and 7 are on the left, and missiles 2, 4, 6, and 8 are on the right.

21.8.7.2.2 Launch Constraints Window. The launch constraints window is a circle that represents the azimuth and elevation constraints within which a missile is launched. The launch constraints window is displayed with the steering symbol.

21.8.7.2.3 Steering Symbol. The steering symbol is a cross that represents the azimuth and elevation angles of the priority missile seeker head relative to the missile longitudinal axis. The center of the launch constraints window represents the longitudinal axis of the missile. The crewmember steers the helicopter to bring the center of the steering symbol within the boundaries of the launch constraint window before the priority missile is launched. When the MASTER ARM switch is not in the ARM position, arrows appear at the base of the launch constraints window.

21.8.8 THCDP Functions (Figure 21-15).

21.8.8.1 Power (BRT/OFF) Switch.

21.8.8.1.1 OFF Position. In this position, primary power is removed from the THCDP, HPCP, RHE, MRTU, and NTS. The 28 vdc power to the launchers is direct from the helicopter circuit breakers.

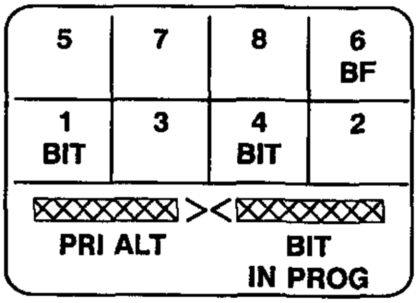
21.8.8.1.2 BRT Position. Applies power to the TMS, HMS, and NTS, and allows adjustment of the brightness of the video display.

21.8.8.2 System Mode Switches. Both the THCDP (Figure 21-15) and HPCP (Figure 21-16) have a rotary-type system mode switch whose HELLFIRE control functions are nearly identical. Panel functions that are peculiar to one panel or the other are noted in the description of the function.

21.8.8.2.1 STBY. STBY is an inactive mode because no missile can be selected, armed, or launched in this mode. All other positions of the system mode switch are active modes because missiles can be selected, armed, and launched in these modes.

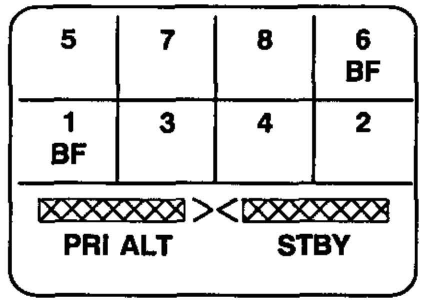
When switching the THCDP on while the mode selection switch is in STBY, a full system BIT is performed. This BIT includes tests of the THCDP and missiles. While this BIT is being performed, the display will appear as shown in Figure 21-21, view A. The numbers 1 through 8 identify the presence of missiles in the launchers. If a missile is not present, but the launcher is, then a dash (-) appears where the missile number would normally be. If a launcher is not present, the corresponding half of the display is completely blanked. The missile status display BF means that a missile failed its BIT and will not be available for launch. The missile status display BIT means that BIT is currently in progress on that missile. Missile BIT is normally performed in pairs when possible. Full system HMS BIT normally lasts around 2-1/2 minutes. NTS will perform its BIT in conjunction with HMS BIT. Time to complete the full HMS BIT will vary depending on the number of missiles loaded. Any BIT in progress can be overridden by switching from STBY to any active mode.

After BIT is completed, the display will appear as shown in Figure 21-21, view B, if no major failures other than missile failures have occurred. The missile status display MF means that a missile failure was detected, but not during BIT. An SF would indicate a station fail. A missile with either status will not be available for launch. If a major unit has failed, i.e., THCDP, HPCP, RHE, MRTU, or launcher, a failure message will appear in the scratchpad area as shown in Figure 21-21, view C. This message will remain until acknowledged by the gunner by pressing the CLR pushbutton on the keyboard. If a failure occurs that renders the system inoperative, then a SYSTEM FAIL message appears in the scratchpad as shown in Figure 21-21, view D. When a SYSTEM FAIL occurs, the system is automatically put in the STBY mode and the display is as shown; acknowledgment will allow (where possible) other failed items to be displayed once. When the SYSTEM FAIL comes back up, no other switch actions on the THCDP or the HPCP will be acknowledged. These conditions will remain until



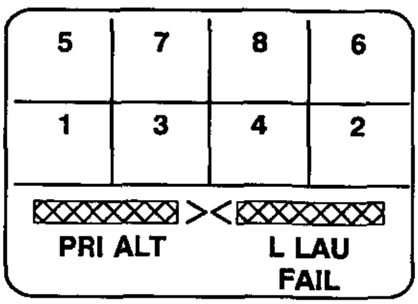
TEST/STBY DISPLAY
DURING BIT

VIEW A



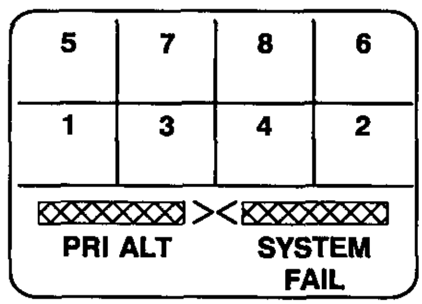
NORMAL TEST/STBY DISPLAY
(AFTER BIT COMPLETED)

VIEW B



TEST/STBY DISPLAY WITH FAIL MESSAGE
(REMAINS UNTIL ACKNOWLEDGED)
L = LEFT HAND
R = RIGHT HAND

VIEW C



TOTAL SYSTEM FAILURE DISPLAY
SYSTEM INOP; NO OPERATOR
INPUTS ACKNOWLEDGED; DISPLAY
REMAINS UNTIL POWER RECYCLED

VIEW D

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Figure 21-21. Test/Standby Displays

the failure clears up, or system power is recycled. Information is available to maintenance personnel by entering the maintenance mode as described in paragraph 21.8.9.14.

When switching from any active mode to STBY, a less comprehensive BIT is performed that includes the RHE, THCDP, and launchers. This BIT normally lasts for about 20 seconds and can be overridden in the same manner as before. Also, if training missiles are loaded and have been launched (simulated) as part of an exercise, they can be recovered by switching from any active mode to STBY. When the THCDP system mode switch is in the STBY position, the rotary and pushbutton switches on the HPCP are nonfunctional.

21.8.8.2.2 LOAL. In the LOAL position, missiles are launched against targets without having previously acquired or locked on to any laser energy. LOAL allows the helicopter to launch missiles without exposing itself to the target. Missiles are selected, assigned laser codes, armed, and are then ready for launch. Three trajectories are selectable for LOAL launch and are selected based on the terrain obstacles and distance between the helicopter and the target. In the LOAL LO mode, the missile climbs to a prescribed altitude after launch, begins searching for a target at the top of its trajectory, and continues on the flightpath until it locks on and homes to a target. In the LOAL HI mode, the missile climbs to a higher prescribed altitude, and in LOAL DIR, it pursues essentially a straight and level flightpath while searching for a target.

21.8.8.2.3 LOBL. In the LOBL position, missiles are launched against targets only after they have locked onto and tracked the laser energy reflected from these targets. LOBL allows a higher probability of kill against obscure or close-range targets. First, missiles are selected and assigned laser codes. Then, after accepting the laser codes, the missile seekers begin a preprogrammed box scan pattern searching for a target. This will continue until a target can be found. Once a target is acquired, locked onto, and tracked, the missile can be launched if the steering symbol is within the launch constraints window on the steering display.

21.8.8.2.4 ORIDE. This position is identical to the LOBL position except that the missile launch is not inhibited by launch constraints. The position is spring-loaded so that override selection must be repeated for each missile launch.

21.8.8.2.5 GNR CONT. This position on the HPCP (Figure 21-16) is used to determine crewmember priority for LOAL/LOBL mode selection, missile channel selection, and missile launch. When the HPCP mode switch is in the GNR CONT position, the THCDP system mode switch and missile channel selection switch have priority and only the gunner can launch a missile by using the WING ARM FIRE button on his cyclic control stick or if selected, the MSL switch on the LHG. When the HPCP mode switch is in any other position (and PILOT OVERRIDE is OFF and the THCDP switch is in an ACTIVE mode), then the HPCP mode switch and missile channel selection switch have priority and only the pilot can launch a missile by using the WING ARM FIRE button on his cyclic control stick.

21.8.8.3 Missile Selection Keys. Both the THCDP and HPCP have a pushbutton switch for PRI and ALT laser channel selection. The THCDP switch, when in control, is used to select channel (PRI or ALT) for laser code and missile quantity assignment or to select the priority channel, the channel for next missile launch. The HPCP switch, when in control, selects the priority channel only.

21.8.8.4 Missile AUTO CODE Selection Switch. This THCDP pushbutton switch prepares the THCDP to receive an alpha laser code designator followed by a numeric missile quantity.

21.8.8.5 Launch Sequence Mode Switch. This THCDP switch is a three-position, lever-lock switch (RAPID, RIPL, and MAN) that determines the sequence (rapid, ripple, or manual) in which missiles are selected and launched.

CAUTION

During autonomous designation with the NTS LCP in AUTO (THCDP priority missile selection sets RFTDL laser code) do not use the ripple launch sequence, or the laser may not designate with the proper code.

21.8.8.6 Data Entry Keyboard (Figure 21-15). Keyboard pushbuttons A through H input alpha laser code designators; 1 through 9 and 0 input numeric laser code digits, missile quantities, and select the next missile for launch when the launch mode switch is in the MAN position; STOR initiates storage of a new alphanumeric laser code list sequence; LIST is used to view codes assigned to A through H input requests; ENTR terminates the data input process; CLR aborts data in process; and CLR, LIST, and ENTR, when pressed simultaneously, zeroize storage laser codes.

21.8.8.7 Miscellaneous Function Switches. The THCDP has three active miscellaneous pushbutton switches: CCM/CAM, LSR, and BIT (Figure 21-15).

21.8.8.8 LSR Key. The LSR pushbutton selects the laser rangefinder first or last pulse logic and engages one of the laser arm interlocks for the NTS RFTDL. The LSR key cycles the laser mode from laser off, to laser first, to laser last with successive presses. The display shows LSR OFF for laser off, LSR FST for laser first, and LSR LST for laser last. When in the TOW mode, the display appears in the lower left hand corner of the scratchpad. When in HELLFIRE mode the display appears in the lower right corner of the scratchpad. The current laser mode is displayed for 5 seconds when the LSR pushbutton is first depressed, or when the THCDP mode has changed between TOW and HELLFIRE. Laser mode changes can only be made while the current state is displayed by pushing the LSR key. The laser mode will initially default to laser off at power-up.

21.8.8.8.1 CCM/CAM. During any active HF mode (LOAL/LOBL), the CCM/CAM pushbutton may be used to cycle the counter-countermeasures functions of the missile from off to on to off. CAM is active only in the TOW mode.

21.8.8.8.2 BIT. When the system is in HF STBY, pushing the BIT pushbutton will perform BIT on all missiles. When in an active mode with the MAN launch sequence selected, pushing the BIT pushbutton will perform BIT only on the currently selected missile. In TOW STBY or TSU/GUN and BIT, pushbutton will initiate BIT on the entire TOW system.

21.8.8.9 Warning Light Annunciator. This annunciator will illuminate FAIL if the 28 vdc input voltage or the CRT controller fails. The annunciator will flash on and off if certain software errors occur.

21.8.8.10 Auto Dim Sensor. The auto dim sensor senses ambient light level and automatically adjusts THCDP brightness relative to the manual setting.

21.8.9 THCDP Operation.

21.8.9.1 Laser Code Entry and Display. Laser codes are used for encoding laser energy to provide the means for the missile seeker to correctly distinguish one enemy target which is being designated from another target which is also being designated and to provide protection from background noise and jamming. A laser code consists of a four-digit number. The THCDP is capable of accepting and storing up to eight different laser codes. Each code is identified and addressed by means of an alphabetic character, A through H. Laser codes can be entered, listed, or zeroized at any time except during the diagnostic mode.

21.8.9.1.1 Laser Code Entry. Laser codes are entered into the system by a sequence of keyboard steps as follows:

1. STOR
2. A, B, C, D, E, F, G, H (laser code address)
3. 1 (most significant digit)
4. 1, 2, 3, 4, 5, 6, or 7 (next most significant digit)
5. 1, 2, 3, 4, 5, 6, 7, or 8 (next most significant digit)
6. 1, 2, 3, 4, 5, 6, 7, or 8 (least significant digit)
7. ENTR.

When the STOR pushbutton is pressed, the scratchpad area blanks, the message STORE appears on the top line, and five underscores appear on the bottom line (Figure 21-22). As characters are entered in stages 2 through 6, the entry will replace one of the underscores from left to right. The THCDP can determine whether a letter or number is intended for the keystrokes by its relative position in the sequence. After all characters have been entered and inspected, the crewmember presses the ENTR key to command acceptance by the system. If the data was entered correctly, the scratchpad will blank and then return to the normal display. Otherwise, the message INVALID will appear in the scratchpad for 5 seconds, indicating that the data was not accepted. The entire sequence can be aborted at any time between the STOR and ENTR steps by pressing the CLR pushbutton. All currently stored laser codes are retained after power off occurs and will be available when the system is powered up again.

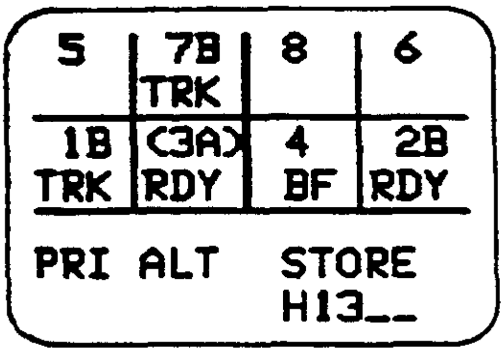

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Figure 21-22. Scratchpad During Store Code Data Entry

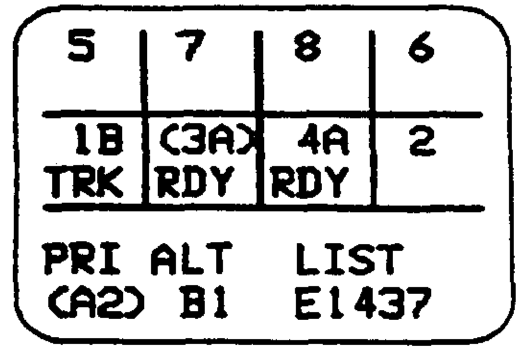

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Figure 21-23. Scratchpad After List Code Request

21.8.9.1.2 Laser Code List. To call up a laser code for display, the following sequence of keyboard steps is required:

1. LIST
2. A, B, C, D, E, F, G, H (laser code designation)
3. ENTR.

When the LIST key is pressed, the scratchpad blanks and the message LIST appears on the top line. After the laser code address (A, B, C, etc.) is entered, the letter and four-digit code currently stored for that address (letter) will appear in the bottom line of the scratchpad (Figure 21-23). The display will remain for 5 seconds, then revert back to the normal display for that mode. If the ENTR key is pressed prior to 5 seconds after the last ENTR key during a LIST operation, the next sequential letter code and four-digit code appear for 5 seconds and then the cycle can be repeated each time the ENTR key is pressed.

21.8.9.1.3 Zeroizing Laser Codes. Zeroizing is accomplished by simultaneously depressing the CLR, LIST/O, and ENTR pushbuttons. When acknowledged, the message CODES ZEROIZED will appear in the scratchpad and last for 5 seconds (Figure 21-24). Once zeroized, the previous laser codes cannot be recovered and must be manually reentered and selected missiles will deselect. STBY ZEROIZED will appear in the scratchpad and will remain until at least one laser code is reentered.

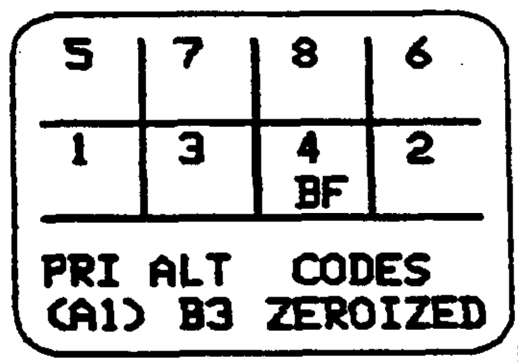

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Figure 21-24. Scratchpad After Press to Zeroize

21.8.9.1.4 Primary and Alternate Laser Channel Selection. Eight laser codes can be stored in the THCDS; only two laser codes can be active with the missiles at any given moment. These two laser codes are designated as the primary and alternate laser channels. Each of these laser channels has from 0 to 3 missiles assigned to it. The quantity shown will be the number of missiles coded on the channel by the system. The legends PRI and ALT always appear on the display (Figure 21-25). Under each is the letter of one laser code (A, B) and the number of missiles (2, 3) currently assigned to that channel. The brackets indicate which is the priority channel. Whichever crewmember has priority for control can toggle the priority channel (and brackets) between the PRI and ALT channels by pressing the missile channel selection switch. Whenever the THCDP system mode switch is in the STBY position, the selection switches are nonfunctional and the display area under the PRI/ALT legends is blanked. After the system has been coded in an active mode, entry into STBY will save the last channel status (code and quantity) for use when an active mode is reentered. This data is lost when the THCDP power is switched to OFF.

21.8.9.2 Launch Sequence Mode Switch. The launch mode switch, a three-position, lever-lock toggle switch, is used to select the mode in which missiles are selected and launched from the helicopter. In the RAPID and RIPL positions, missiles are selected automatically by the system based on designations for the PRI and ALT laser channels. In the MAN position, missiles are selected manually by the gunner. This switch is nonfunctional when the THCDP system mode switch is in STBY.

21.8.9.3 RAPID Mode. In the RAPID mode, missiles are selected automatically and launched successively under a single laser code. This code will be the code assigned to whichever of the PRI/ALT laser channels is designated as the priority channel. Missiles will be automatically replenished as they are launched provided there are uncoded missiles still available.

21.8.9.4 RIPL Mode. In the RIPL (ripple) mode, missiles are selected automatically and launched alternately under each of the two active laser channels. After each successful missile launch, the system automatically switches the priority laser channel between PRI and ALT. Missiles will be automatically replenished as they are launched provided there are uncoded missiles still available.

21.8.9.5 MAN Mode. In the MAN (manual) mode, missiles can be selected either manually or automatically but only one at a time. The missile

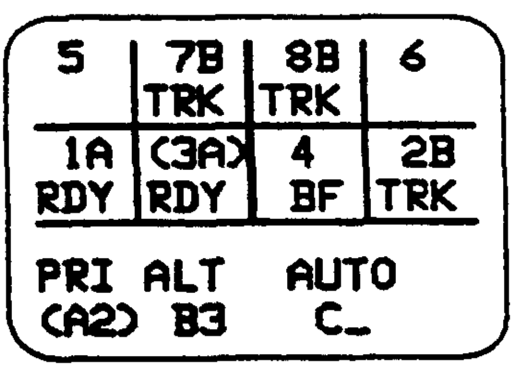

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Figure 21-25. Scratchpad During Auto Code Data Entry

currently selected is assigned the laser code designated to the priority laser channel. After each missile is launched, the next missile in sequence will be automatically selected. However, this selection can be overridden by the procedure described in missile selection. The MAN position of the launch sequence mode switch is lever locked to prevent accidental selection.

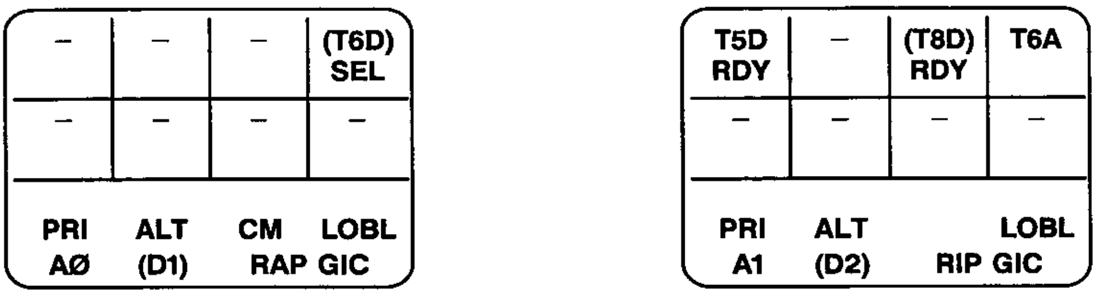
21.8.9.6 Missile Selection. Whenever the system is in an active mode and the RAPID or RIPL launch sequence has been selected, missiles will be automatically selected and replenished based on the current designations for the PRI and ALT laser channels. For the MAN launch sequence, missiles are selected automatically but can be manually overridden. Individual missiles may take up to 30 seconds to spin up and code.

21.8.9.7 Automatic Missile Selection. To change the current designations for laser code and missile quantity of the priority laser channel, the following data entry sequence is used:

1. AUTO CODE
2. A, B, C, D, E, F, G, or H (laser code address)
3. 0, 1, 2 or 3 (missile quantity)
4. ENTR.

When AUTO CODE is pressed, the scratchpad blanks and the message AUTO appears on the top row with two underscores on the bottom row as illustrated in Figure 21-25. As steps (b) and (c) are performed, the underscores are replaced by the character entered. After ENTR or when an invalid key is pressed, the normal display returns or the message INVALID signals an error. The display for PRI and ALT should change accordingly, and, when necessary, missiles will deselect and recode to the new designation. The CLR pushbutton can be used to abort the data entry sequence. This procedure is only allowed when the system is in an active mode. The auto code cycle through the RHE may take 7 to 10 seconds. The same alpha code on both channels is allowed.

21.8.9.8 Manual Missile Selection. The manual missile selection procedure can only be performed when the system is in an active mode and the MAN launch sequence has been selected. At this time, the keyboard will be hot for manual missile selection. The procedure is as follows:



(A) (B)

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Figure 21-26. Training Missile Display

1. 1, 2, 3, 4, 5, 6, 7, or 8 (missile selection)

2. ENTR.

After the first key is pressed, the scratchpad will blank. The legend MAN SEL will appear on the top row with the missile number selected on the bottom row. After ENTR is pressed, the missile number is replaced by the legend IN PROG on the bottom row. This display will remain from 1 to 8 seconds as the system performs the manual selection. If the requested missile is not available, the system will return the original missile. If no missile is available, the system returns to nothing. The CLR pushbutton can be used to abort this sequence. The original missile is then reselected. Zeroize will also abort the sequence and zeroize codes.

21.8.9.9 Selection With Training Missiles. When a mixture of missiles (tactical and training) or only training missiles are present and the system is powered up, the system will be in the simulated launch mode. This mode will allow selection and launch of only training missiles. Training missiles are indicated by a T before the missile number (Figure 21-26).

To leave the simulated launch mode when a mixture of missiles is present, the training missiles must be removed from the launchers.

Tactical missiles are selected and launchable when the system is returned to an active mode.

21.8.9.10 Active Mode Displays. Figure 21-27 illustrates four possible display scenarios for different active modes with different parameters.

21.8.9.10.1 LOBL Status Display. Figure 21-27, detail A, depicts a possible display during LOBL mode. The legend LOBL indicates the LOBL position that the system mode switch has selected. PIC means that the pilot is in control for seeker acquisition selection (LOAL or LOBL), laser channel priority selection (PRI or ALT), and missile launching. RIP indicates that the ripple launch sequence is selected. CM means that the missile counter-countermeasure features are turned on. Inspection of the PRI/ALT display shows that two missiles under laser code A are assigned to the PRI channel and two missiles under laser code B are assigned to the ALT channel. The brackets indicate that the PRI channel has priority.

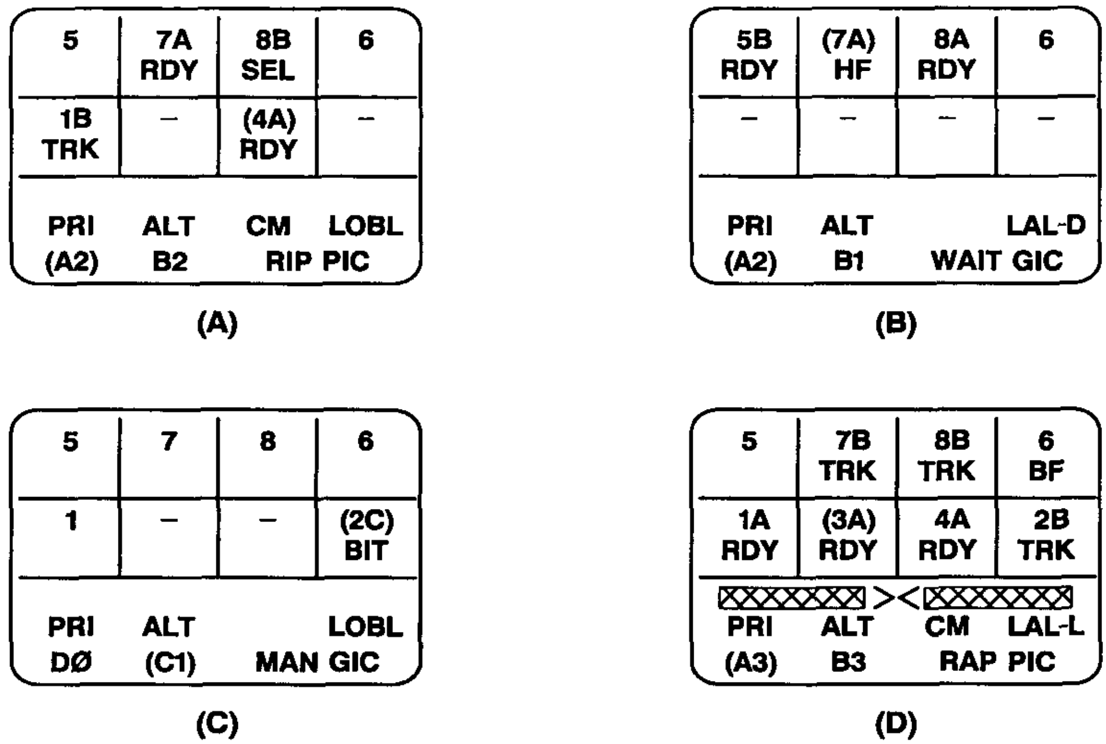

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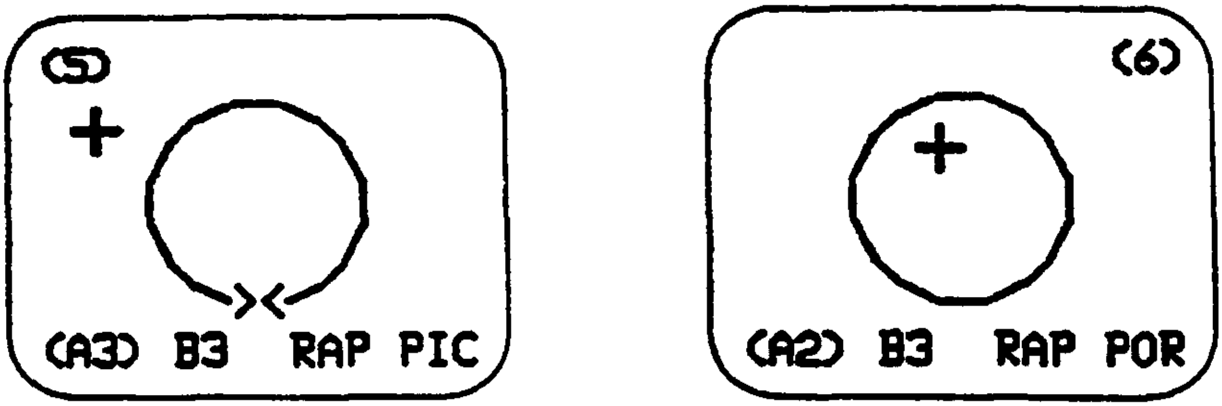
Figure 21-27. Typical Display Scenarios for Different Operational Parameters

The missile status display (Figure 21-27, detail A) shows that six missiles remain. The letter next to a missile indicates the laser code assigned to the missile. Missiles 4 and 7 are assigned to laser code A and missiles 1 and 8 are assigned to laser code B. SEL means that missile 8 has just been selected and the laser code is being sent for acceptance. RDY means that missiles 4 and 7 have already accepted the assigned laser code. Since the LOBL mode is in effect, missile 4 will be employing a box-scan pattern searching for a target. TRK means that missile 1 has already acquired a laser target and is tracking it but no steering display comes up because the ALT channel is not the priority channel. Under normal circumstances, when one missile under a given laser code is tracking a target, all other RDY missiles under the same laser code will be slaved to the same target and display TRK when they acquire. The brackets around missile 4 signify that it is the next missile to be launched (priority missile). However, it must first be tracking a laser target (TRK) before it can be launched because it is in the LOBL mode. Once the priority missile is tracking a laser target, the display will automatically change to the LOBL steering display.

21.8.9.10.2 Steering Display. The steering display is shown in Figure 21-28. The launch constraints window represents a circle of 40° diameter through which a missile can be launched. The center of the circle represents the centerline boresight of the missile. The steering symbol is a dynamic display that is positioned with respect to the center of the circle to represent the direction the seeker is pointing (and thus where the target is) with respect to the missile centerline. The helicopter must be positioned so that the steering symbol is inside the circle. Whenever the center of the steering symbol is outside the circle, the symbol will flash to indicate that the target is outside of launch constraints. A missile can be launched in the LOBL mode whenever the target is within launch restraints. If ORIDE has been enabled, the priority missile can be launched whenever it is tracking a target.

When the MASTER ARM is not armed, the display >< will appear as shown in Figure 21-28, detail A. The POR in Figure 21-28, detail B, is pilot override.

The bracketed number in the upper left or upper right corner of the display indicates the next missile to be launched and will appear on whichever side the missile is loaded: odd on left, even on right. The



(A) (B)

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Figure 21-28. Steering Displays

bottom row of the display will be identical to what was on the bottom row of the status display. If ORIDE has been enabled, the legend ORID will appear in place of the launch sequence mode display.

21.8.9.10.3 LOAL Status Display. Figure 21-27, detail B, depicts a possible display during the LOAL mode. Here, there are no missiles on the bottom rails of either launcher. Missiles 7 and 8 are assigned to laser code A (PRI) and missile 5 to laser code B (ALT). Missiles 5 and 8 are RDY which means laser codes have been accepted and the seekers are in a fixed stare position down the missile centerline. The priority missile 7, as indicated by the brackets with a flashing HF, has a hangfire in progress.

The scratchpad shows that the system is in the LOAL DIR mode (LAL-D) and that the gunner is in control (GIC). The legend WAIT is displayed for a maximum of 8 seconds after missile launch to ensure an adequate time spread between missile launches under the same laser code. This allows the laser designator (ground or airborne) adequate time to switch between targets. The message is informative only and does not actually prohibit the launching of a missile.

21.8.9.11 Missile Launch Enable Trigger. When all prelaunch conditions are met, a missile is launched by pressing the WING ARM FIRE button on the cyclic stick of the crewmember who has control for firing, or the gunner may select MSL switch on the LHG by raising the guard. The actual launch sequence for a missile takes several seconds. While a launch is in progress, the brackets around the priority missile on the display will flash. If the missile being launched hangfires, the legend HF will flash for several seconds before burning steadily.

21.8.9.12 Deicing. Some missiles may be equipped with frangible, opaque domes to prevent ice from forming on the seeker window. These domes are equipped with ejection squibs and must be blown off before the seeker can acquire a target, if icing occurs. In LOAL modes, these domes are ejected as part of the launch sequence and require no direct action by the crewmember. In LOBL modes during icing conditions these domes must be ejected before target acquisition to permit tracking and missile launch. These domes are ejected by using the MSL DEICE switch of the priority crewmember. If the system is in LOBL and the priority missile is not tracking a target, the action of the MSL DEICE switch will send a command to eject the deicing domes on all of the missiles assigned to the priority laser channel. When this occurs, the legend DEICING appears in the bottom row of the scratchpad for 5 seconds.

21.8.9.13 Armed Status Indicators. Figure 21-27, detail D, depicts a display where the MASTER ARM is not armed as indicated below the missile status displays, and both the left and right launchers are safed as indicated by the crosshatched bar below the respective launcher.

21.8.9.14 Maintenance Mode. The maintenance mode allows the crewmember or maintenance personnel to examine detailed BIT status information and to perform interactive BIT checks that cannot be performed without interfering with normal THCDS operation. The maintenance mode can only be initiated in STBY by performing the following data entry sequence:

1. LIST
2. 9
3. 9
4. 9
5. ENTR.

21.8.9.15 Maintenance Mode Display. The maintenance mode enables the menu driven test display to delineate fault isolation to the WRA and for the THCDS to the SRA (Figure 21-29) with successive pages of detailed fault codes (Figure 21-30). Failures are indicated by FAIL in inverse characters, associated with a list of items, and/or an illuminated front panel fail indicator.

21.8.9.15.1 Maintenance Menu. When the maintenance menu is displayed (Figure 21-29), the following data entry is in effect:

1. NXT (next) on the last data line of the page indicates another page follows. To advance the page, depress key 0; to return to the previous (PRE) page, depress key 9.
2. To select an item on the displayed page:
   a. Depress the key for the item number — the underscore will move under that number.
   b. Depress ENTR — a fault page should appear.

21.8.9.15.2 Maintenance Test Displays. When a maintenance test display is present (Figure 21-30), only failed items will be listed.

1. NXT indicates another page as in Figure 21-30, detail B.
2. The faults are listed according to priority and the list can be displayed in sequence by depressing key 1 (detail request key).
3. An advisory page will be displayed between the SRA level and detailed depot level maintenance displays.
4. To exit the display, depress the CLR key.

21.9 AIM-9/AGM-122 MISSILE SYSTEM

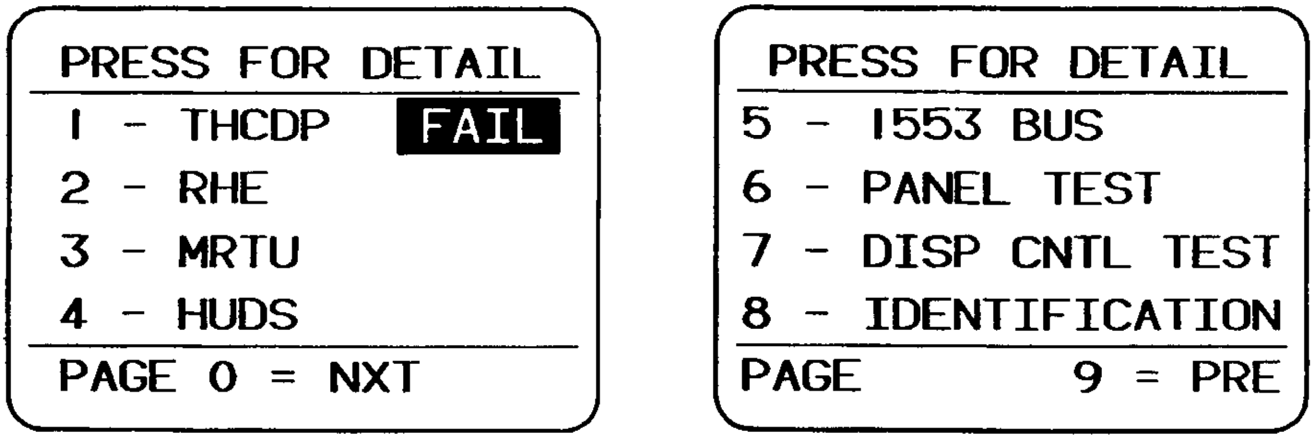
The AIM-9 missile system is an air-to-air weapon system capable of launching Sidewinder missiles. The Sidewinder guided missile is a supersonic weapon with infrared target detection that is propelled by a solid propellant motor. The system is powered by the 28 vdc essential bus and a 115 vac, 400 Hz, 365 volt-ampere, single-phased, AIM-9 static inverter. The AIM-9 circuit breaker, located on the armament circuit breaker panel, applies 28 vdc power and protects the system. The AIM-9/AGM-122 missile system interfaces with other helicopter systems as shown in Figure 21-31. Additionally, the AIM-9 missile system provides all necessary helicopter and missile system interfaces to fire the AGM-122 Sidearm antiradiation missile. The AGM-122 is a supersonic antiradiation guided missile configured with a passive RF target detector and is propelled by the same propellant motor used by the AIM-9.

21.9.1 AIM-9/AGM-122 Launch Control System. The launch control system consists of the CCU, UNCAGE/FIRE switch, PRU, and the AIM-9 interface control unit.

21.9.1.1 Cockpit Control Unit (CCU). The CCU (Figure 21-32) is located on the upper left side of the pilot glareshield. The CCU provides the pilot with selection, arming and firing control, and indicator functions.

21.9.1.1.1 Mode Select Switch. The mode select switch is a three-position, lever-lock, toggle switch.

1. OFF position. Missile detectors are not being cooled and priority missile audio is present on ICS.



(A) (B)

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Figure 21-29. Maintenance Menu Display

2. STBY position. Selected missiles are being cooled and priority missile audio is not present on ICS.
3. ARM position. Selected missiles are being cooled, priority missile audio is present on ICS, and missile lock-on may occur. With the mode select switch in ARM and the MASTER ARM switch in ARM, the ARM indicator is illuminated on the CCU and the missile may be launched. Removal of either switch from the ARM position disarms the priority missile and the ARM indicator extinguishes. The missile will remain selected.

CAUTION

The AGM-122 Sidearm missile seeker does not require cooling. However, the nitrogen bottle should be installed to avoid system contamination.

21.9.1.1.2 Select/Deselect Switches. These switches are pushbutton-type with illuminated indicators. To select missile station, depress the switch; the station selected will illuminate. The selected station will indicate armed when the mode select switch and the MASTER ARM switch are positioned to ARM. To deselect a station, the switch is depressed and the legend will extinguish. The blank switches shown in Figure 21-32 are inactive.

21.9.1.1.3 AIM-9/AGM-122 Volume Control Switch. The VOL switch controls the volume level of the audio tone on the ICS when power is applied to the AIM-9/AGM-122 system.

21.9.1.1.4 DIM/BRT Control Switch. The DIM/BRT control switch controls the brightness level on CCU indicators. (This switch does not control the edge lit panel.)

21.9.1.1.5 STBY AC FAIL Light. This indicator will illuminate if the AIM-9/AGM-122 system loses (AIM-9 inverter) ac voltage (Figure 21-32).

21.9.1.1.6 PUSH TO TEST Switch. This switch, when depressed, will test the indicator lamps on the CCU.

21.9.1.2 AIM-9 UNCAGE/FIRE Switch. This three-position switch (Figure 21-32) is located on the pilot collective switch box and is spring-loaded

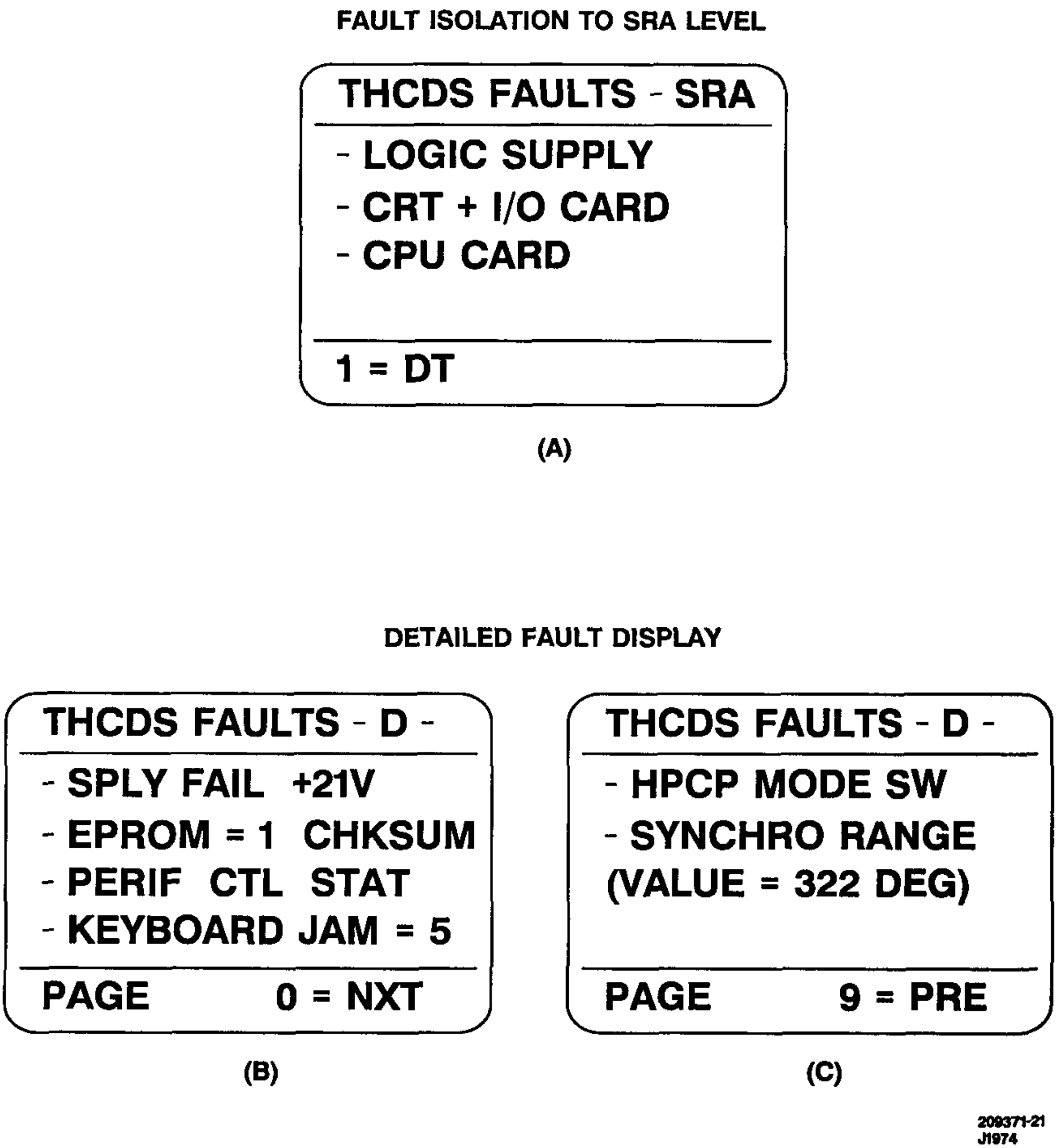


Figure 21-30. Maintenance Test Displays

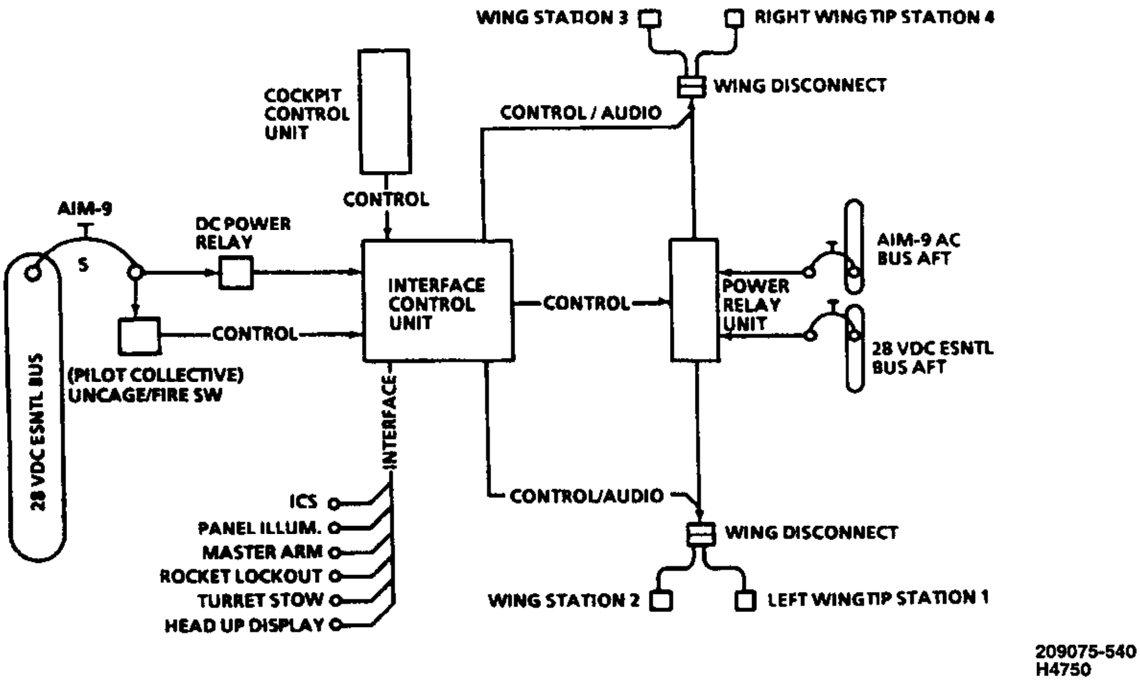


Figure 21-31. AIM-9 Launch Control System Diagram

to the center. The switch provides uncage/cage commands to the missile gyro and fire commands to the priority missile. A switch guard prevents the fire circuit from being activated inadvertently. When the switch is pulled in the direction of the UNCAGE arrow, the missile gyro is uncaged and the UNCAGE indicator on the CCU illuminates. The pilot pulls the UNCAGE trigger when the missile lock-on signal is heard through the ICS. The missile seeker head will uncage and track the target. A second pull of the switch in the direction of the UNCAGE arrow will cage the missile gyro and extinguish the UNCAGE indicator. To launch the missile, raise the switch guard and push the switch in the direction of the FIRE arrow.

Note

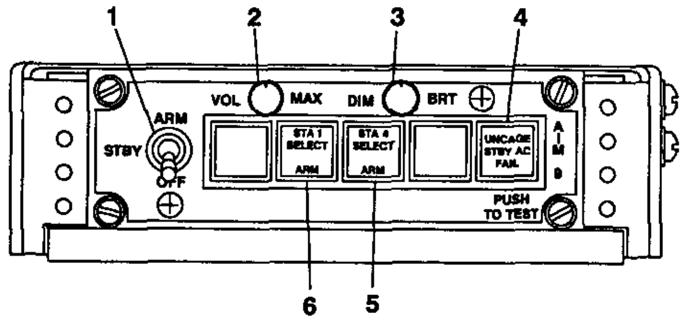
During AIM-9/AGM-122 missile firing, all weapon systems are disabled and the turret automatically returns to the stow position until 4 to 5 seconds after the missile leaves the launcher.

21.9.1.3 AIM-9 Interface Control Unit. The interface control unit contains the circuitry and logic to issue and/or receive commands from the CCU, UNCAGE/FIRE switch, power relay unit, and LAU-7 launchers. The interface control unit will respond only to coolant commands, arm commands, and fire commands for the selected missile.

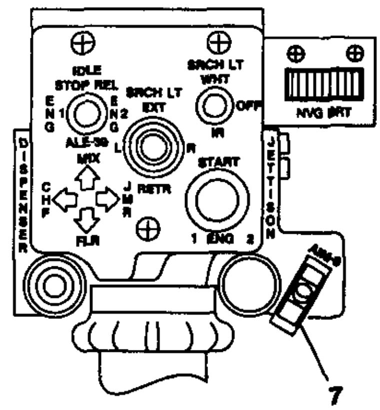
21.9.1.4 Power Relay Unit. The PRU contains relays for controlling each of the loaded missiles on command from the AIM-9 interface control unit. The power controlled to each missile is primary ac, dc, uncage power, coolant power, and arming and firing power. All power applied to the AIM-9 system by the PRU is under control of the AIM-9 interface control unit.

The PRU circuitry is designed to illuminate a STBY AC FAIL indicator on the CCU should the AIM-9 static inverter fail.

21.9.2 LAU-7 Series Missile Launcher. The LAU-7 series missile launcher (Figure 21-33) provides a platform for carriage, suspension, and launching of all AIM-9 series missiles. The launcher is suspended on parent racks with the use of the pylon adapter. The LAU-7 launcher is equipped with a mechanical safety pin, a detent holddown pin, and fin retainer springs. Insertion and turning of the safety pin will raise the aft detent lug, allowing loading and unloading of a missile. The detent holddown pin locks the forward detent in place when



COCKPIT CONTROL UNIT



PILOT COLLECTIVE STICK SWITCH BOX

	NOMENCLATURE	FUNCTION
1.	Mode Select Switch	
	OFF -	Missiles not being cooled. Audio present.
	STBY -	Initiates cooling of selected missile. Audio silent.
	ARM -	Provides arm voltage to launchers (if MASTER ARM switch is in ARM). Audio present.
2.	Audio Volume Control -	Controls audio signal volume on ICS headset.
3.	CCU Indicator light Control -	Controls intensity of panel lamps.
4.	Advisory Test Switch	
	UNCAGE -	Displays when selected missile is uncaged.
	STBY AC FAIL -	Indicates inverter not powering system.
	PUSH TO TEST -	Tests panel lamps.
5.	Select/Deselect Switch	
	STA 4 SELECT -	Displays when station 4 (right launcher) selected.
	ARM -	Indicates station 4 armed.
6.	Select/Deselect Switch	
	STA 1 SELECT -	Displays when station 1 (left launcher) selected.
	ARM -	Indicates station 1 armed.
7.	UNCAGE/FIRE Switch	
	UNCAGE -	Initial movement toward UNCAGE arrow uncages missile gyro. A second movement toward the UNCAGE arrow will cage missile gyro.
	FIRE -	Fires missile. (Switch guard must be raised.)

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Figure 21-32. AIM-9/AGM-122 Missile System Controls

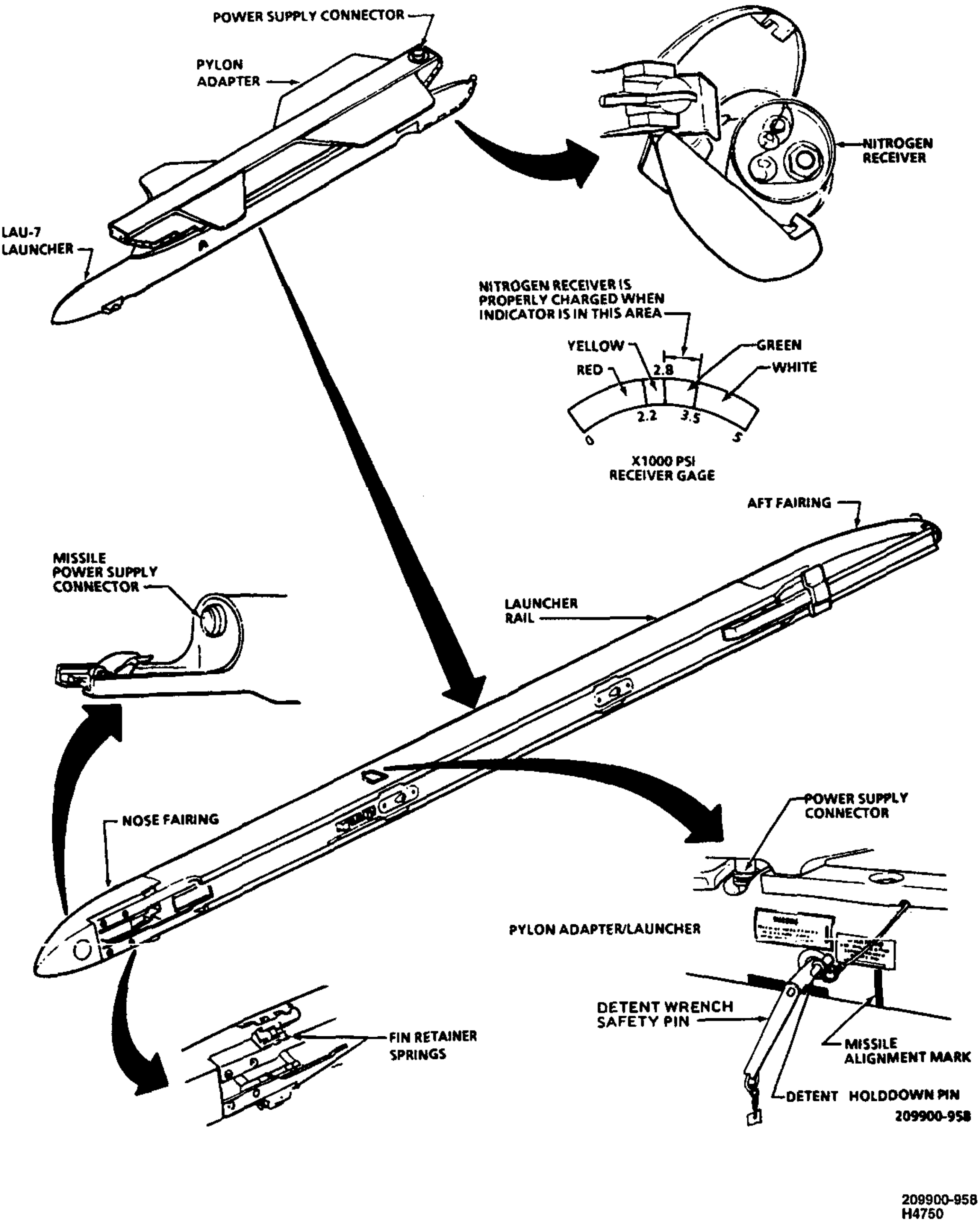


Figure 21-33. LAU-7 Series Missile Launcher

installed. The launcher spring-loaded detent prevents movement of the missile while suspended on the launcher. The launcher power supply obtains 115 vac, 400 Hz and 28 vdc from the helicopter and furnishes all power to the missile. An audio amplifier amplifies the signal from the missile and transmits an aural tone to the pilot. A nitrogen receiver is located in the aft section of the launcher. The receiver provides a flow of nitrogen gas to cool the missile target detector. The AGM-122 does not require nitrogen gas to cool the missile RF target detector; however, the nitrogen bottle should be installed to prevent system contamination.

21.9.3 AIM-9/HUD Interface Unit. This unit provides buffering, amplification, and switching circuits necessary to select missile LOS signals for display on the HUD. The selected LOS signal (which represents the priority missile signal) is sent to the signal processor for processing before being displayed on the HUD.

21.10 WING STORES ARMAMENT SYSTEM

Four attachment points are provided, two under each wing. The pylon assemblies include external store racks, sway braces, and electrical connections for external stores. The entire assembly is enclosed in a fairing that matches the wing contour.

The outboard attachment points of each wing house a TOW pylon actuation system. Hydraulic pressure for system operation is powered by system No. 2. A solenoid operated shutoff valve, closed when deenergized and open when energized, directs flow to independent actuators mounted at the forward end of each of the pylons. Placing the ACQ/TRK/STOW switch on the SHC from the STOW position to either ACQ or TRK will allow hydraulic fluid to position the TOW launcher in elevation, as directed by the TOW missile sighting system. The limits of travel are approximately 12 degrees: 7 degrees up and 5 degrees down from the helicopter waterline axis. In the stowed (4 degrees up) position, the actuators are held in place by an internal locking mechanism. The locks disengage when pressure reaches 250 psig, at which time the actuators function as a load moving cylinder. To return to the locked mode, the ACQ/TRK/STOW switch must be placed in the STOW position; the actuator will return to a predetermined position and will automatically lock at 100 psig decreasing pressure.

The TOW ACTIVATE SW is located in the lower right turret area adjacent to the Ammo Boost switch. This switch will allow the helicopter to simultaneously carry auxiliary fuel tanks on the outboard wing pylons while allowing use of the ACQ/TRK positions of the TOW missile sighting system. The TOW ACTIVATE SW in the ON position enables the outer wing pylons to articulate normally when the TOW missile sighting system is active. The TOW ACTIVATE SW in the OFF position disables the hydraulic system No. 2 solenoid operated shutoff valve, keeping the TOW pylon actuation system in the stowed position while allowing use of the TOW missile sighting system.

The ejector of each pylon is equipped with an electrically operated ballistic jettison device. The jettison system includes a breech block that utilizes cartridges with independent firing circuits.

21.10.1 Wing Store Stations. See Figure 21-34 for wing store station identification. Refer to NWP 55-3-AH1 for authorized loading and descriptive data for wing stores, launchers, dispensers, and delivery data.

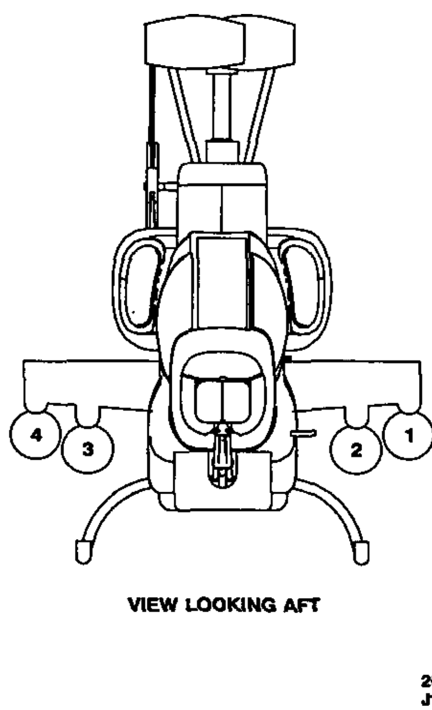


Figure 21-34. Wing Store Stations

21.10.2 Wing Stores Jettison. The helicopter incorporates an Emergency Wing Stores Jettison System that allows the pilot or gunner to jettison selected wing stores when necessary. The pilot has an EMERGENCY JETTISON SELECT panel on the pilot instrument panel and a JETTISON switch on the collective switch box. The gunner has a WING STORES JETTISON switch on the armament control panel and a guarded WGST JETT switch on the miscellaneous control panel. The pilot has five selection switches, while the gunner has only one. The 28 vdc essential bus supplies power through selection and jettison switches provided to both pilot and gunner to detonate electrically fired cartridges installed in each wing pylon stores rack. Gas pressure from these cartridges actuates pistons, which through mechanical linkage both unlatch the stores attachment hooks and push the ejected stores away from the helicopter. Activation of a jettison switch (pilot or gunner) fires the cartridges and separates the stores. Pilot jettison switch must be held depressed for at least 1 second to assure cartridge firing. Circuits are protected by the WING STORES JETT PLT and WING STORES JETT GNR circuit breakers on the pilot armament circuit breaker panel.

21.10.3 Jettison Select Panel. The pilot EMERGENCY JETTISON SELECT panel (Figure 21-35) utilizes five toggle switches to select the wing stations from which weapons/stores are to be jettisoned. Four numbered switches control corresponding wing stations. These switches may be selected individually or in any combination desired to jettison weapons/stores selectively. The switch labeled ALL selects all four wing stations to jettison weapons/stores with one release pulse. Through a time delay circuit in the pilot jettison control panel, the inboard stores will be jettisoned 700 ± 140 milliseconds after the outboard stores to prevent a possible collision of the jettisoned stores. After the selection is made, release is initiated by pressing the JETTISON switch on the collective stick switch box.

The gunner emergency jettison selection switch is a three-position switch labeled INBOARD, OUTBOARD, and BOTH. The gunner cannot select individual stations, but must select all stores through the BOTH position or either the INBOARD or OUTBOARD stores as pairs. The gunner fires the selected stores with the gunner JETTISON switch located on the gunner miscellaneous panel. When the gunner selects BOTH, through a time delay circuit, the inboard stores will be jettisoned 500 milliseconds after the outboard stores to prevent a possible collision of the jettisoned stores.

There are three safety features built into the wing stores jettison system:

1. The delay of inboard stores jettison.
2. To prevent inboard stores from being jettisoned first when certain outboard stores are present that would not permit clearance for the inboard stores.
3. To prevent armed bombs from being jettisoned.

Note

Jettisoning inboard stores with four TOW launchers, four HELLFIRE launchers, an AIM-9 missile, or auxiliary fuel tank installed on the outboard station will cause the outboard stores to be jettisoned first regardless of jettison select switch position.

21.11 PILOT ARMAMENT CONTROLS AND INDICATORS

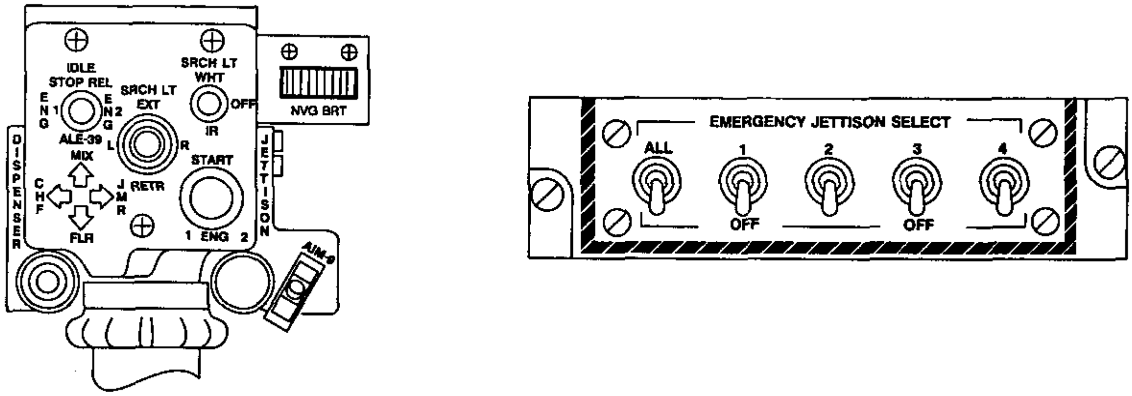
Pilot armament controls are illustrated in Figure 21-36. Refer to armament systems for controls not covered in the following paragraphs.

21.11.1 Pilot Armament Control Panels (Figure 21-37). The lower armament control panel (sheet 1) contains the controls and indicators to arm and fire armament subsystems and use the helmet sight subsystem. The upper armament control panel (sheet 2) contains the controls to provide recoil compensation inputs to the SCAS and manual selection of range for the 20-mm turret and rockets and to vary the brightness of the pilot HS reticle. Testing of HS reticle lamps is provided.

Note

The ROCKET RANGE KM knob factors in airspeed but is calibrated to 100-foot altitude, level delivery. Altitude deviation will require reticle adjustment. The GUN RANGE KM knob setting is calibrated for 200-foot level delivery. Altitude deviation will require reticle adjustment. The airspeed compensation system adjusts for changing airspeeds

21.11.1.1 MASTER ARM Switch. The MASTER ARM switch (Figure 21-37, sheet 1) is a



NOMENCLATURE	FUNCTION
ALL switch	Selects all wing stores for jettison simultaneously.
1,2,3, and 4 switches	Selects stores for jettison by wing station.
JETTISON switch	Jettison wing stores in accordance with EMERGENCY JETTISON SELECT panel switch setting.

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Figure 21-35. Pilot Wing Stores Jettison Control

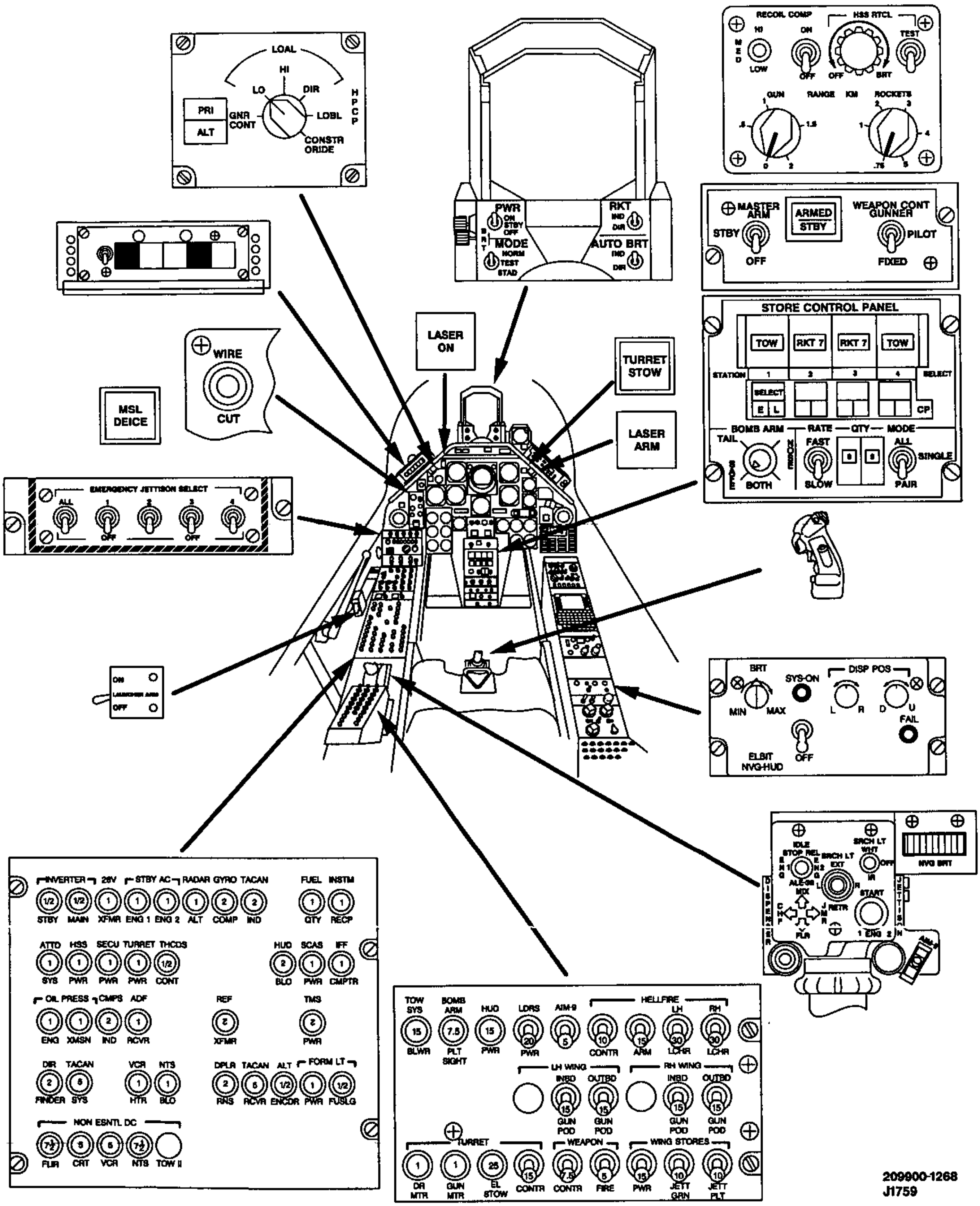
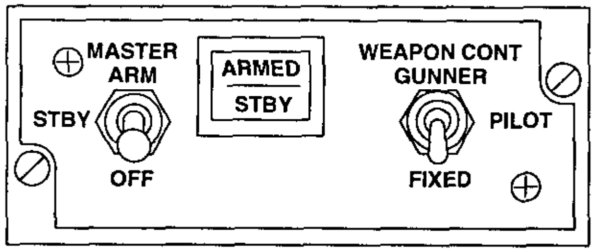


Figure 21-36. Pilot Armament Controls



LOCATION: PILOT INSTRUMENT PANEL

NOMENCLATURE		FUNCTION
MASTER ARM Switch	OFF	- Deactivates all sights (except HUD) and weapon control/ firing circuits.
	STBY	- Activates all sights (except HUD), turret and TOW missile control circuits. Charges wing gun pod battery. Illuminates pilot and gunner STBY lights.
	ARM	- Activates all sights (except HUD) and weapon control/ firing circuits. Charges wing gun pod battery. Illuminates pilot and gunner ARMED lights.
WEAPON CONT Switch	FIXED	- Permits pilot to fire turret and wing stores (not TOW) using HUD.
	PILOT	- Permits pilot to fire turret using HS and wing stores (not TOW) using HUD.
	GUNNER	- Permits gunner to fire turret using HS or TSU, and TOW using TSU. Illuminates GUNNER IN CONT light on gunner armament control panel.
ARMED STBY Indicator	ARMED	- Illuminates when MASTER ARM switch in ARM or gunner PILOT OVERRIDE switch is in OVERRIDE.
	STBY	- Illuminates when MASTER ARM switch is in STBY.
	Press	- Tests indicator lights.

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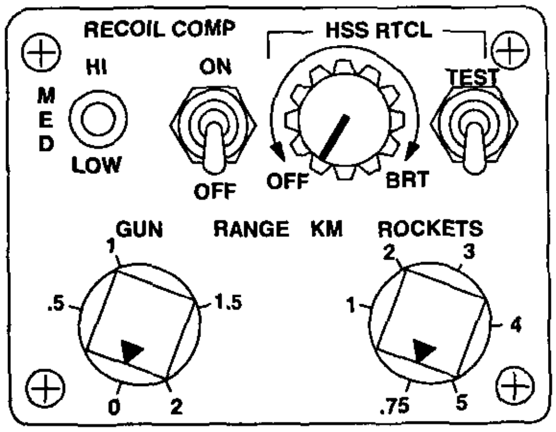
Figure 21-37. Pilot Armament Control Panels (Sheet 1 of 2)



LOCATION: PILOT INSTRUMENT PANEL

NOMENCLATURE		FUNCTION
RECOIL COMP Switches:	ON	- Activates turret recoil compensation circuits in SCAS.
	OFF	- Deactivates turret recoil compensation circuits.
	LOW	- Provides low SCAS input to flight controls during turret fire.
	MED	- Provides medium SCAS input to flight controls during turret fire.
	HI	- Provides high SCAS input to flight controls during turret fire.
HSS RTCL Switches:	OFF	- Deactivates pilot HS reticle lamps.
	BRT	- Adjusts brightness of pilot HS reticle lamps.
	TEST	- Test pilot HS reticle lamps.
RANGE KM Switches:	GUN	- Provides kilometers-to-target range data to gun elevation compensation circuit. Provides movement of HUD gun reticle which is superimposed on target for firing fixed gun or gun pod.
	ROCKETS	- Provides 0.50 to 6 km range selection for movement of the HUD rocket reticle that is superimposed on the target for firing rockets.

Note: Both selected range and angular depression of reticle are displayed on the HUD.

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Figure 21-37. Pilot Armament Control Panels (Sheet 2 of 2) three-position (ARM, STBY, and OFF) switch that permits the pilot to energize and deenergize the armament circuits. Placing the switch in ARM arms the armament system. Placing the switch in STBY energizes the control circuits for complete operation of weapons systems with the exception of the trigger fire circuits. Placing the switch in OFF deenergizes the armament and control circuits.

21.11.1.2 Weapon Control Switch. A three-position WEAPON CONT switch is provided to allow the pilot to select the mode of operation of the armament system. In the GUNNER position, the gunner is the primary armament system operator.

The WEAPON CONT switch must be in the GUNNER position to operate the TMS. However, the pilot can also select and fire wing stores. If the gunner places the THCDP mode select in any of the TOW functions, control of the turret reverts to the PHS. In the FIXED position, the pilot is in control of the turret and wing stores. This position is used in conjunction with the pilot HUD. In the PILOT position, the pilot is the primary armament system operator and has the capability to fire the turret with the HSS and select and fire wing stores. For a depiction of armament firing modes, refer to Figure 21-2.

21.11.2 Navy Armament Rocket Control and Delivery System. The NARCADS can be operated in any one of 10 modes, depending on switch setup and type of stores selected. The NARCADS selectively programs and controls the firing of stores from four helicopter wing stations. The NARCADS store control panel (Figure 21-38) enables the pilot to program the release of weapons/stores from the four wing stations in the quantity, mode, and rate selected, and the gunner to select, in the PILOT OVERRIDE condition, inboard or outboard paired stations only. The system permits selective weapons/stores release by the pilot. It incorporates safety features that require (with some weapons/stores) matching the selected station and the selected type of weapons/stores registered for that station. NARCADS also provides the capability for in-flight arming of droppable weapons.

For rocket firing, the pilot controls NARCADS in both pilot-in-control and gunner-in-control. For firing gun pods, the pilot controls NARCADS in pilot-in-control. For bomb release, the pilot controls NARCADS in pilot-in-control and gunner-in-control. For emergency jettison, the pilot controls NARCADS in any mode. The gunner controls rocket firing, gun pod firing, and bomb release in PILOT OVERRIDE only.

The WRAs for arming, selection, and release of NARCADS wing stores are: SCP, WRDU, and pilot EMERGENCY JETTISON SELECT control panel. The 28 vdc power required for NARCADS operation is supplied through circuit breakers on the pilot ac and armament circuit breaker panels.

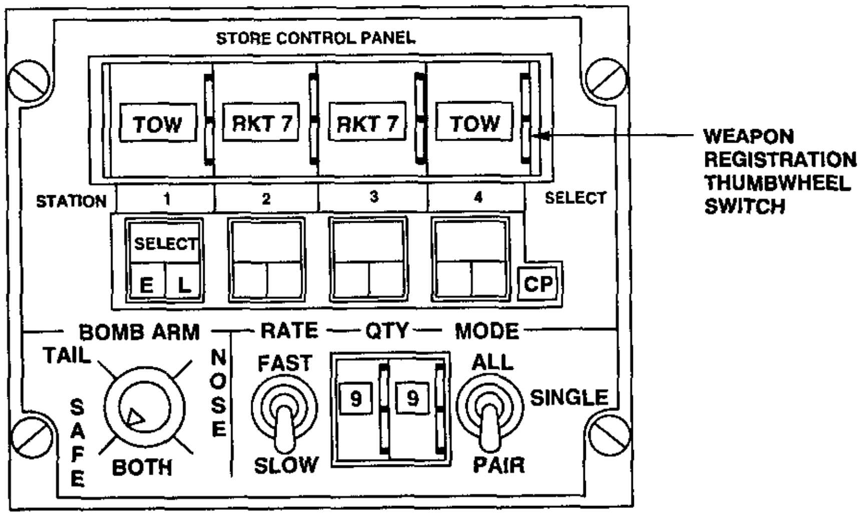
21.11.3 STORE CONTROL Panel. The SCP (Figure 21-38) contains the operating controls and indicators for the NARCADS. Four station SELECT switches are provided for the selection of weapons to be fired and arming of selected stations. The RATE, QTY, and MODE switches provide release programming for selected stations. A BOMB ARM switch provides arming when bomb stores are selected.

21.11.3.1 Weapons Release Modes. The three basic weapons release modes are provided through the pilot STORE CONTROL panel (Figure 21-38) mode switch: SINGLE, PAIR, and ALL. In addition to these basic modes, logic circuits give firing priority to outboard wing stations before inboard wing stations and left side before right side. The quantity and type of weapons loaded at each wing station and applicable weapons interlock circuits also modify actual weapons firing.

In the SINGLE mode, opposite wing stations (1 and 4, or 2 and 3) (if selected) receive fire pulses alternately until one station is depleted of stores. At that time the fire pulses are directed to the remaining station until it is also depleted. The priority logic circuits remember the last station fired in order to maintain an alternate release sequence under any condition.

In the PAIR mode, fire pulses are sent to each pair of selected equal priority wing stations simultaneously. If one of a priority pair becomes depleted during firing, the system reverts to SINGLE mode firing until the remaining station is depleted.

In the ALL mode, all selected wing stations receive fire pulses simultaneously unless restricted by weapons interlock circuits. This mode cannot be initiated if the selected weapon cannot be fired in the mode. QTY function is inoperative in this mode.



NOMENCLATURE	FUNCTION
Weapon Registration Thumbwheel Switches (one for each wing station)	Designates type of weapon loaded at the corresponding wing station and connects appropriate weapons release interlock circuits. Switches must be manually set to indicate weapons installed before weapons can be fired (except TOW, Hellfire and AIM-9 missile systems).

EMPTY - Indicates no weapons installed (Off).

RKT 7 - 7-tube rocket launcher.

RKT 19 - 19-tube rocket launcher.

GUN PD - GPU-2A.

HTW - *Not used.*

FLARE - SUU-44.

TNG BB - Training bomb.

BOMBS - Bomb.

RKT 4 - 4-tube rocket launcher.

DISP - SUU-25 dispenser.

TOW - Indicates TOW missile launchers installed (advisory only).

Blank - Not used/inoperative.

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Figure 21-38. Pilot Store Control Panel (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
STATION SELECT (1, 2, 3, 4) pushbutton indicator/switches	Selects wing station to receive fire pulses and shows condition of stores weapons (except TOW, Hellfire, and AIM-9). SELECT - Illuminates when wing station is selected for firing and weapons are present. Light goes out when E illuminates. L - Rockets only. Illuminates when five or less rockets remain in 7-tube and 19-tube launchers. E - Illuminates when weapons are depleted, except for GUN PD.
Copilot override (CP) indicator	Illuminates when copilot/gunner has selected PILOT OVERRIDE mode and controls the turret and wing stores. Previous station selections are deactivated. RATE, QTY, and MODE switch settings are unchanged.
BOMB ARM switch	Controls bomb arming solenoids in ejector racks. SAFE - All arming solenoids de-energized. TAIL - Tail arming solenoids energized. Nose arming solenoids de-energized. NOSE - Nose arming solenoids energized. Tail arming solenoids de-energized. BOTH - Both nose and tail arming solenoids energized.
RATE switch	Controls rocket firing release rate. FAST - Sets release rate at 90 milliseconds. SLOW - Sets release rate at 180 milliseconds.
QTY thumbwheel indicator/switches	Selects and displays number of fire pulses to be generated in the SINGLE or PAIR mode. (This function is disabled in ALL mode.)
MODE switch	Controls rocket firing sequence. SINGLE - Opposite wing stations of equal priority, if selected, receive fire pulses alternately. PAIR - Each pair of wing stations of equal priority, if selected, receives fire pulses simultaneously. ALL - All selected wing stations receive fire pulses simultaneously. QTY select function is disabled.

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Figure 21-38. Pilot Store Control Panel (Sheet 2 of 2)

21.11.3.2 Bomb Arm. In the BOMB ARM function (Figure 21-38), with the weapon registration switch set to BOMB or TNG BB position, the BOMB ARM switch has the capability of selecting SAFE (all arming solenoids de-energized), TAIL (only tail arming solenoids energized), NOSE (only nose arming solenoids energized), or BOTH (nose and tail arming solenoids energized).

Rate Two weapons release rates are provided through the RATE switch. Either of two basic ranges, FAST or SLOW, is selected by the pilot.

21.11.3.3 Quantity Select. The pilot can select any quantity of fire pulses from 1 through 99 by setting the QTY thumbwheel switches (Figure 21-38) to the desired number. When the system is activated, the selected number is loaded into a counter in the quantity select logic circuits. Fire-pulse enables signals from the priority control logic to decrease the counter until it is at 0. The counter then generates a disable signal to the priority control logic circuits to prevent generation of additional fire-pulse-enable signals. Reinitiation of WING ARM FIRE button resets the counter, permitting another series of fire-pulse-enable signals to be generated. This process can be repeated until the selected weapons are depleted. Recycling WEAPON CONTR circuit breaker OFF then ON reactivates the system.

21.11.3.4 Weapon Registration. Various weapons can be loaded at each wing station. Weapon registration switches on the SCP, set by the loading crew when weapons are loaded, indicate to the pilot the type of weapon available at each station. Weapon registration also programs the SCP to the type of store installed.

21.11.3.5 Station Select. The pilot can select any of the four wing stations by pressing the applicable pushbutton STATION SELECT indicator/switch. When a station selection is made, any previous selection of unlike stores is automatically cancelled. Pressing STATION SELECT switch a second time cancels selection. This puts the system into a standby mode.

21.11.3.6 Pilot Rocket Firing (Pilot-in-Control). In the PILOT or pilot FIXED mode, the pilot can select and fire wing stores. The rockets are fired by pressing the WING ARM FIRE switch on the pilot cyclic grip.

21.11.3.7 Pilot Rocket Firing (Gunner-in-Control). With the WEAPON CONT switch selected to GUNNER, the pilot can select and fire wing stores while the gunner has control of the turret. To fire the rocket, the pilot must press the WING ARM FIRE switch on the pilot cyclic grip. This disables gunner control circuits, causing the turret to return to stow and remain there for one-half second after switch is released. (The turret must be in 0° azimuth position to fire wing stores.)

21.11.3.8 Gunner Rocket Firing (Pilot Override). When the gunner initiates PILOT OVERRIDE, all pilot armament control circuits except AIM-9/AGM-122 are disabled and the pilot armament control panel MASTER ARM switch is bypassed when positioned to STBY. No armament control circuits function when MASTER ARM switch is OFF. The gunner must select INBD or OUTBD on the WING STORES SELECT switch prior to firing. The gunner fires the rockets by pressing the WING ARM FIRE switch on the gunner cyclic grip.

21.11.3.9 Pilot Bomb Release (Pilot or Gunner in Control). With the WEAPON CONT switch selected to PILOT or GUNNER, the pilot can select and release wing store bombs while the gunner has control of the turret. To release the bombs, the pilot must position the BOMB ARM switch to the desired position (out of SAFE). The RATE and MODE switches are inoperative when BOMB mode is selected. The rate is internally set to 360 milliseconds and the mode is internally set to single. The bomb is released by pressing the WING ARM FIRE switch on the pilot cyclic grip. When bombs are released, the turret is not interrupted.

21.11.3.10 Gunner Bomb Release (Pilot Override). When the gunner initiates PILOT OVERRIDE, all pilot armament circuits except AIM-9/AGM-122 are disabled and the MASTER ARM switch is bypassed if in STBY. The gunner must select INBD or OUTBD for bomb release. When the gunner selects PILOT OVERRIDE, any station that was armed by pilot selection is deenergized. The pilot must select BOMB ARM position prior to releasing bombs. The RATE and MODE switches are inoperative when bomb mode is selected. The rate is internally set to 360 milliseconds and the mode is internally set to single. The bomb is released by pressing the WING ARM FIRE switch on the gunner cyclic grip.

Note

- Incorrect thumbwheel settings may allow weapons to fire.
- Identical weapons may be released/fired simultaneously from wing stations. The pilot has no capability to fire dissimilar weapons simultaneously.
- By selecting a dissimilar store on the station select, the previously selected dissimilar store will automatically deselect. The pilot can select additional stations for the gunner. Example: If the gunner selects PILOT OVERRIDE, INBD, the pilot can additionally select stations 1 and/or 4. If the QTY counter shows 0/0 in SINGLE or PAIR mode, no weapons will fire.

21.11.4 Head-Up Display. The HUD (Figure 21-39) provides the pilot visual information for flight and weapon delivery. The pilot laser annunciator lights, mounted beneath the glareshield, provide the pilot with information about laser ARM and firing status. The HUD contains a semireflective multilayer combiner glass that projects the HUD symbols overlaid on the pilot image of the real world. The symbols enable the pilot to align the helicopter for launching of the TOW, HELLFIRE, Sidearm, and Sidewinder missiles and provides a sight reticle for gun and rocket firing. Flight data presented on the HUD enables the pilot to fly without scanning the instrument panel for critical information. Flight data displays include engine torque, radar altitude, magnetic heading, ADF heading, TACAN heading, pitch and roll attitude, rocket and gun reticle depression angle digital readout, and laser range when available from NTS. HUD provides for automatic adjustment (for range) of the rocket and gun reticles during laser rangefinding and for up to 15 seconds after lasing has ceased. Lased reticle may be overridden within 15 second period after lasing has stopped by manual adjustment using rocket or gun range knob, as applicable. HUD also displays post launch rectangle when laser is designating as a steering aid to the pilot. Laser designation will not affect rocket or gun reticle settings.

Note

Displayed constraints rectangle depicts NTS TSU limits. Laser is shut down prior to reaching TSU limits.

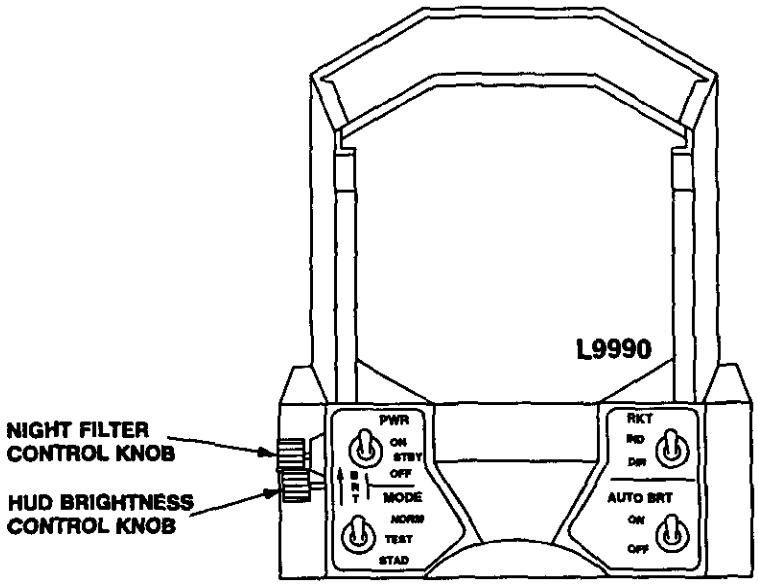
HUD system components consist of the head-up display, signal processor, AIM-9/HUD interface unit, and boresightable mount. The signal processor generates the symbols for the HUD and provides the control circuitry for the HUD operation and BIT checks. The AIM-9/HUD interface unit is required to make the AIM-9 system compatible with the HUD signal processor circuitry. The HUD system is powered by the 28 vdc essential bus and protected by the HUD PWR circuit breaker. The signal processor cooling blower is powered by the 115 vac essential bus and protected by the HUD BLO circuit breaker.

21.11.4.1 HUD Controls.

See Figure 21-39.

In addition to the functions listed on the figure a declutter feature has been incorporated. HUD declutter is selected by moving the pilot cyclic four-position switch to the right or by depressing the pilot CDU DCLT key. Three levels of declutter are alternately selectable: normal, level 1 and level 2. For details on symbols displayed in each level refer to paragraph 21.11.4.4.

21.11.4.2 HUD Built-In Test. BIT indicators are located on the HUD and in the signal processor. A malfunction in either unit will trip the respective indicator and change the indicator center from black to white. The indicators cannot be viewed by the crew. A failure indicator on the caution panel will place a crosshatch on the HUD if the HUD, the signal processor, or both fail.



NOMENCLATURE	FUNCTION
PWR Switch	
ON	Electrical power applied, symbols displayed depend on MODE switch position.
STBY	Electrical power applied, no symbols displayed.
OFF	All electrical power removed from HUD circuits.
MODE Switch	
NORM	All basic symbols displayed.
TEST	Displays selected set of test symbols.
STAD	Displays stadiametric reticle which is a backup reticle.
RKT Switch	Switch inactive.
AUTO BRT Switch	
ON	Allows brightness of displayed symbols to be automatically adjusted.
OFF	Disables automatic brightness feature.
NIGHT FILTER Control Knob	Selects usage of night filter by rotating knob.
HUD BRIGHTNESS Control Knob	Used for nominal setting. Controls brightness of head-up display element when rotated as shown by BRT arrow.

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Figure 21-39. HUD Laser Range Display and Laser Annunciators (Sheet 1 of 2)

NOMENCLATURE	FUNCTION
LASER ARM	The Laser Designator and Ranging System (LDRS) has been enabled. All interlocks are engaged. System is ready to transmit.
LASER ON	Laser energy is being transmitted from the Night Targeting System Laser.

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Figure 21-39. HUD Laser Range Display and Laser Annunciators (Sheet 2 of 2)

21.11.4.3 HUD Night Filter Operation. A night filter changes the color of the display for normal night and NVG operations. The night filter is operated by turning the NIGHT FILTER control knob, located on the left side of the HUD (Figure 21-39).

CAUTION

Do not use the night filter during daytime operation. Always reset the night filter when turning off HUD. Direct sunlight on HUD optics will focus sunlight on the night filter and will result in damage to the filter.

21.11.4.4 HUD Symbol Definitions. Symbols displayed on the HUD are determined by the armament system mode and pilot selectable declutter level. There are 10 basic armament modes and 3 declutter levels. Table 21-1 lists the armament operating modes of the HUD, their display priority, and what determines the active mode. Figure 21-40 lists the symbols that will be displayed on the HUD for the selected armament mode and declutter level. Figure 21-41 describes available HUD symbol definitions and descriptions. Figure 21-42 depicts typical HUD displays of selected modes. Figure 21-43 shows the dimensions of armament reticles.

TABLE 21-1. HUD ARMAMENT OPERATING MODES

HUD Display Mode	Priority	Selection of Mode
Air/Air	1	AIM-9 Control unit to ARM and a missile selected.
TOW Prelaunch	2	TOW ARMED on THCDP, MASTER ARM to ARM, ACQ/TRK/STOW to track and LHG action depressed. Must have a TML and missile or simulator present.
TOW Postlaunch	3	1.5 sec after firing TOW until wire cut.
Hellfire	4	Must be in an active Hellfire mode (LOBL/LOAL).
Fixed Gun	5	WEAPON CONT switch in fixed and TRIGGER ACTION depressed.
Wing Store Rocket	6	RKT 4/7/19 station selected.
Wing Store Gun	7	GUN PD station selected.
Navigation	8	No weapons selected. (MASTER ARM may be in any position.)
Test	9	HUD MODE switch to TEST.
Stadiametric	10	HUD MODE switch to STAD.

21.11.4.5 HUD Turn On Procedures.

1. Set PWR switch to STBY. Wait 1 minute for warmup.
2. Set AUTO BRT switch to OFF.
3. Set MODE switch to TEST.
4. Set PWR switch to ON.
5. *Adjust HUD BRIGHTNESS control knob to* desired level.
6. Turn NIGHT FILTER control knob to position desired.
7. Verify test display passes.
8. Set MODE switch to NORM.
9. Set AUTO BRT switch to ON.

21.11.5 Pilot Armament Circuit Breakers. (See Figure 21-44.)

21.12 CYCLIC STICK ARMAMENT SWITCHES

The pilot and gunner cyclic sticks (Figure 21-45) provide three armament switches: WING ARM FIRE, TRIGGER TURRET FIRE, and TRIGGER ACTION.

21.12.1 WING ARM FIRE Switch. The WING ARM FIRE switch on the cyclic stick is used to fire wing stores. After selecting wing stores, wing stores may be fired. An interrupter circuit interrupts turret firing. Gunner WING ARM FIRE switch is disabled when MSL guard is raised.

21.12.2 TRIGGER TURRET FIRE Switch. The TRIGGER TURRET FIRE switch on the cyclic stick is used to fire the turret. After presetting switches on the pilot or gunner armament control panel, the turret may be fired. The TRIGGER ACTION switch on the cyclic stick must be depressed prior to depressing the TRIGGER TURRET FIRE switch except when firing turret in the fixed mode. When firing the turret in the fixed mode, there will be no reticle present on the HUD unless the TRIGGER ACTION switch is depressed. The gunner cyclic switches are energized only when his PILOT OVERRIDE switch is in the OVERRIDE position. A hinged guard prevents the TRIGGER TURRET FIRE switch from being inadvertently depressed.

HUD SYMBOLS	DCLT LEVEL (Note 1)	MODES								
		Nav	TOW PreL	TOW PostL	Hell-Fire	Fixed Gun	WS Rkt	WS Gun	Air-Air	Test
Heading Tape	2	X	X	X	X	X	X	X	X	X
Mag/True Heading Pointer (2)	2	X	X	X	X	X	X	X	X	
Tacan and ADF Pointers	2	X								
CMD/DIR to WPT Pointers	2	X	X	X	X	X	X	X	X	
Torque Numerics and Indicator		X	X	X	X	X	X	X	X	
Pitch Ladder	1	X	X	X	X	X	X	X	X	X
Altitude Numerics		X	X	X	X	X	X	X	X	X
Altitude Indicator (3)	2	X	X	X	X	X	X	X	X	
Low Altitude Limit Indicator		X	X	X	X	X	X	X	X	
Air Speed Numerics		X	X	X	X	X	X	X	X	
Groundspeed Numerics		X	X	X	X	X	X	X	X	
ADL Boresight Reference	2	X	X	X	X	X	X	X	X	X
CCS √ Status Annunciations (4)		X	X	X	X	X	X	X	X	
Warning Box		X	X	X	X	X	X	X	X	
Cross Track Indicator	1	X	X	X	X				X	
Distance To Go	2	X	X	X	X	X	X	X	X	
Time To Go Numerics	2	X	X	X	X	X	X	X	X	
Time To Hit (5)			X	X	X					
Timer/Time of Day (6)	2	X	X	X	X	X	X	X	X	
TSU LOS Cueing Reticle (7)		X	X	X	X	X	X	X	X	
TSU LOS Warning "X"		X	X	X	X	X	X	X	X	

Notes:
1. Blank space denotes all indicated symbols will be displayed in the applicable mode, a 1 denotes symbol will not be displayed in declutter steps 1 and 2, and a 2 denotes symbol will not be displayed in full declutter.
2. CNU True may be selected on NAV 2/2 page.
3. Displayed at altitudes below 200 ft AGL.
4. Displayed when an annunciation is displayed on the CDU annunciation line
5. Displayed as result of valid laser return. Will count down only in LOBL, Rapid mode.
6. Displayed when selected and active as set up on the TIMERS page.
7. Displayed when Master Arm is energized.
8. Is also displayed when actively designating with LDRS.
9. Displayed in the stadiametric mode.

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Figure 21-40. HUD Symbols vs Mode and Declutter (Sheet 1 of 2)

Continued:

HUD SYMBOLS	DCLT LEVEL (Note 1)	MODES								
		Nav	TOW PreL	TOW PostL	Hell-Fire	Fixed Gun	WS Rkt	WS Gun	Air-Air	Test
Pre-launch Rectangle			X							
TSU Ascend Symbol			X							
TSU Descend Symbol			X							
Post-launch Rectangle (8)				X	X		X			
Sidewinder Caged									X	X
Sidewinder Uncaged									X	X
Sidewinder HUD FOV Limit Box									X	X
Sidewinder Constraint "X"									X	X
Right or Left Missile Symbol			X		X				X	
Hellfire Seeker Symbol					X					
Hellfire Constraint Circle					X					
Hellfire Mode					X					
PRI and ALT Laser Channels					X					
HF Priority Code Symbol					X					
Manual Range Numerics						X	X	X		
Laser Range Numerics		X	X	X	X	X	X	X	X	
Mil Depression						X	X	X		
Rocket Reticle							X			
Gun Reticle						X		X		
CNU Sideslip Indicator						X	X			
Stadiametric (9)										

Notes:
1. Blank space denotes all indicated symbols will be displayed in the applicable mode, a 1 denotes symbol will not be displayed in declutter steps 1 and 2, and a 2 denotes symbol will not be displayed in full declutter.
2. CNU True may be selected on NAV 2/2 page.
3. Displayed at altitudes below 200 ft AGL.
4. Displayed when an annunciation is displayed on the CDU annunciation line
5. Displayed as result of valid laser return. Will count down only in LOBL, Rapid mode.
6. Displayed when selected and active as set up on the TIMERS page.
7. Displayed when Master Arm is energized.
8. Is also displayed when actively designating with LDRS.
9. Displayed in the stadiametric mode.

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Figure 21-40. HUD Symbols vs Mode and Declutter (Sheet 2 of 2)

SYMBOL	DESCRIPTION
	HEADING TAPE. A change in heading appears as a moving tape with a vertical mark every 5 degrees. At 10-degree increments, a 2-digit number is displayed over the appropriate mark. The units digit will be left off, for example, and 140 degrees appears as 14 and 20 degrees appears as 02. The aircraft heading is shown on this tape directly above the heading pointer that is centered in line with the boresight. As this heading tape moves, the numerics will disappear and appear at the end of the baselines as if they were going behind an abrupt vertical wall.
	MAGNETIC HEADING POINTER. Pointer is displayed aligned with the aircraft vertical boresight and indicates the aircraft current magnetic heading.
	CNU TRUE HEADING POINTER. Pointer is displayed aligned with the aircraft vertical boresight and indicates the aircraft current true heading. True heading reference may be selected on the CCS NAV 2/2 page.
	TACAN POINTER. The TACAN radial is displayed on the heading tape. The heading tape has a baseline that extends out plus and minus 15 degrees from the heading reference. The bearing angle (BA) is referenced from the aircraft magnetic heading. If 0 degrees ≤ BA ≤ 15 degrees or 345 degrees ≤ BA ≤ 360 degrees, the TACAN arrow will appear just below the heading tape pointing up. The position of the arrow from the heading reference will be BA degrees using the same +15 degree scale as the heading. For example, if TA equals 5 degrees, the arrow is off to the right of the heading reference one-third of the way to the end of the scale. If 165 degrees ≤ BA ≤ 195 degrees, the TACAN arrow will appear just below the heading tape but pointing down away from the tape. If BA is located to the right/left of the helicopter and off of the heading tape, the arrow will be on the right side of the display pointing right/left.
	ADF POINTER. Displayed under heading tape. Operation is same as TACAN.
	The Command Heading to waypoint pointer is the caret with the letter "C" embedded in it. When the Command Heading is outside of the portion of the Heading Tape presently in view, the caret points in the direction closest to the Command Heading. In these cases, the pointer is rotated on its side (<>).
	The Bearing to Waypoint pointer is the caret. When the Bearing to Waypoint is outside of the Heading Tape presently in view, the caret points in the direction closest to the waypoint bearing. In these cases, the pointer is rotated on its side (<>).
85%	TRANSMISSION TORQUE NUMERICS. Displayed in upper left corner, in all modes except STAD. Numerics displayed are the total of the left and right torque inputs. The lowest number displayed will be 0%. The box (not the numbers) will flash ON and OFF when torque is ≥ 95%. Two flashes per second.
	TORQUE INDICATOR. Displayed around the engine torque. The torque indicator displays when torque numerics are ≥ 40%. After display, torque indicator will be removed when torque drops below 37% and at ≤ 40% the arrowhead will point to the counterclockwise end of the indicator scale. As torque numerics increase, the arrowhead moves clockwise linearly. At and above 100% torque, the arrowhead points to the 12:30 position.

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Figure 21-41. HUD Symbol Definitions and Descriptions (Sheet 1 of 4)

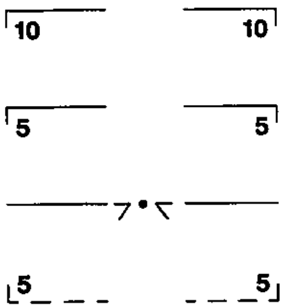
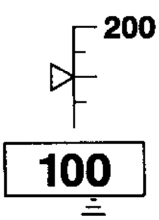
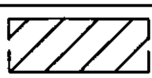
SYMBOL	DESCRIPTION
	PITCH LADDER. Indicates aircraft pitch and roll by scrolling the ladder for pitch and rolling the ladder in banks so that lines of the ladder remain parallel to the horizon. Displayed pitch lines are in 5 - degree increments. Pitch angles above the horizon are indicated by solid lines with vertical ticks indicating direction to move nose toward horizon. Pitch angles below the horizon are indicated by dashed lines with vertical ticks indicating direction to move nose toward horizon. The pitch ladder is scaled 2:1 with respect to the real world. HUD will display two lines above the ADL and one line below.
100	RADAR ALTITUDE NUMERICS. The altitude numerics display a one- to four-digit number, indicating altitude in increments of 5 feet. The units digit will only appear as "0" or "5". For a signal in the range -100 to 0 feet, the readout will be "0". For a signal < -100 feet, the numerics are blanked. The maximum value displayed will be 4995 feet. If the radar altitude input signal converts to a value higher than this, the numerics are blanked. After being blanked for any reason, the altitude must obtain a display value < 4975 and ≥ 0 before the altitude numerics are displayed again.
	RADAR ALTITUDE SCALE AND INDICATOR. The scale is displayed rising out of the altitude numerics box. The scale appears at all altitudes between 0 and 200 feet. As altitude increases, the scale will disappear when the altitude exceeds 225 feet. The scale will appear again when altitude drops below 200 feet. The scale will display altitude as a linear scale from 0 to 200 feet with scale marks at 50, 100, 150 and 200 feet. The indicator points to the altitude value. Between 200 and 225 feet, the indicator is at 200 foot mark. For a signal in the range -100 feet to 0 feet, the indicator is at the 0 foot mark. For a signal < -100 feet (abnormal radar function) no scale is shown.
	LOW ALTITUDE LIMIT INDICATOR. Displayed under radar altitude numerics when below preset (DH index on pilot RADALT) low altitude limit.
52 G 000	AIRSPEED AND GROUNDSPEED NUMERICS. Airspeed will be displayed as a one- to three-digit number above groundspeed. Groundspeed is further identified by a "G" to the left.
	ADL BORESIGHT REFERENCE. Stationary and centered on ADL. Displayed in all modes except Stadiametric mode. Angle formed within boresight reference is 30 degrees.
√ CDU	CHECK CDU ANNUNCIATOR. √CDU will be displayed whenever an annunciation appears on the CDU (√ STATUS, √ TIMER N, etc.). Symbol is cleared by pressing the CDU CLR key or accessing the Status page.
	WARNING BOX. Displayed about the ADL when the Master Caution is illuminated. When displayed symbol flashes 2 times per second.

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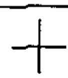
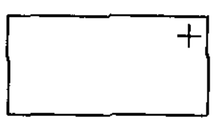
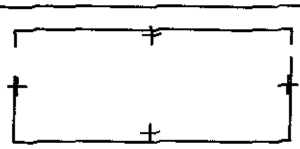
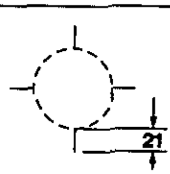
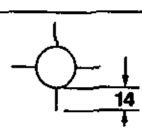
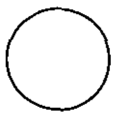
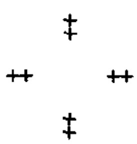
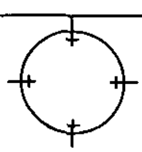
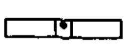
Figure 21-41. HUD Symbol Definitions and Descriptions (Sheet 2 of 4)

SYMBOL	DESCRIPTION
000.0	DISTANCE TO WAYPOINT. Shows the distance in nautical miles to the "TO" point indicator on the progress page.
00:00:00	TIME TO WAYPOINT. Shows the time-to-go in hours/minutes/seconds to the "TO" point indicated on the progress page. NOTE Time to waypoint is a function of groundspeed and distance and will frequently change when airspeed changes. Time to waypoint will "max out" in a hover.
TTH 10	NTS TIME TO HIT. TTH is displayed during lasing in the TOW or Hellfire modes. In LOBL RAPID, the time will count down when a Hellfire missile is launched.
T2 00:00:32	TIMER DISPLAY. Displays active timer when CDU Timers page TM DSP function is selected on. If more than one timer or TTH is active, the display priority is TTH, T1, T2, then T3.
TOD 00:00:32	TIME OF DAY. Displays CDU time when CDU Timers page TOD DSP function is selected on. If timer or TTH is active, the display priority is TTH, T1, T2, T3 then TOD.
	TSU LOS POINTER. Indicates where the TSU is pointing on the real world with 1:1 scaling. While laser is designating and during TOW postlaunch the pointer is moved at 23:1 scaling to the real world.
	TOW PRE-LAUNCH RECTANGLE. Displayed in pre-launch mode only. Either left or right missile is displayed dependent upon missile selected. Vertically positioned rectangle. Scale factor of area covered by rectangle to real world is 1:1 in azimuth and elevation.
	TSU ASCEND/DESCEND. Displayed attached to TSU reticle. Arrowhead pointing vertically up/down is an indication TSU is being driven up/down.
	TOW POST LAUNCH RECTANGLE. Fixed horizontal rectangle displayed 1.5 seconds after TOW missile trigger pulled. Scale factor of area covered by rectangle to real world is 23:1 in azimuth and elevation. TOW post launch window is removed from HUD display at wire cut.
	Laser designation constraints rectangle is displayed to aid the pilot in maintaining the TSU LOS in constraints. CAUTION The TSU LOS pointers depicted at left indicate the approximate locations where the laser is electrically shut off prior to the TSU mechanical limits.
 21	SIDEWINDER/SIDEARM CAGED RETICLE. Displays seeker staring acquisition window of 65 mils. The reticle will move during aircraft maneuvers due to seeker lag. All dimensions are in milliradians.
 14	SIDEWINDER/SIDEARM UNCAGED RETICLE. Reticle indicates seeker LOS 1:1 on the real world to aid pilot in determining proper track. All dimensions are in milliradians.

209704-198-10
J1974

Figure 21-41. HUD Symbol Definitions and Descriptions (Sheet 3 of 4)

SYMBOL	DESCRIPTION
	SIDEWINDER/SIDEARM HUD FOV LIMIT. Box will appear when HUD display limits are reached and seeker remains tracking. Box will have an X overlaying it when seeker limits are reached.
	SELECTED MISSILE SYMBOL. The missile symbol will display left or right of the HUD field of view dependent upon missile selected. Displayed for Sidewinder, Sidearm, TOW or Hellfire.
	HELLFIRE RETICLE. Shows position of seeker. Reticle will flash when launch window constraints are reached. Scaled by a factor of 8:1 to real world. This reticle has an occlusion zone about it.
	HELLFIRE CONSTRAINT WINDOW. Displayed after missile tracking and is located 4° up from ADL. This corresponds to recommended launch constraints. The 5° diameter constraint window is scaled 8:1 with respect to real world (seeker 40° limit).
LOBL	HELLFIRE MODE. Displays selected Hellfire mode LOBL, LALL, LALH or LALD with a -G or -P depending on pilot or gunner control.
B3	Displays selected primary and alternate laser codes and quantity of missiles that have been coded up. Primary is displayed on the left and alternate on the right.
(E3)	Priority (next to launch) laser code is indicated by brackets around the primary or alternate code symbol.
4000	RANGE SETTING. Displayed in the lower right corner above the MIL setting as a four-digit number. Range depends on the pilot input on the gun or rocket potentiometer. Range is in 50 - meter increments. Range settings will indicate from 500 to 6,000 meters.
L2210 L - - -	NTS LASER RANGE. Displayed at lower right of display in lieu of GUN/ROCKET range setting. Displays maximum range of 9990 or 15990 meters depending on which version is installed. Lowest order digit is always a zero.
+50 MIL MAX	MIL SETTING. Displayed in the lower right corner as a one- to three-digit number. MIL setting is calculated in the FFSP based on pilot input on the gun or rocket range potentiometer and aircraft airspeed. MIL setting will indicate from approximately +50 to a -130 elevation value (+ is up). MAX will be displayed when laser range exceeds 6,000 meters in Rocket mode.
	ROCKET RETICLE. Positioned vertically using manual rocket range knob setting and sensed airspeed. During laser rangefinder operation reticle will be positioned using laser range and sensed airspeed. 15 seconds after laser rangefinding has been stopped the reticle will return to manual range setting position. During 15 second period after stopping laser rangefinder laser reticle setting may be overridden by reselecting a manual range.
	GUN RETICLE. Positioned vertically using manual gun range knob setting. During laser rangefinder operation reticle will be positioned using laser range. 15 seconds after laser rangefinding has been stopped the reticle will return to manual range setting position. During 15 second period after stopping laser rangefinder laser reticle setting may be overridden by reselecting a manual range.
	CNU SIDESLIP INDICATOR. Gives the pilot an indication of sideslip. Does not match the sideslip ball during transient conditions.

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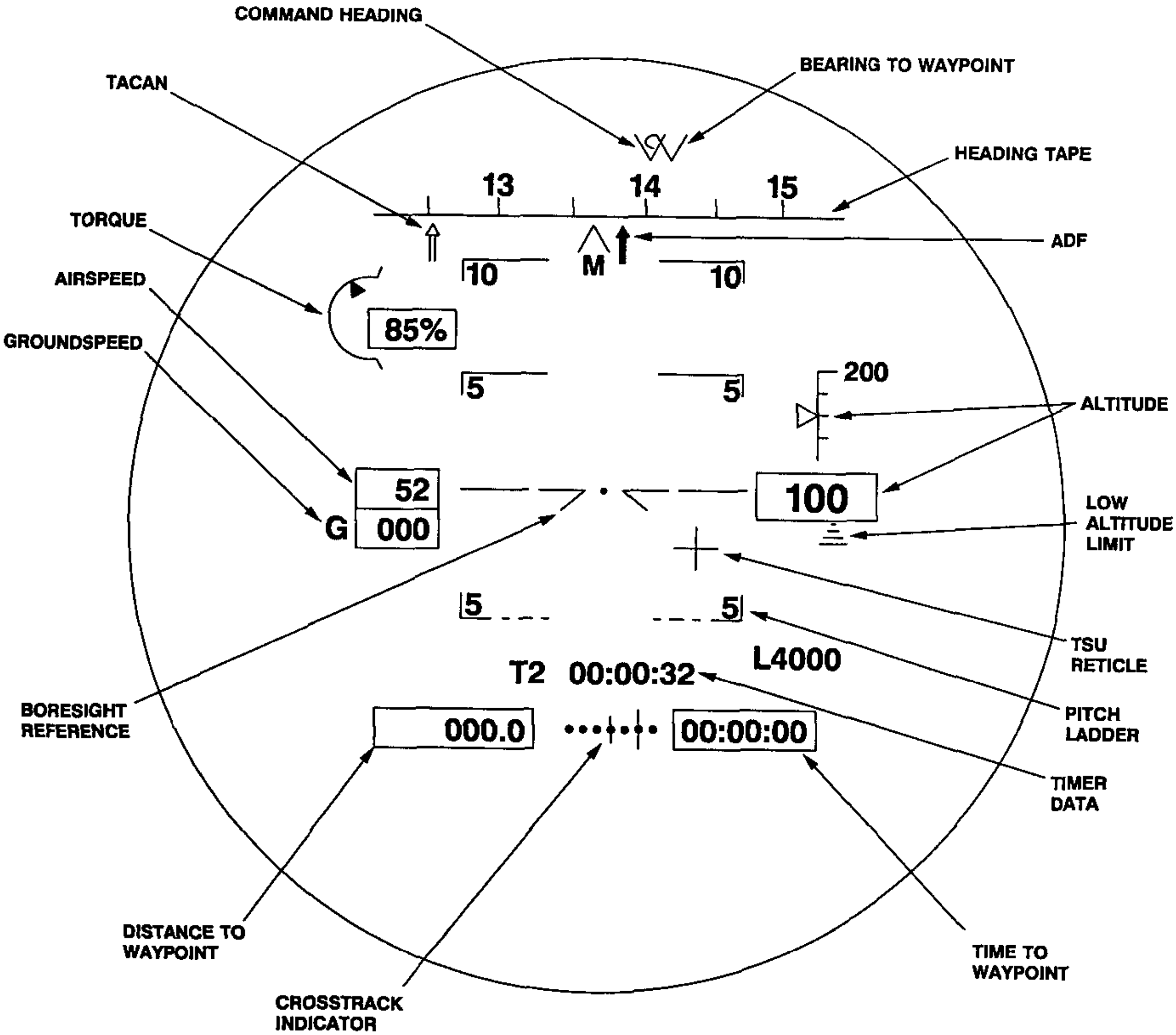
J1924

Figure 21-41. HUD Symbol Definitions and Descriptions (Sheet 4 of 4)

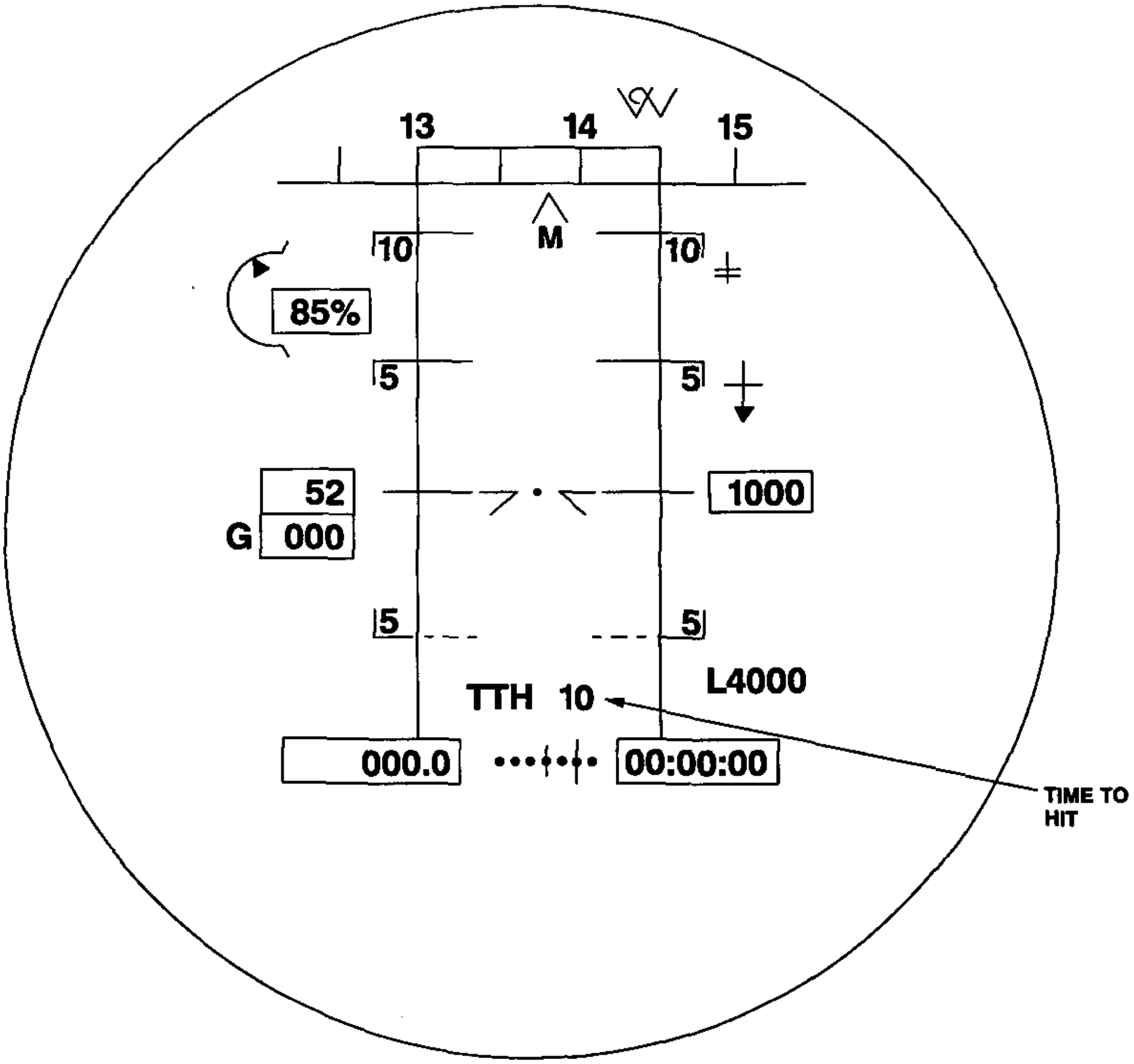


- For head up VFR navigation.
- TSU reticle automatically on with MASTER ARM.
- Blinking command heading, and direct to waypoint heading symbol (within 10 seconds of waypoint).

NAVIGATION MODE

209704-216-1
J1974

Figure 21-42. HUD Mode Displays (Sheet 1 of 9)

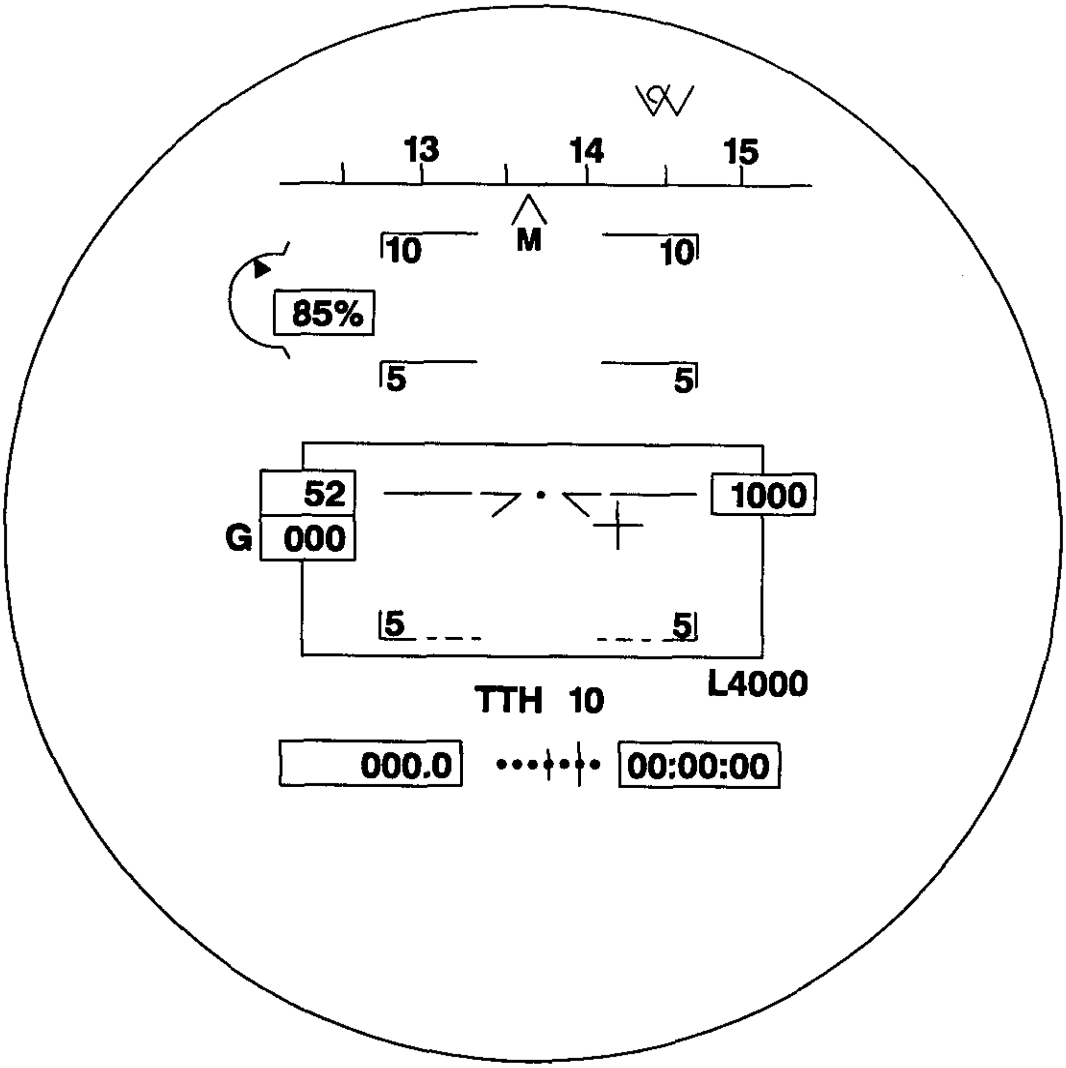


- Prelaunch constraints shown.
- *Gunner's TSU reticle flashes if out of constraints.*
- Pilot brings TSU reticle into prelaunch constraints window.
- TSU reticle will stop flashing when all constraints are met.
- If there is no laser, there will be no range displayed.
- TTH displayed during lasing, over Timer or TOD.

TOW PRELAUNCH MODE

209704-216-2
J1926

Figure 21-42. HUD Mode Displays (Sheet 2 of 9)

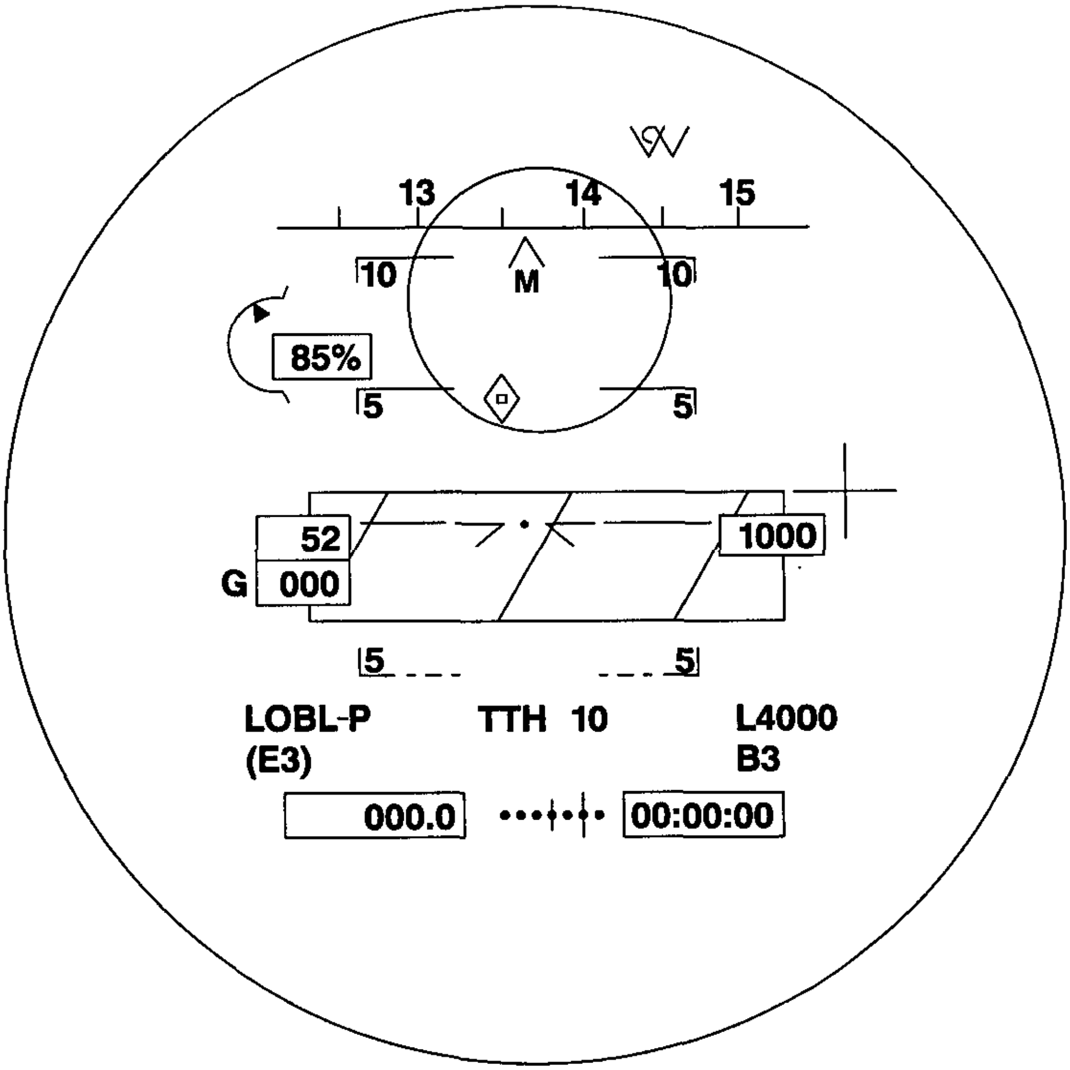


- 1.5 seconds after missile firing postlaunch constraint limit window appears on display.
- Pilot flies to keep TSU reticle inside postlaunch constraint limit window.
- Postlaunch constraint window is scaled 23:1 against real world.
- If there is no laser, there will be no range displayed.

TOW POSTLAUNCH MODE

209704-216-3
J1926

Figure 21-42. HUD Mode Displays (Sheet 3 of 9)

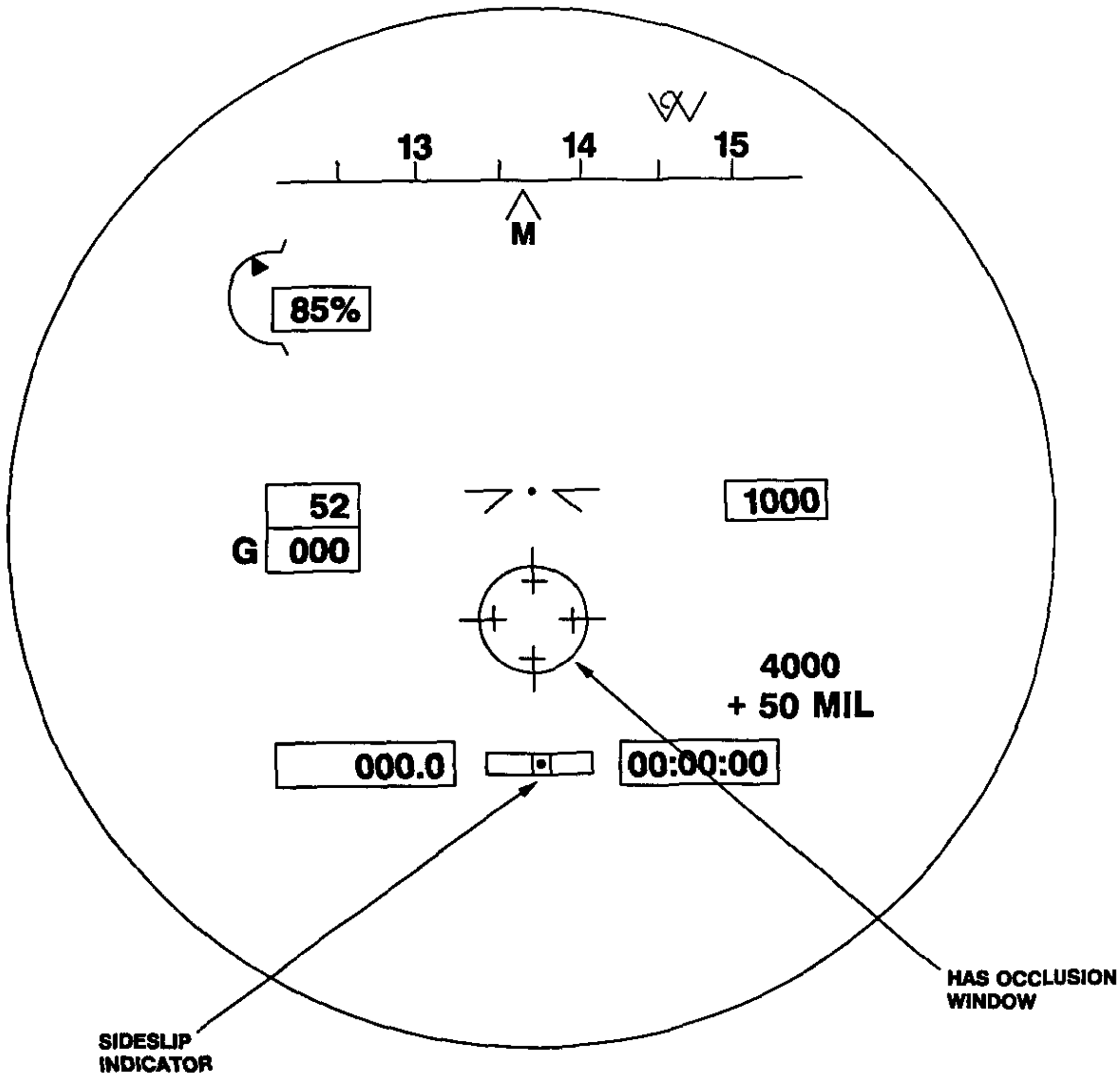


- In lock on before launch, after lock on, pilot maneuvers aircraft to keep reticle inside of constraint circle.
- Hellfire seeker reticle will flash when launch constraints are reached.

HELLFIRE MODE

209704-216-4
J1926

Figure 21-42. HUD Mode Displays (Sheet 4 of 9)

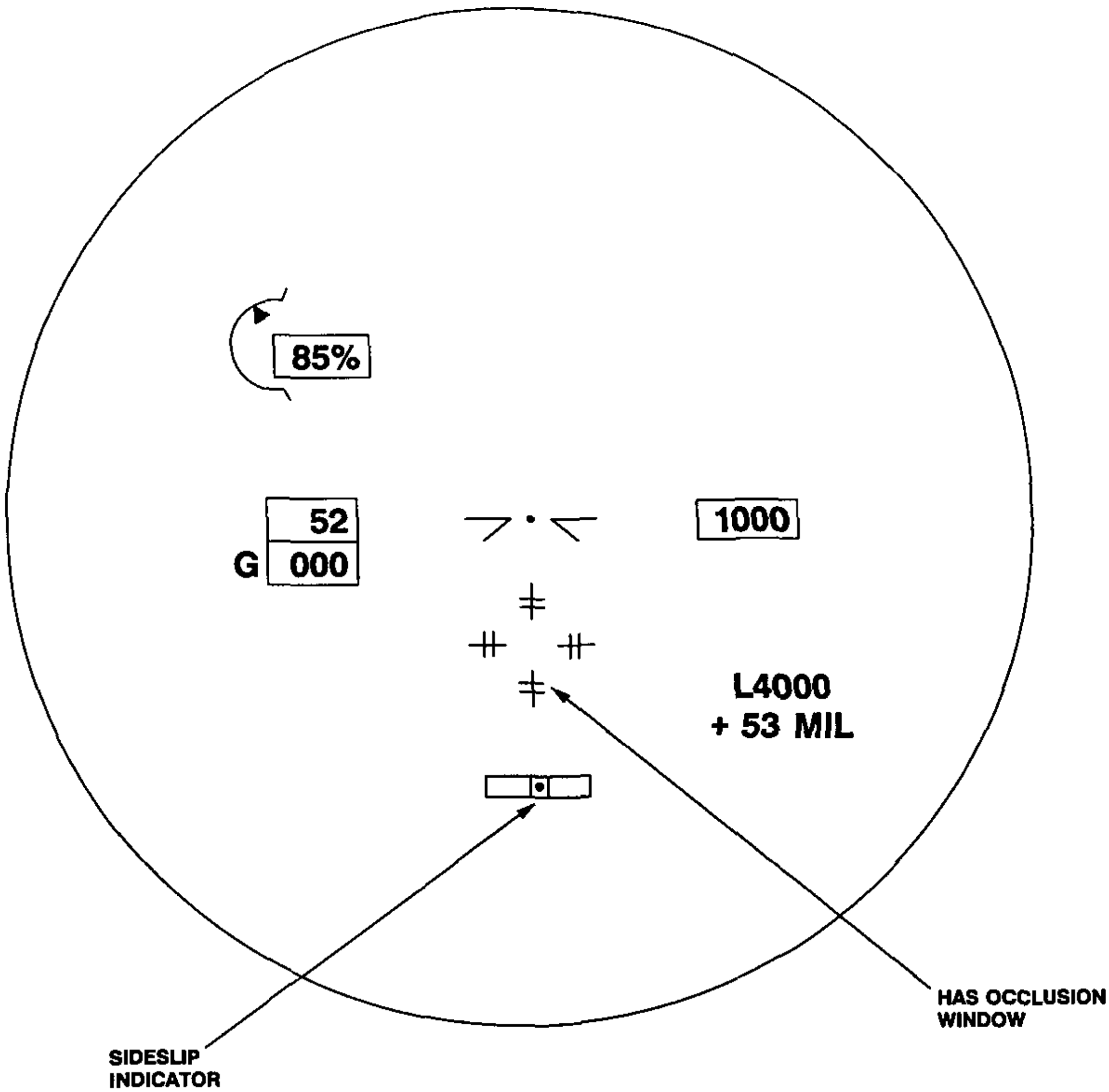


- For fixed gun firing.
- Reticle is depressed based on laser range or pilot defined depression.
- Manual range and depression will be displayed if no laser range available.
- Sideslip indicator replaces Crosstrack symbol in CNU.
- Sideslip indicator is not displayed in non-CNU aircraft.
- Pitch Ladder, TACAN, ADF and crosstrack decluttered.

GUNS MODE (SHOWN AT DECLUTTER LEVEL 1)

209704-216-5
J1926

Figure 21-42. HUD Mode Displays (Sheet 5 of 9)

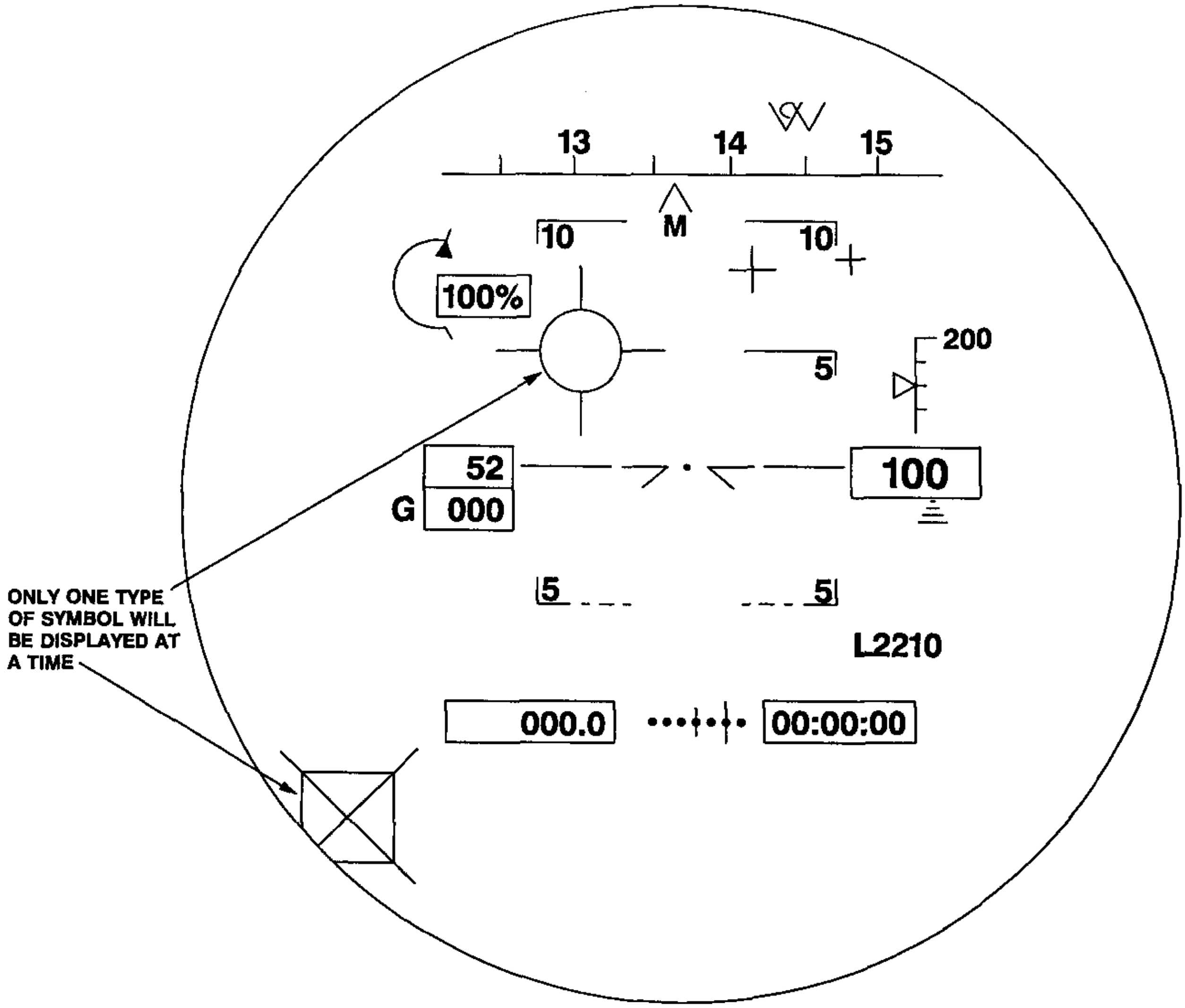


- For rocket firing.
- Reticle is depressed based on laser range or pilot defined manual range and depression.
- Manual range and depression will be displayed if no laser range available.
- Depression angle numerics displayed with laser range.
- Sideslip indicator replaces Crosstrack symbol in CNU A/C.
- Sideslip indicator or Crosstrack not displayed in Non- CNU A/C.
- Pitch Ladder, TACAN, ADF and crosstrack remain decluttered.
- NAV symbols decluttered.

ROCKETS MODE (SHOWN AT DECLUTTER LEVEL 2)

209704-216-6
J1926

Figure 21-42. HUD Mode Displays (Sheet 6 of 9)



- Pilot will verify reticle overlays target and tone is correct.
- Box will appear when display limits are reached.
- Box will have a caution symbol overlaying it when seeker limits are reached.
- If there is no laser, there will be no range displayed.

SIDEWINDER MODE

209704-216-7
J1926

Figure 21-42. HUD Mode Displays (Sheet 7 of 9)

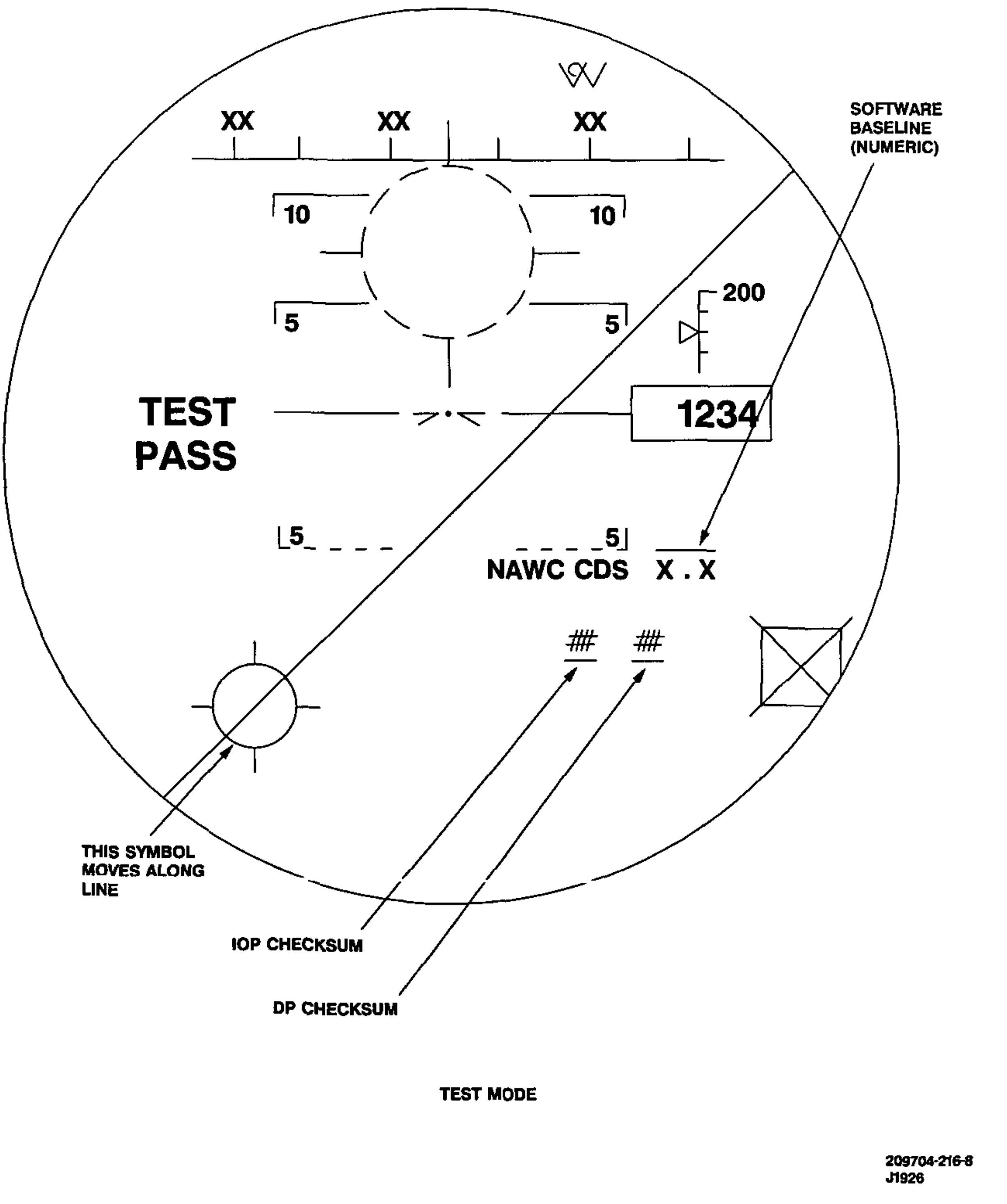
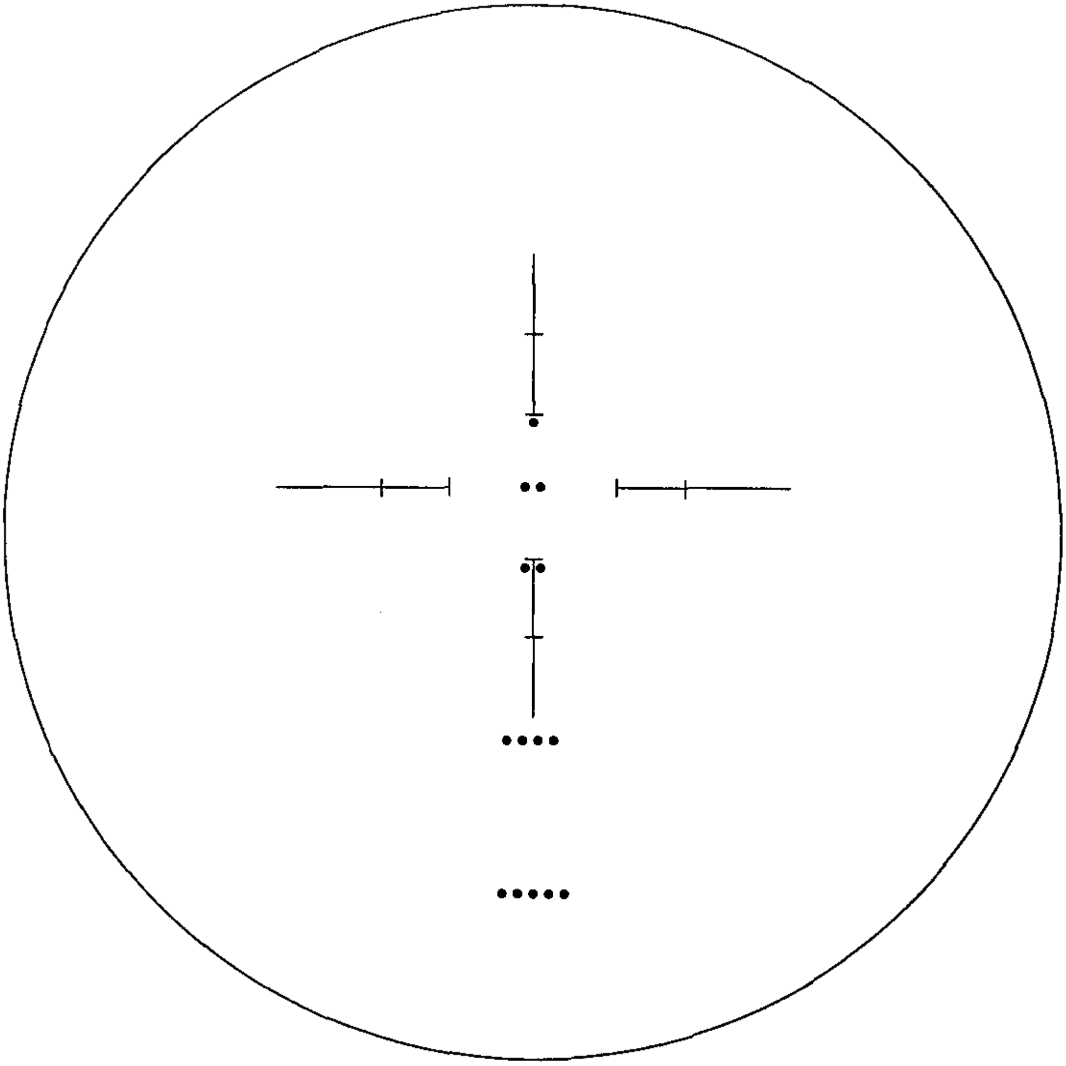


Figure 21-42. HUD Mode Displays (Sheet 8 of 9)



STADIAMETRIC MODE

209704-216-9
J1926

Figure 21-42. HUD Mode Displays (Sheet 9 of 9)

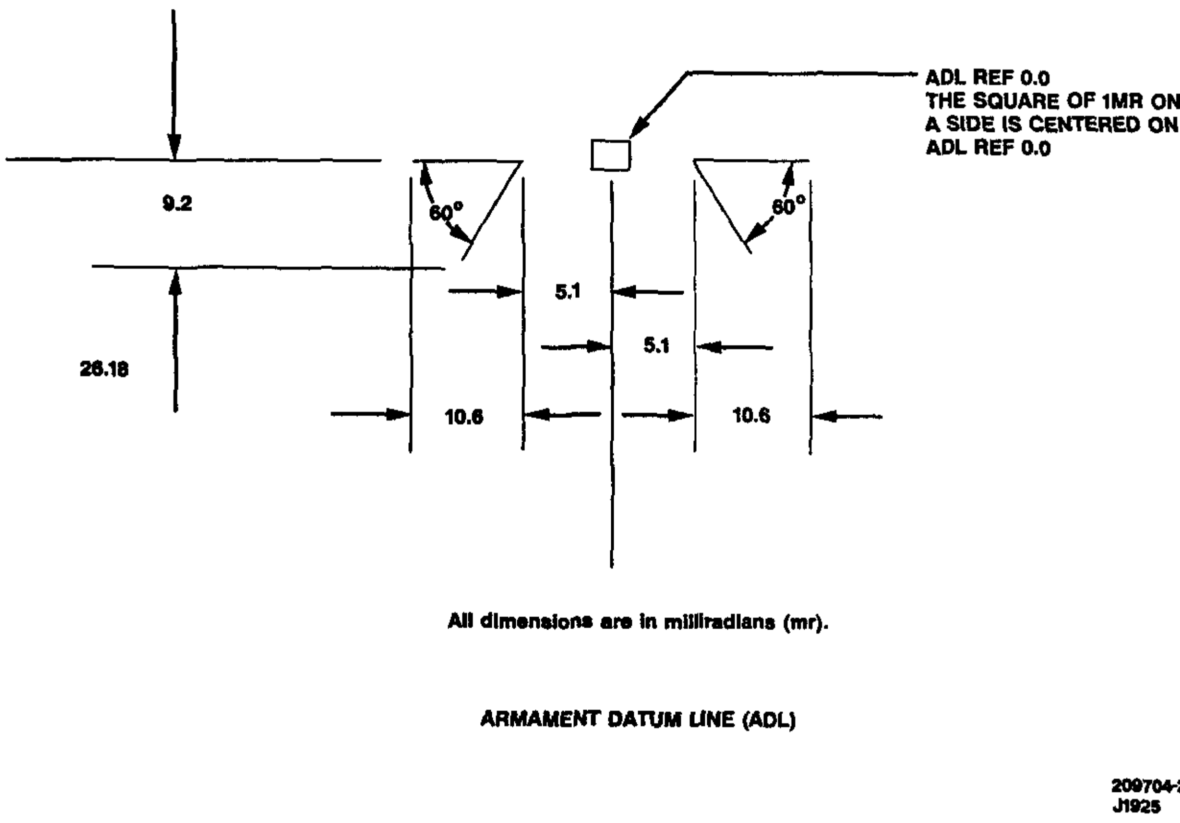
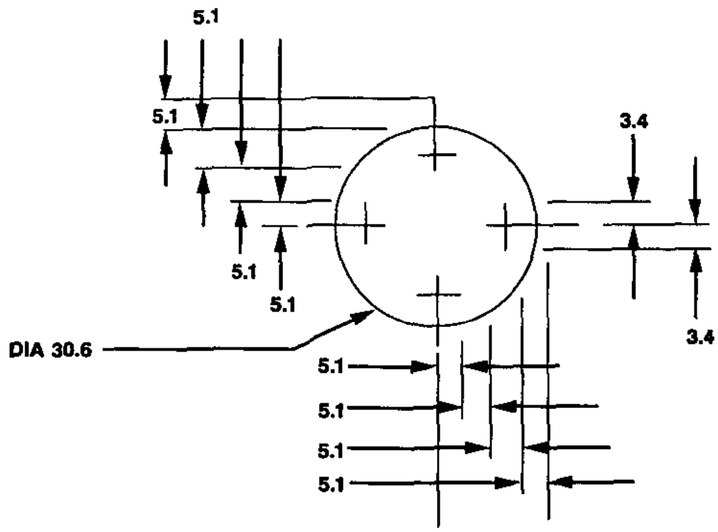
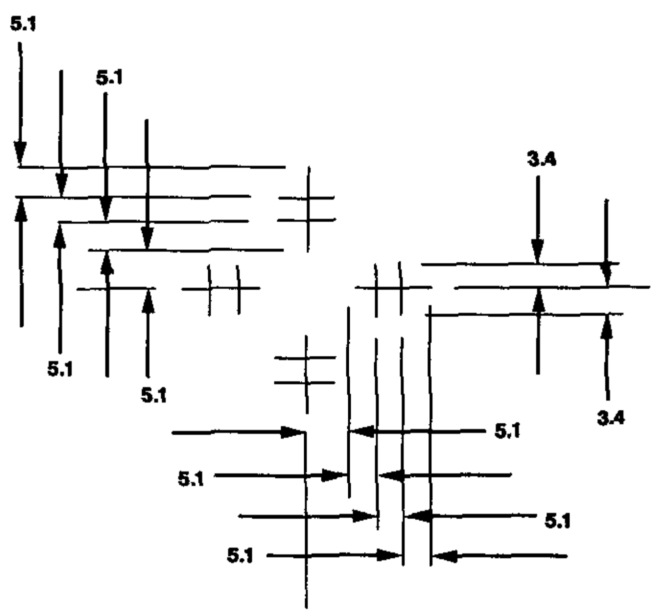


Figure 21-43. HUD Reticle Dimensions (Sheet 1 of 4)



All dimensions are in milliradians (mr).

GUN RETICLE



All dimensions are in milliradians (mr).

ROCKET RETICLE

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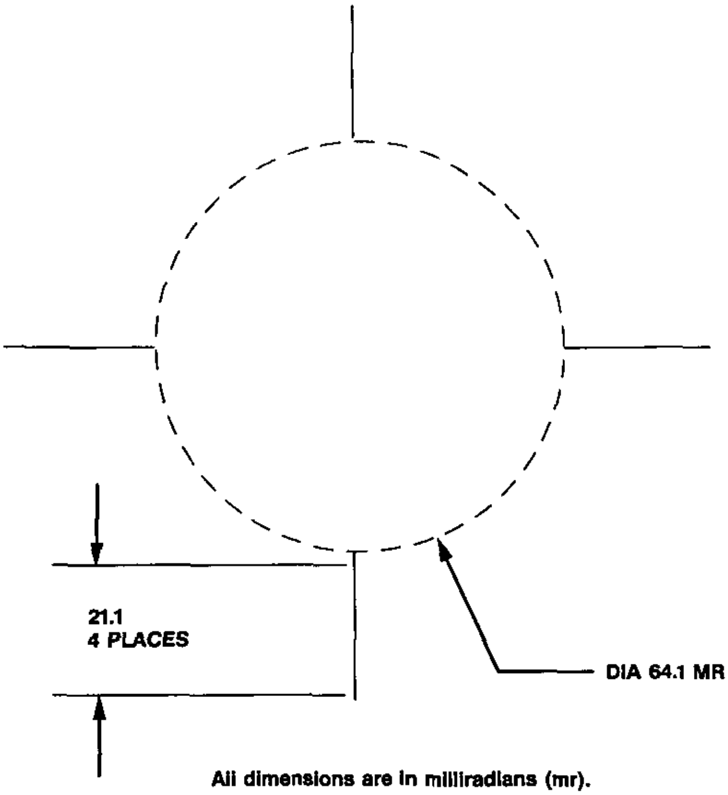
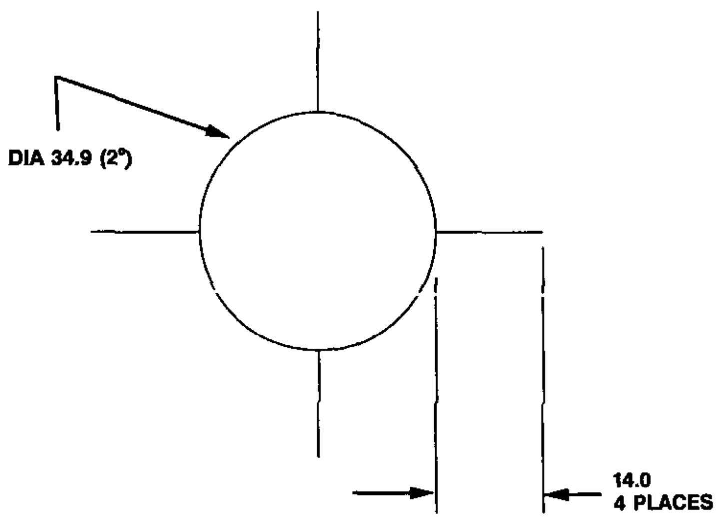
J1925

Figure 21-43. HUD Reticle Dimensions (Sheet 2 of 4)



All dimensions are in milliradians (mr).

SIDEWINDER CAGED



All dimensions are in milliradians (mr).

SIDEWINDER UNCHANGED

209704-215-3
J1925

Figure 21-43. HUD Reticle Dimensions (Sheet 3 of 4)

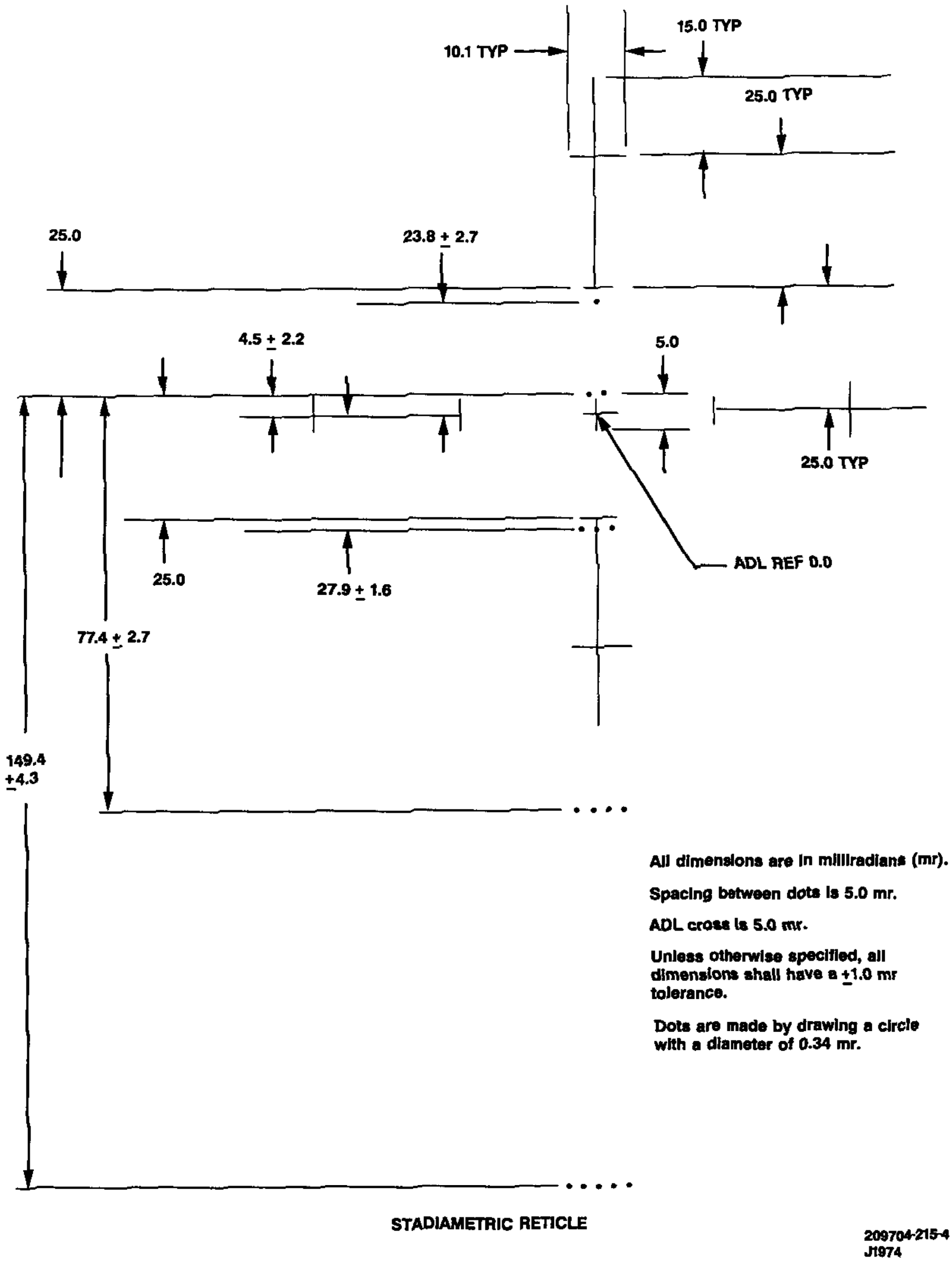
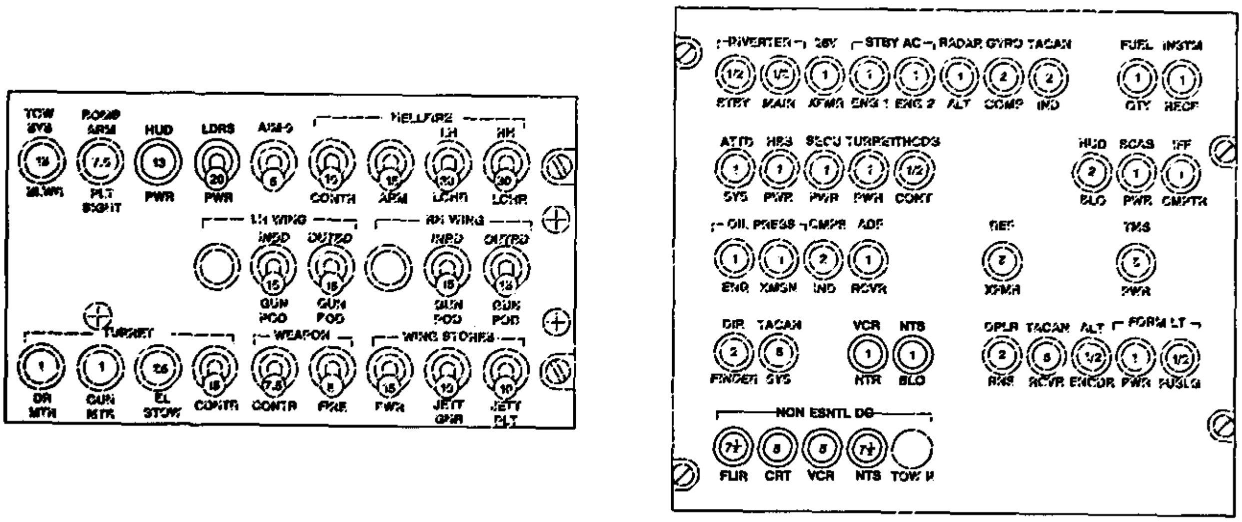


Figure 21-43. HUD Reticle Dimensions (Sheet 4 of 4)



CIRCUIT BREAKER	BUS/POWER SOURCE	APPLIES POWER TO AND PROTECTS CIRCUIT FOR
NIGHT TARGETING		
FLIR	28 vdc nonesntl	Forward looking infrared system power.
CCD	Not used	Not used.
CRT	28 vdc nonesntl	Cathode ray tube (tv video monitor) power.
VCR	28 vdc nonesntl	Video cassette recorder power.
NTS	28 vdc nonesntl	NTS power relay.
VCR HTR	115 vac ØA STBY INV	VCR heater.
NTS BLO	115 vac ØC STBY INV	NTS blower.
LDRS PWR	28 vdc esntl	Laser designator and range finding system power.

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J1761

Figure 21-44. Pilot Armament Circuit Breakers (Sheet 1 of 2)

CIRCUIT BREAKER	BUS/POWER SOURCE	APPLIES POWER TO AND PROTECTS CIRCUIT FOR
TURRET		
DR MTR	28 vdc esntl	Turret drive motor power control.
GUN MTR	28 vdc esntl	Gun motor power control.
EL STOW	28 vdc esntl	Turret stow control box.
CONTR	28 vdc esntl	Low level turret control.
WEAPON		
CONTR	28 vdc esntl	Weapon system control including IFCU.
FIRE	28 vdc esntl	Weapon system trigger control.
WING STORES		
PWR	28 vdc esntl	Weapon firing.
JETT GNR	28 vdc esntl	Gunner wing stores jettison power.
JETT PLT	28 vdc esntl	Pilot wing stores jettison power.
HSS PWR	115 vac ref xfmr	HSS and IFCU.
SECU PWR	115 vac ref xfmr	Servo electronics control unit.
TURRET PWR	115 vac ref xfmr	Turret ac control power.
HUD BLO	115 vac esntl	HUD signal processor blower power.
REF XFMR	115 vac esntl	Helicopter reference transformer.
TMS PWR	115 vac esntl	TOW missile system power.
THCDS CONT	115 vac ref xfmr	AC power to THCDP.

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J1761

Figure 21-44. Pilot Armament Circuit Breakers (Sheet 2 of 2)

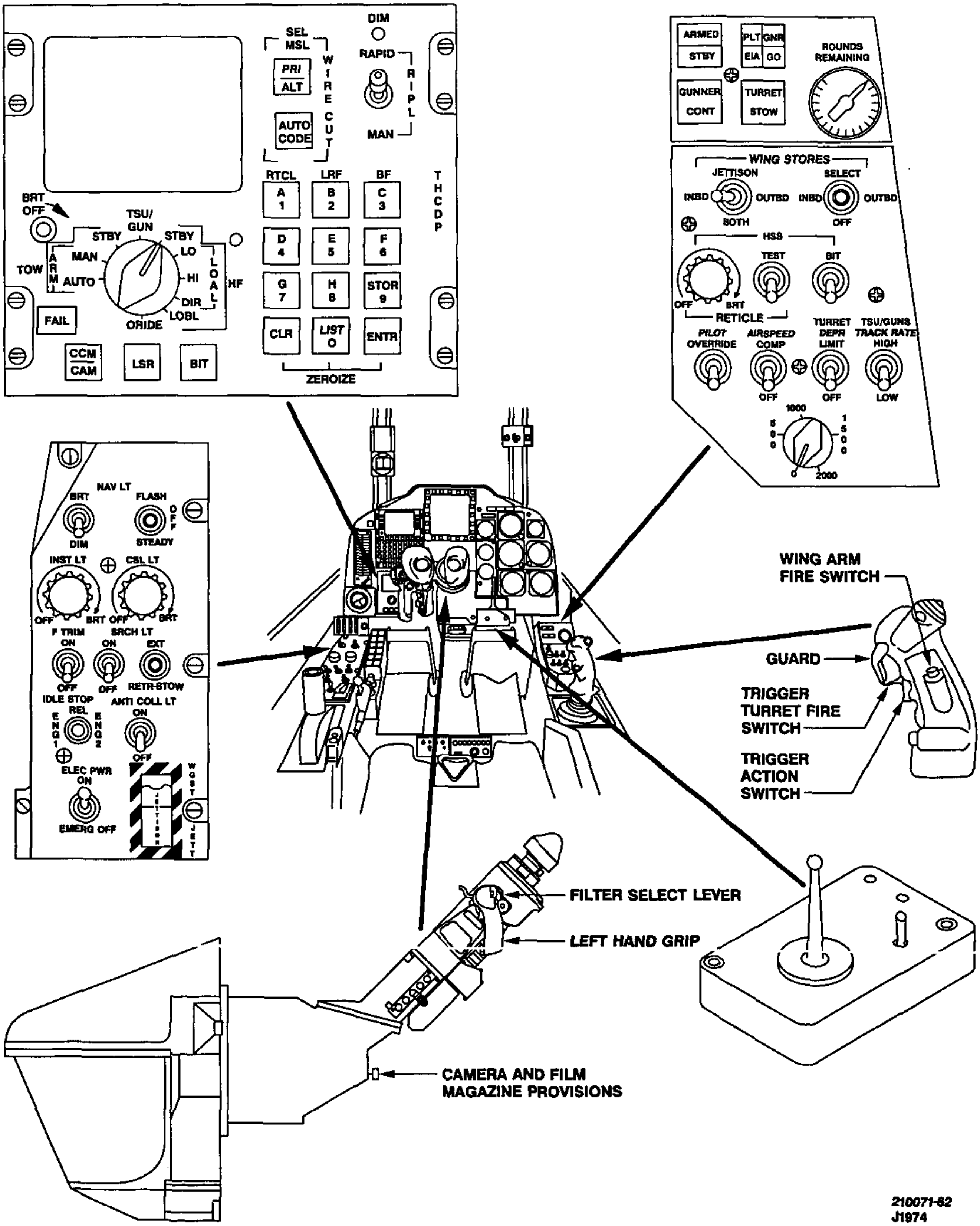
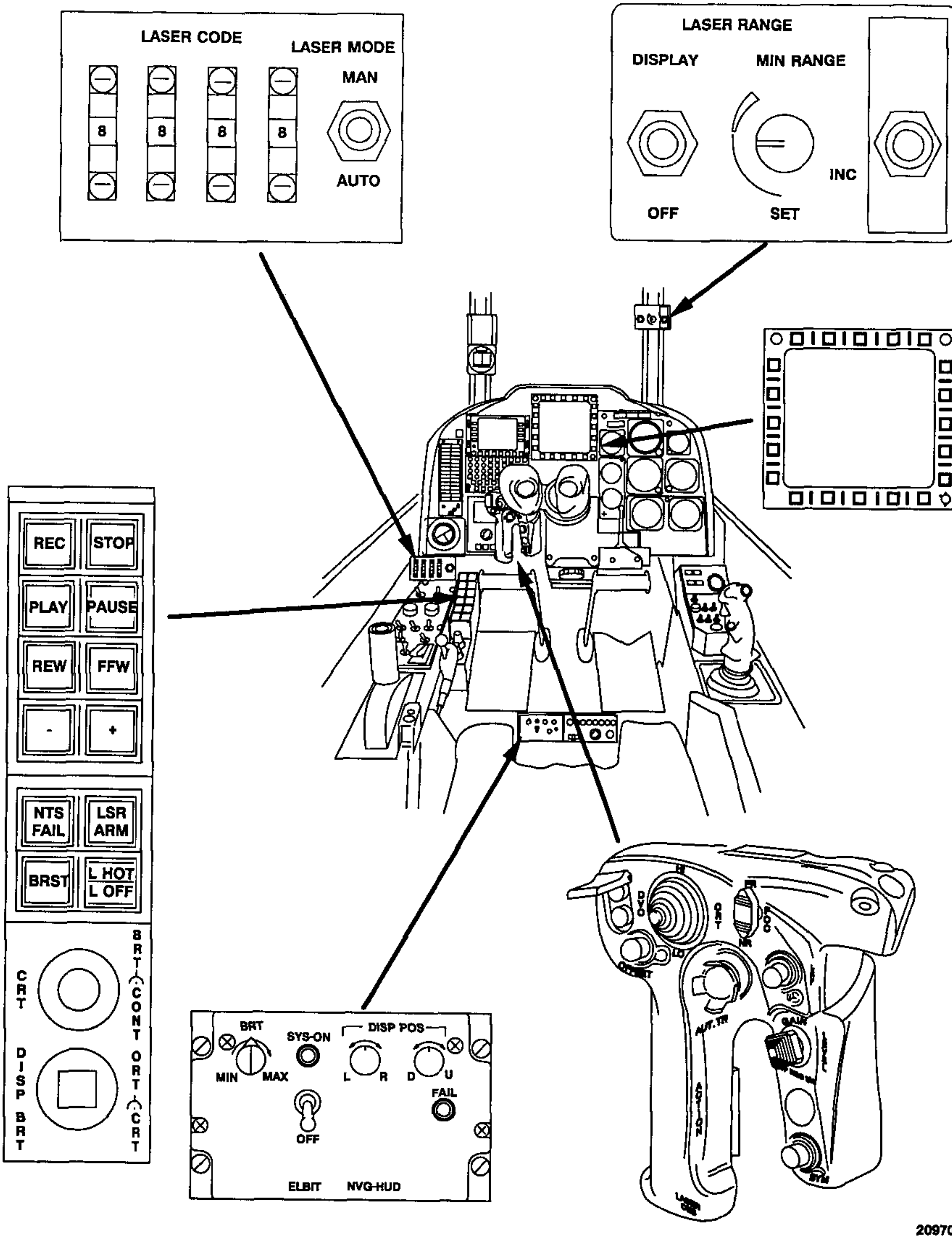


Figure 21-45. Copilot/Gunner Armament Controls and Indicators (Sheet 1 of 2)



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J1761

Figure 21-45. Copilot/Gunner Armament Controls and Indicators (Sheet 2 of 2)

21.12.3 TRIGGER ACTION Switch. The TRIGGER ACTION switch on the cyclic stick is used to slave turret movement to helmet sight movement and to provide a gun reticle in the fixed mode. A hinged guard prevents the TRIGGER ACTION switch from being inadvertently depressed. When the gunner is firing the turret by use of the LHG trigger, the pilot can interrupt by placing the WEAPON CONT switch to PILOT or FIXED or by placing the MASTER ARM switch to STBY or OFF.

21.13 GUNNER ARMAMENT CONTROLS AND INDICATORS

Gunner armament controls are illustrated in Figure 21-45. Refer to armament systems for controls not covered in the following paragraphs.

21.13.1 Gunner Armament Control Panel. The panel (Figure 21-45) is located on the gunner's right console and contains controls and indicators that enable the gunner to operate and monitor armament subsystems. The gunner can take armament command, provided the pilot MASTER ARM switch position is in STBY or ARM position, through the use of the PILOT OVERRIDE switch. The gunner can then fire the turret and wing stores, not TOW or Sidewinder, by use of the cyclic stick armament switches.

21.13.1.1 PILOT OVERRIDE Switch. The PILOT OVERRIDE switch is located on the gunner armament control panel (Figure 21-45). When in PILOT OVERRIDE, all pilot STORE CONTROL panel switch positions remain valid. The CP light on the pilot STORE CONTROL panel illuminates, GUNNER IN CONT light illuminates, and the pilot and gunner ARMED lights illuminate. Armament systems are armed and controlled by the gunner, with the exception of TOW, HELLFIRE, and Sidewinder (if installed). The TSU is disabled during PILOT OVERRIDE operation; however, the turret can be controlled by the HS. The gunner can then fire the turret by depressing the cyclic TRIGGER ACTION and the TRIGGER TURRET FIRE switches. Wing stores can be released or fired by placing the gunner armament control panel WING STORES SELECT switch in INBD or OUTBD and depressing the cyclic WING ARM FIRE button. When the gunner places the WING STORES SELECT switch to INBD, stations 2 and 3 are selected; when placed to OUTBD, stations 1 and 4 are selected. Placing the switch to OFF deselects all previously selected stations. The OFF position of the PILOT OVERRIDE switch allows normal control and operation of the armament systems. The pilot can disable all armament circuits by deenergizing the appropriate circuit breakers.

CAUTION

The pilot overrride switch will disable NTS and should be used only in emergencies in order to prevent inadvertent damage to NTS components

Note

LHG MSL guard must be down for wing arm fire circuits to revert to the gunner cyclic.

21.13.1.2 Gunner WING STORES SELECT Switch. The gunner WING STORES SELECT switch (Figure 21-45) selects which stores (inboard or outboard) are to be fired or released, as programmed by the pilot SCP when PILOT OVERRIDE is selected.

21.13.1.3 Wing Rocket Delivery Unit. Two identical and interchangeable WRDUs are installed in the helicopter, one on each wing. The WRDU provides interfacing between the NARCADS controls and switches and the wing stations. Each WRDU supplies the necessary switching and control functions for two wing stations. In addition to switching and control functions, the WRDUs receive the firing signals from the SCP and, in turn, activate the fire control relays which release the actual fire pulses to the selected wing stations. Fire pulse power is supplied by the helicopter electrical system. The WRDUs also receive jettison signals and transmit jettison signal pulses to selected wing stations.

When in PILOT OVERRIDE, the armament system is armed and may be fired if MASTER ARM switch is in STBY or ARM position.

The gunner, while in PILOT OVERRIDE, may select but not fire dissimilar stores if dissimilar stores are loaded on opposite inboard or outboard stations. It is essential to place the PILOT OVERRIDE switch to the override position prior to placing the wing stores select switch to either INBD or OUTBD position. Placing the WING STORES SELECT switch to either INBD or OUTBD position prior to placing the PILOT OVERRIDE switch in the override position could result in deselecting the desired weapons station on the NARCADS and preventing delivery of the desired ordnance.

CAUTION

NTS The PILOT OVERRIDE switch will disable the NTS and should be used only in emergencies in order to prevent inadvertent damage to NTS components.

21.14 NTS NIGHT TARGETING SYSTEM

WARNING

Laser operation is involved in performing the following tests. Standard laser precautions in ANSI Z136.1-1986 must be followed. Wear appropriate goggles during laser operation.

21.14.1 Operation. The Night Targeting System (NTS) is a fire control system providing the flightcrew with the ability to detect, acquire, track, lock on, range, and designate targets under day, night, and adverse weather conditions.

In accomplishing these functions, the NTS in conjunction with the existing M-65 TSU and armament system incorporates the following functions:

1. Weapon Aiming
2. Observation
3. BIT and In-Flight Boresight
4. Line of sight (LOS) Stabilization and Steering
5. Automatic Tracking (Lock On)
6. Display
7. Coordinate Computation
8. Automatic Controls
9. Manual Controls.

The weapon aiming function enables the flightcrew to direct fire accurately to a specified target. The weapons aiming portion of the NTS consists of laser designation (for HELLFIRE missiles and other laser-guided weapons), laser rangefinding, Xenon Error detection (for TOW missiles), and gimbals direction (for M-197 gun).

The neodymium YAG laser operates on a wavelength of 1064 nanometers. The laser energy can be used for rangefinding or be coded for guiding laser directed munitions. The laser designating and ranging system (LDRS) is mounted on top of the TSU.

The observation function enables the flightcrew to locate and sight targets. It includes day vision optics (DVO), television camera (TVC), and thermal imagery (FLIR). Selected video (FLIR/TVC) is displayed on both the multifunction display (MFD) and the CRT.

The TVC operates in the visible light spectrum and produces a black and white video image. The FLIR operates in the infrared spectrum sensing energy in the infrared wavelength range. The germanium window is opaque to most light, but passes eight wavelengths. The FLIR detector strip is cooled so that detectors will measure the IR energy that passes through the germanium window. The FLIR IR energy is scanned across a 120-element detector strip that transmits a signal to the FLIR electronic box (FEB). The signal is then processed into a two dimensional video image for display on the CRT or MFD.

The VCR can record on either SVHS or standard VHS tapes. The VCR automatically senses which tape is installed and will record high resolution on SVHS tapes and standard resolution on VHS tapes. If SVHS tapes are used, then an SVHS VCR must be used for playback.

CAUTION

Forcing the VCR tape release button or knob to remove a tape from the VCR will result in damage to the tape eject mechanism. To remove a tape from the VCR, the STOP button on the cockpit control unit panel (CCUP) must be pressed prior to turning off power to the NTS.

Note

If MFD blanks (turns off) during playback of recorded video, cycle OFF/N/D (power) to OFF, then ON.

The built-in test (BIT) function is designed to detect failures and to isolate faults in NTS on ground, aboard ship, and in flight. Extended BIT starts upon command from the copilot/gunner by pressing the BIT button on the THCDP (initiated BIT) or when the system is powered on. Periodical BIT executes the entire time the NTS is in operating mode. Each subsystem performs autonomous extended or periodic BIT and reports a diagnostic message to the processor electronic box (PEB). The PEB software analyzes the NTS status and displays BIT results on the CRT/MFD to the subsystem level functions and diagnostic failures. During the boresight process, NTS will enter initiated BIT by pressing the BIT button on the THCDP. After initiated BIT is complete, NTS will complete the boresight process.

The boresight function is designed to accurately align and boresight the different sensors and optical subsystems of the NTS. Boresight is conducted on the ground or airborne after the FLIR detectors have cooled by pressing the boresight (BRST) button on the CCUP.

Note

Successful boresight is optimized when conducted on the ground. Successful airborne boresight is optimized at night at 90 knots straight and level flight. Airborne boresight may require up to three attempts to pass.

The stabilization and steering function allows the flightcrew to aim the system LOS to track targets. It includes manual and automatic tracking and slaving functions as well as standard TMS motion compensation.

The display function provides the interface between the aircrew and the observation function. It contains direct view through the normal TSU optics, a FLIR/TV video, or a recorded VCR image through the MFD/CRT. There is also an alphanumeric information system that allows the aircrew to monitor the system status.

The coordinates computation function provides the aircrew with target range and magnetic azimuth. After integration with the TNS, it will provide target coordinates and present position coordinates.

Control functions provide the aircrew with the ability to use all system functions. The automatic command and control function contains servo controls, system operational logic, symbol generator, communication control and data computations. Manual command and control function contains: left hand grip (LHG), TOW/Hellfire control display panel (THCDP), optical relay tube (ORT), sight hand control (SHC), and control panels.

The NTS is a modification and an enhancement of the M-65 system. The discussion and descriptions that follow refer to those functions that are added to or modified on the M-65 system. The additional and modified hardware devices are sorted according to the system functions.

21.14.1.1 Aiming Function Hardware. Additions to the aiming function include adding the laser designating and ranging system (LDRS). The LDRS provides coded laser information for the HELLFIRE or other laser-guided weapons. The other weapon aiming devices, goniometer (for TOW) and gimbal direction (for gun), are not altered.

21.14.1.2 Observation Function Hardware. The FLIR system provides the thermal image. A TV camera replaces the standard TSU 16-mm gun camera and provides the day television image to the MFD/CRT. These two systems are added to the existing DVO, which maintains its performance.

21.14.1.3 Boresight Function Hardware. The boresight subsystem automatically aligns the goniometer LOS and the LDRS LOS to the FLIR and TVC LOS.

The boresight subsystem includes the collimator that produces a common source for the goniometer and FLIR. The boresight subsystem also transforms the laser radiation from a common source with the required wavelength for the FLIR and for the TVC. This subsystem contains a corner cube assembly that transfers all the radiation sources to or from the FLIR, collimator, goniometer, and LDRS. The TV tracker enables the automatic boresight procedure by measuring the location of the common sources and aligning the LDRS and FLIR reticle to them. These sources are already aligned to the goniometer and DVO/TVC reticle. The original boresight between the DVO reticles and the goniometer is unaffected. Boresight function will be initiated by command from the BRST switch on the CCUP, and may take up to 100 seconds to complete.

21.14.1.4 Steering Function Hardware. The gimbals of the system are inertially stabilized and all the subsystems are mounted to them. The stabilized LOS of the sensors are designed to allow the operator to distinguish and engage targets.

The operator can acquire and track targets by driving the gimbals in elevation and azimuth through the steering devices. The existing SHC provides manual tracking while the addition of the TVT provides the automatic tracking feature and is engaged by a control on the LHG. The features of the HSS remain unchanged.

21.14.1.5 Display Function Hardware. The NTS uses a CRT/MFD to display video signals from the FLIR, TVC, or VCR. The CRT is attached to the existing ORT. The addition of a channel selector switch to the LHG allows the operator to choose between the DVO and the video images. A manual channel selector handle is incorporated on the right side of the ORT for backup in the event of electrical control failure. Rotating the channel selector handle aft selects DVO and rotating it forward selects video imaging. There is a seven segment alphanumeric display area and four caution lamps inside the ORT. The M-65 TSU ATTK, RDY, and GUNS indicators are no longer mechanical flags, but are LED displays A, R, and G mounted on fixed flags. These annunciators will also be displayed as ATTK, RDY, and GUNS video on MFD.

21.14.1.6 Coordinates Computation Function Hardware. The range finder target designator laser (RFTDL) provides the range to the target. The TSU provides the TSU elevation and azimuth angles. The heading gyro provides the aircraft heading. The TNS provides the present aircraft position (in LAT/LONG), pitch, and roll. The PEB performs the coordinates computation.

21.14.1.7 Automatic Controls Hardware. All of the new and modified electronic boxes that provide automatic control are listed below. The PEB contains the following functions:

1. System CPU
2. Operational logic
3. Boresight procedure
4. Tracking loops
5. Special computation (coordinates) when integrated with TNS
6. Video signal symbols
7. System BIT control

The CCUP performs the following functions:

1. Organizes all electrical signals
2. Converts electrical signals to serial data bus communications
3. Controls all status signals
4. Controls the VCR

The SCA has been modified and in addition to its original purpose, now performs these new functions:

1. Improved stabilization of the TSU gimbals
2. Autotrack capability
3. Scales the HUD gunner TSU reticle to indicate post launch constraint limits of the modified TSU.

The MCA has been modified to allow operation of the TOW II/IIA to its design envelope.

21.14.1.8 Manual Controls Hardware. This group of devices is the interface between the electrical components and the operator. These components additionally allow the operator to control all the system functions that require input from the gunner. These manual controls and their functions are as follows:

1. LHG contains the switches that control the most necessary weapon system aiming functions (Figure 21-46).
2. LRP contains an OFF/DISPLAY switch, minimum range setting potentiometer and the gunner emergency UHF selector switch (Figure 21-47).
3. THCDP performs all of previous functions and supplies some signals and functions to the NTS.
4. CCUP contains all switches for operating the VCR, ORT, CRT, boresight and status lights (Figure 21-48).
5. LCP is used to manually set LDRS designation codes and to control the display of the detailed NTS BIT on the CRT when the LASER MODE select switch is in the MAN position (Figure 21-49).
6. Laser LAST/FIRST switch is used to manually select range based on laser pulse energy return.

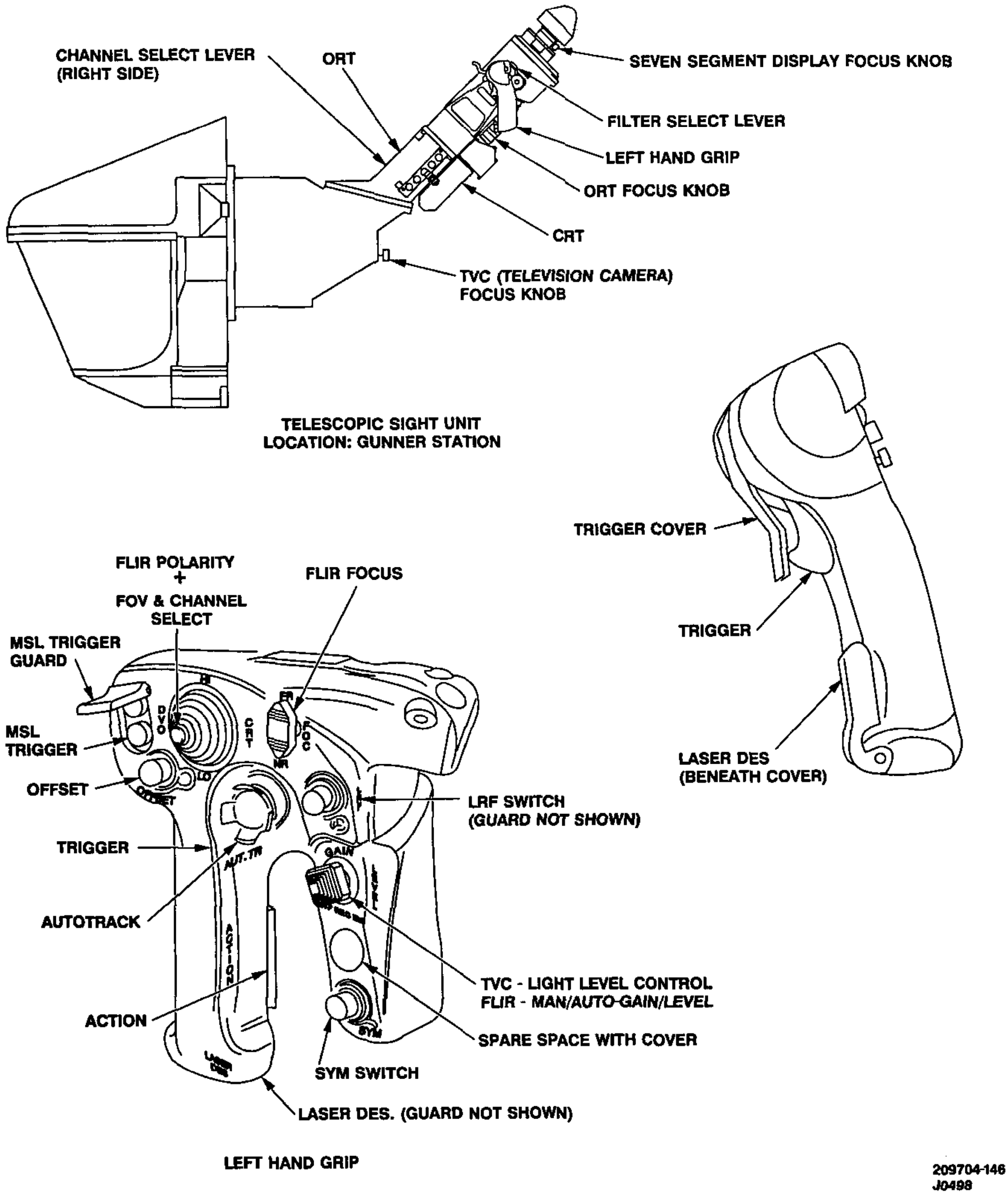
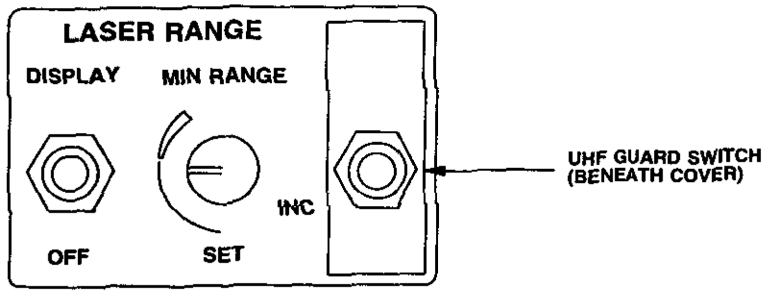


Figure 21-46. Left Hand Grip



LRP NOMENCLATURE	POSITION / ACTION	FUNCTION
MIN RANGE/SET (knob)	INC	- Clockwise movement increases minimum range recognized by the RFTDL. - Adjustment range is 250 to 6000 meters.
DISPLAY/OFF (switch)	DISPLAY	- Turns ORT seven segment and video symbology minimum range display ON. During lasing, target range is displayed if greater than MIN RANGE setting.
	OFF	- Turns ORT seven segment and video symbology minimum range display OFF.
UHF GUARD (switch)	Push Up	- Gunner selects GUARD channel on command and tactical UHF radios.

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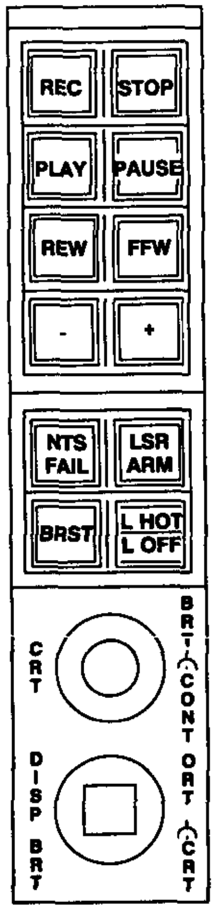
Figure 21-47. Laser Range Panel



CCU

CCU KEY NOMENCLATURE	POSITION/ ACTION	FUNCTION
REC Switch	Press	- VCR records signal from TVC or FLIR.
Light	Indicator	- Illuminates when VCR is in REC mode.
Play Switch	Press	- VCR will send video signal for display on CRT.
Light	Indicator	- Illuminates when VCR is in PLAY mode.
STOP Switch	Press	- Stops VCR operation regardless of CCU present mode of operation.
Light	Indicator	- Illuminates when VCR is in STOP mode.
PAUSE Switch	Press	- Freezes image on CRT when VCR is in PLAY or REC mode. PAUSE function is overridden after 5 minutes or by pressing any other function key.
Light	Indicator	- Illuminates when VCR is in PAUSE mode.

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Figure 21-48. Cockpit Control Unit Panel (Sheet 1 of 3)

CCU NOMENCLATURE	POSITION/ACTION	FUNCTION
REW Switch	When in Play or Pause:	
	Press one time	- VCR begins fast reverse search.
	Press twice	- VCR begins fast rewind.
	Press three times	- VCR goes back to reverse search.
Light	Indicator	- Illuminates when VCR is in REW mode, or in reverse search together with PLAY light.
FFW Switch	When in Play or Pause:	
	Press one time	- VCR begins fast forward search.
	Press twice	- VCR begins fast forward mode.
	Press three times	- VCR goes back to fast forward search.
Light	Indicator	- Illuminates when VCR is in FFW mode, or in forward search together with PLAY light.
-Switch	When in Play or Search:	
	Press	- Decreases VCR speed.
Light	Indicator	- Illuminates when VCR is operating at slower than normal speed.
		- Pages backward through NTS maintenance pages.
+Switch	Press	- Increases VCR speed.
Light	Indicator	- Illuminates when VCR is operating at faster than normal speed.
		- Pages forward through NTS maintenance pages.
NTS FAIL Switch	Press	- Acknowledges failure functions of NTS by displaying the list on video picture.
Light	Indicator	- Illuminates when any component of NTS fails.
LSR ARM light	Indicator	- Illuminates when all interlocks to laser system are engaged.
L HOT light	Indicator	- Illuminates when laser is hot and automatic shutoff is imminent. Operator should stop lasing.
L OFF light	Indicator	- Illuminates when laser temperature threshold has been exceeded and system has shut down to avoid damage. Light will extinguish when temperature has decreased to safe limits and BIT has passed.
CRT (concentric knob)	BRT (outside knob)	- Increases and decreases brightness of the image displayed on the CRT.
	CONT (inside knob)	- Increases and decreases contrast of the image displayed on the CRT.
DIST BRT (concentric knob)	ORT (outside knob)	- Increases and decreases brightness of the seven segment display on the ORT. The ORT brightness is dual range. Brightness range is a function of CAUTION panel being in BRIGHT or DIM position.
	CRT (inside knob)	- Increases or decreases brightness of the symbols displayed on the CRT.
BRST Switch	Press	- Initiates boresight process.
Light	Indicator	- Illuminates when the boresight is in progress.

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Figure 21-48. Cockpit Control Unit Panel (Sheet 2 of 3)

CCU NOMENCLATURE	POSITION/ACTION	FUNCTION
REW And - switches	Press simultaneously	- Event mark search (reverse)
FFW And + switches	Press simultaneously	- Event mark search (forward)
- Switch	When in D888 Mode: Press	- Increases the hours of the clock at a slow rate
- And REW switches	When in D888 Mode: Press	- Increase the hours of the clock at a high rate
+ Switch	When in D888 Mode: Press	- Increases the minutes of the clock at a slow rate
+ And FFW switches	When in D888 Mode: Press simultaneously	- Increase the minutes of the clock at a high rate

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Figure 21-48. Cockpit Control Unit Panel (Sheet 3 of 3)

21.14.2 Display Function. There are two types of displays: sensor images and mission/system data. These displays are combined on the video image.

21.14.2.1 Sensors Image Display. The sensor image display function is divided into the following subfunctions:

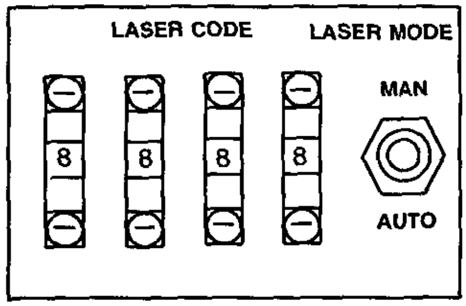
1. Channel selection
2. FOV selection
3. VCR control
4. DVO adjustment
5. CRT adjustment
6. FD adjustment
7. Eyecup adjustment.

21.14.2.1.1 Channel Selection. The gunner can select either direct view or video image for visual input from the TSU. The MFD only displays video images. There are two ways of making the selection:

1. Pressing the channel selector switch on the LHG to the left selects DVO image while pressing it to the right selects video image. This switching action is momentary, requiring less than 1 second to complete.
2. Rotating the channel selector lever on the right side of the ORT aft selects DVO and rotating this selector lever forward selects video imaging. The switching action performed using this selector lever is mechanical and will operate even if the system central processing unit (CPU) has failed or system power is off.

21.14.2.1.2 Video Image Selection. The choice of video image selection is between TV camera and FLIR. The channel selector switch of the LHG is used for this function. Pressing the channel selector switch to the right while the DVO channel is selected will select the video channel. Pressing the channel selector switch to the right while the video channel is selected will select between FLIR and TVC image alternately.

Changing the channel from DVO to CRT will result in TVC image being displayed. Upon initial power-up, video displayed to the CRT/MFD or VCR will default to the channel that was in operation at power-down. The video image selection is controlled by system CPU. If a system failure occurs that inhibits video selection, the FLIR video image is displayed.



LCP

LCP NOMENCLATURE	POSITION / ACTION	FUNCTION
LASER CODE (pushbuttons)	XXXX	- Four pushbuttons select laser codes and maintenance codes.
	A1XX	- Causes all system function failures to LRU level to be displayed on CRT.
	B2XX	- CRT symbology will detail failures of each LRU and SRUS. - +/- pushbuttons on the CCU allow selection of LRU pages.
	C3XX	- Causes all system failures from a nonvolatile memory to LRU level to be displayed on CRT.
		NOTE Use only authorized maintenance codes. Use of unauthorized codes can adversely affect FLIR and laser boresight accuracy.
	D444	- Erases the information written in the nonvolatile memory.
LASER MODE	MAN	- Enables laser code and maintenance codes to be selected by the LCP.
	AUTO	- The LDRS laser code will be selected by the THCDP priority missile code.

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Figure 21-49. Laser Code Panel

If one of the video sensors, TV camera or FLIR, is powered off or disconnected, a uniform image is displayed instead of the image normally received from that source.

The VCR functions may be selected by the use of controls on the CCUP. Pulling the trigger or firing the laser will override the CCUP controls and the VCR will begin recording.

21.14.2.1.3 VCR Display.

1. Inputs to VCR — With channel selector in the CRT position, the VCR records the same video that is being displayed through the ORT. If the channel selector is in the DVO position, the VCR will continue to record from the last video source that was being displayed on the CRT/MFD before the selection was made to DVO. The audio recorded is determined by gunner CSC panel selection.

2. Controlling the VCR — Control of the VCR may be either automatic or manual at the discretion of the gunner.

   a. Automatic Controls.

      (1) Record — This function will be placed in operation regardless of previous selection whenever the trigger or laser designator switches on the LHG are pressed. Recording will continue until the STP button is pressed on the CCUP. When a missile is present, firing a Hellfire missile using the MSL switch on LHG or either WING ARM FIRE switches will cause the VCR to automatically record. The firing also causes an event mark and TR to display on the MFD.

      (2) Event Mark — An event mark is placed on the tape for 3 seconds whenever the trigger or laser designation switch is pressed while the VCR is recording. The event marks are incrementally displayed in the upper left corner of the CRT/MFD.

      (3) Stop — When the cassette reaches its end the VCR stops automatically.

   b. Manual Controls — CCUP.

      (1) PLAY — Pressing this switch causes VCR to play video tape, and recorded image will be displayed on CRT/MFD overriding all other video signals from TVC or FLIR. Channel must be in CRT to view playback or search the video tape.

      (2) STOP — Pressing will stop VCR operation from any mode. The display on the ORT will return to the video image of the previously selected sensor, TVC, or FLIR.

      (3) PAUSE — With VCR in the PLAY mode, pressing this switch will freeze the image on the CRT/MFD. The VCR will automatically return to the previously selected mode after being in PAUSE for 5 minutes or will perform the required function if another function is selected.

      (4) REW — From the PLAY mode, first press will cause VCR to fast reverse search. Video will be displayed from tape and PLAY and REW lights are illuminated. Second press will cause fast rewind. No video will be seen and REW light is illuminated. From the STOP mode, pressing the REW key one time will cause VCR to fast rewind, no video will be seen, and the REW light will be illuminated. During fast rewind, the CRT/MFD will display TVC or FLIR as selected.

      (5) FFW — From the PLAY mode, first press causes fast forward search, video will be displayed from the tape, and PLAY and FFW lights are illuminated. Second press causes fast forward mode, video will not be displayed from the tape, and FFW light will be illuminated. From STOP mode, pressing the FFW key one time will cause VCR to fast forward, no video will be seen, and the FFW light will be illuminated. During fast forward, the CRT/MFD will display TVC or FLIR as selected.

(6) "-" — Decreases VCR speed in PLAY and SEARCH modes. The indicator light in this button will illuminate and remain illuminated as long as VCR speed is below normal.

(7) "+" — Increases VCR speed in PLAY and SEARCH modes. The indicator light in this button will illuminate and remain illuminated as long as VCR speed is above normal.

(8) CCUP indicator lights are tested by placing the gunner CAUTION panel TEST switch momentarily in the TEST position.

(9) REW and "-" — Searches backward for the nearest electronic event mark. VCR enters into playback mode when that event is reached. The five most recent electronic event marks shall be retained as long as the system is powered.

(10) FFW and "+" — Searches forward for the nearest electronic event mark. VCR enters into playback mode when that event is reached. The five most recent electronic event marks shall be retained as long as the system is powered.

21.14.2.1.4 CRT Adjustment. CRT has only brightness and contrast adjustments, which are accomplished using BRT and CONT controls on CCUP. Adjustments are made as follows:

1. Adjust ORT focus.
2. Switch ORT channel to FLIR.
3. Press SYM on declutter switch, hold 3 seconds.
4. FLIR gray scale image appears on CRT.
5. Adjust brightness and contrast as preferred.
6. Press SYM on declutter switch.
7. FLIR gray scale image disappears from CRT.

21.14.2.1.4.1 MFD Adjustment. The MFD is adjusted using the BRT and CONT controls on the MFD. Adjustments are made as follows:

1. Switch to FLIR channel.
2. Press SYM (declutter) switch, hold 3 seconds.
3. FLIR gray scale image appears on MFD.
4. Adjust brightness and contrast as preferred.
5. Press SYM (declutter) switch.
6. FLIR gray scale image disappears from MFD.

21.14.2.1.5 TVC Adjustment. Focus adjustments of the TVC are accomplished as follows: Adjust ORT DVO HI mag focus to infinity. Switch CRT channel to TVC. Adjust TVC FOCUS knob on TVC. Adjust brightness and contrast using knobs on CCUP.

21.14.2.1.6 Data Displays. The two types of data displayed to aircrew by NTS are system and mission data. This data is displayed in the form of video images, four (seven segment) digits in ORT, and by status and caution lights on system panels. These two types of data are further divided into two groups: FLIR (presented during FLIR observation) and system data which can be controlled by command from the gunner (figures 21-50 and 21-51).

1. FLIR messages.

   a. HOT DET — Indicates a hot FLIR detector element. FLIR is not operational when this message appears.

Note

After initial power-up of NTS, a normal cooling period of 3 to 5 minutes is required before FLIR is operational. Under certain conditions, it may require up to 10 minutes for FLIR to become operational.

   b. MANUAL GAIN/LEVEL — Manual GAIN/LEVEL is indicated by the word MAN. Bar graphs show relative gain and level in the manual mode. Bar graphs will disappear 5 seconds after adjustment, but will reappear each time manual adjustments are made.

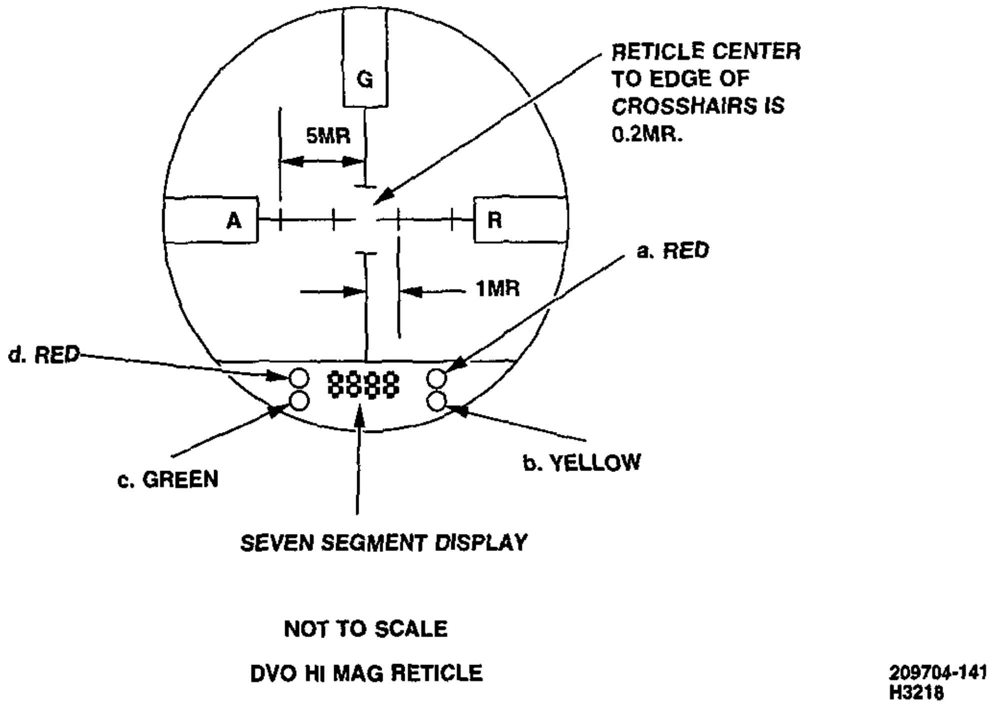


Figure 21-50. ORT Display in DVO Mode

c. FOCUS REFERENCE INDEX — Gives gunner a reference at which the FLIR is focused. Focus reference is represented by one or two digits ranging from 5 ± 5 (near focus) and 90 ± 10 (far focus). This index appears while the focus is engaged, and disappears 3 seconds after release of the focus switch.

d. ZOOM — Zoom indication appears when zoom is activated with FLIR in narrow FOV.

e. FLIR RETICLE — A distinct and different FLIR displayed for each of three different FOV screens.

2. Other Messages.

a. TSU magnetic azimuth — A 180 scale indicating TSU magnetic azimuth. Below the scale is a digital indication of turret magnetic azimuth.

b. Aircraft heading — A marker indicating aircraft magnetic heading.

c. Target Direction — A marker indicating calculated relative direction from helicopter to a selected target position. This function will be incorporated when integrated with TNS.

d. FLIR polarity and AUTOTRACK status — A bar graph indicates AUTOTRACK quality and FLIR polarity. The large bar graph shows FLIR polarity. One small bar adjacent to the large one indicates medium autotracking quality. Two small bar graphs, one on each side of the large one, indicate good autotracking quality. When neither of the two small bar graphs is present, autotracking quality is poor.

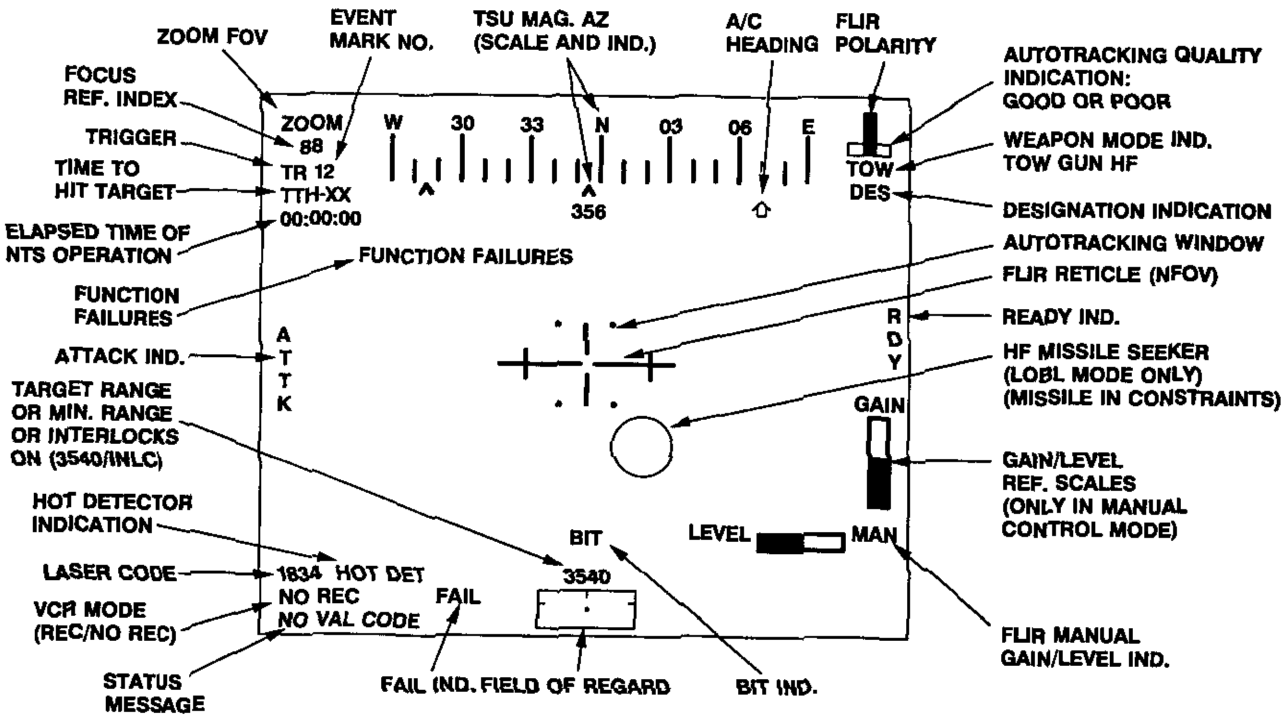
e. Weapon Select — Indicates weapon selected: TOW, GUN, or HF.

f. DES — Displayed during laser designation.

g. System Power — ON Time. An elapsed time counter presenting time from NTS power up until power off.

h. TR — Displayed during TOW/GUN trigger pull.

i. Event Mark — Each press of the trigger or designation switch will increment the



SYMBOLS CAPABILITY WITH FLIR AS IMAGE SOURCE

NOTE: All symbols shown will not be displayed at the same time.

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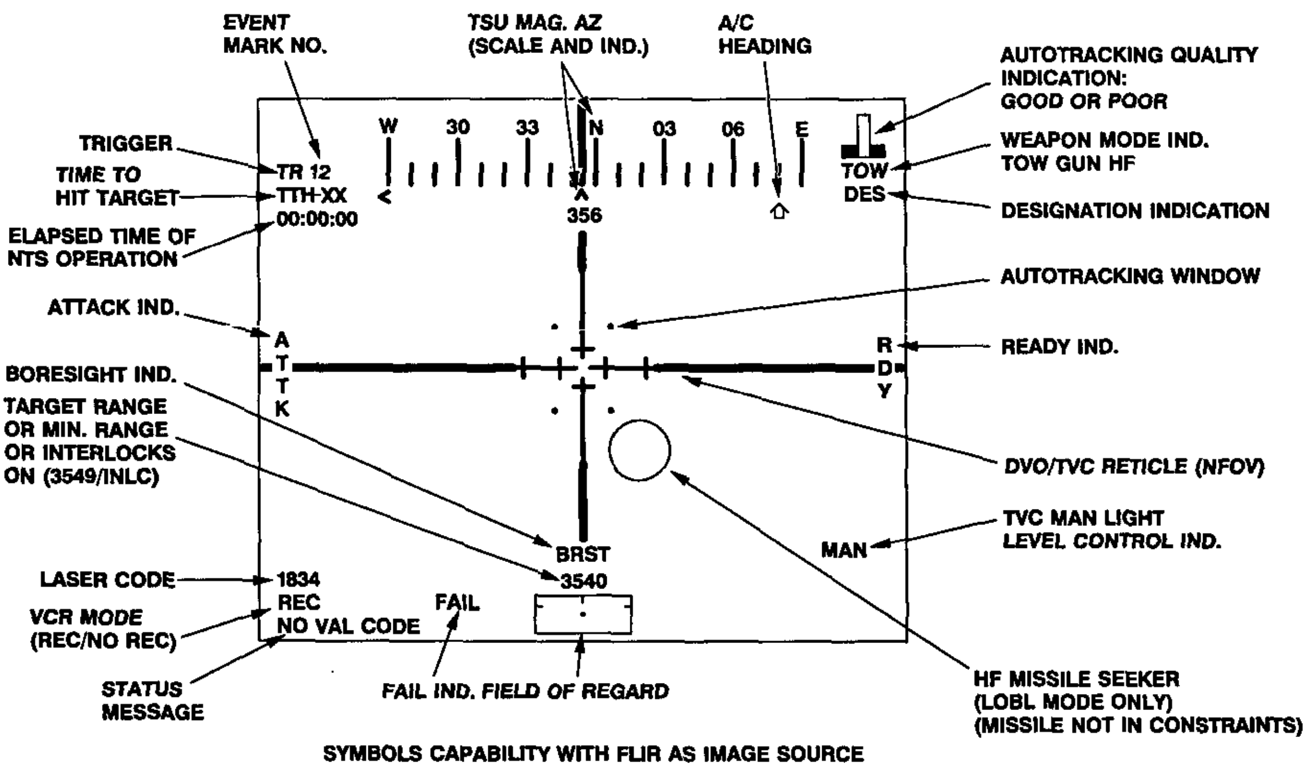
Figure 21-51. MFD/CRT Symbols Capability (Sheet 1 of 2)



SYMBOLS CAPABILITY WITH FLIR AS IMAGE SOURCE

NOTE: All symbols shown will not be displayed at the same time.

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Figure 21-51. MFD/CRT Symbols Capability (Sheet 2 of 2) event counter by one. These event marks are viewed on the CRT/MFD symbology and during playback.

j. TTH — Displays the time required for a TOW or HELLFIRE missile to hit the target. Displayed during rangefinding and designation.

k. ATTK — M-65 operational mode. In HELLFIRE mode, ATTK indicates that the missile has been selected, armed, and has accepted the laser code provided by the THCDP.

l. RDY — M-65 operational mode. In HELLFIRE mode, RDY is displayed when HELLFIRE LOBL prelaunch constraints are met.

m. Laser Range — Displays distance from helicopter to target during rangefinding and for 5 seconds after trigger is released. If no valid return is received, the display shows "----". INLC is displayed if laser firing is attempted with any safety interlock not in place.

n. Laser Code — Displays the laser code received by LDRS.

o. Present Position — Coordinates when integrated with TNS.

p. Target Coordinates — Not used.

q. Autotrack Indication — Four dots are placed around the target during autotrack mode. In predictor mode, the dots will blink.

r. BIT Message — Displays FAIL when any failure is found during BIT. The FAIL indication in the ORT will illuminate as well as NTS FAIL light on CCUP.

s. Status Messages:

(1) NO FL BRST — Illuminates when FLIR boresight does not complete during boresight process. If HOT DET is also displayed, gunner must initiate boresight after FLIR detector elements have cooled sufficiently to extinguish HOT DET display.

(2) NO VAL BRST — Displays if NTS is placed into service before completing boresight.

(3) NO VAL CODE — Displays if a valid laser code has not been entered.

t. REC — Displayed while the VCR is recording. It flashes at the frequency of one Hz in PAUSE mode.

u. NO REC — Displayed while VCR is not recording.

v. BRST — Displayed during boresight process.

w. BIT — Displayed during BIT process.

x. Field of Regard — Indicates LOS position relative to its field of regard.

y. MAN — In TVC channel, indicates that sight level control is in manual mode.

21.14.2.1.7 Control of Video Data Display. Brightness and contrast may also be adjusted for clarity with knobs on CCUP. Under normal conditions, the ORT displays are controlled by CCUP including brightness. Under conditions of failure, however, it may occur that there is no display (seven segment or four indicator lights) at all on the ORT.

21.14.2.1.8 ORT Display in all Modes. The ORT display contains four digits (seven segment) and four indicator lights (figure 21-50). A focus knob for the ORT is located on top of the ORT under the eyepiece assembly. ORT brightness is adjusted using the DISP/BRT ORT knob on the CCUP. Two adjustment ranges are available. The range is a function of the gunner caution panel BRIGHT/DIM selector. Brightness of the display in the dim range allows dimming of the display to zero.

21.14.2.1.9 ORT Seven Segment Display. The following list describes the announcements which are presented on the seven segments during NTS operation:

1. 8888 — Displayed during the first two seconds after system starts initiated BIT.
2. TEST — Displayed during BIT process.
3. BRST — Displays during boresight process.
4. GO — Displayed for 2 seconds after boresight is completed, in case of no failure.

5. FAIL — Illuminates if the NTS system fails boresight. This will be displayed in addition to the failure indication on the CCUP. If the laser is used, the fail indication will be replaced by the laser range for 1.5 seconds, then return to FAIL message.
6. FLIR — Displayed after boresight initiation if the FLIR detectors have not cooled sufficiently for the automatic boresight procedure to be completed. If the detectors will not cool during 10 minutes, the display will change into FAIL.

Note

Pressing the NTS FAIL switch twice on the CCUP will remove the FAIL or FLIR indication from ORT display and return to the operational display.

7. XXXX — Laser Range — Displayed during range finding and for 1.5 seconds after lasing stops. If the range is above 10 kilometers, the display format is XX X with resolution of 100 meters. If ranging while minimum range display is on, display presents range for 1.5 seconds and then reverts back to minimum range.
8. ---- — Displays in case there is no valid return during rangefinding.
9. XXX — Turret magnetic azimuth, a default display will appear if none of the other modes is displayed.
10. XXXX — Minimum laser range, as set on LRP, during rangefinding and for 1.5 seconds after lasing stops when minimum range display is on.
11. L-XX — Count up time (elapsed time) during laser designation. The count up time is in seconds.
12. L-XX — Countdown time to missile impact during TOW or HELLFIRE flight. This will occur only if the target has been lased (rangefinder or designation) within 10 seconds of a missile launch. When the countdown time has reached 0, the display continues to show 0 up to 3 seconds and then switches to the previous display before missile fire.

21.14.2.1.10 Indicator Lights. All four indicator lights will be illuminated during first 2 seconds of BIT. Four indicator lights in the ORT indicate status as follows:

1. Red (upper right) — Illuminated during OFFSET mode
2. Yellow:
   a. Steady — Laser hot indication
   b. Blinks — Laser automatic shutoff.
3. Green — Multiple laser target returns. The range that appears in the ORT and CRT shall be in agreement with the FIRST/LAST switch.
4. Red (upper left):
   a. Steady — System is in the AUTOTRACK mode.
   b. Blinks — System is in the PREDICTOR mode.

All the indicators will be lighted during the first 2 seconds after the system starts the initiated BIT. Indicators will blink at the rate of 2 times per second.

21.14.2.1.11 CCUP Display. The CCUP contains status lights and control switches. On the bottom half of each VCR control switch, there is a light that indicates if that function is active. The VCR control switches and indicator lights are covered in detail in the VCR section. The remainder of the caution lights are:

1. NTS FAIL — Indicates any NTS failure. Does not include any failures of the original M-65 system. Depressing this switch will display a list of functional failures on the existing video display. Depressing the switch a second time will eliminate the list of functional failures and all other BIT fail indications such as indicator lights on CCUP (FAIL) and FAIL display on the video display.
2. LSR — Laser energy is being transmitted.
3. ARM — Laser has been powered up, all interlocks are engaged, BIT is completed, a valid code has been entered, and system is operational.
4. L.HOT — Laser is hot and if lasing continues, LDRS may shut down.
5. L.OFF — Laser overheated and shut down to avoid damage to the LDRS.

6. CCUP indicator lights are tested by momentarily placing gunner CAUTION panel TEST switch in the TEST position.

21.14.2.1.12 Pilot Indications.

1. LASER ARM — Indicator light. Illuminates in addition to LASER ARM indicator on CCUP. The indicator is attached to the glareshield.
2. LASER ON — Indicator light. Illuminates during lasing. The indicator is attached to the glareshield.
3. HUD — During lasing (rangefinding or designation) the HUD will display the range that comes from the laser. TOW post-launch contraints rectangle/laser constraints rectangle is displayed during laser designation. Rocket and gun reticles will be automatically adjusted for the laser range during rangefinding mode and for 15 seconds after lasing has ceased.

21.14.2.1.13 MFD/CRT Display.

The two types of data displayed to aircrew by NTS are system and mission data. This data is displayed in the form of video images and by status and caution lights on system panels. These two types of data are further divided into three groups: FLIR (presented during FLIR observation), TVC (presented during TVC observation), and system data, which can be controlled by command from the gunner (figure 21-51).

1. Hot Detector — Illuminated while the TIS detectors are hot.
2. Manual Gain/Level — Two bars for gain and level indication. The display will appear in manual mode during gain and level adjustment. 5 seconds after releasing the gain/level switch, the two bars will disappear and only the MAN indication will be displayed.
3. Focus Reference Index — Two digits present the focus absolute position (from near to infinity). The indication is displayed each time the focus switch is used in AUTO or MAN and disappears after 3 seconds.
4. Zoom Indication — Displayed when the FLIR is set into narrow FOV with zoom.
5. FLIR Reticle — Three types of reticles display with the FLIR image:

— Narrow and narrow with zoom FOV (figure 21-52)

— Medium FOV

— Wide FOV.

21.14.2.1.13.1 MFD/CRT Displays Presented during FLIR Observation.

1. HOT DET — In lower-left display area, indicates a hot FLIR TIS detector. FLIR is not operational when this message appears.

Note

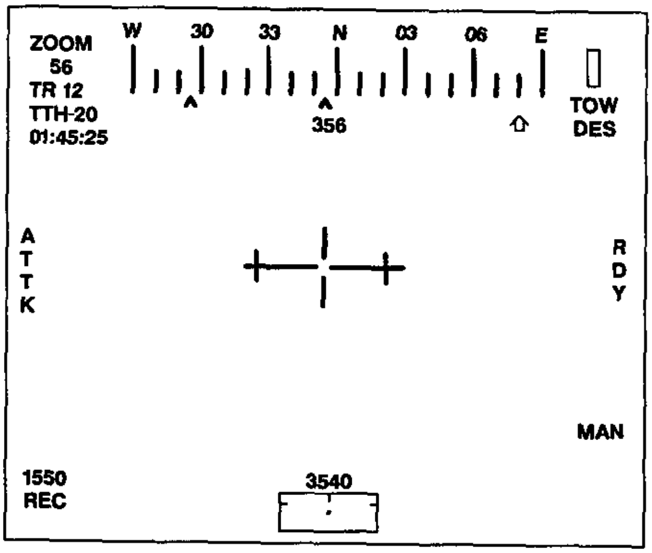
After initial power-up of NTS, a normal cooling period of 3 to 5 minutes is required before FLIR is operational. Under certain conditions, it may require up to 10 minutes for FLIR to become operational.

2. MANUAL GAIN/LEVEL — FLIR manual gain/level adjustment is indicated by the word MAN in the lower-right corner of the display area. Two bar graphs in lower-right corner of display area show relative gain and level in the manual mode. Bar graphs will disappear 5 seconds after adjustment, but will reappear each time manual adjustments are made.
3. FOCUS REFERENCE INDEX — In the upper-left display area, gives gunner a reference at which the FLIR is focused. Focus reference is represented by two digits ranging from 5 ±5 (near focus) and 90 ±10 (far focus). This index appears while focus is engaged, and disappears 3 seconds after release of the focus switch.
4. ZOOM — Zoom indication in upper-left corner of display area appears when zoom is activated with FLIR in narrow FOV.
5. FLIR Reticle — Three types of reticles display with the FLIR image (figure 21-52):

— Narrow and narrow with zoom FOV

— Medium FOV

— Wide FOV.



NARROW AND NARROW ZOOM FOV

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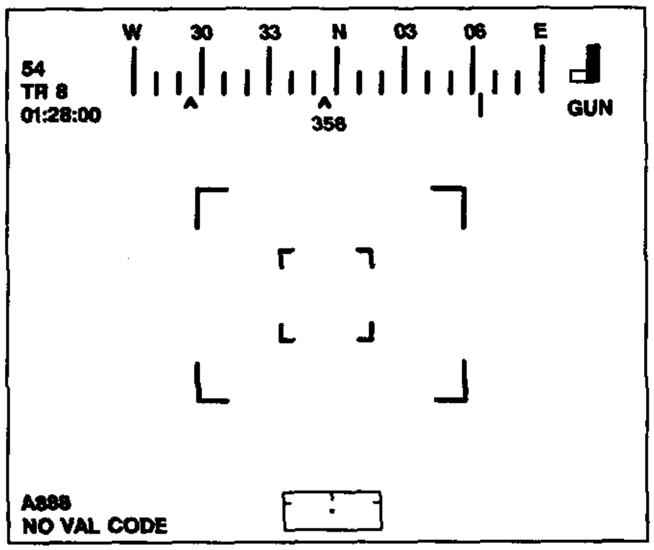
J1021

Figure 21-52. FLIR Reticles With Typical Symbols (Sheet 1 of 4)



WIDE FOV

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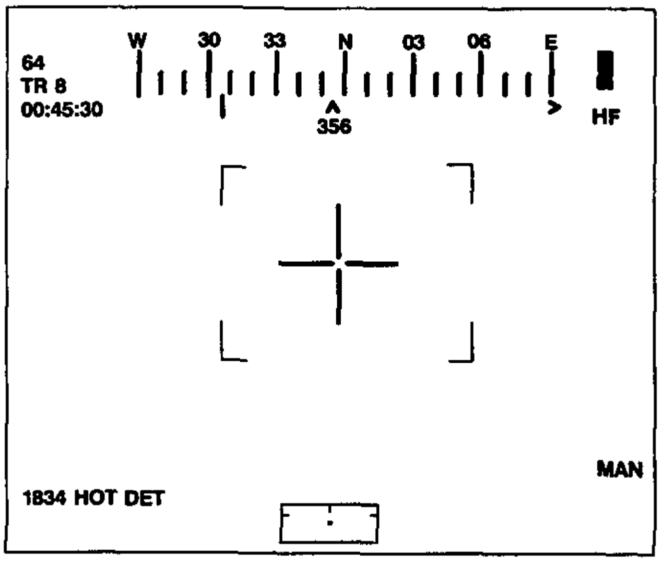
J1974

Figure 21-52. FLIR Reticles With Typical Symbols (Sheet 2 of 4)



MEDIUM FOV

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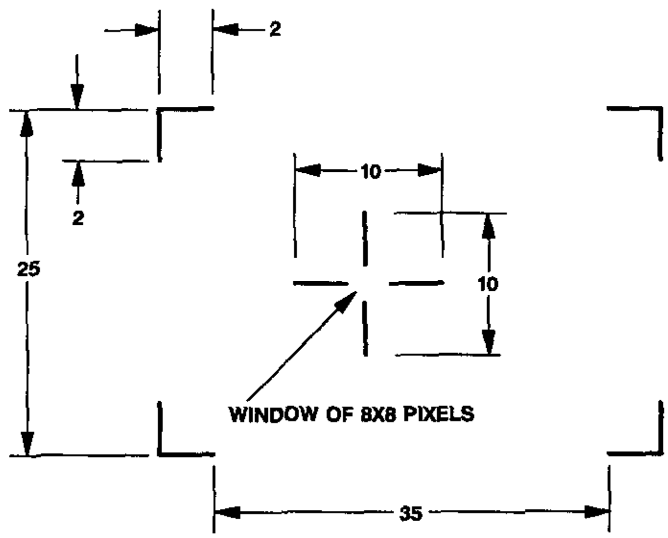
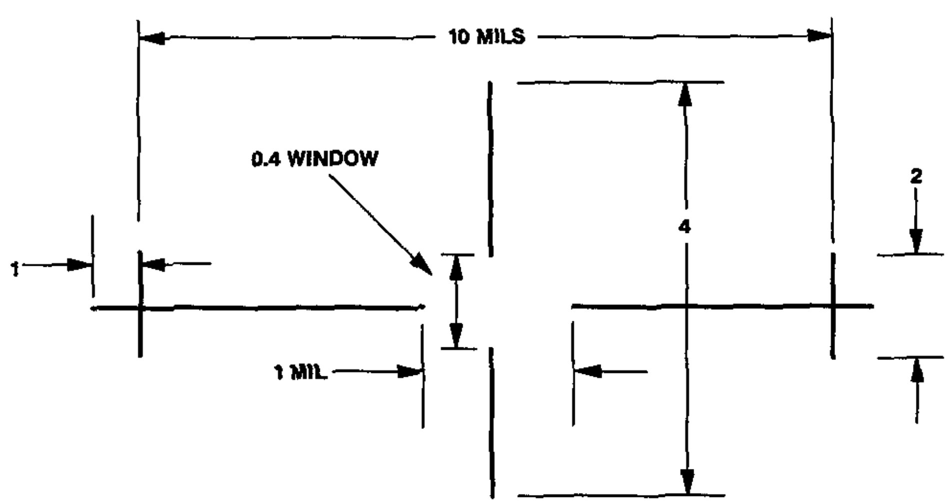
Figure 21-52. FLIR Reticles With Typical Symbols (Sheet 3 of 4)



MEDIUM FOV RETICLE



NARROW FOV RETICLE

NOTE: ALL NUMBERS ARE IN URAD

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J1763

Figure 21-52. FLIR Reticles With Typical Symbols (Sheet 4 of 4)

21.14.2.1.13.2 MFD/CRT Displays Presented during TVC Observation.

1. MANUAL GAIN CONTROL — In TVC channel, the word MAN indicates that camera brightness control is in manual mode. Display in lower-right corner.
2. TVC/DVO Reticle — Reticle displayed in TVC image.

21.14.2.1.13.3 General MFD/CRT Displays.

1. TSU magnetic azimuth — A 180° scale indicating TSU magnetic azimuth. The azimuth tape moves. Below the scale is a three-digit indication of turret magnetic azimuth.
2. Aircraft heading — A marker indicating aircraft magnetic heading below the azimuth tape.
3. FLIR polarity and AUTOTRACK status — A bar graph in upper-right corner of display area indicates AUTOTRACK quality and FLIR polarity (white hot or black hot). The large bar graph shows FLIR polarity. One small bar adjacent to the large one indicates bad autotracking quality. Two small bar graphs, one on each side of the large one, indicate good autotracking quality. Figure 21-53 shows symbol possibilities.

Note

While the system operates without autotracking or during prediction, only the center block appears.

During autotrack with TVC, the center block appears in black.

4. Weapon Mode — Indicates weapon selected: TOW, GUN, HF (HELLFIRE). GUN indication blinks when the Gun LOS and turret LOS are out of coincidence. Display is in upper-right corner.
5. DES — Displayed during laser designation. The indication displays together with LASER ON indication in pilot cockpit. Display is in upper-right corner.
6. System Clock — Display presenting local or zulu time which can be adjusted by gunner/copilot using code D888 on LCP and VCR buttons on CCUP. When system is powered on, time starts counting from 00:00:00 until it is adjusted. When the NAV bus is connected to NTS, time shall be updated from Tactical Navigation System and cannot be adjusted from NTS controls. Display is in upper-left corner.
7. TR — Displayed during TOW/GUN/HELLFIRE trigger pull while pressing LHG switch. Display is in upper-left corner.
8. Event Mark — Each press of the trigger or designation switch will increment the event mark counter by one. These event marks are viewed on the CRT/MFD symbology and during playback. Display illuminates for approximately 10 seconds in upper-left corner next to TR.
9. TTH — Displays the time required for a TOW or HELLFIRE missile to hit a target. Displayed during laser operation. In case the laser indicates No Valid Return, the TTH will display "----". The display shall be deleted 15 seconds after lasing stops. Display is in upper-left corner. Upon missile launch, TTH will count down to 0, remain at 0 for up to 3 seconds, and then disappear.
10. ATTK — When in TOW mode, indicates M-65 attack mode. In HELLFIRE mode, ATTK indicates that a Hellfire missile has been selected and armed and has accepted the laser code provided by the THCDP or LCP. Display is in left center.
11. RDY — When in TOW mode, indicates M-65 ready mode. In HELLFIRE mode, RDY is displayed when ATTK conditions are met, the THCDP is set to LOBL mode, and the Hellfire missile detects a laser spot. Display is in right center.
12. Laser (Target) Range/Minimum Range/INLC Indication — Displays a five-digit range (5 meter resolution) from helicopter to target during laser range finding or designation. If No Valid Return is received, indication will be "----". INLC is displayed if laser firing is attempted with any safety interlock not in place or with TOW missile in flight. While range is displayed, switching on minimum range on LRP causes display to present minimum range. If ranging while minimum range switch is on, display presents laser range for 1.5 seconds and then reverts back to minimum range. Display is in lower center. Range display can be eliminated by pressing SYS switch on LHG.

13. Laser Code — Displays the laser code received by RFTDL from the THCDP or LCP. Display is in lower-left corner.

14. Present Position Coordinates (A/C Coordinates) — Display indicates present position coordinates in LAT/LONG. Display is in lower-right corner.

15. Target Coordinates — This display indicates the coordinates of the lased target. Coordinates display during lasing and remain displayed until the laser is used again, at which time the updated coordinates will be displayed. Display is deleted by pressing SYM switch on LHG. Display is in lower-right corner.

16. Autotrack Indication — Four dots are placed around the target during autotrack mode. In predictor mode, the dots will blink. In offset mode, the four dots move and track the target.

17. FAIL Indication — In case of failure in one of the NTS units (LDRS, TSU, PEB, CCUP, TVC, CRT, FEB, or VCR), the display indicates FAIL and is lit in addition to the FAIL indication on the ORT display and the NTS FAIL indication on the CCUP. The FAIL indication blinks at one pulse per second. Display is in lower-right corner.

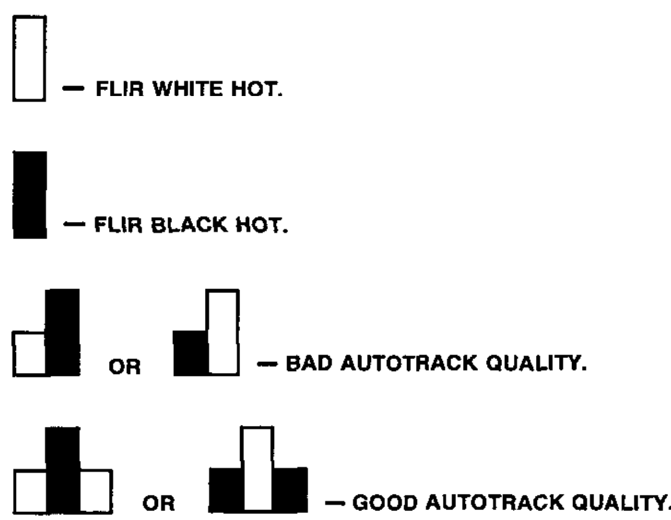
18. Status Messages: Display is in lower-left corner.

    a. NO FL BRST — Illuminates when FLIR boresight does not complete during boresight process. If HOT DET is also displayed, gunner must initiate boresight after FLIR detector elements have cooled sufficiently to extinguish HOT DET display and to complete system boresight. This message displays together with FLIR indication in ORT.

    b. NO VAL BRST — Displays if NTS did not complete the boresight process or if boresight was not performed upon NTS power up.

    c. NO VAL CODE — Displays if a valid laser code has not been entered.

19. VCR Mode: Display is in lower-left corner.



NOTES: 1. WHILE SYSTEM OPERATES WITHOUT AUTOTRACKING OR DURING PREDICTION, ONLY THE CENTER BLOCK APPEARS.

2. DURING AUTOTRACK WITH TVC, THE CENTER BLOCK APPEARS IN BLACK, WHILE THE SIDE BLOCKS APPEAR WHITE.

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Figure 21-53. FLIR Polarity and Autotrack Status

a. REC — Displayed while the VCR is recording. It flashes at the frequency of one Hz in PAUSE mode.

b. NO REC — Displayed while VCR is not recording.

20. BIT/BRST Indications: Display is in lower center.

a. BIT — Displayed during BIT process.

b. BRST — Displayed during boresight process.

21. Field of Regard (FOR) — Displays direction of selected sensor LOS as compared to TSU mechanical limits. The symbol shall provide real-time vertical and horizontal reference to sensor location in the FOR for the gunner/pilot. Display is in lower center.

22. Missile in Constraints Indication — Displays a fixed-size circle in the center of FOV in LOBL mode when a selected missile detects a laser spot and the aircraft is in prelaunch constraints mode. The circle becomes dashed when the aircraft is not in prelaunch constraints mode but the missile still detects the laser spot.

21.14.2.1.14 MFD/CRT Symbology/Message Description.

1. TSU Magnetic Azimuth — A 180° scale presenting the TSU turret magnetic azimuth. The azimuth tape moves. Below the index is a digital readout of turret magnetic azimuth.
2. Aircraft Heading — A marker that indicates the aircraft magnetic heading.
3. FLIR Polarity and Autotrack Status — The center block represents the FLIR polarity. The two side blocks represent autotrack quality from the TVT. Figure 21-53 shows symbol possibilities.
4. Weapon Mode — Indicates weapon selected: TOW, GUN or HF (HELLFIRE).
5. DES — Illuminates during laser designation. The indication displays together with LASER ON indication in pilot cockpit.
6. System Power On Time — A counter timer presenting elapsed time from 00:00:00 of NTS operation.
7. TR — Displays during TOW/GUN trigger pull.
8. Event Mark — Each trigger pull or laser designation will cause an automatic event mark and increase the counter by one.
9. TTH — Time to hit, displayed during laser operation, the time for TOW or HELLFIRE to hit a target. If the laser indicates NO VALID RETURN, the TTH will display "--".
10. Function Failures — Displays NTS system failures after pressing NTS FAIL switch/light once when illuminated. Pressing NTS FAIL switch/light a second time will extinguish functions failures list.
11. ATTK — Indicates M-65 attack mode. Indicates that a HELLFIRE missile has been selected and armed, and has accepted the laser code provided by the THCDP or LCP.
12. RDY — In TOW mode, indicates all prelaunch constraints have been met. In HF LOBL mode, with solid laser energy received circle, indicates prelaunch constraints have been met. In HF LOBL mode with dashed laser energy received circle, indicates prelaunch constraints are not met. In HF LOAL mode, indicates prelaunch constraints are met.
13. Laser Energy Received Circle — See RDY flag description for HELLFIRE LOBL modes.
14. Laser Range — Displayed during rangefinding and designation. The range will be displayed for 5 seconds after laser trigger is released. In case the laser indicates NO VALID RETURN during lasing, the indication will be "—". In case one of the interlocks is not connected, pressing the laser switches on the LHG (DES or RF) will cause INLC to appear on MFD/CRT.
15. Laser Code — Displays the laser code which is received by the LDRS.
16. Autotrack Indication — Four dots around the target during autotrack mode. In predictor mode, the four dots blink. In offset mode the four dots move and track the target.

17. FAIL Messages — In case of a failure in one of the NTS units, LDRS, TSU, PEB, CCUP, TVC, CRT, FEB, or VCR. The display indicates FAIL and it is lit in addition to the FAIL indication on the ORT display and the NTS FAIL indication on the CCUP. The FAIL indication blinks at one pulse per second.

18. MAN — Displays while system is operating in TVC channel and the camera operates in manual brightness control, and while in FLIR for 3 seconds after releasing manual level/gain control.

19. REC/NO REC — REC Indication — Indicates that VCR is in the record mode. When the VCR is in the PAUSE mode during recording, the REC indication will flash.

NO REC Indication — Indicates that the VCR is not recording.

20. FOR — Displays the direction of the selected sensor LOS as compared to TSU mechanical limits.

The symbol shall provide the vertical and horizontal reference to sensor location in the FOR for the gunner.

21. BIT/BRST — BIT Indication — Displays during the system BIT process.

BRST Indication — Displays during boresight.

22. Status Messages — Displays NTS status messages:

NO FLIR BRST — Illuminates when the FLIR boresight is incomplete during boresight process. This indication, in conjunction with the HOT DET, tells the gunner that the FLIR detector elements have not cooled sufficiently to complete boresight. The NO FLIR BRST message displays together with FLIR indication in the ORT.

NO VALID BRST — Illuminates if the system did not perform the boresight process.

NO VALID CODE — Displays in case of no valid laser code.

21.14.3 Observation Function. The three image sources available to the gunner are:

1. DVO
2. TV Camera (MFD/ORT)
3. FLIR (MFD/ORT).

All three sources operate together, but only one may be observed at a time through the ORT. The control of the TV camera and the DVO is selection of wide or narrow FOV using the channel selector switch on the LHG. The TV camera sees the same reticle as the DVO. Figure 21-52 shows the narrow FOV with default symbols displayed.

The FLIR is placed into operation from the CRT mode. Momentarily moving the five-position switch FLIR POLARITY/FOV/CHANNEL SELECT to CRT one more time after the system is already in the CRT mode will place the FLIR in operation. The FLIR has three optical FOVs which are selected as required using the FOV selector switch on the LHG. When the FLIR is placed in operation initially, medium FOV is displayed. Pressing the switch up narrows the FOV and increases magnification, and pressing it down widens the FOV and decreases magnification. In the FLIR narrow FOV, a two to one electronic zoom is available.

The zoom function is activated by momentarily moving the five-position FOV and CHANNEL SELECT switch to HI one more time after the system is in the narrow field of view. The zoom function is automatic and fixed at 2:1 magnification. The zoom does not have intermediate ranges available and the gunner has no other control over the zoom. FLIR polarity (white hot or black hot) is selected by pressing the five-position FOV and CHANNEL SELECT switch momentarily.

Manual or automatic focus of the FLIR is available using the FOC switch on the LHG. Pressing the FOC switch on the LHG momentarily will place the FLIR in automatic focus mode. If the FOC switch is moved momentarily to FR, the focus will change to objects farther away. Focus changes continuously to the end of the focus limits as long as the switch is held. If the FOC switch is momentarily moved to NR, the focus will change to objects closer. The relative focus of the FLIR is displayed in the upper left corner of the CRT/MFD while the focus switch is engaged, and disappears 3 seconds after releasing the focus switch. Figure 21-52 shows the display of each FLIR FOV with typical symbols occurring with each display. Each FLIR FOV has a unique reticle with the peripheral symbols being common. Narrow field of view and zoom are the same.

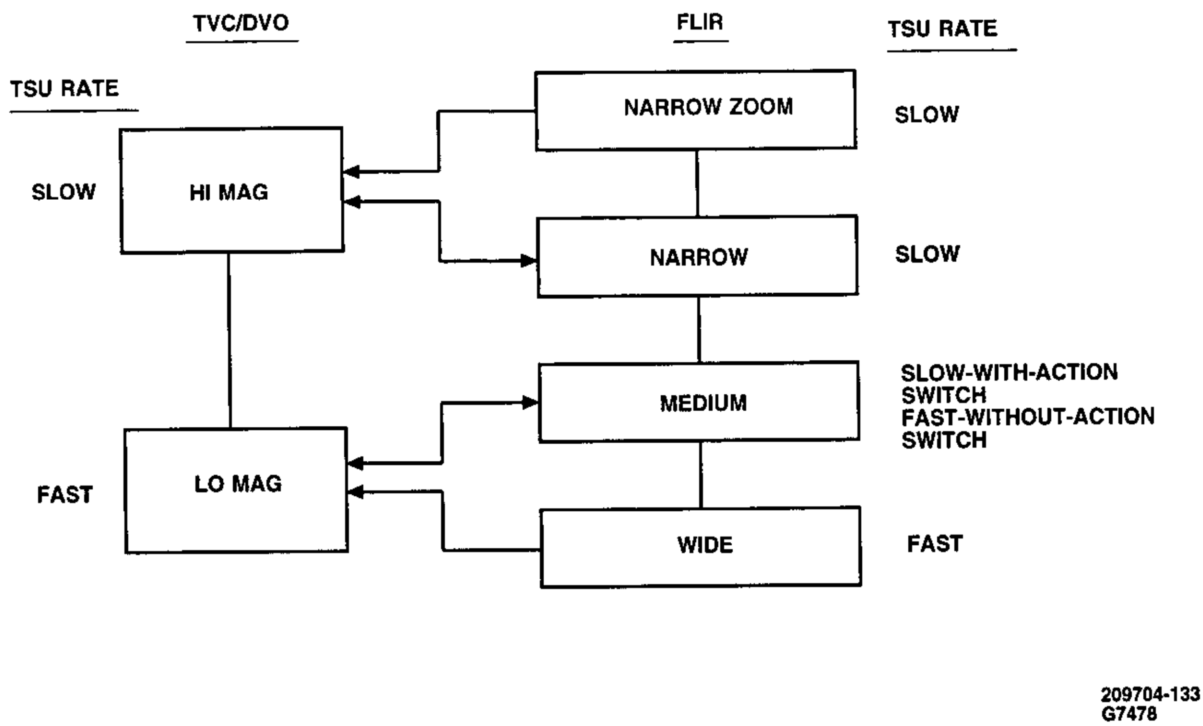


Figure 21-54. Automatic Action During Channel Selection

21.14.3.1 Automatic Action During Channel Selection. If the channel is changed between TVC/DVO and FLIR, the system will automatically change to the appropriate FOV and TSU slew rate for the selected channel. When the system is in FLIR medium FOV, the TSU tracking rate will depend on the ACTION switch. Pressing the ACTION switch in FLIR medium FOV will result in TSU slow track rate, and releasing the ACTION switch will cause the system to default back to fast track rate (figure 21-54).

21.14.3.2 Steering the Gimbals — Autotrack Mode. The TSU gimbals have an autotrack mode of operation in addition to the original modes of operation which remain unaffected by the addition of NTS (figure 21-55). The autotracker is a video tracker or TVT that works off both TVC and FLIR signals.

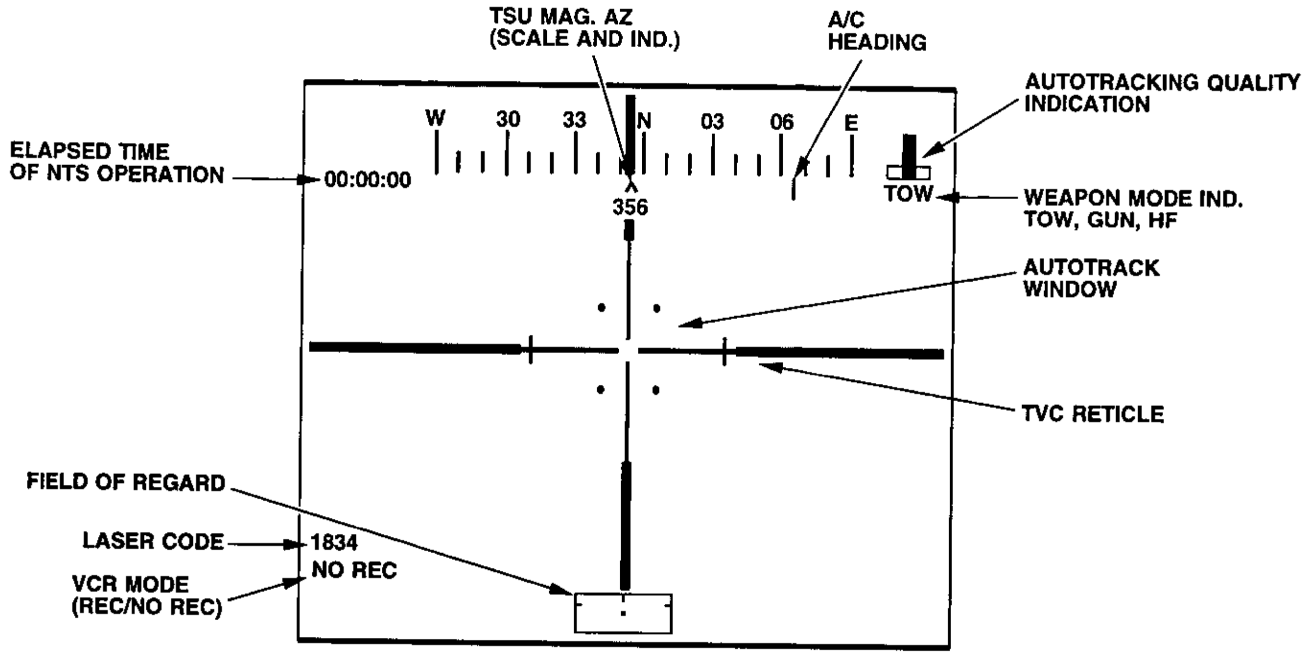
Autotracking may be performed in all THCDP modes, using all FOVs in DVO, TVC, or FLIR. Using Autotrack mode requires meeting the following conditions:

Note

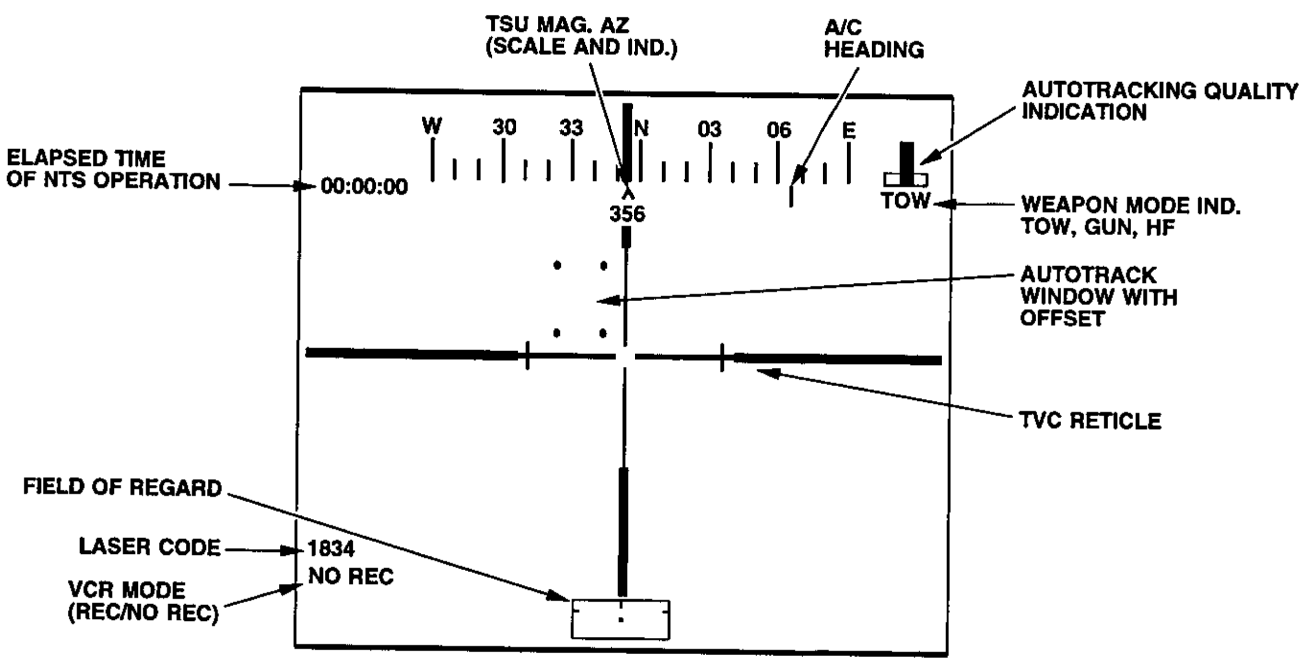
- Once autotracking is in operation, any attempt to change channel or FOV will cause an automatic switch back to manual mode.
- The autotracker will continue to track from either the FLIR or TV mode if the channel select switch is pressed left to select DVO in the ORT, because the MFD mode displayed does not change in this case.
- If autotracking in FLIR, switching to DVO and back to video will switch MFD to TV from FLIR and autotrack will be lost.

1. ACQ/TRK/STOW switch on the SHC must be in the TRK position.
2. The AUT TR switch must be pressed in momentarily on the LHG. Autotracking will begin immediately.

Adjustment of the difference between the aiming point of the gimbals LOS and autotrack centroid (offset) may be made in the autotrack mode by:



AUTOTRACK WITHOUT OFFSET



AUTOTRACK WITH OFFSET

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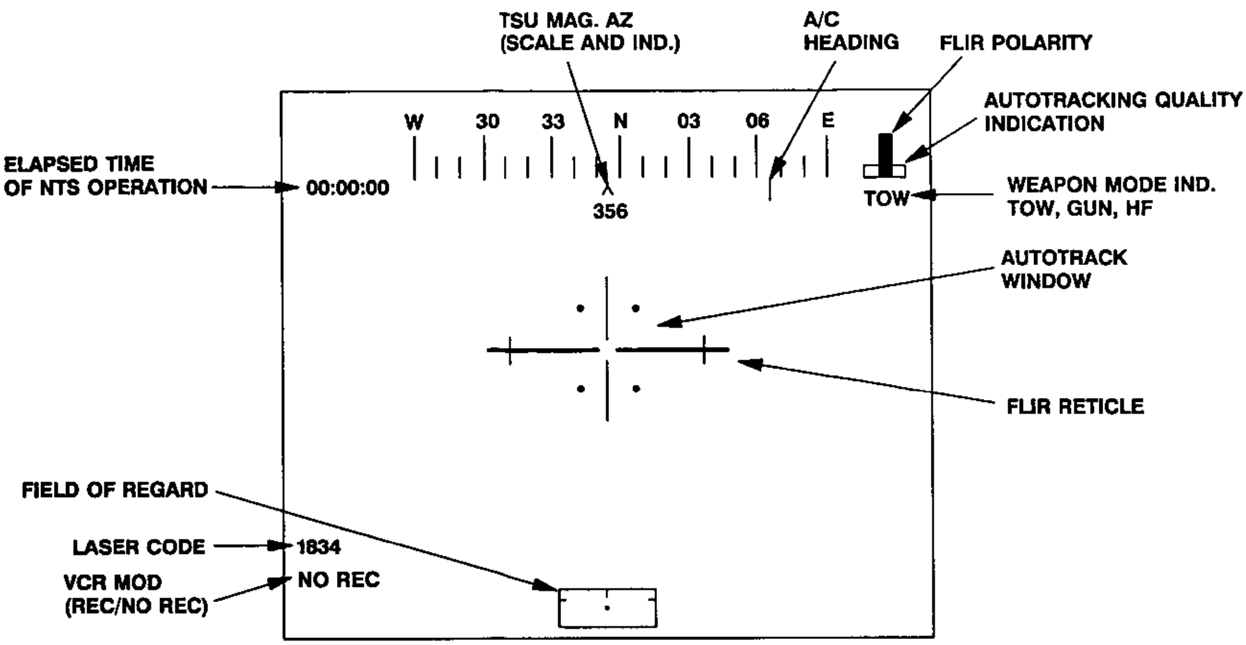
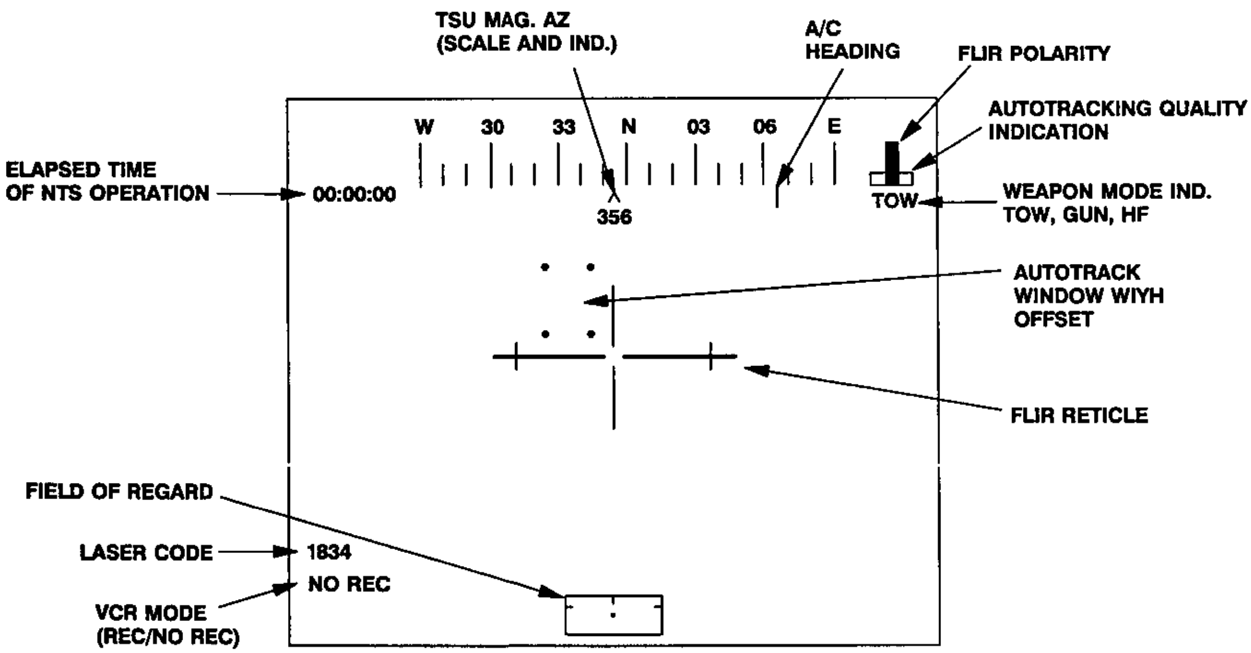
Figure 21-55. TVC and FLIR Optical Indications and Symbols (Sheet 1 of 2)



AUTOTRACK WITHOUT OFFSET



AUTOTRACK WITH OFFSET

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Figure 21-55. TVC and FLIR Optical Indications and Symbols (Sheet 2 of 2)

1. Press the OFFSET switch momentarily on the LHG. The right red light in the ORT will illuminate.
2. Adjust the amount of offset by using the stick on the SHC to steer the reticle off the autotrack point. There is an offset limit that is one-fourth of the field of view.

To exit the OFFSET mode, the gunner presses the OFFSET switch one more time. The OFFSET will cancel within 1 second.

To stop autotracking and place the system in manual mode, the gunner may:

1. Press the AUT TR switch on the LHG.
2. Press the stick of the SHC equivalent to half of the maximum speed in any direction (except while adjusting OFFSET).
3. Move the ACQ/TRK/STOW switch from the TRK position.
4. Change FOV.
5. Change channel from FLIR to TVC or from FLIR to DVO or vice versa.

21.14.3.2.1 Indications During Autotracking. The following events occur when autotracking function is selected:

1. Four dots appear forming a square around the aiming point on the current video image.
2. The right red indicator light in the ORT illuminates.
3. An autotracking quality indicator appears on the upper right side of the video image.

21.14.3.3 Prediction Mode. When the system is autotracking and the TV tracker loses the target for any reason, the system will automatically go into the prediction mode. The prediction mode will result in the TVT maintaining the last known slew rate.

21.14.3.3.1 Indications During Prediction Mode. The following events indicate the system has defaulted to the prediction mode:

1. The four boundary dots will blink.
2. The quality indicators for TV camera image indicate poor quality. On the FLIR image, only the FLIR polarity indicator remains, which indicates poor quality of autotracking.
3. If the TV tracker recovers the target and locks on, the system returns automatically to the autotrack mode.

21.14.3.3.2 Stopping Prediction Mode. Prediction mode may be stopped by:

1. Pressing the AUT TR switch on the LHG.
2. Pressing the stick of the SHC to half of the maximum speed in any direction (while the system is not in OFFSET).
3. Moving the ACQ/TRK/STOW switch from the TRK position
4. Changing displayed channel.
5. Changing FOV.

21.14.4 Laser Modes. The laser has three modes of operation.

21.14.4.1 Rangefinding. Rangefinding is defined as measuring the distance between the helicopter and the target. The gunner can measure range to the target by continuously pressing the LRF switch on the LHG. The minimum range potentiometer and the laser LAST/FIRST function are provided to assist the gunner in obtaining accurate range information in the event of multiple laser returns during rangefinding. The gunner may control the selected minimum range to the target with the potentiometer on the LRP. The LDRS will ignore laser returns at ranges less than that selected by the gunner. The gunner may choose first or last laser pulse logic. If FIRST is selected, the laser return that will be used for range computation will be the first return pulse received that exceeds the minimum range setting selected on the LRP. If LAST is selected, the laser return that will be used for range computation will be the last return pulse received. The techniques used for multiple laser return will vary depending on the target relationship to the terrain and vegetation along the line of sight.

21.14.4.2 Designation and Designator Coding. Designation provides coded laser energy for guiding HELLFIRE missiles and other applicable munitions. Laser designation may be selected by the gunner by pressing the LASER DES switch on the LHG. Designation begins immediately upon pressing the switch; however, it requires 3.50 seconds to achieve full performance from the laser beam.

The two sources for coding the laser system are as follows:

1. The code may be set using switches on the THCDP. Codes are sent at the same time to the missiles and the LDRS on a 1553 data bus. To enable the LDRS to use this code, the laser MODE SELECT switch on the LCP must be in the AUTO position. The LDRS will operate on the selected priority (bracketed) missile code.

2. The code may be set using pushbutton switches on the LCP. This code is sent to the LDRS on an RS-422 serial data bus without any relation to the current THCDS missile codes. To enable the LDRS to use the manually selected codes, the laser MODE SELECT switch on the LCP must be in the MAN position.

21.14.4.3 Designation During Boresighting. Boresighting is the alignment performed between laser beam and TSU line of sight. The system fires the laser automatically during the boresighting process. Either the cover on the DVO must be in place or the helicopter engines must be running with either generator on line and the ACQ/TRK/STOW switch in the STOW position, or the system will not fire the laser. As an additional safety measure, the laser cannot be fired unless the elevation gimbal is in the -60 position (looking down). While the laser is firing, DES will appear in the upper right corner of the CRT display and the LASER ON caution light will illuminate in the pilot cockpit.

21.14.4.4 Interlocks. In rangefinding and designation modes, the following interlocks must be engaged before laser can be fired:

1. TURRET DEPR limit switch must be in the OFF position.

2. The TSU filter select lever must be in the LASER position.

3. Laser remote LAST/FIRST/OFF switch must be in the FIRST or LAST mode.

4. Engine must be running with one or both generators on line or the DVO window cover must be installed.

5. SHC ACQ/TRK/STOW switch must be in the TRK position.

6. Master ARM switch must be in the ARM position.

Note

Laser may be fired using any channel and in any FOV. Designation and rangefinding will continue as long as applicable switch is being pressed. If any interlock is not in place and lasing is being attempted, the video symbology will display INLC in place of range information.

21.14.4.5 Internal Conditions. Some internal safety interlocks that are controlled by the system, and may cause cessation of lasing are as follows:

1. Limits of gimbal rotation (elevation up 20°, down 50°, or azimuth, electrical limits +87°, –90°) are exceeded.

2. During boresight — While boresight position (down 60°) is not exceeded.

3. Communication failure — If there is a communication failure between LDRS and PEB or between CCUP and PEB for more than 150 milliseconds.

4. LASER OFF — If the temperature in the laser reaches its threshold.

If any one of these interlocks is not in place, the laser will not perform rangefinding or designation. If, during rangefinding or designation, any one of these interlocks is violated, lasing will be stopped immediately.

21.14.5 Displays During Rangefinding, Designation, and Boresighting.

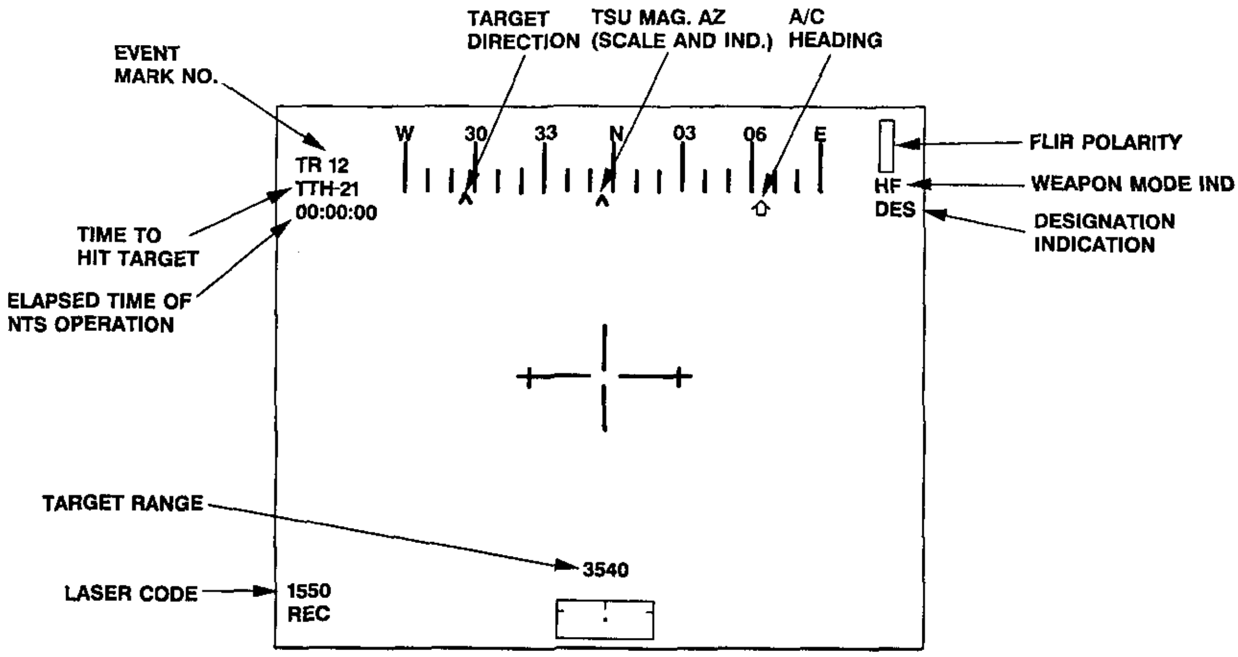
21.14.5.1 Video Image Displays. Figure 21-56 shows typical video images and symbols displayed during laser operation.

21.14.5.2 Seven Segment Display. The following displays will be seen on the seven segment display:

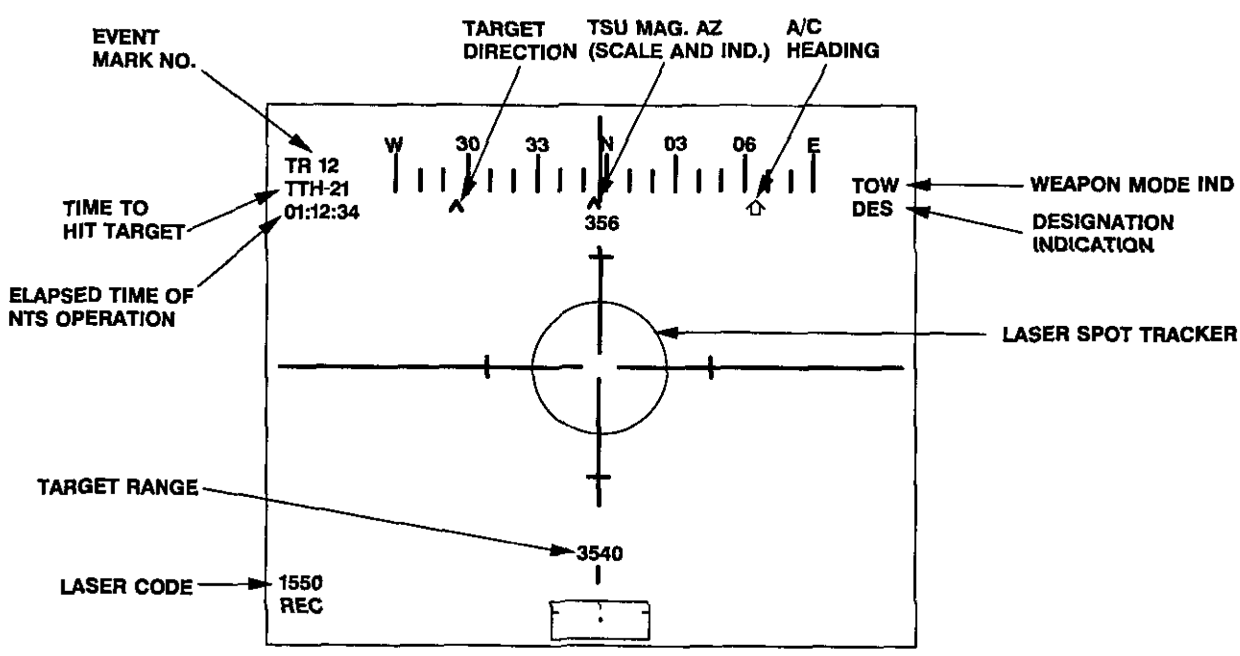
1. L-XX — Count up during designation (up to 99 seconds).

2. L-XX — Count down time to hit target after firing a TOW or HELLFIRE missile if the missile is fired within 10 seconds after last range measurement.

3. — – No valid return of laser.



SYMBOLS ON CRT USING FLIR SENSOR AS IMAGE SOURCE DURING LASING



SYMBOLS ON CRT USING TV CAMERA AS IMAGE SOURCE DURING LASING

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Figure 21-56. Video Images and Symbols Displayed During Lasing

4. XXXX — Laser range appears during rangefinding or designation and disappears 1.5 seconds after lasing has stopped.

5. XXXX — Minimum range as set by the LRP.

21.14.5.3 Indicator Lights.

1. ORT. The following indicator lights are visual signals that require gunner's attention:

   a. The steady yellow lamp indicates that LDRS has reached its first temperature threshold and the gunner should stop lasing.

   b. The flashing yellow lamp indicates that temperature of LDRS has reached its final threshold before damage and the laser will automatically shut off.

   c. Multiple laser returns are detected when the green lamp lights.

2. CCUP. The following indicator lights are visual signals that require gunner's attention:

   a. LASER HOT — Same as ORT display.

   b. LASER OFF — Same as ORT display.

   c. LSR ARM — Indicates that all interlocks are operational and the LDRS is ready to fire the laser upon command.

3. Pilot Indications. The following indicator lights are visual signals that require pilot's attention:

   a. LASER ON — Caution lamp which lights each time the LDRS fires the laser including boresighting.

   b. LASER ARM — Caution lamp that lights in conjunction with ARM indicator light in CCUP.

   c. RANGE appears on HUD display during designation and rangefinding. Range is preceded by the letter L.

   d. HUD TOW post launch constraints rectangle is displayed during lasing.

21.14.6 Weapon Guidance. The video image displayed to the gunner during operation with NTS installed (figure 21-56) has additional information as follows:

1. ATTK — When in TOW mode, indicates M-65 attack mode. In HELLFIRE mode, ATTK indicates that a Hellfire missile has been selected and armed and has accepted the laser code provided by the THCDP or LCP. Display is in left corner.

2. RDY — When in TOW mode, indicates M-65 ready mode. In HELLFIRE mode, RDY is displayed when ATTK conditions are met, the THCDP is set to LOBL mode, and the Hellfire missile detects a laser spot. Display is in right center.

3. TR — Displayed during TOW/GUN/HELLFIRE trigger pull while pressing LHG switch. Display is in upper-left corner.

4. Weapon Mode — Indicates weapon selected: TOW, GUN, or HF (HELLFIRE). GUN indication blinks when the Gun LOS and Turret LOS are out of coincidence. Display is in upper-right corner.

5. TTH — Displays the time required for a TOW or HELLFIRE missile to hit a target. Displayed during laser operation. In case the laser indicates No Valid Return, the TTH will display "----". The display shall be deleted 15 seconds after lasing stops. Display is in upper-left corner. Upon missile launch, TTH will count down to 0, remain at 0 for up to 3 seconds, and disappear.

6. Missile in Constraints Indication — Displays a fixed-size circle in the center of FOV in LOBL mode when a selected missile detects a laser spot and the aircraft is in prelaunch constraints mode. The circle becomes dashed when the aircraft is not in prelaunch constraints mode but the missile still detects the laser spot.

21.15 ARMAMENT PREFLIGHT PROCEDURES

21.15.1 Before Exterior Check — ALL ARMAMENT.

WARNING

- Personnel shall remain clear of the gun and the turret travel area when helicopter electrical circuits are energized.
- Personnel shall remain clear of the hazardous areas of loaded weapons.
- Helicopters with loaded weapons shall be pointed toward a clear area.

1. MASTER ARM switch — OFF.
2. LAUNCHER ARM switch — OFF.
3. PILOT OVERRIDE — OFF.
4. THCDP OFF/BRT switch — OFF.
5. ALE-39 ARM — SAFE (down).
6. ALE-39 PWR — OFF.
7. AIM-9 Mode Select switch — OFF.

21.15.2 Exterior Check — ARMAMENT PREFLIGHT.

21.15.2.1 TSU.

1. TSU movement — FREE.
2. TSU germanium window — CLEAN.
3. TSU optics — CLEAN.

21.15.2.2 M197 Gun System.

1. Booster motor — ELECTRICALLY CONNECTED.
2. Feed chute — INSTALLED.
3. Ammunition box security pins — INSTALLED.
4. Right ammunition bay door — CLOSED.
5. Elevation brake — ON (down position).
6. Safeing connection — DISCONNECTED.
7. Gun drive motor — ELECTRICALLY CONNECTED.
8. Firing voltage connector — CONNECTED.
9. Gun quick-release pins — INSTALLED (ring up).
10. Feeder retaining pins — SAFETY WIRED/SECURED WITH LOCK CLIPS.
11. Muzzle clamp — SECURE.
12. Barrel tompions — REMOVED.
13. Booster motor cable — SECURE.
14. ROUND REMAINING counter — SET.
15. Left ammunition bay door — CLOSED.

21.15.2.3 Wing Stores.

1. Fuel tanks or weapons loaded (outboard racks) — CHECK.
2. TOW ACTIVATE SW — As required.

21.15.2.3.1 Ejector Racks.

1. Safety stop lever — LATCHED POSITION (inboard racks).
2. Ground safety pins — INSTALLED (outboard racks).
3. Breech caps — SECURE.
4. Sway brace pads — ADJUSTED IN FIRM CONTACT WITH STORES (jamnuts secure).

21.15.2.3.2 ALE-39 Dispensing Pods.

1. Dispenser module — INSTALLED.
2. ARM/SAFE handle — SAFE.

21.15.2.3.3 Practice Bombs/Practice Multiple Bomb Rack.

1. Safety pin (Mk 106) — INSTALLED.
2. Safety block with safety pin (BDU-33D/B) — INSTALLED ON FIRING PIN.
3. PMBR adapter harness — ELECTRICALLY CONNECTED.
4. PMBR station selector switch — SAFE.

21.15.2.3.4 CBU-55 Fuel Air Explosive (FAE).

1. FMU-83/B fuze — INSPECT.
   a. Fuze cover — REMOVED.

b. Fuze delay — SET.

c. Fuze safety pin — REMOVED.

2. Tail fin thruster safety pin — REMOVED.
3. Arming wire extractor — CONNECTED.
4. Fins — SPREAD/LOCKED.
5. Leak detector — SAFE.
6. Overall condition — CHECK.

21.15.2.3.5 Mk 77 Mod 2/4 Fire Bombs.

1. Fire bomb — NO LEAK OR DAMAGE.
2. Fire bomb to parent rack attachment — SECURE.

21.15.2.3.6 GPU-2/A Gun Pod.

1. Helicopter adapter cables — DISCONNECT.
2. Fire volts access doors — OPEN.
3. Battery cable — CONNECTED.
4. Drum — LOADED.
5. Overall condition — CHECK.

21.15.2.3.7 Flare Dispenser.

1. SUU-44/A — INSPECT.

   a. Detent safety pin — INSTALLED.

   b. Dispenser — ELECTRICALLY CONNECTED.

   c. Shear latches — INSTALLED.

   d. Shear pins — INSTALLED FROM TOP, ENDS BENT.

   e. Cartridge and flare fuze timer setting — NOTED.

   f. Nose fairing — INSTALLED/SECURE.

2. SUU-25F/A — INSPECT.

   a. Safety switch safety pin — INSTALLED.

   b. Dispenser — ELECTRICALLY CONNECTED.

   c. Retaining links — CLOSED.

   d. Shear pin — INSTALLED, ENDS BENT.

   e. Cartridge and flare fuze timer setting — NOTED.

   f. Nose fairing — INSTALLED/SECURE.

21.15.2.3.8 LAU 10/61/68 Rocket Launchers.

1. Launcher safety pin — INSTALLED.
2. Launcher — NOT ELECTRICALLY CONNECTED.

21.15.2.3.9 TOW Launchers and Missiles.

1. Launchers — INSPECT:

   a. Forward and aft suspension lugs — SECURE.

   b. Sway brace pads — FIRMLY AGAINST BOLTS.

   c. Lower launcher forward and aft attaching points — SECURE.

   d. Electrical connectors — SECURE.

   e. Jettison quick-disconnect lanyard — ATTACHED.

2. Missiles — INSPECT:

   a. Missile container front ring — SEATED.

   b. Hinged center gate — SECURE.

   c. Debris director captive locking pins — SECURE.

   d. Note number and location of installed missiles.

3. TOW ACTIVATE SW — ON (up).

21.15.2.3.10 HELLFIRE Launchers and Missiles.

1. Launchers — INSPECT:

   a. SAFE/ARM switch — SAFE.

   b. Forward and aft suspension lugs — SECURE.

   c. Parent rack sway braces — ADJUSTED.

   d. Rail latches — LATCHED (with or without missiles loaded).

   e. Electrical connector — SECURE.

   f. Ejector foot/hoist adapter plug — FLUSH.

g. Jettison quick-disconnect lanyard — IN PLACE.

2. Missiles — INSPECT:

a. Missiles — SEATED.

b. Holdback latch — LATCHED.

c. Seeker dome — SECURE.

d. Note number and location of installed missiles.

3. TOW ACTIVATE SW — ON (up).

21.15.2.3.11 AIM-9 (Sidewinder) Launchers and Missiles.

1. Launchers — INSPECT:

a. Parent rack adapter cable — CONNECTED.

b. Launcher detent wrench safety pin — INSTALLED.

c. Launcher detent hold down pin — INSTALLED, NOT BINDING.

d. Pylon adapter and launcher — CONDITION, SECURITY.

2. Missiles — INSPECT:

a. Motor SAFE/ARM mechanism — SAFE (as applicable).

b. Missile dome/antenna covers — INSTALLED.

c. Missile umbilical plug — CONNECTED.

d. Missile umbilical block pins — SECURED.

e. Upper fin trailing edges — ENGAGED.

f. Rolleron covers — REMOVED.

21.15.3 Arm/Dearm Procedures.

1. Appropriate Arming Heading — ASSUME.

2. EXT Lights — As required.

3. Throttles — OPEN.

4. VCR — STOP.

5. Gunner Armament Control Panel — SET.

a. PILOT OVERRIDE — OFF.

b. TURRET DEPR LIMIT — LIMIT.

c. WING STORES SELECT — OFF.

6. ACQ/TRK/STOW — STOW.

7. THCDP BRT — OFF.

8. MASTER ARM — OFF.

9. WEAPON CONTROL — FIXED.

10. Store Control Panel — SET.

a. BOMB ARM — SAFE.

b. QUANTITY — 0/0.

11. Armament circuit breakers — UP/INBOARD.
(except HUD, AIM-9, and TURRET EL STOW)

12. LAUNCHER ARM — OFF.

13. EMERGENCY JETTISON SELECT — OFF.

14. Canopy removal system safety pins — INSTALLED.

15. AIM-9 Mode Select — OFF/STBY (as required).

16. ALE-39 — SET.

a. ARM — SAFE.

b. PWR — OFF.

c. CHAFF DISP and CONT circuit breakers — OUT.

17. Radar Altimeter — OFF.

18. Transponder — STBY.

19. TACAN — RECEIVE.

20. TNS Doppler — OFF.

Note

If no AIM-9/AGM-122, go to step 37.

21. AIM-9 CCU push-to-test — PRESS.

CAUTION

If STBY AC FAIL LIGHT on CCU illuminates, do not remove yellow boots from missile. Do not proceed with AIM-9/AGM-122 test.

22. AIM-9 boots — REMOVE AND STOW.

23. AIM-9 ARM — ARM.

Note

Placing AIM-9 ARM switch to ARM does not energize any firing circuits, provided the remaining weapon system circuit breakers and MASTER ARM switch remain OFF. Allow 60 seconds for AIM-9 cooldown prior to tone check.

24. AIM-9 CCU STA 1 and STA 4 — SELECT.

25. AIM-9 VOL control knob — SET.

26. HUD symbology — CHECK CAGED.

Note

The purpose of the AIM-9/AGM-122 missile on aircraft test (MOAT) is to ensure that missile circuits function when an IR/RF stimulus is provided and to ensure the proper HUD symbology is displayed.

27. Ordnance crew — STEP INBOARD FOR STA-1 MOAT.

28. Tone generator — ACTIVATED. Check clear tone (AGM-122)/strong growl (AIM-9).

29. Ordnance crew — Move Tone Generator (L/R/U/D). Check fuzzy tone (AGM-122)/ weak growl (AIM-9).

30. Collective CAGE/UNCAGE switch — UNCAGE.

Check the following:

a. Audio tone clear/strong.

b. UNCAGE light on CCU illuminates.

c. HUD symbology uncages, reticle tracks outboard.

31. Ordnance crew — STEP INBOARD. Check HUD symbology remains uncaged, reticle tracks outboard.

32. CAGE/UNCAGE — CAGE.

Check the following:

a. Audio tone pauses 1.25 seconds, then resumes.

b. UNCAGE light on CCU extinguishes.

c. HUD symbology cages.

33. AIM-9 CCU STA-1 — DESELECT.

34. Repeat steps 27. through 33. for STA-4.

Note

If both AIM-9/AGM-122 stations are selected, STA-4 MOAT will be ineffective, as STA-1 has audio and symbology priority.

35. AIM-9 CCU STA-1 — SELECT.

CAUTION

Damage to missile seekers can occur if not selected before flight because seeker heads default to the uncaged mode when deselected.

36. AIM-9 ARM — OFF/STANDBY (missile test complete).

37. FORCE TRIM — ON.

38. HOT MIC/VOX/CSC — ON/SET.

39. Hands in full view of ground personnel.

WARNING

All armament control switches except AIM-9, HUD, and EL STOW circuit breakers shall be in OFF, SAFE, or NORMAL position during arming procedures.

21.15.4 After Arming.

1. HOT MIKE — OFF.

2. RADAR altimeter/TACAN/TNS Doppler — ON.

3. Transponder — As required.

4. NARCADS — SET.

   a. Weapon Registration Thumbwheel — As required.

   b. Rate — As desired.

   c. QTY — SET (minimum of 1)

   d. Mode — As desired.

5. Armament circuit breakers — IN/ OUTBOARD.

6. MASTER ARM — STBY.
7. WEAPON CONT — GUNNER.
8. THCDP BRT — ON
9. THCDP mode — STBY TOW or TSU/GUN.
10. Rounds remaining counter — SET.
11. TSU GUNS TRACK RATE — As desired.
12. PHS and GHS rail arm assembly — Attach to BIT magnet.
13. HSS BIT — BIT/RELEASE.
14. PHS and GHS rail arm assembly — Attach to Helmets.
15. PHS and GHS sight assembly — ADJUST
16. Pilot and Gunner HSS RTCL — TEST.
17. THCDP display scratchpad — INDICATES STBY TOW (BIT pass).

Note

A successful TOW BIT completion can take up to 2 minutes.

18. HELLFIRE missile BIT and laser code storing:
    a. HPCP mode — GNR CONT.
    b. THCDP system mode — HF STBY.
    c. STOR button — PRESS.

Note

Store laser codes after completion of a successful HF BIT.

    d. Laser (single digit A through H) alpha code — ENTER.
    e. Laser four-digit numeric code — ENTER.
    f. ENTR button — PRESS.
    g. Repeat steps c. through f. (as required) to store each additional laser code.

Note

The designator may be encoded manually by placing the LASER MODE switch in MAN position and using the LASER CODE pushbuttons to enter the code. The priority missile will lock on to the laser return only if the designator code matches the priority code entered and selected on the THCDP.

19. HELLFIRE missile channel and laser code assignment:
    a. Launcher ARM/SAFE switches — ARM.
    b. THCDP system mode switch — LOAL/LOBL.
    c. THCDP launch sequence mode — RAPID.
    d. PRI/ALT button — PRESS (brackets should be below PRI in display).
    e. AUTO CODE button — PRESS.
    f. Laser alpha code — ENTER.
    g. Missile quantity — ENTER.
    h. ENTR button — PRESS.
    i. Verify laser code, channel, and missile quantity are accepted.
    j. PRI/ALT button — PRESS (brackets should be below ALT in display).
    k. Repeat steps e through j if other channel is required.
20. THCDP system mode — As desired.
21. NTS NTS — Check BRST.

Note

Allow cooldown of FLIR prior to BRST.

22. CHAFF DISP and CONT circuit breakers — IN.
23. Jettison select — As required.
24. Pretakeoff checklist — COMPLETE.

21.16 ARMAMENT IN-FLIGHT PROCEDURES

The following armament in-flight procedure paragraphs are based on only one weapon installed, all armament circuit breakers energized, and the pilot RECOIL COMP switch on. See Figure 21-2 for firing modes when two or more weapons are installed.

WARNING

Do not engage cyclic or LHG switches during any switching action on armament control panels.

CAUTION

If weapon firing stoppage occurs, immediately release the firing switch, or extensive damage to equipment may occur. Do not attempt to fire the weapon until stoppage corrective action has been taken. In the event of a runaway gun, place the MASTER ARM/PILOT OVERRIDE switch OFF.

21.16.1 Turret Operation.

21.16.1.1 Turret Operation — Gunner.

1. MASTER ARM — STBY.
2. WEAPON CONT — GUNNER.
3. RECOIL COMP — ON.
4. PILOT OVERRIDE — OFF.
5. *GUN RANGE KM — As desired.*
6. AIRSPEED COMP — COMP.
7. TURRET DEPR LIMIT — OFF.

When using HSS:

1. ACQ/TRK/STOW — STOW.
2. THCDP system mode switch — Any Position Except TOW Function.
3. MASTER ARM — ARM.
4. LHG ACTION — DEPRESS.
5. LHG TRIGGER — DEPRESS (first detent 16 ±4 round burst, second detent continuous).

When using TSU/GUN:

1. THCDP system mode switch — TSU/GUN.
2. ACQ/TRK/STOW — TRK.
3. MASTER ARM — ARM.
4. LHG ACTION — DEPRESS.
5. LHG TRIGGER — DEPRESS (first detent 16 ±4 round burst, second detent continuous).

When in PILOT OVERRIDE:

1. PILOT OVERRIDE — OVERRIDE.
2. Cyclic TRIGGER ACTION — DEPRESS.
3. *Cyclic TRIGGER TURRET FIRE —* DEPRESS.

Note

The pilot can interrupt firing by deenergizing the appropriate circuit breaker or control switches.

21.16.1.2 Turret Operation — Pilot.

1. MASTER ARM — STBY.
2. RECOIL COMP — ON.
3. PILOT OVERRIDE — OFF.
4. GUN RANGE KM — As desired.
5. AIRSPEED COMP — COMP.
6. TURRET DEPR LIMIT — OFF.

When using HSS:

1. WEAPON CONT — PILOT.
2. MASTER ARM — ARM.
3. Cyclic TRIGGER ACTION — DEPRESS.
4. Cyclic TRIGGER TURRET FIRE — DEPRESS (first detent 16 ±4 round burst, second detent continuous).

When using HUD sight:

1. WEAPON CONT — FIXED.
2. MASTER ARM — ARM.
3. Cyclic TRIGGER ACTION — DEPRESS (to obtain gun reticle).

4. Cyclic TRIGGER TURRET FIRE — DEPRESS (first detent 16 ±4 round burst, second detent continuous).

WARNING

When the gunner comes out of the TSU, the LHG MAG switch should be placed in LO MAG and ACQ/TRK/STOW to STOW to prevent firing of the system in an undesired mode.

Note

With the weapon control in the gunner mode and the THCDP system mode switch in a TOW mode, the pilot will have control of, and can fire, the turret using his HSS.

21.16.2 Wing Stores Operation — Gunner in PILOT OVERRIDE.

1. MASTER ARM — STBY.
2. STORE CONTROL panel — SET:
   a. STATION SELECT — SELECT (desired station).
   b. QTY — AS DESIRED (at least 01).
3. PILOT OVERRIDE — ON.
4. WING STORES SELECT — As desired.
5. Cyclic WING ARM FIRE — DEPRESS.

Note

Placing the WING STORES SELECT switch to INBD or OUTBD prior to positioning the PILOT OVERRIDE switch to ON may cause the STORE CONTROL panel to deselect and forward firing weapons to fail to release.

21.16.3 TOW Operation.

21.16.3.1 TOW Firing Checklist.

1. MASTER ARM — STBY.
2. WEAPON CONT — GUNNER.
3. THCDP OFF/BRT switch — ON.
4. THCDP system mode switch — ARM, MAN, OR AUTO.
5. ACQ/TRK/STOW — TRK.
6. PHS ACQ — DEPRESS FOR PHS ACQ THEN RELEASE WHEN TARGET ACQUIRED.
7. ACQ/TRK/STOW — ACQ FOR GHS ACQ THEN RELEASE.
8. LHG ACTION — DEPRESS.
9. CHANNEL SELECT switch — CHANNEL As desired (DVO/TVC/FLIR).
   a. FOV — HI FOR DVO.
   b. FOV — MEDIUM, NARROW, OR NARROW ZOOM FOR FLIR.
10. MASTER ARM — ARM.
11. LHG LRF switch — PRESS.
12. THCDP keyboard — SELECT MISSILE MANUALLY, As required.
13. Helicopter — MANEUVER INTO PRELAUNCH CONSTRAINTS AS INDICATED BY HUD.
14. LHG TRIGGER — Depress, then Release.

WARNING

Jettisoning of TOW launchers for a misfire condition is extremely dangerous. Do not jettison launchers unless fire is encountered.

Note

- Smoke may emerge from the launcher after TRIGGER is depressed and before the missile exits the launcher. Smoke is caused by missile gyro and battery squibs firing and should not be regarded as a misfire.
- If the TOW missile fails to exit from the launcher within 1.5 seconds and the TSU reticle on the HUD begins flashing, a misfire has occurred.
- Gunner may attempt second firing by releasing and depressing the LHG TRIGGER. If the TOW missile again fails to fire, set the THCDP keyboard to select another TOW missile.
- Gunner cannot fire if the helicopter is not within prelaunch constraints boundary. Gunner can override the prelaunch constraints by pressing CONST OVRD switch on the SHC. If this mode of operation is employed, degraded system performance can be expected.

15. Helicopter — MANEUVER. Keep the TSU line of sight reticle within postlaunch constraints until wire cut or missile impact.

Note

- Loss of missile guidance can result if postlaunch constraints are exceeded.
- Missile wires are cut automatically and the HUD postlaunch window disappears. If wires are not automatically cut, the pilot can manually cut the wires using the pilot WIRE CUT pushbutton or the gunner can manually cut wires using the THCDP WIRE CUT pushbuttons.
- Additional missile firing — Next missile is selected automatically when the gunner THCDP system mode switch is in ARMED AUTO.

21.16.3.2 TOW Misfire Checklist.

INDICATION:

1. The TSU reticle on the HUD begins flashing and the TOW missile fails to exit the launcher within 1.5 seconds.

PROCEDURE:

1. LHG trigger — RELEASE, THEN PRESS.

If missile again misfires:

2. THCDP keyboard — SELECT ANOTHER TOW MISSILE.

Upon completion of the mission:

3. Land heading downrange.
4. Accomplish dearm checklist.
5. Shut down helicopter.
6. Wait 30 minutes; download the missile.

21.16.3.3 TOW Hangfire Checklist.

INDICATION A:

1. Motor ignites; missile does not separate.
2. Slight helicopter yaw.
3. No fire in launcher.

PROCEDURE A:

1. Maintain helicopter control.
2. Land heading downrange.
3. Accomplish dearm checklist.
4. Shut down helicopter.
5. Wait 1 hour; download the missile.
6. Special handling is required.

INDICATION B:

1. Motor ignites; missile does not separate.
2. Slight helicopter yaw.
3. Fire in launcher.

PROCEDURE B:

1. Maintain helicopter control.
2. Jettison launcher.

21.16.4 Rocket Operation.

1. MASTER ARM — STBY.
2. PILOT OVERRIDE — OFF.
3. STORE CONTROL panel — SET:
   a. STATION SELECT — SELECT.
   b. RATE — As desired.
   c. QTY — As desired.
   d. MODE — As desired.
4. ROCKETS RANGE KM — As required.
5. MASTER ARM — ARM.
6. Cyclic WING ARM FIRE — DEPRESS.

21.16.5 Bomb Operation.

1. MASTER ARM — STBY.
2. PILOT OVERRIDE — OFF.
3. STORE CONTROL PANEL — SET:
   a. STATION SELECT — SELECT.
   b. BOMB ARM — As desired.
4. MASTER ARM — ARM.
5. Cyclic WING ARM FIRE — DEPRESS.

21.16.6 Flare Operation.

1. MASTER ARM — STBY.
2. PILOT OVERRIDE — OFF.
3. STORE CONTROL panel — SET:
   a. STATION SELECT — SELECT.
   b. RATE — As desired.
   c. QTY — As desired.
   d. MODE — As desired.
4. MASTER ARM — ARM.
5. Cyclic WING ARM FIRE — DEPRESS.

21.16.7 HELLFIRE Missile Operation.

21.16.7.1 LDRS Operation — Gunner.

1. MASTER ARM — STBY.
2. WEAPON CONT — GUNNER.
3. PILOT OVERRIDE — OFF.
4. Turret DEPR — OFF.
5. ACQ/TRK/STOW — TRK.
6. THCDP OFF/BRT — ON.
7. SYS MODE — ANY MODE.
8. FIRST/LAST — As desired.
9. MIN RANGE DISPLAY — As desired
10. TSU FILTER SELECT — LASER.
11. MASTER ARM — ARM (LASER ARM indicator on pilot glareshield illuminated).
12. LHG — Depress RF or DES switch as desired. View readout in HUD, ORT, or MFD. On pilot glareshield, LASER ON light illuminated.

21.16.7.2 Tactical Missile Launch.

1. MASTER ARM — STBY.
2. THCDP launch sequence mode switch — As required.

Note

If MAN position is selected, the system will automatically select missiles. However, the gunner may select the number of the missile to be launched by depressing the number of the missile and the ENTR buttons.

3. PRI/ALT button — As required.
4. CCM button — As required.

For LOAL, proceed as follows:

1. THCDP system mode switch — LO/HI/DIR.
2. HPCP mode switch — GNR CONT or LO/HI/DIR.
3. Align helicopter on general line to target.
4. MASTER ARM — ARM.
5. Cyclic WING ARM FIRE — PRESS and HOLD or raise HELLFIRE trigger guard and PRESS and HOLD HELLFIRE trigger.
6. THCDP and HPCP system mode switches — As required.

For autonomous designation:

7. LASER DES switch — PRESS and HOLD.
8. LASER DES switch — Release After Missile Impact.
9. THCDP and HPCP system mode switches — As required.

For LOBL, proceed as follows:

1. THCDP system mode switch — LOBL.
2. HPCP system mode switch — GNR CONT or LOBL.
3. Gunner track target using CRT or DVO.

Note

A circle appears on the HUD when the seeker has locked on the target. If the steering symbol on the HUD is out of the constraint circle, constraints may be overridden by the crewmember in control of HMS.

4. MASTER ARM — ARM.
5. LASER DES switch — PRESS AND HOLD.
6. MSL DEICE switch — PRESS If Required.
7. Align target within constraints circle.

Note

- ATTK — M-65 operational mode. Display is in left corner. In HELLFIRE mode, ATTK indicates that missile has been selected, armed, and has accepted the laser code provided by the THCDP.
- RDY — M-65 operational mode. Display is in right corner. In HELLFIRE mode, RDY indicates that LOBL prelaunch constraints have been met.

If target cannot be brought into constraints, proceed to step 11.

8. Cyclic WING ARM FIRE — PRESS AND HOLD, or raise HELLFIRE trigger guard and PRESS and HOLD HELLFIRE trigger.
9. LASER DES switch — RELEASE AFTER MISSILE IMPACT.
10. THCDP and HPCP system mode switches — As required.

For LOBL launch, target not within constraints circle, proceed as follows:

11. THCDP or HPCP SYSTEM MODE switch in control — ORIDE.
12. Cyclic WING ARM FIRE — PRESS and HOLD, or raise HELLFIRE trigger guard and PRESS and HOLD HELLFIRE trigger.
13. LASER DES switch — RELEASE AFTER MISSILE IMPACT.
14. THCDP and HPCP system mode switches — As required.

Note

The copilot/gunner can also fire HELLFIRE missiles by switching to PILOT OVERRIDE and selecting outboard wing stores when the THCDP is in any active HELLFIRE mode and the MASTER ARM is in ARMED or STBY.

21.16.8.3 Practice Missile Launch.

Note

Practice missiles are launched in the same manner as tactical missiles; however, practice missiles can be recovered for additional launchings.

For recovery, proceed as follows:

1. THCDP system mode switch — STBY.
2. THCDP and HPCP system mode switches — As required.

21.16.8.4 Missile BIT.

1. THCDP system mode switch — STBY.
2. BIT button — PRESS.

21.16.8.5 Laser Code and Missile Quantity Change for Priority Channel.

1. HPCP system mode switch — GNR CONT.
2. THCDP system mode switch — LOAL or LOBL.
3. AUTO CODE button — PRESS.
4. LASER alpha code — ENTER.
5. Missile quantity — ENTER.
6. ENTR button — PRESS.

21.16.8.6 HELLFIRE Missile Emergency Procedures.

21.16.8.6.1 Unlatched Missile.

Indication:

1. The UNL legend appears on missile status display.

Procedure:

1. Slow the helicopter, maintain level flight.
2. Land as soon as practicable.

After Landing:

3. Accomplish dearm checklist.
4. Groundcrew/gunner — RELATCH MISSILE.

If the missile cannot be latched:

5. Engines — SHUT DOWN.
6. Alert armament personnel.

21.16.8.6.2 Misfire.

Indication:

1. Motor does not ignite.
2. MF legend appears on missile status display.

Procedure:

1. Land downrange.
2. Accomplish dearm checklist.
3. Wait 30 minutes, download missile.
4. No special handling required.

21.16.8.6.3 Hangfire.

Indication A:

1. Motor does not ignite.
2. The HF legend appears on the missile status display, flashing in all missile positions for the affected launcher for approximately 5 seconds and then remaining steady and appearing only for the affected missile position.

Procedure A:

1. Land downrange.
2. Accomplish dearm checklist.
3. Wait 1 hour; download missile.
4. Special handling required.

Indication B:

1. Motor ignites, missile does not separate.
2. Helicopter yaws.
3. HF legend appears on the missile status display.

Procedure B:

1. Attempt to maintain helicopter control.
2. Follow yaw with cyclic and pedal inputs.
3. Jettison outboard stores (if feasible).

After Landing:

4. HELLFIRE launcher ARM/SAFE switch — SAFE.

21.16.9 AIM-9/AGM-122 Missile Operation.

1. Cockpit control unit — SET:
   a. STA SELECT switch — SELECT. Observe missile symbol appears on HUD.
   b. Mode select switch — STBY.

Note

A 60 second cooldown is required (AIM-9 only).

   c. Mode select switch — ARM.
2. MASTER ARM — ARM.
3. Align the target within the reticle FOV and obtain an audio tone indication on the ICS.
4. UNCAGE/FIRE switch — UNCAGE. Verify the reticle tracks the target, or upon obtaining audio tone, go directly to step 5 if target verification (and/or positive tracking indication) is not required.
5. UNCAGE/FIRE switch — FIRE.

21.16.9.1 AIM-9/AGM-122 Missile Emergency Procedures Misfire.

Indication:

1. Motor does not ignite.

Procedure:

1. Land downrange.
2. Accomplish dearm checklist.

3. Wait 30 minutes; download missile.
4. No special handling required.

21.16.9.2 Hangfire.

Indication:

1. Motor ignites; missile fails to separate.

Procedure:

1. Attempt to maintain helicopter control.
2. Follow yaw with cyclic and pedal inputs.
3. Jettison outboard store (if feasible).

After Landing:

4. AIM-9 mode select switch — OFF.

21.17 ARMAMENT POSTFIRING/BEFORE LANDING CHECK

1. PILOT OVERRIDE — OFF.
2. TURRET DEPR LIMIT — LIMIT.
3. MASTER ARM — STBY.
4. WEAPON CONT — FIXED.
5. ALE-39 control panel — SET.
   a. ARM switch — SAFE.
   b. PWR switch — OFF.
6. ARMED/CP lights — EXTINGUISHED.
7. TURRET CONTR circuit breaker — INBOARD.
8. TURRET STOW light — ON.

21.17.1 After Dearm.

1. Armament Circuit Breakers — DOWN/OUT (except TURRET CONTR, DR MTR, GUN MTR).
2. MASTER ARM — STBY.
3. WEAPON CONT — GUNNER.
4. THCDP — ON.
5. RADAR altimeter/TACAN/IFF/TNS Doppler — As required.
6. Pretakeoff Checklist — Complete.

21.18 ANVIS HUD SYSTEM

21.19 AVIATORS NIGHT VISION IMAGING SYSTEM HEAD-UP DISPLAY

The ANVIS HUD, also referred to as the Gideon system, consisting of add-on electronic and optical components that are designed to provide night vision HUD capability in addition to the existing HUD system. This is done by adding a helmet-mounted optical display system for use by the pilot and copilot/gunner to repeat the HUD symbology while incorporating night vision compatible imaging. The ANVIS HUD (Figure 21-57) consists of two HDUs, the ECU, the CU, and a remote BRT control. The ANVIS HUD is a head-up display graphic and symbology repeater for use with the AN/AVS-6 (V) ANVIS. The ANVIS HUD relays the helicopter HUD generated graphics and symbology information (Figure 21-58) to the objective lens of the ANVIS, superimposed over the image intensified visual imagery of the ANVIS.

21.19.1 Helmet Display Unit. Each HDU (Figure 21-59) consists of an ODA and HVPS connected by a cable assembly. The helmet mounted module of each HDU is a housing containing a CRT and combiner lens to project graphics and symbology onto the ANVIS objective lens. This module is referred to as the ODA. At the opposite end of the HDU cable is the HVPS module that plugs into a cockpit connector. An L/R EYE SELECT switch is located on each HVPS. The EYE SELECT switch makes possible the installation of the HDU ODA on either side of the ANVIS goggle assembly. The pilot and copilot/gunner portion of the ANVIS HUD may be operated independently of the other. There is a focus knob located on the aft end of the ODA. The HDU ODA mounts to either side of the pilot or copilot/gunner helmet. The HVPS module is connected to the existing HUD system through a quick-disconnect electrical connector for rapid release and removal of the HDU. The HDU receives video information signals from the ECU and represents those signals in visual form to the ANVIS HUD objective lens. The HDUs process the display signals that are formatted by the HDU signal processor of the HUD system. Refer to Figure 21-60 for a functional block diagram. Information displayed on the ODAs is exactly the same as that displayed on the pilot HUD, including target, essential system, and flight attitude information. The HDU supplies a display image that is compatible with night vision goggles. Electrical power is supplied as +15 vdc and −15 vdc from the ECU.

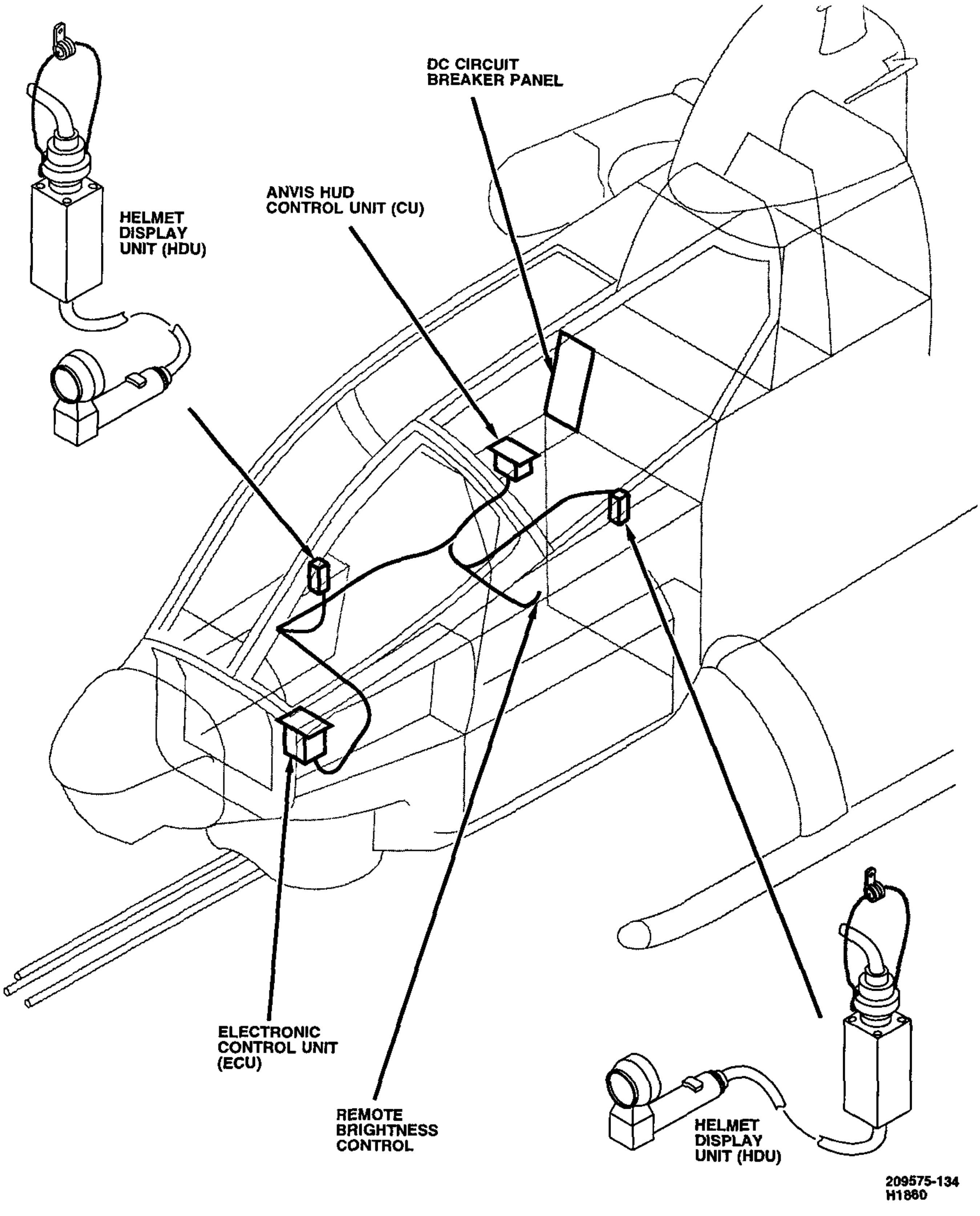
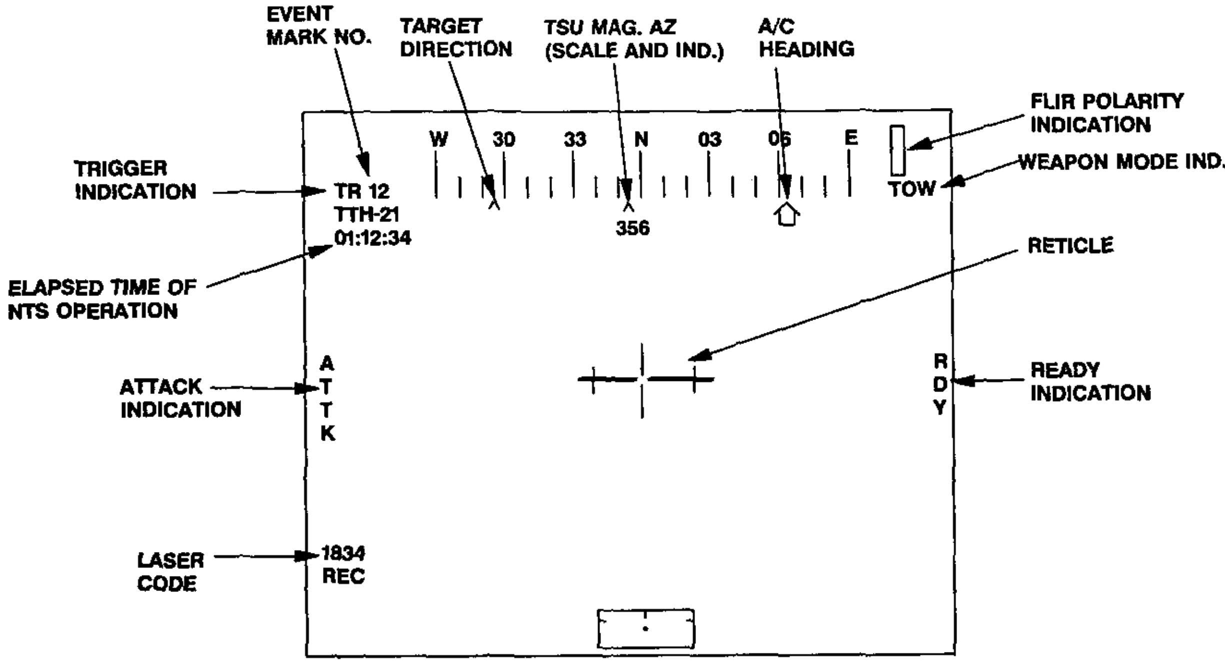
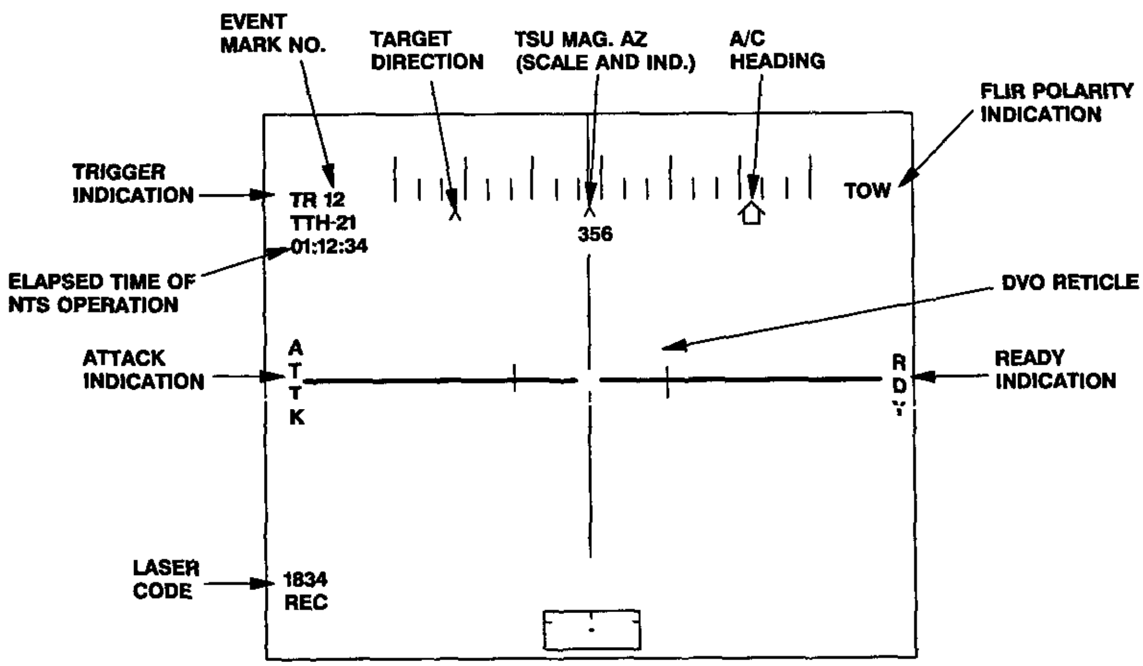


Figure 21-57. ANVIS HUD Equipment



SYMBOLS WITH FLIR AS IMAGE SOURCE



SYMBOLS WITH TV CAMERA AS IMAGE SOURCE

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Figure 21-58. Objective Lens Graphics and Symbology

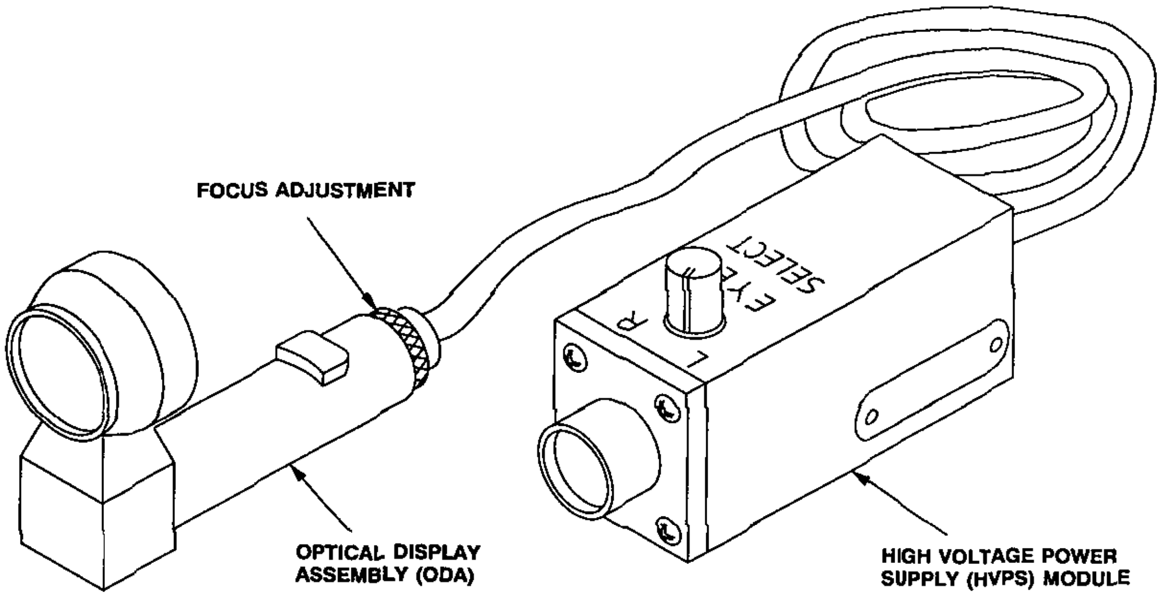


Figure 21-59. Helmet Display Unit

21.19.1.1 HDU Controls and Functions (Figure 21-59).

21.19.1.2 HDU Operating Procedures.

1. HVPS electrical connections — CHECK.
2. Focus — Adjust After ANVIS HUD Is Turned ON.

21.19.2 Electronic Control Unit. The ECU consists of a CRT driver, low voltage power supply, and processing electronics to receive stroke signals from the helicopter FFSP, also referenced as the HUD signal processor, and produces the deflection signals to drive both HDUs. The ECU also contains the control functions for the copilot/gunner HDU. The CU (Figure 21-61) provides separate operating controls for the pilot HDU. The ECU contains controls and circuits required to interface the ANVIS HUD with the existing HUD and drives the CRTs in both the copilot/gunner and pilot HDUs. The ECU is located in the copilot/gunner cockpit next to the CSC panel and controls the brightness via the BRT knob and display position adjustment (DISP POS) functions for the copilot/gunner HDU. The control panel for the ECU is labeled ANVIS HUD. The ECU display position has controls, one for U and D, and one for L and R. The system ON/OFF power switch with a SYS-ON indicator light for the copilot/gunner position and an HDU FAIL indicator light are also located on the ECU control panel. The ECU has a maximum warmup time of 1 minute from the first application of power. There is an internal time totalizing meter that clocks total on-time of the ANVIS HUD system and may be retrieved only by a maintenance technician. The ECU receives 28 vdc power from the essential bus and is protected by the GID PWR circuit breaker.

Note

The LEFT/RIGHT EYE select switch shall be turned to the opposite position if the image in the ANVIS HUD is inverted.

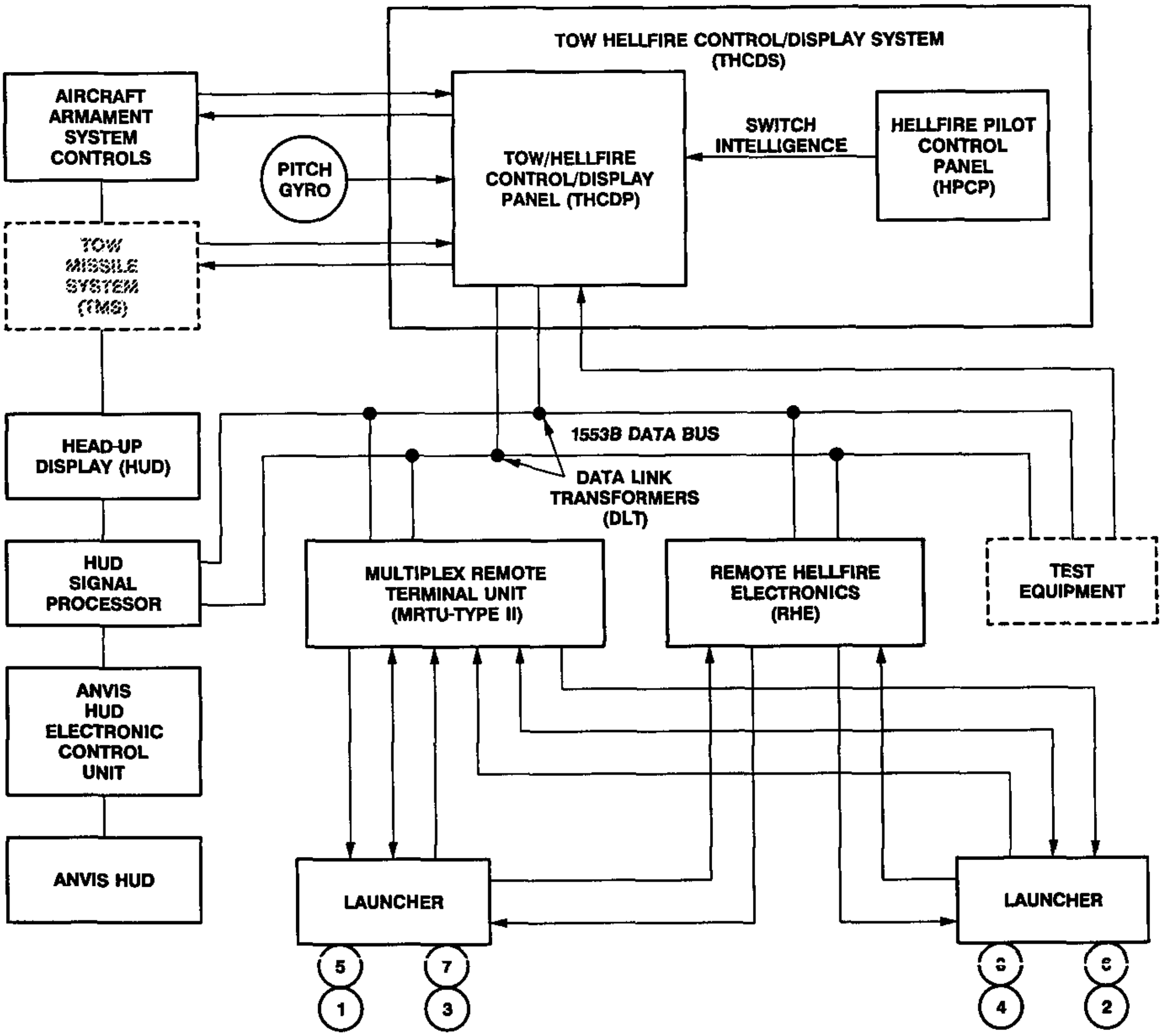
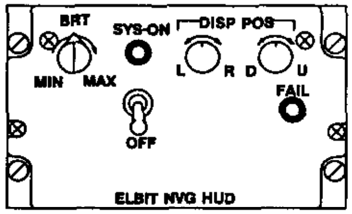
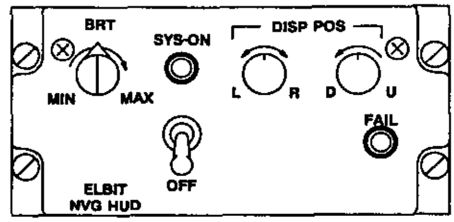


Figure 21-60. HMS Functional Block Diagram



ANVIS HUD ELECTRONIC CONTROL UNIT
(COPILOT/GUNNER STATION)



ANVIS HUD CONTROL UNIT
(PILOT STATION)

CONTROLLER/INDICATOR	FUNCTION
BRT knob	Adjusts ANVIS HUD CRT display brightness. CU (pilot station) BRT knob is not used.
SYS-ON light	Light illuminates to indicate ANVIS HUD system is activated.
DISP POS knobs	L/R adjusts CRT image horizontally left or right to center display.
	D/U adjusts CRT image vertically down or up to center display.
FAIL indicator light	Light illuminates to indicate ANVIS HUD system failure.
OFF switch	Activates ANVIS HUD system or turns system off.

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Figure 21-61. ANVIS HUD Electronic Control Unit and Control Unit

21.19.2.1 ECU Controls and Functions (Figure 21-61).

21.19.2.2 ECU Operating Procedures.

1. ANVIS HUD system on/OFF switch — ON.
2. BRT knob — ADJUST BRIGHTNESS As required.
3. LEFT/RIGHT EYE select switch (on HVPS) — As required.

Note

The LEFT/RIGHT EYE select switch shall be turned to the opposite position if the image in the ANVIS HUD is inverted.

4. DISP POS — Adjust Display Position As Required.

21.19.3 Control Unit. The CU contains controls and circuits required to operate the pilot HDU. The CU is located on the pilot right console and the control panel is labeled ANVIS HUD. The CU controls and functions are identical to the ECU except for the BRT knob. The BRT control on the CU has been bypassed and is not functional. The pilot may adjust brightness of the ANVIS HUD ODA using remote brightness control. The pilot or the copilot/gunner ANVIS HUD may be turned on independently. The CU receives all signals from the ECU through aircraft electrical wiring. All of the signal processing is performed in the ECU and the HVPS. The CU provides control-only circuitry for the pilot cockpit. The ECU receives 28 vdc power from the essential bus and is protected by the GID PWR circuit breaker.

21.19.3.1 CU Controls and Functions (Figure 21-61).

21.19.3.2 CU Operating Procedures.

1. ANVIS HUD system on/OFF switch — ON.
2. BRT knob (pilot collective switch box) — Adjust Brightness As Required.
3. LEFT/RIGHT EYE select switch (on HVPS) — As required.

Note

The LEFT/RIGHT EYE select switch shall be turned to the opposite position if the image in the ANVIS HUD is inverted.

4. DISP POS — ADJUST DISPLAY POSITION, As required.

21.19.3.3 Remote Brightness (NVG BRT) Control. A remote NVG BRT control is used on the ANVIS HUD and is located in the pilot cockpit on the collective switch box (Figure 21-36). This control is provided to allow the pilot to adjust ODA brightness since the BRT switch on the control unit is not used. ODA displays brightness in the pilot cockpit is adjusted with a remote BRT control for pilot convenience and ease of access. ANVIS HUD brightness controls for the copilot/gunner are located on the ECU.

21.20 MULTIFUNCTION DISPLAY

The MFD (Figure 21-62) is a CRT that displays video signals, TVC or FLIR, produced in the PEB. The MFD repeats the image or display presented in the ORT. The MFD is located on the copilot/gunner instrument panel behind the ORT. A BRT (brightness control) knob is located on the upper right corner of the MFD to control brightness of the background display. A CONT knob (contrast control) is located on the upper left corner of the MFD to control the contrast of the background. The mode select key to the right of the contrast control selects overscan/underscan of display. The OFF/N/D switch, located on the lower right corner of the MFD bezel, turns display to night brightness, day brightness, or OFF. All other keys on the MFD bezel are not functional.

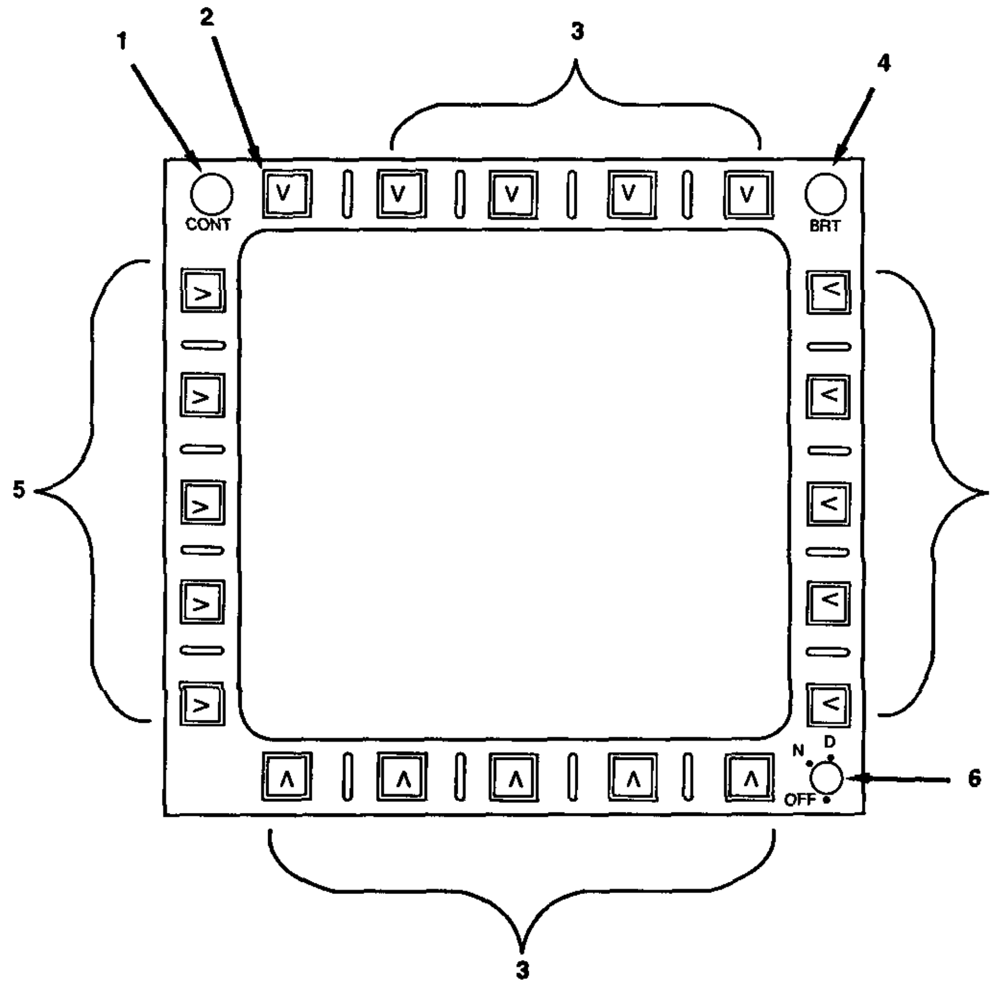
21.20.1 MFD Controls and Functions (Figure 21-62).

21.20.2 MFD Operating Procedures.

1. THCDP BRT/OFF switch — Adjust to Midrange.
2. TVC (television camera) FOCUS knob — Adjust As desired.
3. FLIR FOCUS switch — Adjust As desired.
4. MFD BRT knob — Adjust Brightness As desired.
5. MFD CONT knob — Adjust Contrast As desired.

21.21 LASER DESIGNATION/RANGE FINDING

1. TURRET DEPR LIMIT — OFF.
2. LSR switch — FIRST/LAST.
3. Laser Min Range — SET.
4. TSU FILTER — LASER.
5. LCP — Set, MAN/AUTO.
6. ACQ/TRK/STOW — TRK.
7. MASTER ARM — ARM.
8. LASER ARM light — VERIFY.
9. LRF/LASER DES button — DEPRESS.



	CONTROL/INDICATOR	FUNCTION
1.	CONT knob	Adjusts contrast of display.
2.	Mode select key	Push to select overscan/underscan of display.
3.	Remaining mode select keys	Not used.
4.	BRT knob	Adjusts brightness of display.
5.	Line select keys	Not used.
6.	Mode select switch	Turns MFD on and selects day night displays.

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Figure 21-62. Multifunction Display

CHAPTER 22

Countermeasure Systems

22.1 COUNTERMEASURE SYSTEM AVIONICS

The countermeasure system avionics (Figure 22-1) consist of the AN/ALE-39 countermeasure dispensing system, AN/APR-44 radar warning system, AN/APR-39(V)1 radar detector system, and AN/ALQ-144 countermeasure system.

22.2 AN/ALE-39 COUNTERMEASURE DISPENSING SYSTEM

The AN/ALE-39 countermeasure dispensing system (Figure 22-2) permits the pilot or copilot/gunner to selectively eject flares, chaff, or active radio devices (jammers) from dispensing pods on the wings. These items are designed to counter enemy surveillance radar, missile guidance radar, and passive homing missiles. The AN/ALE-39 has the capability of dispensing up to 60 chaff, flare, and jammer payloads in any combination. All three types of payloads can be dispensed in either single or programmed mode. The dispensing function can be initiated by the pilot or copilot/gunner. The AN/ALE-39 system consists of two dispenser housings, two dispenser assemblies, pilot and copilot/gunner dispenser switches, two sequencer switch assemblies, one programmer assembly, and a cockpit control unit that consists of the AN/ALE-39 CDCP and the AN/ALE-39 housing control unit.

22.2.1 Countermeasure Dispensing System Operation.

1. ALE-39 programmer — SET as required.
2. ALE-39 CCU — SET as required.
3. CHAFF DISP and CONT circuit breakers — IN.
4. ALE-39 PWR switch — ON.
5. ALE-39 PROG RESET switch — RESET (minimum 5 seconds).
6. ALE-39 ARM switch — ARM.
7. Pilot DISPENSER or copilot/gunner MANUAL SELECT switch — As required.

22.3 AN/APR-44 RADAR WARNING SYSTEM

The APR-44 radar warning system is used to detect continuous wave radar signals, both ground (SAM threat) and AI, aimed at the helicopter. Radar detection is indicated by a tone in the headset and illumination of the SAM or AI lights. The SAM/AI lights are located on the AN/ALE-39 indicator support bracket in the pilot cockpit and in the caution panel in the copilot/gunner cockpit.

The system consists of four antennas, two receivers, a low pass filter, SAM/AI indicator lights, and a control panel. See Figure 22-3 for descriptions and functions of the control panel and indicator lights. The system is powered by the 28 vdc essential bus, and circuit protection is provided by the RADAR WRN circuit breaker.

Note

The AI radar detection function of the APR-44 is inoperative. Provisions are included in the helicopter for subsequent installation.

22.3.1 Radar Warning System Operation. (Figure 22-3)

1. RADAR WRN circuit breaker — IN.
2. POWER switch — ON (audio tone and SAM alert lamp comes on momentarily and then goes off).
3. SAM indicator light — PRESS TO TEST SAM/AI lights.
4. VOLUME control knob — As required.

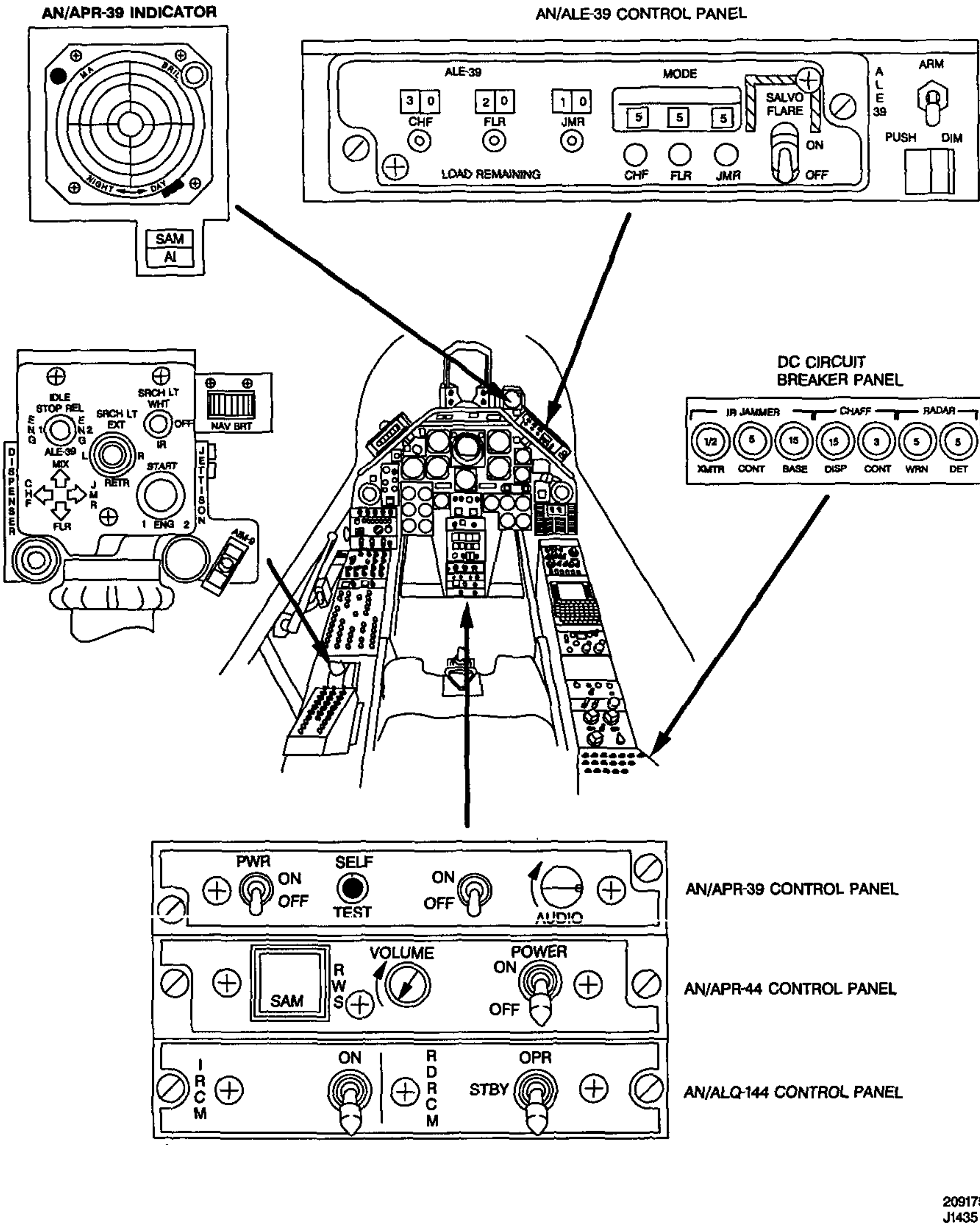


Figure 22-1. Countermeasure System Avionics (Sheet 1 of 2)

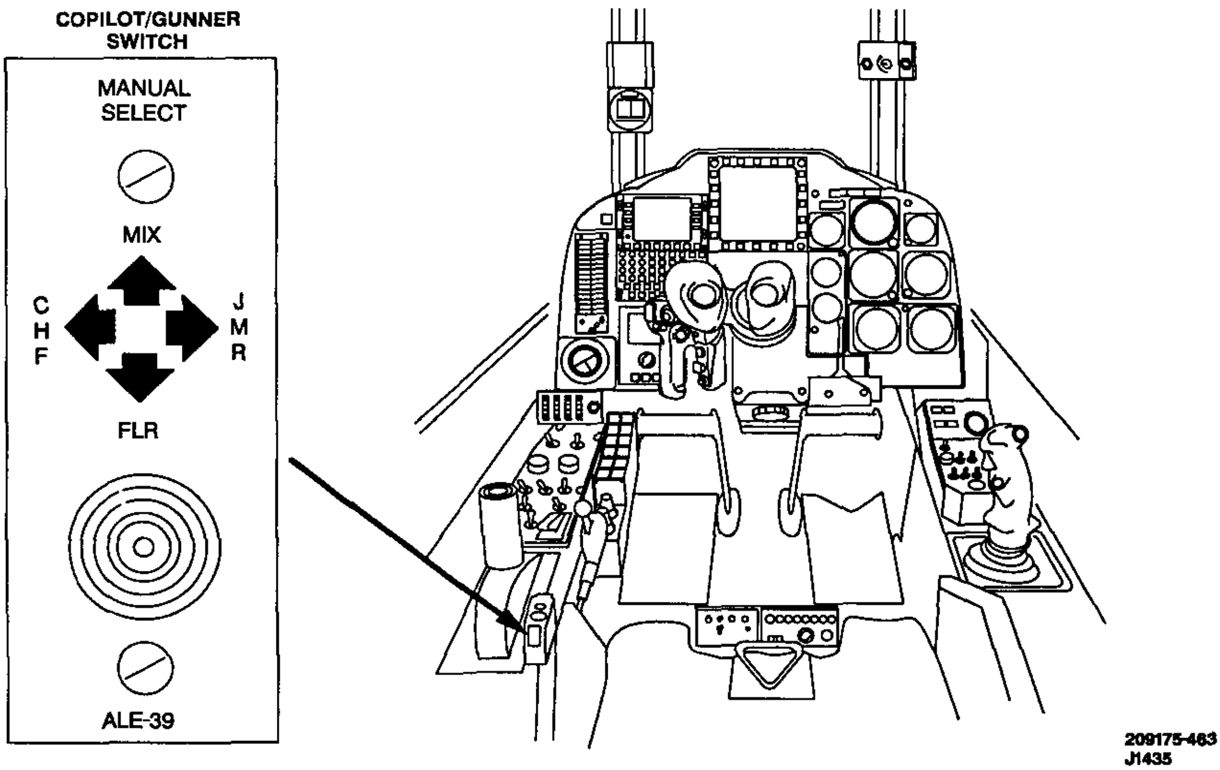


Figure 22-1. Countermeasure System Avionics (Sheet 2 of 2)

22.4 AN/APR-39(V)1 RADAR DETECTOR SYSTEM

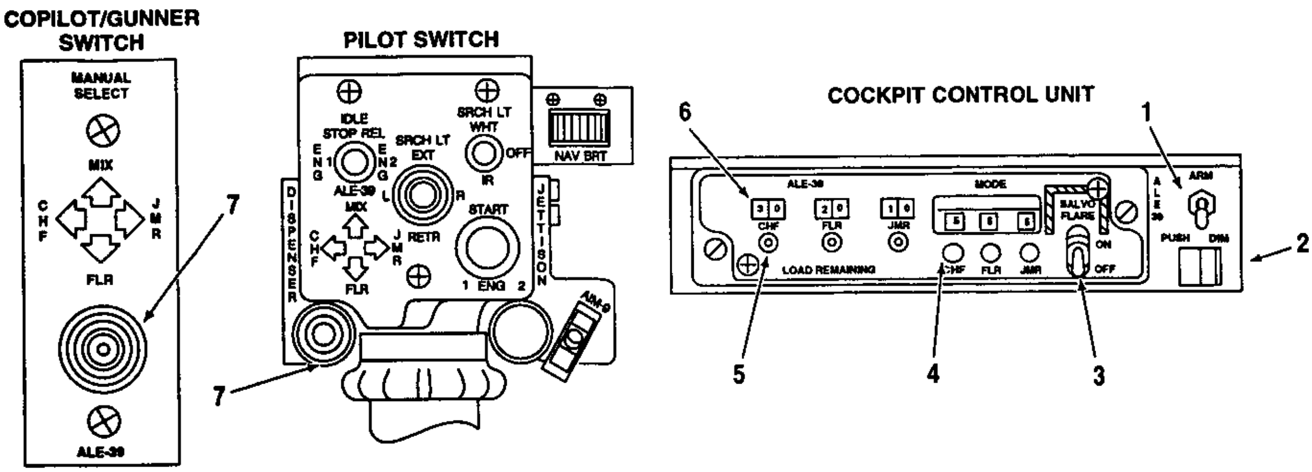
The AN/APR-39(V)1 is a passive omnidirectional radar detection system receiving and displaying information to the pilot concerning the radar environment surrounding the helicopter. The equipment responds to radar signals associated with hostile fire control radar in E, F, G, H, I, and J frequency bands (wide band) and provides visual and aural indications of the presence and direction of emitters.

Missile guidance signals in C and D bands are also received by this system. When a low-band signal is correlated with a tracking radar signal, the equipment identifies the combination as an activated SAM radar complex. This system consists of four spiral antennas, one blade antenna, a comparator, an APR-39 control panel, two receivers, and an APR-39 radar signal indicator.

The control panel (Figure 22-4) is located on the right side of the pilot glareshield. System control and test functions are provided by this unit.

22.4.1 Radar Detector System Operation.

1. RADAR DET circuit breaker — IN.
2. DSCRM switch — OFF.
3. PWR ON/OFF switch — ON (allow a minimum of 30 seconds for equipment to become fully operational).
4. AUDIO — ON.
5. SELF TEST — DEPRESS.
    a. Confirm solid strobe at 12 and 6 o'clock (adjust BRIL and filter as required).
    b. Confirm associated PRF tone (adjust volume as required).
    c. Confirm Missile Alert light flashes and produces an associated warbling tone 5 to 6 seconds after appearance of strobe.
6. SELF TEST — RELEASE.
7. DSCRM switch — ON.
8. SELF TEST — DEPRESS.
    a. Confirm solid strobe from either the center of indicator to the 12 o'clock position or center of indicator to the 6 o'clock position.
    b. Confirm associated PRF tone.



	NOMENCLATUTRE	FUNCTION
1.	ALE-39 ARM switch	Down - OFF position. Disables ALE-39 dispenser pods. ARM - ON position. Enables ALE-39 dispenser pods.
2.	Armed light (Left/right segment for left/right dispenser)	Extinguished when ARM switch is OFF or when dispenser ARM/SAFE handle is in SAFE position. Armed light is on when ARM switch is ON and dispenser ARM/SAFE handle is in ARMED position.
3.	Power (PWR) switch	OFF - Power off to ALE-39 system. ON - Activates ALE-39 system. SALVO FLARE - Fires all flare positions.
4.	MODE-SEL switches (chaff (CHF), flare (FLR), and jammer (JMR) countermeasures)	O - Off, disables that countermeasure. S - Single, one dispense command per actuation of DISPENSER/MANUAL SELECT switch. P - Programmed, initiates dispense sequence as per programmer. R - Radar Warning Receiver allows automatic initiation of expendables with cueing from the on-board Radar Warning Receiver. This function is currently disabled in the AH-1W. M - Will initiate multiple bursts of 2, 3 or 4 expendables simultaneously and concurrently depending on the number of subsections (L-10, L-20, R-10, R-20) identified in the programmer as either Flare (F), Chaff (C) or Jammer (J) with a single initiation of the dispenser switch. G - Group, multiple bursts of flares dispensed as per programmer.
5.	PAYLOAD REMAINING reset switches	Provides for manual setting of LOAD REMAINING counters. One for each countermeasure.
6.	PAYLOAD REMAINING counters	Indicates number of loads remaining in dispensers. One for each countermeasure.
7.	DISPENSER/MANUAL SELECT switches	Push to dispense or initiate dispense sequence. One position for each countermeasure. Mix dispenses a preselected combination of two flares and one chaff.

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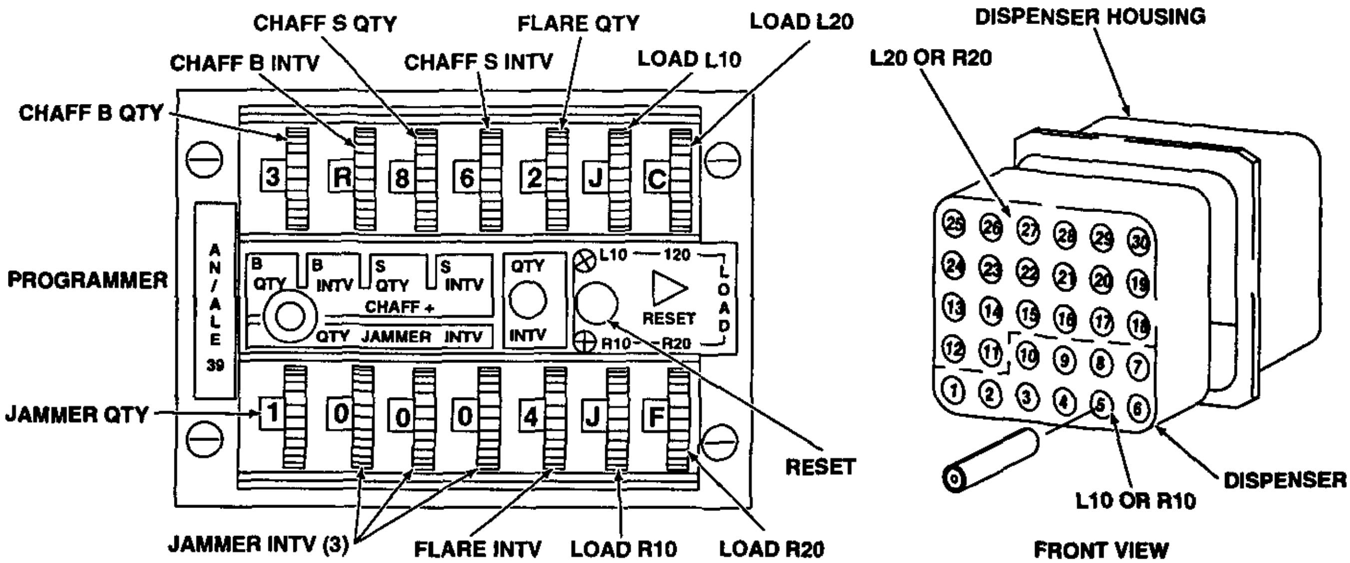
Figure 22-2. Countermeasure Dispensing System (Sheet 1 of 2)



NOMENCLATURE	FUNCTION
CHAFF Section	
B QTY switch	1, 2, 3, 4, C or R selects number of chaff bursts in one salvo (C is continuous and R is random).
B INTV switch	.1, .2, .5, .7, 1.0 or R selects time interval between chaff bursts of each salvo in seconds (R is random).
S QTY switch	1, 2, 4, 8, 10 or 15 selects number of chaff salvos in one programmed sequence.
S INTV switch	2, 4, 6, 8 or 10 selects time interval between chaff salvos in seconds.
FLARE Section	
QTY switch	2, 3, 4, 6, 8, or 10 selects number of flare bursts in one programmed sequence.
INTV switch	2, 3, 4, 6, 8, or 10 selects time interval, in seconds, between bursts in programmed sequence.
LOAD Section	
L10 switch	C, F or J indicates type of payload in L10 dispenser.
L20 switch	C, F or J indicates type of payload in L20 dispenser.
R20 switch	C, F or J indicates type of payload in R20 dispenser.
R10 switch	C, F or J indicates type of payload in R10 dispenser.
RESET switch	When positioned to RESET (3 seconds minimum), clears all registers and counters in programmer and resets sequencer switches.
JAMMER Section	
INTV switches	Selects, in seconds, the time interval between bursts of programmed sequence (from 000 thru 299). At interval 000, only one payload is dispensed.
QTY switch	1, 2, 3 or 4 selects number of jammer bursts in one programmed sequence.

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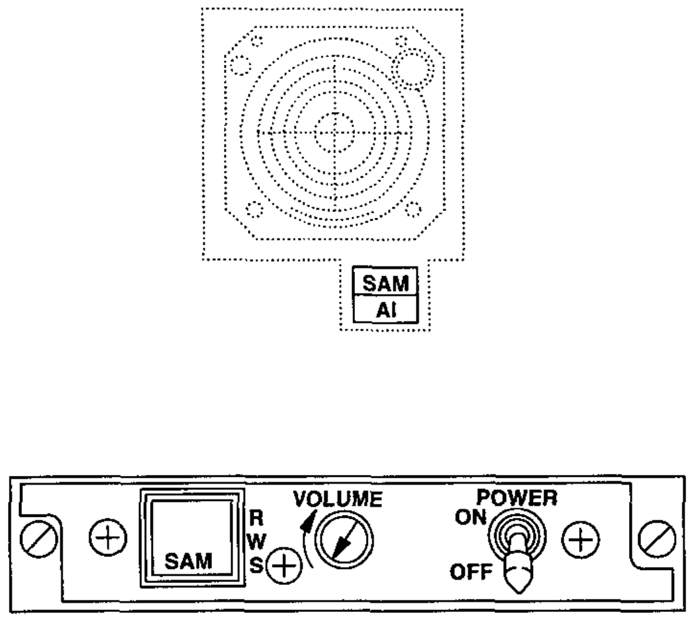
Figure 22-2. Countermeasure Dispensing System (Sheet 2 of 2)



NOMENCLATURE	FUNCTION
SAM/AI indicator light (Segments in copilot/gunner caution panel not shown)	SAM segment illuminates when ground threat radar signals are received. AI segment illuminates when airborne threat radar signals are received.
SAM Indicator light/test switch	Indicator function disconnected.
	Press to test SAM/AI light segments.
VOLUME control knob	Controls audio signal volume.
POWER switch	Turns system ON and OFF.

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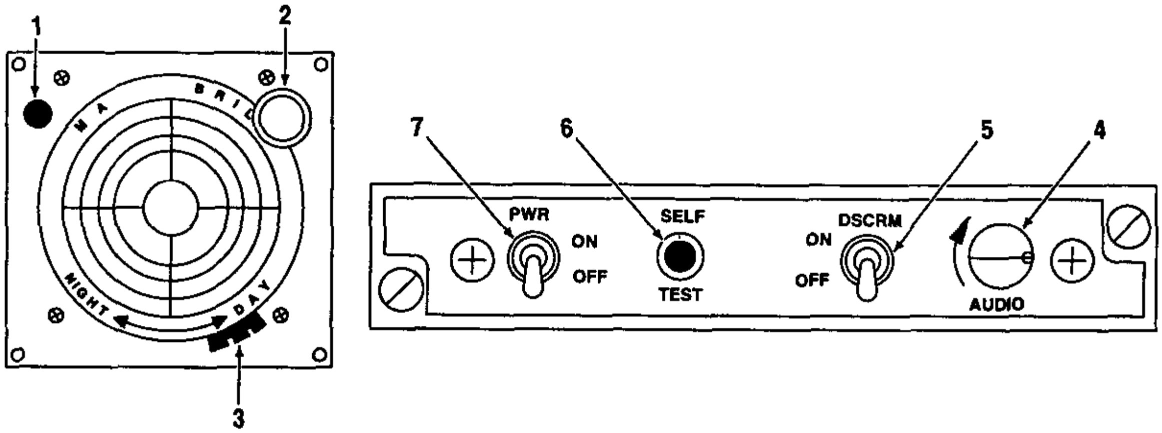
Figure 22-3. AN/APR-44 Radar Warning System Indicator and Control Panel



NOMENCLATURE	FUNCTION
1. MA (missile alert) light	Flashes to indicate missile guidance signal detection.
2. BRIL control	Adjusts indicator strobe illumination.
3. NIGHT - DAY control	Adjusts indicator screen intensity.
4. AUDIO control	Adjusts radar warning audio volume.
5. DSCRM switch:	
OFF	Enables system to respond to threat and nonthreat radar signals.
	Without missile activity - Provides strobe lines for ground radar signals and pulse repetition frequency (PRF) audio indications.
	With missile activity - Provides flashing strobe lines for ground radar signals, alarm audio (whooping) and flashing MA light.
ON	Eliminates nonthreat radar indications.
	Without missile activity - Provides strobe lines for threat radar signals and PRF audio indications.
	With missile activity - Provides flashing strobe lines for threat radar signals, flashing MA light, and alarm audio.
6. SELF TEST switch:	
DSCRM switch OFF	Forward and aft strobes appear, extend to third circle on the indicator, and PRF audio present immediately. After 6 seconds, strobes will flash, alarm audio present, and MA light starts flashing.
DSCRM switch ON	After 4 seconds a forward or aft strobe will appear and PRF audio present. Within 6 seconds, the other strobe will appear, PRF audio will double, and MA light flashes with alarm audio present.
7. PWR switch:	
OFF	Deenergizes radar set.
ON	Applies power to the radar set.

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Figure 22-4. AN/APR-39 Radar Detector Indicator and Control

c. Confirm that within 4 to 5 seconds the strobe increases to a full 12 to 6 o'clock position and the associated PRF tone increases in pitch.

d. Confirm that within 4 to 5 seconds of completed 12 to 6 o'clock strobe the missile alert light flashes and produces an associated warbling tone.

9. SELF TEST — RELEASE.

10. DSCRM switch — As required.

WARNING

If on initiation of the self-test function strobes other than from the 6 and 12 o'clock position are presented, the associated spiral antenna may be inoperable and will display erroneous information to the pilot with regards to threat radar system azimuth/bearing.

A solid strobe from the center of the indicator to the 12 or 6 o'clock positions indicate a self-test pass. Any other indication is a fail. A fail may indicate an inoperable spiral antenna which will give the pilot incorrect information with regards to threat radar system azimuth/bearing.

CAUTION

To prevent damage to the receiver detector crystals, ensure that the AN/APR-39(V)1 antennas are at least 60 yards from any active ground-based radar antenna or 6 yards from any active airborne radar antenna. Allow an extra margin for new, unusual, or high-powered antennas. Ensure the AN/APR-39(V)1 is deenergized for all shipboard takeoffs and landings because of the close proximity of high-powered emitters.

22.5 AN/ALQ-144 COUNTERMEASURES SYSTEM

The AN/ALQ-144 is an active countermeasure system that provides mechanical modulation of radiation from an electrically heated source designed to counter the homing capability of approaching hostile heat-seeking missiles. The system consists of a transmitter, an operator control unit, and a bus transfer relay assembly. The operator control unit, and a bus transfer relay assembly. The operator control unit (Figure 22-1) is positioned at the bottom of the armament control panel between the pilot's legs. Control, operating test, and display functions are provided by this unit. Control is provided by an IRCM ON/OFF switch (Figure 22-1) that activates the system by applying 28 vdc power. The RDRCM switch is inactive.

22.5.1 IR Jammer Operating Procedures.

1. IR JAMMER (XMTR, CONT, BASE) circuit breakers — IN.

2. ON/OFF switch — ON.

Note

- Positioning the ON/OFF switch to ON should not cause the IRCM advisory light to illuminate. If the IRCM light remains illuminated after the initial warmup period of approximately 1 minute, an inoperative condition exists and the system should be secured by placing the ON/OFF switch to OFF.
- The AN/ALQ-144 should be operated for at least 15 minutes after energizing the system before turning it off. This will enhance transmitter source life.

3. ON/OFF switch — OFF.

Note

The IRCM light should illuminate for approximately 1 minute and then extinguish.

PART IX

Flightcrew Coordination

CHAPTER 23

Crewmember Responsibilities

23.1 INTRODUCTION

While the helicopter can be flown by a single pilot, the combat mission requires two pilots to occupy the crew positions. A qualified observer or enlisted noncrewmember may occupy the front crew position on some flights not requiring crew duties of that person. Coordination between the two personnel occupying the crew positions is absolutely necessary to enhance the mission capability and safety of the crew.

23.1.1 Observer. The following personnel, authorized by the commanding officer or his designated deputy, may occupy the front crew position if the following requirements are met:

1. Must complete an egress drill
2. Must be fully briefed on the front cockpit
3. Must have a current physical
4. Must be fully briefed on what is expected of them during the flight to include but not limited to the following:
    a. Being alert for other aircraft or obstacles to flight
    b. Operating altitudes
    c. Mission plan
    d. Actions during an emergency
    e. Lost communication with the pilot.

23.1.2 Noncrewmembers. These personnel are designated in writing by the commanding officer and assigned to temporary-definite orders involving flying. Noncrewmembers shall occupy the front crew position. In addition to receiving the same information as outlined in the observer paragraph, noncrewmembers shall perform duties as directed by the helicopter commander. Those duties may include but are not limited to the following:

1. Assisting the helicopter commander in preparing the helicopter for flight
2. Acting as an observer
3. Recording data as directed by the helicopter commander.

Noncrewmembers shall meet the following requirements and all others required by applicable directives:

1. Must have a current flight physical
2. Must be a second class or better swimmer
3. Must have current physiology training
4. Must have current water survival training.

These requirements are not to be interpreted as limiting in any way the establishment of higher requirements by proper authority. Noncrewmember ground training should include but is not limited to the following:

1. Ground handling — Instructions in the operation and use of all ground support equipment, helicopter towing, and tiedown procedures (helicopter security). Instruction in the use of proper taxi director signals, both day and night.
2. Fueling and servicing — Instructions in the proper fueling and servicing procedures with particular emphasis on safety precautions, fuel contamination, alternate fuels, oils, and lubricants.
3. Equipment stowage — Instructions in the proper location and stowage of loose equipment.

4. Helicopter inspection — Instructions in assisting the helicopter commander in inspecting the helicopter and securing helicopter panels, doors, etc.

5. Fireguard — Instruction in procedures for performing the duties of the fireguard during starts.

WARNING

The fireguard shall remain clear of the tip-path plane, engine compressor, and engine exhaust areas during start.

CHAPTER 24

Mission Coordination

24.1 INTRODUCTION

Aircrew coordination is the flightcrew's use and integration of all available skills and resources to collectively achieve and maintain crew efficiency, situational awareness, and mission effectiveness. The modern battlefield presents a complex environment for the helicopter crew. Air-to-ground ordnance delivery, transport helicopter escort, antimechanized operation, and air-to-air combat each require specific skills and tasks to be integrated and coordinated to ensure successful mission accomplishment.

The importance of each crewmember being completely aware of all responsibilities must be continuously stressed. The crew must realize that successful mission accomplishment and safety depends on flightcrew coordination both in the cockpit and within the flight. The most successful crews work together continuously and know each other's reactions, weaknesses, and strengths.

Note

The contents of this chapter are designed to be used as a guide for squadron and unit ground training and are not intended nor designed to be used as checklists.

24.2 IN-FLIGHT PROCEDURES

24.2.1 Pilot at the Controls. The PAC will normally accomplish the following:

1. Control the helicopter.
2. Communicate on the radios.
3. Inform the PNAC of intentions.
4. Monitor engine and performance indications.
5. Avoid obstacles.
6. Look out toward the inside of the flight or as briefed.

24.2.2 Pilot Not at the Controls. The PNAC will normally accomplish the following:

1. Copy all clearances, frequencies, etc., and inform the PAC of such.
2. Monitor instruments.
3. Assume responsibility for primary navigation.
4. Receive and return hand and arm signals.
5. Initiate the Mayday call in an actual emergency.
6. Look out toward the outside of the flight or as briefed.

24.2.3 Communication. Do not assume the other pilot can see the obvious. Information has not been passed until it is verbalized on the ICS. Call traffic utilizing left/right, high/level/low, clock code, and factor/no factor.

24.2.4 Control Changes. All control changes will be a positive three-way control change with the following specific verbiage used: "I have the controls." "Roger, you have the controls." "Roger, I have the controls." The pilot relinquishing the controls should slap the canopy.

24.2.5 Simulated Emergencies. No simulated emergencies are authorized unless prebriefed.

24.2.6 Nonbriefed Maneuvers. Do not hesitate to question any maneuver or procedure that is not briefed, appears unsafe, is nonstandard, or is unauthorized.

24.2.7 Switches and Circuit Breakers. Do not secure any switches or circuit breakers without informing the other pilot.

24.3 GENERAL RESPONSIBILITIES

The PNAC will monitor instruments and make a "check call" when any IMC or VMC flight parameter is exceeded.

24.3.1 IMC Parameters.

1. Angle of bank exceeds 30°.
2. Heading of 10° off the assigned heading.
3. Altitude is consistently off by 100 feet.
4. Descent rate is in excess of 1000 fpm.
5. Runway environment is not in sight upon reaching decision height.
6. Vertigo is suspected.

24.3.2 VMC Parameters.

1. Angle of bank exceeds 60°.
2. Inclinometer is one-half ball off center.
3. Altitude is ± 50 feet from assigned altitude.
4. Closure rate is excessive.

24.4 SPECIFIC RESPONSIBILITIES

24.4.1 Flight Planning/Mission Planning.

24.4.1.1 Mission Commander. The mission commander is responsible for all phases of the assigned mission and for the effectiveness of the flight.

24.4.1.2 Flight Leader. The flight leader will assist the mission commander in preparing required charts, flight logs navigation computations (including fuel planning and checking weather and NOTAMs), and in completing required flight plans.

24.4.1.3 Pilot.

1. Assist the mission commander or flight leader in preparing required charts, flight logs, navigation computations (including fuel planning and checking weather and NOTAMs), and in completing required flight plans.
2. Be prepared to assume flight lead; thus have a thorough understanding of the conduct of the flight.
3. Ensure a correct weight and balance form is completed.

24.4.1.4 Copilot/Gunner.

1. Assist the mission commander, flight leader, or pilot in preparing required charts, flight logs, navigation computations (including fuel planning and checking weather and NOTAMs), and in completing required flight plans.
2. Be prepared to assist the pilot in assuming flight lead; thus have a thorough understanding of the conduct of flight.

24.4.2 Aircrew Brief.

24.4.2.1 Mission Commander.

1. Responsible for briefing all crewmembers on all aspects of the operation and conduct of the flight.
2. Utilize the briefing guide or syllabus card as outlined in PART III, chapter 6, paragraphs 6.1 and 6.2, or appropriate tactical briefing guide.

24.4.2.2 Flight Leader.

1. Assist the mission commander in preparing required flight or briefing forms and, if directed, brief all crewmembers on all aspects of the operation and conduct of the flight.
2. When directed, in addition, to using the briefing guide or syllabus card, brief the following:
   a. Crew coordination in each flight evolution
   b. Command/control of helicopter
   c. Utilization of each weapon system
   d. System degradation.

24.4.2.3 Pilot.

1. Assist the mission commander or flight leader in preparing required flight or briefing forms and, if directed, brief all crewmembers on all aspects of the operation and conduct of the flight.
2. When directed, in addition to using the briefing guide or syllabus card, brief the following:
   a. Crew coordination in each flight evolution

b. Command/control of the helicopter

c. Utilization of each weapon system

d. System degradation.

24.4.2.4 Copilot/Gunner. The copilot/gunner will assist the mission commander or flight leader in preparing required flight or briefing forms.

24.4.3 Preflight.

24.4.3.1 Pilot.

1. Review Aircraft Discrepancy Book for at least the last 10 flights.
2. Ensure daily/turnaround inspections are complete.
3. Sign for the helicopter to accept it.
4. Preflight the helicopter.
5. Note any discrepancies and ensure they are logged on the appropriate VIDS/MAF.

24.4.3.2 Copilot/Gunner.

1. Review the Aircraft Discrepancy Book for at least the last 10 flights when directed by the pilot.
2. Ensure daily/turnaround inspections are complete when directed by the pilot.
3. Preflight the helicopter when directed by the pilot.
4. Note any discrepancies and ensure they are logged on the appropriate VIDS/MAF when directed by the pilot.

24.4.4 Start.

24.4.4.1 Pilot.

1. Execute prestart checks (refer to Chapter 7).
2. Ensure the ICS is functioning properly.
3. Receive a clear to start signal from the plane captain.
4. Start engines (refer to Chapter 7).
5. Watch for emergency signals from the plane captain or copilot/gunner.

24.4.4.2 Copilot/Gunner.

1. Execute restart checks (refer to Chapter 7).
2. Ensure the ICS is functioning properly.
3. Watch for emergency signals from the plane captain.
4. Monitor the start and inform the pilot of any problems.

24.4.5 Taxi.

24.4.5.1 PAC.

1. Ensure all takeoff checklists are complete.
2. Receive taxi instructions from the appropriate controlling agency; verify any unclear instructions prior to taxi.
3. Clear the area.
4. Taxi as directed, begin alert for subsequent ground/tower instructions.

24.4.5.2 PNAC.

1. Copy all taxi instructions.
2. Clear the area.
3. Remain watchful for obstructions and taxi signals and relay them to the pilot.
4. Be alert for subsequent ground/tower instructions.

24.4.6 Takeoff/Departure.

24.4.6.1 PAC.

1. Complete takeoff checks and relate to the PNAC (refer to Chapter 7).
2. Initiate takeoff and inform the PNAC.

24.4.6.2 PNAC.

1. Ensure takeoff checks are complete.
2. Monitor performance indications.
3. Be prepared to assist the pilot in the event of an emergency.

24.4.7 En Route/Return.

24.4.7.1 PAC.

1. Control the helicopter.
2. Maintain a good lookout doctrine.
3. Report fuel and instrument status periodically.

4. Inform the PNAC when changing radios, TACAN, or IFF.

24.4.7.2 PNAC.

1. Maintain a good lookout doctrine.
2. Monitor instruments.

24.5 MISSIONS

24.5.1 Ordnance.

24.5.1.1 Pilot.

1. Complete ordnance checklists with the copilot/gunner (refer to Chapter 21).
2. Confirm delivery parameters with the copilot/gunner.
3. Report visual acquisition of the target.
4. Advise the copilot/gunner of other than prebriefed release parameters.

24.5.1.2 Copilot/Gunner.

1. Complete ordnance checklists with the pilot (refer to Chapter 21).
2. Confirm delivery parameters with the pilot.
3. Report visual acquisition of the target.
4. Advise the pilot of other than prebriefed release parameters.

24.5.1.3 Missile Launch Terminology. Missile employment requires considerable coordination and communication between the pilot and copilot/gunner. The following terminology shall be used to ensure clear, concise communications during missile prelaunch and postlaunch operations:

1. IN CONSTRAINTS — Missile can be launched.
2. COME UP/DOWN/LEFT/RIGHT — The copilot/gunner request for the pilot to maneuver the helicopter.
3. ROCKING INTO PITCH/ROLL — Pilot advisory of maneuver intended to bring the target into constraints.
4. DRIFTING FORWARD/BACK/LEFT/RIGHT — Pilot advisory of maneuver to maintain the target without constraints.
5. MOVING UP/DOWN/LEFT/RIGHT — Pilot advisory of postlaunch maneuver.
6. ROGER — Acknowledgment of the acceptable request or advisory.
7. NEGATIVE, COME UP/DOWN/LEFT/RIGHT — The copilot/gunner reaction of pilot maneuvering advisory and request to maneuver the helicopter to maintain target tracking for the TOW missile.
8. WIRE CUT — Pilot or copilot/gunner advisory that the TOW missile control wire has been cut.
9. IMPACT — Pilot or copilot/gunner advisory that missile impact has occurred.

24.5.2 Terrain Flight.

24.5.2.1 PAC.

1. Control the helicopter.
2. Avoid obstacles.
3. Execute the mission.
4. Keep an outside scan.
5. Control the helicopter during emergencies.

24.5.2.2 PNAC.

1. Navigate.
2. Monitor cockpit instructions.

24.5.3 Night Vision Goggles. The same principles apply in NVG flight as in TERF. The front-seat pilot has increased responsibility for terrain clearance forward because of the restricted forward view of the rear-seat pilot.

24.5.4 Air Combat Maneuvering. Delineating the entire realm of aircrew responsibility during ACM is beyond the scope of this manual. Careful preplanning and briefing are necessary to ensure adequate crew coordination prior to any ACM mission. As a minimum, each crewmember must have a constant awareness of the rules of engagement, flight safety, fuel state (including bingo), altitude, and minimum prebriefed base altitude.

24.5.4.1 PAC.

1. Control the helicopter.
2. Look out toward the inside of the flight or as briefed.
3. Maintain safe separation between aircraft.

4. Maintain obstacle clearance.

24.5.4.2 PNAC.

1. Look out toward the outside of the flight or as briefed.
2. Cross-check instruments.
3. Assist the pilot in obstacle clearance.

24.5.5 Shipboard.

24.5.5.1 PAC — VMC.

1. Control the helicopter.
2. Maintain an outside scan.
3. Maintain pattern parameters.

24.5.5.2 PAC — IMC Night.

1. Control the helicopter.
2. Maintain initial scan outside for takeoff.
3. Transition to instrument scan for climb to altitude.
4. Transition to outside scan for landing.
5. Positive control changes should be initiated to the front seat for frequency changes as required.

24.5.5.3 PNAC — VMC.

1. Monitor instruments.
2. Monitor helicopter parameters and advise PAC when parameters are exceeded.
3. Copy all clearances.
4. Monitor the closure rate on final.

24.5.5.4 PNAC — IMC Night.

1. Backup instrument scan during takeoff and approach.
2. Scan for the landing platform and advise when it is sight.
3. Monitor pattern parameters and advise PAC of deviations.

24.5.6 Emergencies (PAC/PNAC).

Emergencies tend to be delineated according to the specific mission.

24.5.7 Descent/Approach.

24.5.7.1 PAC.

1. Select the approach to be made.
2. Inform the PNAC when going from outside to inside scan or vise versa.
3. Inform the PNAC when changing radios, TACAN, or IFF.

24.5.7.2 PNAC.

1. Assist the pilot in deciding on the type of approach.
2. Monitor instruments.
3. Monitor approach plate and backup the PAC.
4. Notify the PAC of any deviations.

24.5.8 Landing.

24.5.8.1 PAC.

1. Complete the Landing Checklist and advise the PNAC.
2. Adhere to parameters for landing.
3. Monitor instruments.

24.5.8.2 PNAC.

1. Ensure landing checks are complete.
2. Monitor parameters for landing.
3. Monitor instruments.
4. Be prepared to assist the pilot in the event of an emergency.

24.5.9 After Landing/Taxi/Shutdown.

24.5.9.1 PAC.

1. Follow the instructions of the tower/ground.
2. Ensure the Shutdown Checklist is completed (refer to Chapter 7).

24.5.9.2 PNAC.

1. Backup the PAC on all clearances given by the tower/ground.
2. Assist the PAC with the Shutdown Checklist.

24.5.10 Postflight. The pilot and copilot/gunner will complete postflight (refer to Chapter 7).

24.5.11 Debrief. The pilot and copilot/gunner will debrief at the time and place covered in the brief.

24.6 SPECIAL CONSIDERATIONS

24.6.1 Functional Checkflights. The front-seat crewman should take the test card and write down the inputs for the pilot as the pilot relates them over the ICS.

24.6.2 Formation Flights. Because of the close proximity of the helicopters to each other, there is a definite need for an increased outside scan by all members of a flight. Special attention must be paid by crewmembers of each helicopter to maintain safe separation. The PAC of the lead helicopter must concentrate on being as smooth as possible. Consideration must be given to the wingman in order for the wingman to maintain his position in the flight.

PART X

NATOPS Evaluation

CHAPTER 25

NATOPS Ground and Flight Evaluation

25.1 CONCEPT

The standard operating procedures prescribed in this manual represent the optimum method of operating the helicopter. 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 active, vigorous support of all pilots and flight crewmembers.

25.2 IMPLEMENTATION

The NATOPS evaluation program shall be carried out in every unit operating naval aircraft. The various categories of flight crewmembers desiring to attain/retain qualification in the AH-1W shall be evaluated in accordance with OPNAVINST 3710.7. Individual and unit NATOPS evaluations will be conducted periodically; however, instructions in and adherence to NATOPS procedures must be on a daily basis with each unit to obtain maximum benefits from the program. The NATOPS coordinators, evaluators, and instructors shall administer the program as outlined in OPNAVINST 3710.7. Evaluees who receive a grade of unqualified on a ground or flight evaluation shall be allowed 30 days in which to complete a reevaluation. A maximum of 60 days may elapse between the date the initial ground evaluation commenced and the date the flight evaluation is satisfactorily completed.

25.3 DEFINITIONS

The following terms, used throughout this selection, are defined as to their specific meaning within the NATOPS program.

1. NATOPS Evaluation — A periodic evaluation of individual flight crewmember standardization consisting of an open-book examination, an oral examination, and a fight evaluation.
2. NATOPS Reevaluation — A partial NATOPS evaluation administered to a flight crewmember who has been placed in an unqualified status by receiving an unqualified grade for any of his ground examinations or the flight evaluation. Only those areas in which an unsatisfactory level was noted need be observed during an reevaluation.
3. Qualified — That degree of standardization demonstrated by a very reliable flight crewmember who has a good knowledge of standard operating procedures and a thorough understanding of helicopter capabilities and limitations.
4. Conditionally Qualified — That degree of standardization demonstrated by a flight crewmember who meets the minimum acceptable standards. He is considered safe enough to fly as a pilot in command or to perform normal duties without supervision but more practice is needed to become qualified.
5. Unqualified — That degree of standardization demonstrated by a flight crewmember who fails to meet minimum acceptable criteria. He shall receive a supervised instruction until he has achieved a grade of qualified or conditionally qualified.
6. Area — A routine of preflight, flight, or postflight.
7. Subarea — A performance subdivision within an area that is observed and evaluated.
8. Critical Area/Subarea — Any area or subarea that covers items of significant importance to the overall mission requirements, the marginal performance of

which could jeopardize safe conduct of the flight.

9. Emergency — A helicopter component, system failure, or condition that requires instantaneous recognition, analysis, and proper action.

10. Malfunction — A helicopter component or system failure or condition that requires recognition and analysis but permits more deliberate action than that required for an emergency.

25.4 GROUND EVALUATION

Prior to commencing the flight evaluation, an evaluee must achieve a minimum grade of qualified on the open-book and closed-book examinations as part of the ground evaluation. The oral examination is also part of the ground evaluation but may be conducted as part of the flight evaluation. To ensure a degree of standardization between units, the NATOPS instructions may use the bank of questions contained in this section in preparing portions of the written examinations.

25.4.1 Open-Book Examination. The open-book examination may consist of but shall not be limited to the question from the question bank. The number of questions shall not exceed that of the question bank nor be less than 50. The purpose of the open-book examination portion of the written examination is to evaluate crewmember knowledge of appropriate publications and the aircraft. The maximum time for this examination should not exceed 7 days.

25.4.2 Closed-Book Examination. The closed-book examination may consist of but shall not be limited to the questions from the question bank. The number of questions on the examination will not exceed 40 or be less than 20. Questions designated critical will be so marked. An incorrect answer to any question in the critical category will result in a grade of unqualified being assigned to the examination.

25.4.3 Oral Examination. The questions for the oral examination may be taken from this manual and/or drawn from the experience of the instructor/evaluator. Such questions should be direct and positive and should in no way be opinionated.

25.4.4 Operational Flight Trainer/Weapons System Trainer Procedures Evaluation. An Operational Flight Trainer/Weapons System Trainer (OFT/WST) may be used to assist in measuring crewmember efficiency in the execution of normal operating procedures and his reaction to emergencies and malfunctions. In areas not served by these facilities, this may be done by placing the crewmember in the helicopter and administering appropriate questions.

25.5 GRADING INSTRUCTIONS

Examination grades shall be computed on a 4.0 scale and converted to an adjective grade of qualified or unqualified.

25.5.1 Open-Book Examination. To obtain a grade of qualified for the open-book examination, an evaluee must obtain a minimum score of 3.5.

25.5.2 Closed-Book Examination. To obtain a grade of qualified for the closed-book examination, an evaluee must obtain a minimum score of 3.3.

25.5.3 Oral Examination and OFT Procedure Check. If an oral examination and OFT procedure check is conducted, a grade of qualified or unqualified shall be assigned by the instructor evaluator.

25.6 FLIGHT EVALUATION

The NATOPS flight evaluation is intended to evaluate unit/individual compliance with approved standardized operating procedures. The successful completion of all ground evaluations and examinations is required prior to commencement of the flight evaluation. Insofar as possible, evaluation flights will be scheduled so as not to interfere with squadron operations. The flight evaluation should conform to any syllabus flight. Only those areas observed or required by the mission will be evaluated. Determination of the final flight evaluation grade will be made as outlined in paragraph 25.8.

Note

Areas/subareas to be evaluated are listed. Critical area/subareas are marked by an asterisk.

25.6.1 Pilot Nontactical Flight Evaluation.

25.6.1.1 Mission Planning.

1. Flightplan
2. Computation card
3. Weather.

25.6.1.2 Briefing.

25.6.1.3 Preflight.

1. Records check
2. Preflight check
3. Crew briefing.

25.6.1.4 Engine and Rotor Start.

1. Start
2. Poststart.

25.6.1.5 Air Taxi.

1. Taxi.

25.6.1.6 Takeoff Transition.

1. Procedures
2. Type of takeoff:
   a. Vertical
   b. Crosswind
   c. Maximum power
3. Transition.

25.6.1.7 Climb Cruise.

1. Procedures
2. Power control
3. Helicopter control.

25.6.1.8 Approach and Landing.

1. Procedures
2. Power control
3. Helicopter control
4. Type of landing:
   a. Vertical
   b. Running
   c. Crosswind
   d. Maximum gross.

25.6.1.9 Autorotation.

1. Procedures
2. Rpm control
3. Airspeed control
4. Recovery.

25.6.1.10 Emergency Procedures.

1. Procedures
2. Helicopter control.

25.6.1.11 Crew Coordination.

1. Debriefing
2. Mission flight evaluation
3. Confined area landing precision approach:
   a. Procedures
   b. Approach
   c. Power control
   d. Helicopter control.
4. Navigation
5. Tactical applications.

25.6.2 Crewmember Evaluation Areas.

1. Preflight
2. Security
3. Ground safety precautions
4. Hand signals
5. Fuel and helicopter servicing
6. Postflight
7. Emergency Procedures
8. Tactical applications.

25.7 FLIGHT EVALUATION GRADING CRITERIA

Only those subareas provided or required will be graded. The grades assigned for a subarea shall be determined by comparing the degree of adherence to standard operating procedures with adjectival ratings listed below. Momentary deviations from standard operating procedures should not be considered as unqualifying provided such deviations do not jeopardize flight safety and the evaluee applies prompt corrective action.

25.7.1 Qualified. A well-standardized evaluee who demonstrated highly professional knowledge of and compliance with NATOPS standards and procedures is considered qualified. Momentary deviations from or minor omissions in noncritical areas are permitted if prompt and timely remedial action is initiated by the evaluee.

25.7.2 Conditionally Qualified. The evaluee is considered conditionally qualified and is satisfactorily standardized with one or more significant deviations from NATOPS standards and procedures, but no errors in critical areas and no errors that jeopardize mission accomplishment or flight safety.

25.7.3 Unqualified. The evaluee is considered unqualified and is not acceptably standardized; the evaluee fails to meet minimum standards regarding knowledge of and/or ability to apply NATOPS procedures. Commits one or more significant deviations from NATOPS standards and procedures that could jeopardize mission accomplishment or flight safety.

25.7.4 Flight Evaluation Grade Determination. The following procedure shall be used in determining the flight evaluation grade. A grade of unqualified in any critical area/subarea will result in an overall grade of unqualified for the flight. Otherwise, flight evaluation (or area) grades shall be determined by assigning the following numerical equivalents to the adjective grade for each subarea. Only the numerals 0, 2, or 4 will be assigned in subareas. No interpolation is allowed.

Unqualified 0.0

Conditionally Qualified 2.0

Qualified 4.0

To determine the numerical grade for each area and the overall grade for the flight, add all the points assigned to the subareas and divide this sum by the number of subareas graded. The adjective grades shall then be determined on the basis of the following scale:

0.0 to 2.19 .... Unqualified

2.2 to 2.99 .... Conditionally Qualified

3.0 to 4.0 .... Qualified

EXAMPLE: (add Subarea numerical equivalents)

$$\frac{4+2+4+2+4}{5} = \frac{16}{5} = 3.20 \text{ Qualified.}$$

25.8 FINAL GRADE DETERMINATION

The final NATOPS evaluation grade shall be the same as the grade assigned to the flight evaluation. An evaluee who receives an unqualified on any ground examination or the flight evaluation shall be placed in an unqualified status until he achieves a grade of conditionally qualified or qualified on a reevaluation.

25.9 RECORDS AND REPORTS

A NATOPS evaluation report (OPNAV Form 3710/7) shall be complete for each evaluation and forwarded to the evaluees commanding officer. Refer to Figure 25-1.

This report shall be filed in the individual flight training record and retained therein for 18 months. In addition, an entry shall be made in the pilot/NFO flight log book under "Qualifications and Achievements" as shown in Figure 25-2.

NATOPS EVALUATION REPORT

OPNAV 3710/7 (4-90) S/N 0107-LF-009-8000

REPORT SYMBOL OPNAV 3710-21

NAME (Last, first, initial)		GRADE	SERVICE NUMBER
SQUADRON/UNIT	AIRCRAFT MODEL		CREW POSITION
TOTAL PILOT/FLIGHT HOURS	TOTAL HOURS IN MODEL		DATE OF LAST EVALUATION

NATOPS EVALUATION

REQUIREMENT	DATE COMPLETED	GRADE		
		Q	CQ	U
OPEN BOOK EXAMINATION				
CLOSED BOOK EXAMINATION				
ORAL EXAMINATION				
*EVALUATION FLIGHT				
FLIGHT DURATION	AIRCRAFT BUNO	OVERALL FINAL GRADE		

REMARKS OF EVALUATOR/INSTRUCTOR

☐ CHECK IF CONTINUED ON REVERSE SIDE

GRADE, NAME OF EVALUATOR/INSTRUCTOR	SIGNATURE	DATE
GRADE, NAME OF EVALUEE	SIGNATURE	DATE

REMARKS OF UNIT COMMANDER

RANK, NAME OF UNIT COMMANDER	SIGNATURE	DATE

*WST, OFT, COT, or cockpit check in accordance with OPNAVINST 3710.7 (effective edition)

209900-2063-1
J1393

Figure 25-1. NATOPS Evaluation Report

QUALIFICATION			DATE	SIGNATURE	
NATOPS EVAL.	(Aircraft Model)	(Crew Position)	(Date)	(Authenticating Signature)	(Unit which Administered Eval.)

209900-2063-2
J1393

Figure 25-2. Pilot/NFO Flight Log Book Entry

25.10 NATOPS EVALUATION QUESTION BANK

The following list of questions is provided as a source reference for the development of open-book, closed-book, and oral examinations to be administered to flight crewmembers in accordance with the NATOPS evaluation program.

1. Should conflict exist between the NATOPS flight manual and other publications, the NATOPS flight manual shall govern.

   True ________ False ________

2. Anyone can recommend a change to NATOPS in accordance with OPNAVINST 3710.7.

   True ________ False ________

3. A WARNING as defined in NATOPS is an operating procedure or technique that may result in damage to equipment if not carefully observed or followed.

   True ________ False ________

4. Each General Electric T700-GE-401 engine is rated (uninstalled) at ________________ (intermediate power) shp.

5. The T700-GE-401 engines are ________ ________________, of modular construction.

6. Each engine is composed of a combination ________ ________ ________ ________, ________ ________ ________ ________ ________ ________ ________, and a ________ ________ ________.

7. A coaxial drive shaft extends from the power turbine rearward through the gas generator turbine and compressor.

   True ________ False ________

8. The fuel system for the T700-GE-401 engine consists of the main fuel manifold, ________ ________, ________ ________ ________ ________, ________ ________ ________ and the fuel filter.

9. The ODV sends fuel through the ODV manifold to the ________ ________ for ________ ________ and all other engine operating conditions.

10. Engine anti-icing is provided by an __________ heated bellmouth, installed between each engine and the intake ducts, and hot axial compressor discharge __________ __________ flowing through the swirl and inlet guide vanes.

11. The engine starting system consists of __________ starter for each engine, __________ batteries and a __________ engine start switch located on the pilot collective box.

12. The power turbine rotor (N_P) is protected from destructive overspeed by an __________ __________ __________.

13. The __________ is a solid state device that processes inputs from the __________, __________ __________ __________ __________ __________, N_P and torque sensors, __________ __________, N_r sensor, and the HMU.

14. The gas producer tachometer operates independently from the helicopter electrical system.

True ________ False ________

15. An __________ __________ __________ is attached to the right side of each engine and displays __________ digital counters.

16. When the rotor has slowed to approximately __________ __________ __________, release the rotor brake.

17. The transmission incorporates chip detectors that are the __________ type that are activated by pressing the illuminated __________ segment on the __________ __________ indicator.

18. The OIL COOLER switch selects and controls the oil cooler fan __________.

19. The combining gearbox drives two dc generators and the __________ __________ __________ __________.

20. The combining gearbox incorporates __________ type chip detectors.

21. At 9° nosedown (cruise) attitude with the fuel cell interconnect valve open, the __________ __________ __________ light illuminates when __________ pounds of fuel remain.

22. One air pump can pressurize both auxiliary fuel tanks if a failure of one pump occurs.

True ________ False ________

23. DC power is supplied by __________ generators, __________ batteries, or external power source through the __________ __________ __________.

24. Battery charging is provided by __________ __________.

25. When the START switch is activated, the batteries initially act in __________, then in series to provide up to __________ volts (6 seconds parallel, then series) for starting.

26. When the BUS switch is in the NORM position, power is supplied to the nonessential bus provided at least __________ __________ is operating.

27. In the event both generators fail, the pilot may reclaim nonessential 28 Vdc bus loads by placing the __________ switch to the __________ position.

28. AC power for the helicopter is provided from three separate sources: __________, __________, and __________ __________.

29. AC power for the AIM-9 missile system is provided by an __________ __________.

30. In the event of dual generator failure, use of the TACAN can be reclaimed by placing the BUS switch in MAN.

True ________ False ________

31. Redundant navigation light controls enable both the pilot and copilot/gunner to select overriding modes as circumstances may dictate.

True ________ False ________

32. The hydraulic system consists of three completely independent systems comprised of hydraulic systems __________ and __________ and the __________ hydraulic system.

33. Hydraulic systems No. 1 and No. 2 provide dual power boost for the main rotor controls through ______________
______ ______ ______.

34. Hydraulic system No. 2 supplies system power for the main rotor controls (cyclic and collective), ______ ______
______ unit, ______
______ actuators, ______
______ ______ ______
actuator, ______ ______
actuator, ______ system, and
______ ______ fan.

35. The utility hydraulic system powers a hydraulic motor-driven fan on the ______ / ______ ______
______ ______ during normal operation.

36. Setting the OIL COOLER switch to the SEC position disables the ______
______ system and ______
system, and selects a secondary hydraulic motor to power the ______
______ fan.

37. The SCAS NO-GO lights are illuminated during the warmup to indicate the presence of ______ in each associated actuator channel.

38. SCAS actuators are unaffected should engagement be made prior to a nulled condition (i.e., NO-GO lights illuminated).

True ______ False ______

39. The VSS is an ______ controlled, powered system, that automatically ______ and ______ the apparent effect of rotor induced vibrations.

40. The VSS will suppress two-per-revolution vibrations only between ______ and ______ percent rotor rpm when pressure is above ______ psi on hydraulic system No. 2.

41. Loss of hydraulic system No. 2 will not disable VSS.

True ______ False ______

42. In addition to warning indicators and caution advisory lights, an ______ provides audio signals (voice and tones) over the ______ for abnormal system conditions.

43. The AAU generates voice warning messages and ______ separate, discernible tones.

44. Do not actuate the FIRE WARN TEST switch more than ______ seconds.

45. Pulling the FIRE PULL handle will shut off ______ to the affected engine, deactivate the ______ and
______ ______ circuits, and arm ______ fire extinguisher bottles.

46. Pulling a FIRE PULL handle and setting the FIRE EXT switch to MAIN will result in that bottle being ______ into the selected ______ compartment.

47. To actuate the CRS, rotate the handle or ring ______
______ and pull.

48. The avionic and TOW compartments are cooled by ______ blowers located under the ______
______ floor.

49. The inertia reel will automatically lock when the helicopter encounters an impact force in excess of a ______ deceleration.

50. The relief tubes are located in the ______ and ______
______ compartments.

51. Wire strike protection consists of ______ and ______
______ installed on upper and lower portions of the forward fuselage.

52. Only personnel designated by ______ ______ shall be authorized to conduct engine motoring wash procedures.

53. The pressure fueling system consists of a ______ located in the ______ side of the ______ fuel cell, a ______ pilot valve in the ______ cell, a ______ shutoff valve, and ______ press-to-test precheck valves.

54. It is recommended that engines be serviced only with ______ oil when operating at sustained ground temperatures of –32 °C(–25 °F) or below.

55. Service the main rotor hub reservoir sight glass to approximately ________________ ________________.

56. Total internal fuel capacity is ________ U.S. gallons of which ________ U.S. gallons are unusable.

57. Engine starter limits are ________ on, ________ off, ________ on, ________ off.

58. With the ENG WASH switch in the WASH position, the duty cycle of the starter is ________ on, ________ off, and repeated ________ additional times.

59. For a rotor brake start, release within ________ seconds after ________ N_g is attained.

60. Decrease airspeed ________ for each 1000 feet of density altitude above ________ feet.

61. Below 4000 feet of density altitude, maximum airspeed in any configuration with stores is ________.

62. The maximum airspeed for steady state autorotation is ________.

63. The most right or left lateral cg limit is ________ inches.

64. The maximum transmission torque in a dive at airspeeds above V_h is ________

65. Steady state operation of N_p in the ________ to ________ percent range may result in shortened engine life.

66. Maximum engine torque with one engine out is ________ percent for ________ minutes.

67. Normal operation dual hydraulic pressure is ________ to ________ psi.

68. The maximum transient MGT with one engine inoperative is ________ °C for ________ seconds.

69. A basic crew day of 12 hours from first brief to last shutdown shall never be exceeded.

True ________ False ________

70. For APU starts, place the DCVM selector to ________ and check for 26 to 29 vdc.

71. A nonengaged engine is indicated by a higher ________ rpm than the engaged engine along with ________ torque.

72. When making a slope landing, if mast bumping occurs, reposition cyclic toward ________________.

73. During steep approaches at less than ________, avoid descent rates exceeding ________ fpm.

74. Full autorotation landing shall not be attempted as a practice measure except by pilots specifically ________ by the ________ ________ ________.

75. At average gross weights, best glide airspeed is approximately ________ KIAS, and minimum rate of descent airspeed is approximately ________ KIAS.

76. Hovering autorotations should only be practiced at or below ________ pounds gross weight.

77. Without the use of the rotor brake upon shutdown, winds of approximately ________ knots or above may cause the rotor to windmill indefinitely.

78. Carrier qualification remains current for ________ months.

79. In an emergency, the helicopter may be launched in ________ knot relative winds.

80. During night operations, the 180° position is ________ KIAS, ________ feet of altitude, and about ________ yards abeam of the ship.

81. Lighting at night becomes a critical area. The general rule of limiting ________ lights on the flight deck should be observed.

82. The two basic types of formations are ________ and ________.

83. A marked increase in airframe vibration and possible control feedback is an indication of impending ________.

84. During left rolling maneuvers of high-power dives, ________, ________, ________ and will increase while ________ and ________ decrease momentarily.

85. The helicopter has a tendency to roll to the ________ when forward cyclic is used to initiate a lower-than- ________ ________ maneuver in forward flight.

86. Mast bumping as a result of low-g maneuvering can occur even though ________ ________, ________ ________, ________, and ________ ________ ________ are within limits.

87. Maximum rotor rpm is achieved at a steady state autorotation of ________ to ________ KIAS.

88. List the four factors that affect power-off rotor rpm.

a. ________

b. ________

c. ________

d. ________

89. With a dual hydraulic failure, cyclic feedback may be encountered at airspeeds below ________ KIAS.

90. In hydraulic off landing, ________ is necessary to maintain directional control during the landing slide.

91. Failure of the VSS will be evidenced by increased ________ vibration intensity and/or erratic vibrations.

92. For most gross weights, it is unlikely that the helicopter can achieve a ________ power flight condition following loss of tail rotor thrust.

93. There are failure modes (i.e., engine alternator failure) that may result in zero ________, ________, and/or ________ ________ indications in conjunction with an overspeed condition.

94. When transient droop exceeds normal limits, maneuvers requiring large power changes, (i.e., ________, ________, ________ ________) should be avoided.

95. In the event both generators fail in flight, emergency power is supplied by the ________ and, assuming an 85-percent charge, will supply essential bus power for ________ minutes.

96. Whenever outside ambient temperature is minus ________ ________ ________, preheating of the engines, gearbox, transmission, and associated system components is required.

97. During cold weather starts, do not advance beyond ________ percent N_g until both engines, combining gearbox, and transmission oil pressure are stabilized within desired operating range.

98. The rain removal system should not be utilized on a ________ windshield.

99. The copilot/gunner must position the CSC panel ________ to proper position to transmit utilizing the footswitch.

100. Both the command and tactical radio sets operate independently in the ________ mode.

101. When the NAV CONTROL switch is in the BOTH position, FM homing and course deviation are disabled.

True ________ False ________

102. [**TNS**] When the NAV CONTROL switch is in the DPLR position, FM homing and course deviation are disabled.

True ________ False ________

103. The azimuth drive system of the turret rotates the turret through a range of ________ either side of 0° azimuth. The gun can be lowered ________ below 0° elevation.

104. The copilot/gunner has control of his HS when the THCDP is in any position and the pilot WEAPON CONT is in GUNNER.

True ________ False ________

105. The PILOT OVERRIDE switch electrically bypasses all circuits on the pilot armament control except when the MASTER ARM switch is in the OFF position.

True ________ False ________

106. The TSU optical fields of view offer a __________ field of view in LO MAG, (2X magnification), and a __________ field of view in HI MAG, (13X magnification).

107. The copilot/gunner must push the PRI/ALT and the AUTO CODE pushbuttons simultaneously to initiate wire cut.

True ________ False ________

108. Each HELLFIRE missile launcher is capable of carrying ______________ HELLFIRE missiles.

109. The HPCP is not active when the THCDP system mode switch is set to ____________, ____________, or ______________________.

110. The pilot can arm the HELLFIRE launcher from the cockpit by positioning the ______________ switch to ON.

111. In the __________ position, HELLFIRE missiles are launched against targets without having previously acquired or locked on to any laser energy.

112. To zero laser codes, simultaneously depress the __________, __________, and ______________ pushbuttons.

113. The ____________ missile system is an air-to-air weapon system capable of launching ______________ missiles.

114. When the AIM-9 UNCAGE/FIRE switch is pulled in the direction of the UNCAGE arrow, the missile gyro is uncaged and the ________________ indicator on the ______________________ illuminates.

115. The AIM-9 power relay circuitry is designed to illuminate a __________ __________ __________ indicator on the cockpit control unit should the AIM-9 static inverter fail.

116. The __________ series missile launcher provides a platform for carriage, suspension, and launching of all AIM-9 series missiles.

117. The NARCADS has no capability to allow firing of dissimilar weapons simultaneously by the pilot.

True ________ False ________

118. A failure indicator on the caution panel will place a ________________ on the HUD if either the HUD, __________ __________ __________ or both fail.

119. What is the warning symbol displayed on the HUD when the MASTER CAUTION is illuminated? ______________________________.

120. The TSU is disabled during ______________________ operation.

121. If a TOW missile fails to exit from the launcher within __________ seconds and the TSU reticle in the ______________ flashes, a misfire has occurred.

122. The countermeasure avionic system consists of __________ countermeasure dispensing system, __________ radar warning system, ____________ radar detector system, and the __________ countermeasure system.

PART XI

Performance Data

CHAPTER 26

Takeoff

26.1 INTRODUCTION

The charts presented on the following pages are provided to aid in preflight and in-flight planning. Through the use of the charts, the pilot is able to select the best power setting, altitude, and airspeed to obtain optimum performance for the mission being flown. The charts are based on flight test data, estimated data, or calculated data as indicated on the chart.

26.2 MAXIMUM GROSS WEIGHT FOR HOVERING

The maximum gross weight for hovering charts (Figure 26-1, sheets 1 and 2) present data for twin-engine operation. The charts show the maximum gross weight hover capability at a pressure altitude/ OAT combination while at maximum torque available. The effect of skid height above ground is shown on sheet 1, and the effect of headwind is presented on sheet 2.

EXAMPLE: Find the maximum gross weight to HIGE at a 10-foot skid height with zero headwind at +7 °C (standard day) and 4000 feet, during twin-engine operation.

SOLUTION:

1. Enter Figure 26-1, sheet 1, on the left at 4000 feet on the PRESSURE ALTITUDE scale.

2. Move to the right and interpolate between the 0 °C and +10 °C lines for +7 °C.

3. Drop down to the OGE GROSS WEIGHT scale, then read 14,570 pounds maximum gross weight to HOGE at 4000 feet, standard day.

4. Move straight down to the BASELINE, then following the trend of the GUIDELINES move down to the 10-foot SKID HT line.

5. Drop down, read 15,650 pounds maximum GROSS WEIGHT to HIGE at a 10-foot skid height at 4000 feet, standard day.

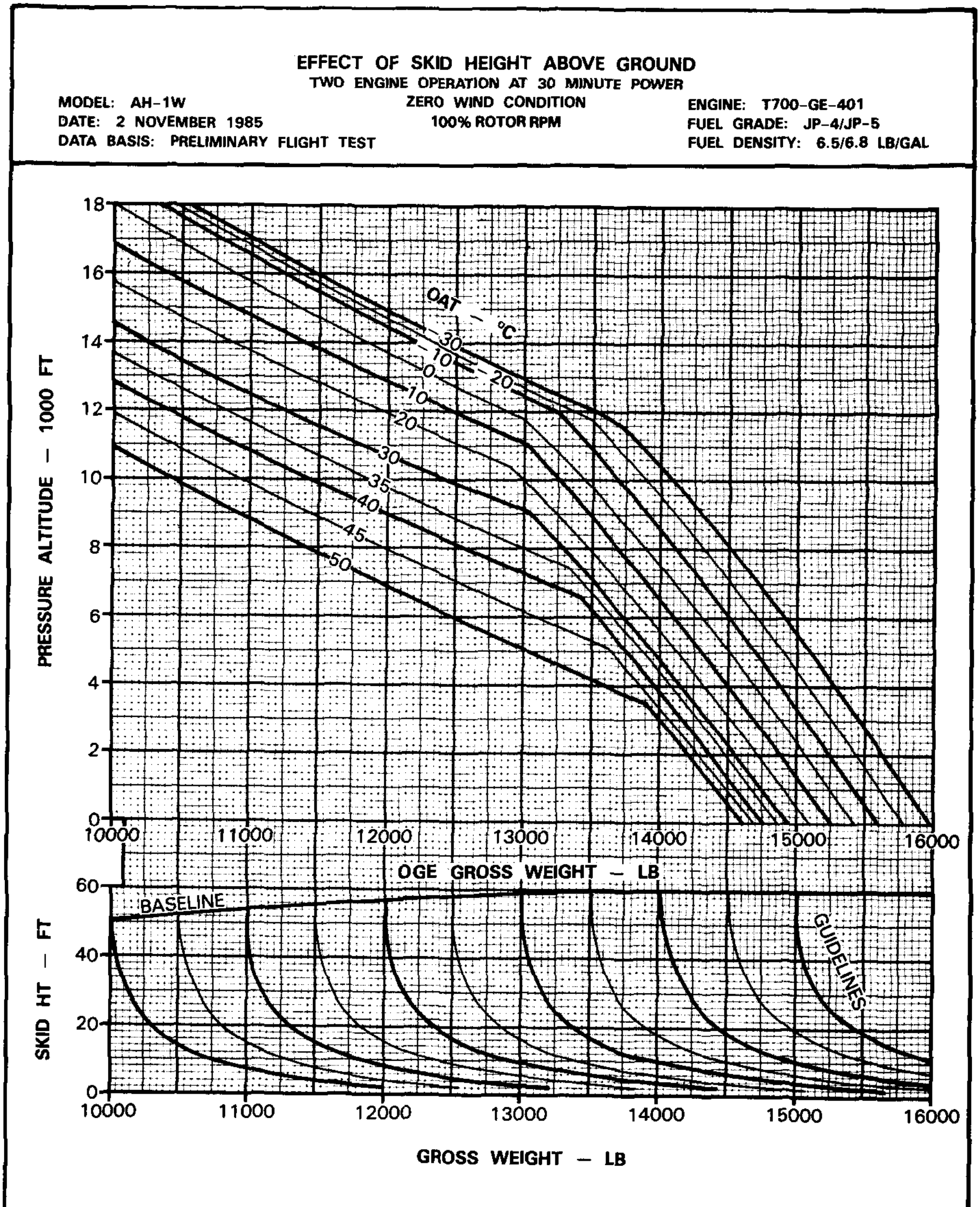

Figure 26-1. Maximum Gross Weight for Hovering (Sheet 1 of 2)

EXAMPLE: Find the maximum gross weight to HOGE with zero and 10-knot headwind at +7 °C (standard day) and 4000 feet, during twin-engine operation.

SOLUTION:

1. Enter Figure 26-1, sheet 2, on the left at 4000 feet on the PRESSURE ALTITUDE scale.
2. Move to the right and interpolate between the 0 °C and +10 °C lines to +7 °C.
3. Drop down to the OGE GROSS WEIGHT scale, then read 14,570 pounds maximum gross weight to HOGE at 4000 feet, standard day.
4. Move straight down to the BASELINE, then following the trend of the GUIDELINES, move down to the 10-knot HEADWIND line.
5. Drop down, read 15,300 pounds maximum GROSS WEIGHT to HOGE at 4000 feet, standard day with a 10-knot headwind.

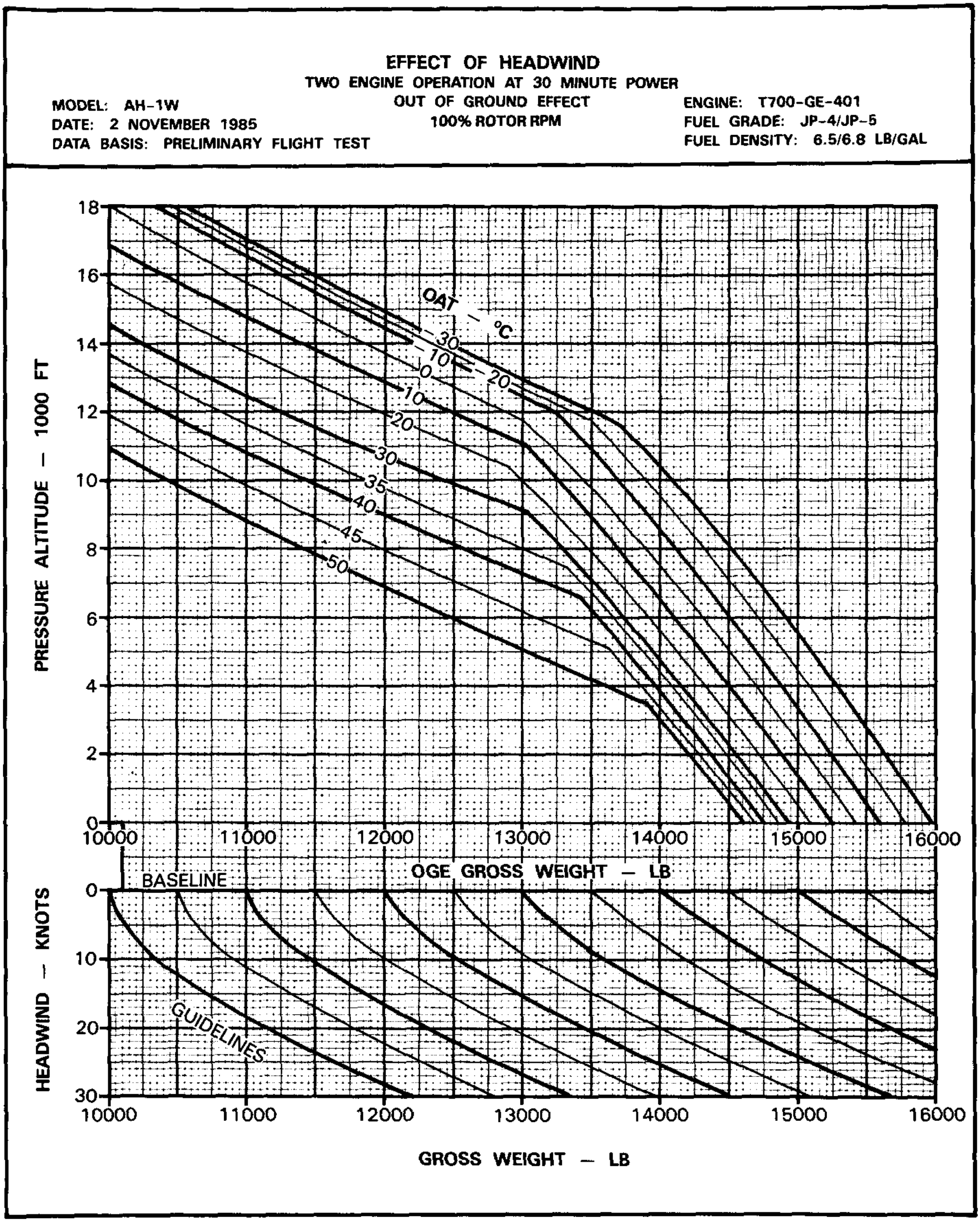

Figure 26-1. Maximum Gross Weight for Hovering (Sheet 2 of 2)

26.3 INDICATED TORQUE REQUIRED TO HOVER

The indicated torque required to hover charts (Figure 26-2, sheets 1 and 2) present the torque required to hover for various gross weights at pressure altitudes between sea level and 12,000 feet and outside temperatures between +50 °C and -50 °C. Effect of skid height above ground is shown on sheet 1, and effect of headwind is presented on sheet 2.

EXAMPLE: Find the torque required to hover a 12,000-pound helicopter in ground effect, at a 10-foot skid height, with a zero headwind; and out of ground effect with a 10-knot headwind at +7 °C (standard day) and a 4000-foot pressure altitude, during twin-engine operation.

SOLUTION:

1. Enter Figure 26-2, sheet 1 at 12,000 pounds on the GROSS WEIGHT scale.
2. Move right to the 4000-foot PRESSURE ALTITUDE line.
3. Drop down to the OAT BASELINE and follow the trend of the GUIDELINES to +7 °C (standard day). From this intersection, drop down to the OGE TORQUE scale and read 75.0 percent Q torque required to HOGE (zero wind).
4. Continue down to the SKID HT BASELINE and follow the trend of the GUIDELINES to a 10-foot skid height. From this intersection, drop down to the final TORQUE scale and read 68.0 percent Q torque required to HIGE at a 10-foot skid height.
5. Now enter Figure 26-2, sheet 2, drop down to the HEADWIND baseline at 75.0 percent Q torque required.
6. Move down and follow the trend of the GUIDELINES to a 10-knot headwind and from this intersection drop down to the final TORQUE scale and read 70.0 percent Q torque required to HOGE with a 10-knot headwind.
7. To obtain the effect of the headwind in terms of torque required, subtract the 10-knot headwind torque required condition from the zero wind condition (75.0 - 70.0) = 5.0 percent Q delta torque.

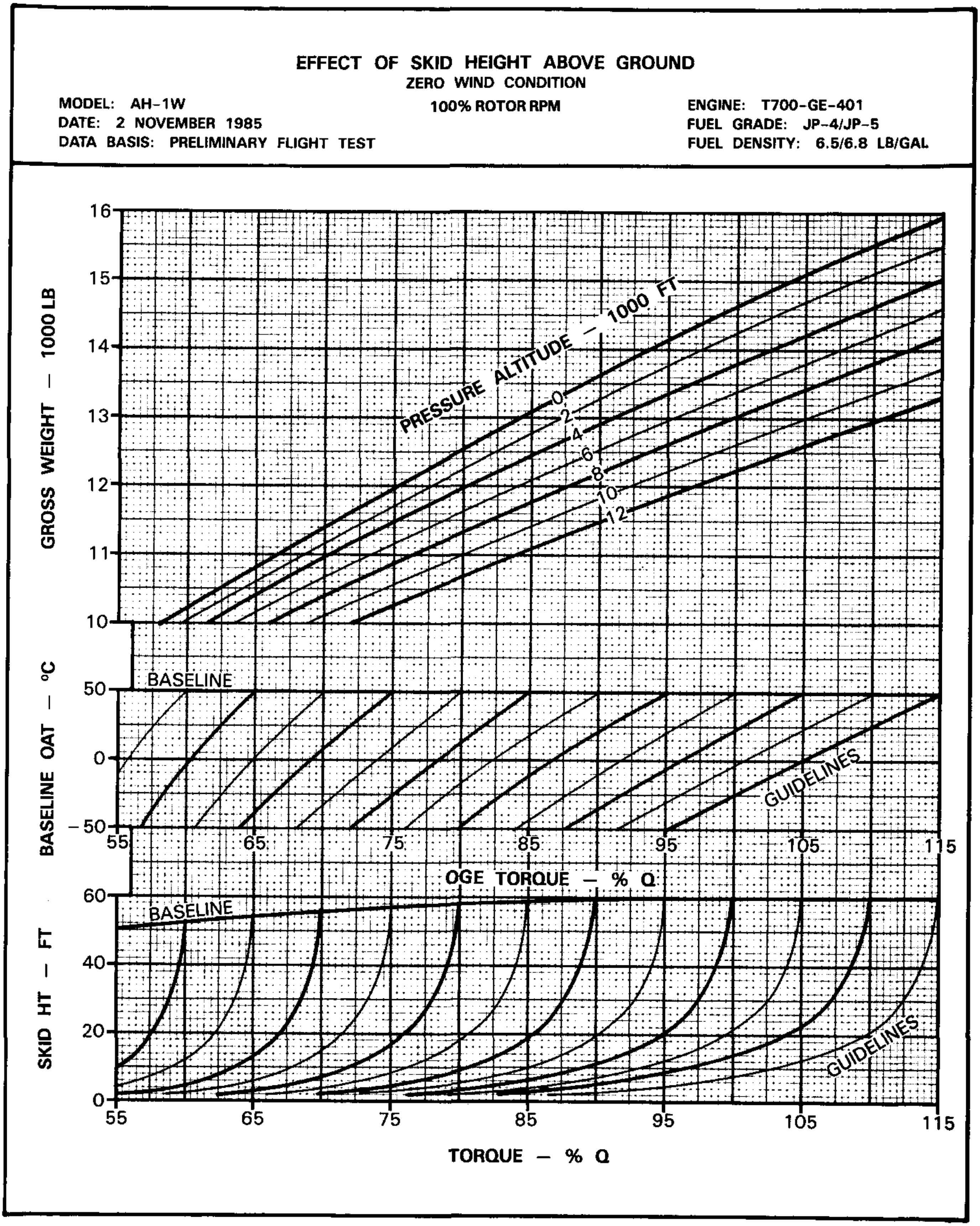

Figure 26-2. Indicated Torque Required to Hover (Sheet 1 of 2)

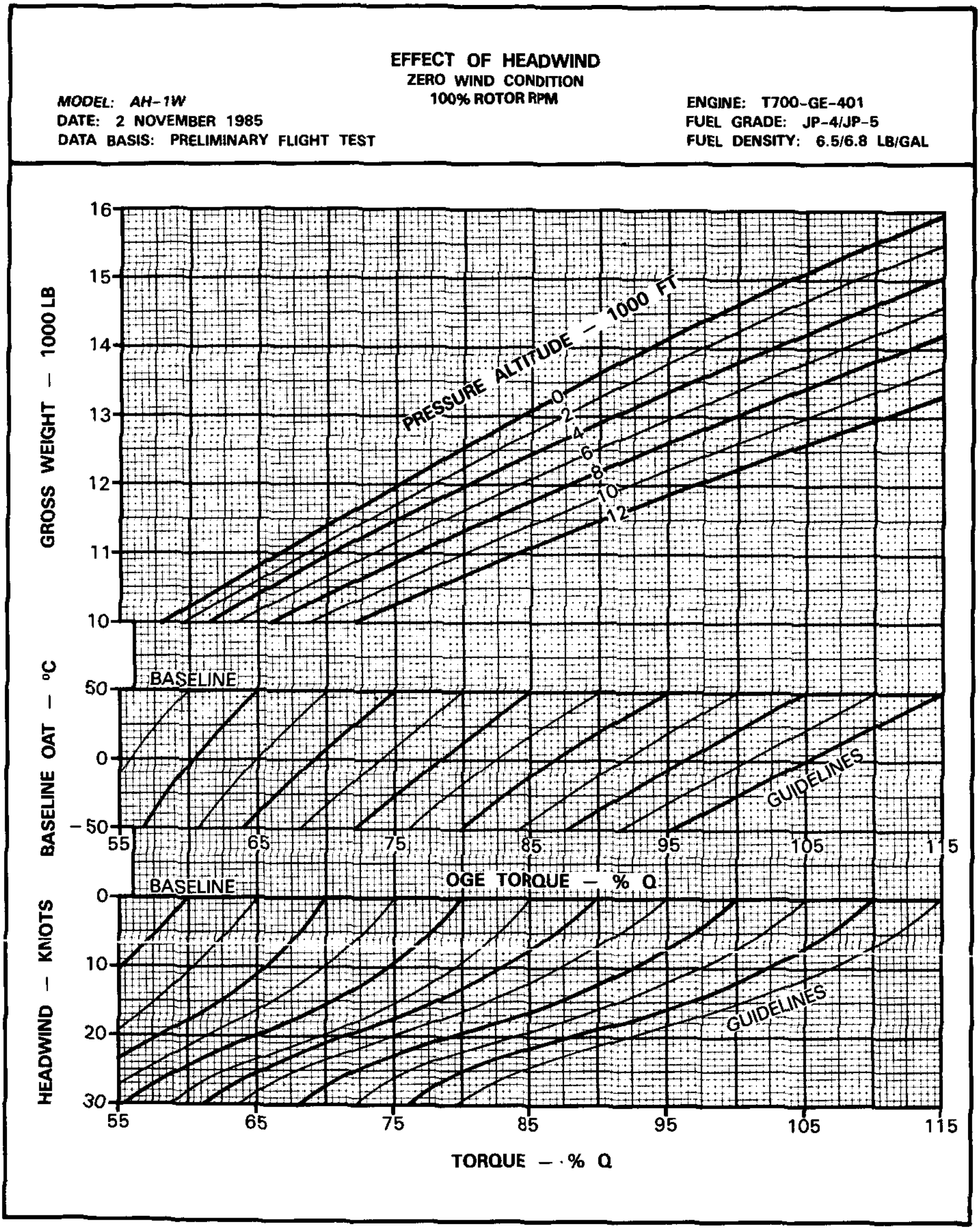

Figure 26-2. Indicated Torque Required to Hover (Sheet 2 of 2)

CHAPTER 27

Climb

27.1 CLIMB PERFORMANCE

The climb performance charts (Figure 27-1, sheets 1 and 2) are presented for twin-engine operation and represent a synthesis of the cruise performance charts to ease estimation of the climb portion of the flight plan. These charts show relationships between gross weight, initial and final altitude and temperatures, time to climb, distance traveled while climbing, and fuel expended while climbing. The charts are presented for intermediate rated (30 minute) power available and may be used for all drag configurations. These charts represent climb performance at optimum conditions, that is minimum power required and stated torque available. Climb is presented at 65 KIAS in Figure 27-1, sheet 1 and at 90 KIAS in Figure 27-1, sheet 2. Warmup and taxi fuel are not included in fuel flow calculations. Climb performance is calculated for 100 percent rotor rpm and 100 percent engine rpm. The charts are based upon a no-wind condition; therefore, the distance traveled will not be valid when winds are present.

EXAMPLE: Find the time, distance, and fuel required to climb from 4000 feet, + 17 °C, to 10,000 feet, with a gross weight of 12,000 pounds, twin-engine operation, and at an airspeed of 65 KIAS.

SOLUTION:

1. Enter the GROSS WEIGHT scale of Figure 27-1, sheet 1, at 12,000 pounds. Proceed vertically upward to the initial altitude of 4000 feet and read +7 °C OAT, which is standard day temperature.

2. Calculate delta OAT from standard day OAT. Delta OAT = (actual OAT minus standard day OAT). Delta OAT = (17 − 7) = 10 °C OAT. Note that this delta remains constant for all altitudes.

3. Proceed right to the International Standard Atmosphere (ISA) +10 °C (DELTA OAT) line.

4. Drop vertically down to the TIME scale and read 1.5 minutes.

5. Continue down to the FUEL and DISTANCE lines and read 26 pounds of fuel and 1.9 nm.

6. Enter the GROSS WEIGHT scale again at 12,000 pounds. Proceed vertically upward to the final altitude of 10,000 feet and read (or interpolate for) −5 °C OAT.

7. Repeat steps 3 through 5 using the final altitude data and read:

Time = 3.6 minutes

Fuel = 62 pounds

Distance = 4.6 nm.

8. Subtract the initial time, fuel, and distance amounts from the final amounts, respectively, to obtain the actual time, fuel, and distance:

Actual time = (3.6 − 1.5) ≈ 2.1 minutes

Actual fuel (62 − 26) = 36 pounds

Actual distance ≈ (4.6 − 1.9) = 2.7 nm.

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

65 KIAS

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

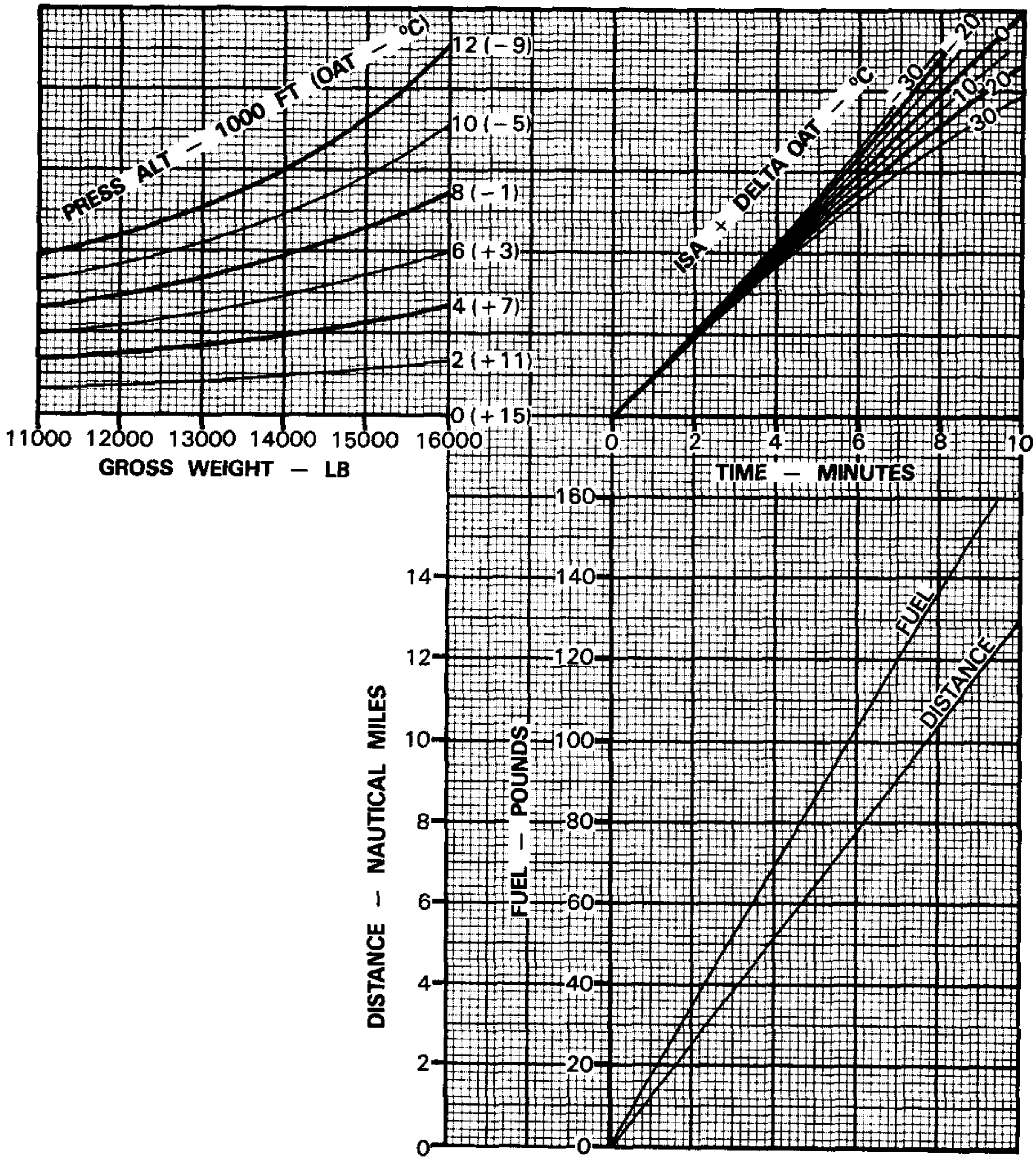

Figure 27-1. Climb Performance — Two-Engine Operation at Intermediate Rated Power — All Configurations — 100 Percent RPM (Sheet 1 of 2)

EXAMPLE: Find the time, distance, and fuel required to climb from 4000 feet, +17 °C, to 10,000 feet, with a gross weight of 12,000 pounds, twin-engine operation, and at an airspeed of 90 KIAS.

SOLUTION:

1. Enter the GROSS WEIGHT scale of Figure 27-1, sheet 2, at 12,000 pounds. Proceed vertically upward to the initial altitude of 4000 feet and read +7 °C OAT, which is standard day temperature.

2. Calculate delta OAT from standard day OAT. Delta OAT = (actual OAT minus standard day OAT). Delta OAT = (actual OAT minus standard day OAT). Delta OAT = (17 − 7) = 10 °C OAT. Note that this delta remains constant for all altitudes.

3. Proceed right to the ISA +10 °C (DELTA OAT) lines.

4. Drop vertically down to the TIME scale and read 1.6 minutes.

5. Continue down to the FUEL and DISTANCE lines and read 30 pounds of fuel and 2.7 nm.

6. Enter the GROSS WEIGHT scale again at 12,000 pounds. Proceed vertically upward to the final altitude of 10,000 feet and read (or interpolate for) −5 °C OAT.

7. Repeat steps 3 through 5 using the final altitude data and read:

Time = 4.2 minutes

Fuel = 71 pounds

Distance = 7.7 nm.

8. Subtract the initial time, fuel, and distance amounts from the final amounts, respectively, to obtain the actual time, fuel, and distance:

Actual time = (4.2 − 1.6) = 2.6 minutes

Actual fuel (71 − 30) = 41 pounds

Actual (7.7 − 2.7) = 5.0 nm.

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

90 KIAS

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

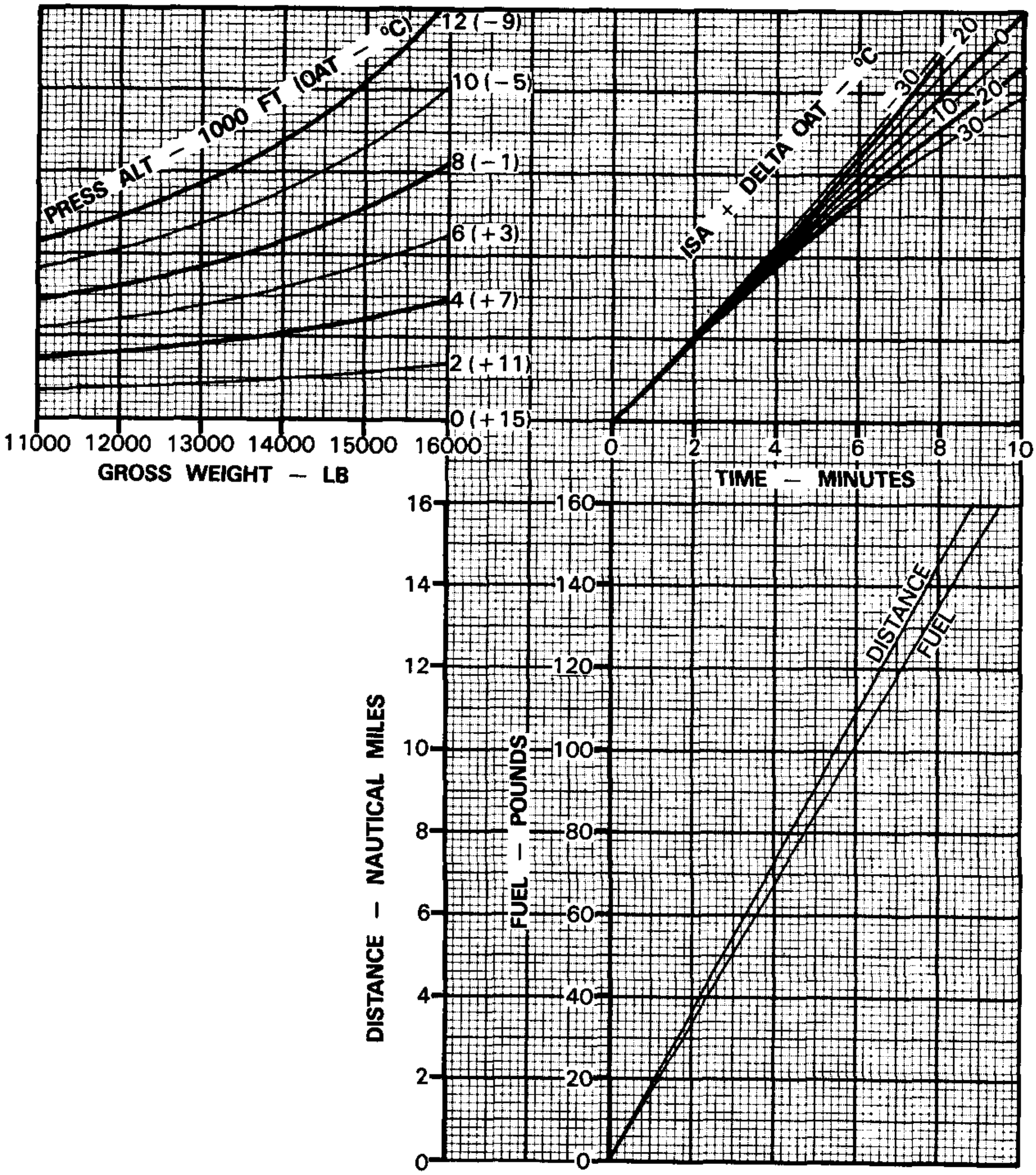

Figure 27-1. Climb Performance — Two-Engine Operation at Intermediate Rated Power — All Configurations — 100 Percent RPM (Sheet 2 of 2)

27.2 SERVICE CEILING

The service ceiling charts (figure 27-2, sheets 1 and 2) are shown for twin-engine operation at maximum continuous power available. Figure 27-2, sheet 1, is presented at 65 KIAS, and Figure 27-2 sheet 2, is presented *for 90 KIAS.*

EXAMPLE: Find the maximum gross weight of a helicopter that can fly 150 feet over a mountain peak of 15,850 feet on a -10 °C day, at twin-engine operation, maximum continuous power, and 65 KIAS.

SOLUTION:

1. Add 150 feet to 15,850 feet to obtain the *desired altitude of 16,000 feet.*
2. Enter Figure 27-2, sheet 1, at 16,000 feet on the PRESSURE ALTITUDE scale.
3. Move right to the −10 °C OAT line.
4. From this intersection, drop down to the *GROSS WEIGHT scale* and read a maximum gross weight of 15,000 pounds that may be used for this mission.

MODEL: AH-1W	65 KIAS	ENGINE: T700-GE-401
DATE: 2 NOVEMBER 1985		FUEL GRADE: JP-4/JP-5
DATA BASIS: PRELIMINARY FLIGHT TEST		FUEL DENSITY: 6.5/6.8 LB/GAL

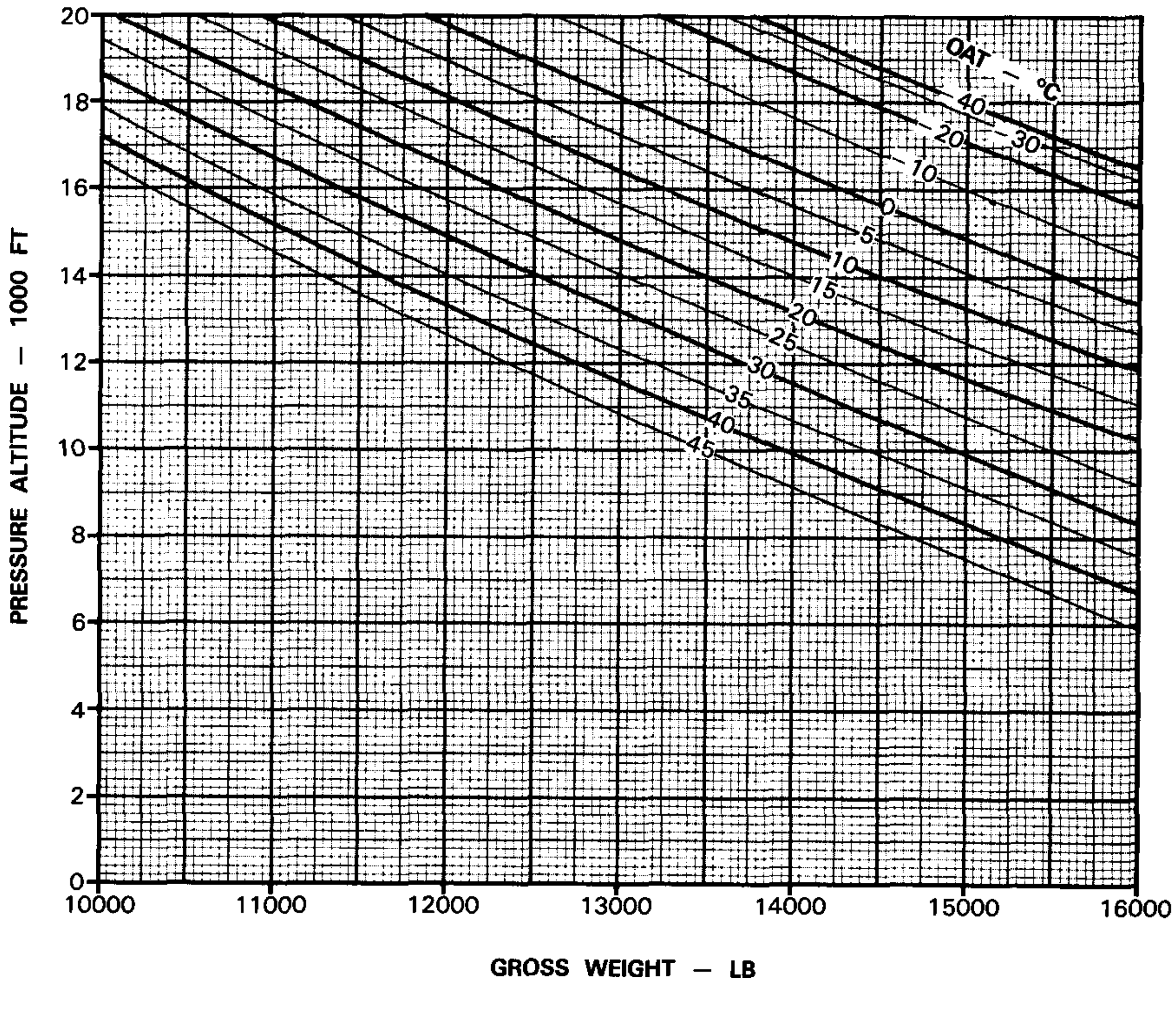

Figure 27-2. Service Ceiling — Two-Engine Operation at Maximum Continuous Power — All Configurations — 100 Percent RPM (Sheet 1 of 2)

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

90 KIAS

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

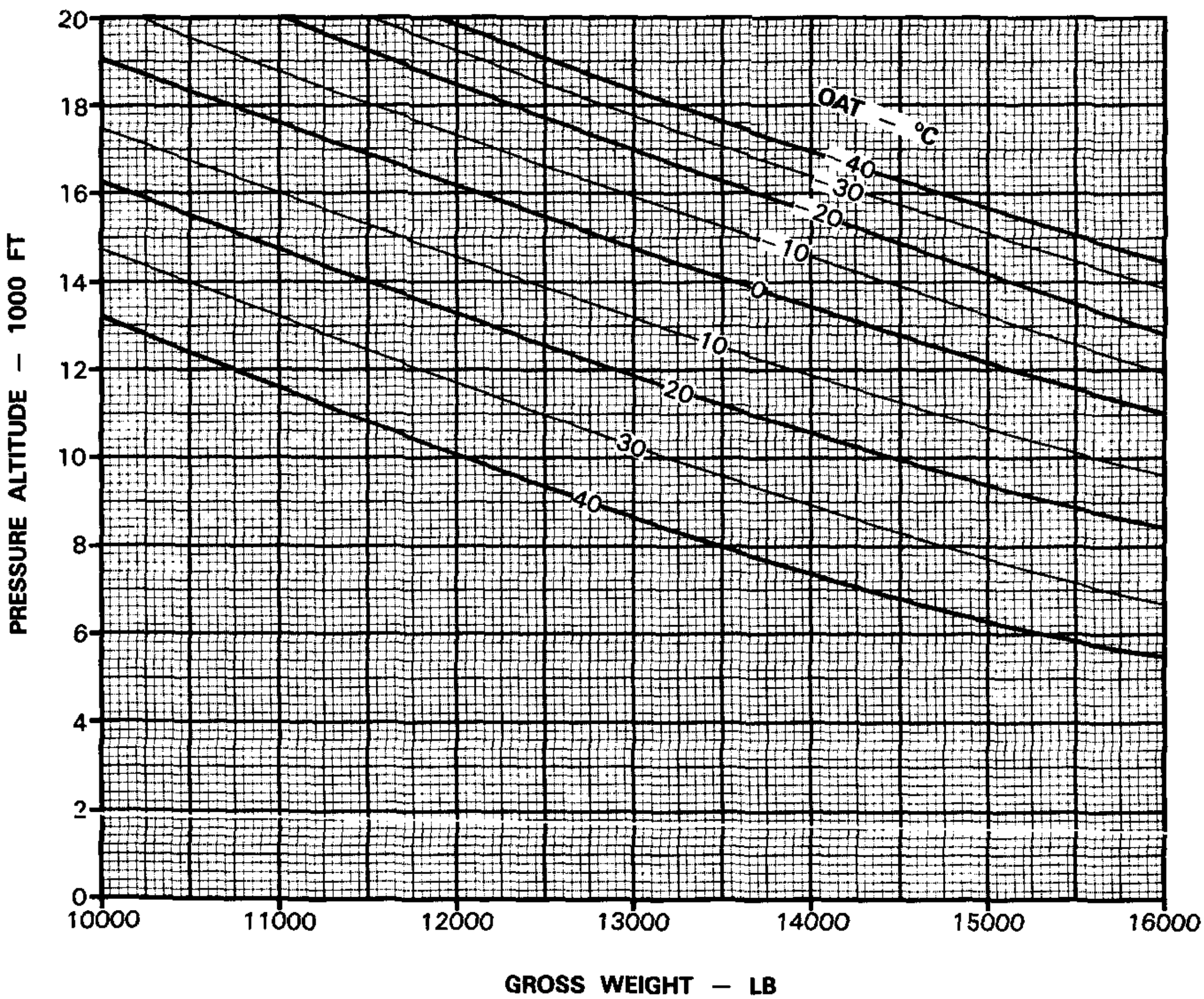

Figure 27-2. Service Ceiling — Two Engine Operation at Maximum Continuous Power — All Configurations — 100 Percent RPM (Sheet 2 of 2)

CHAPTER 28

Cruise

28.1 CRUISE PERFORMANCE

The cruise performance charts (Figure 28-1, sheets 1 through 21) present twin- and single-engine torque available, fuel flow, indicated airspeed, true airspeed, standard drag (delta F = 0 square feet) configuration, hover torque required, maximum endurance torque required, best range torque required, engine and mechanical limit speeds. Lines are shown for a continuous transmission limit of 85-percent Q torque and for a 30-minute transmission limit of 100 percent Q torque. Airspeed is presented for even values of true airspeed near the bottom left side of the cruise chart. Indicated airspeed is presented with an uneven (or wiped) scale at the bottom-most left side of the chart. Delta drag is presented as a 10-square-foot delta F line on each cruise chart. Any additional delta drag should be computed in terms of percent, based on its delta drag (paragraph 28.2) and the 10-square-foot delta F line.

28.2 DIFFERENT DRAG CONFIGURATIONS

For ease of interpolation for the many armament configurations that the AH-1W affords, standard configuration and a line for a standard +10-square-foot drag are presented in this chapter. For authorized stores configuration, refer to NWP 3-22.5-AH1, Vol. I. The following incremental drags may be added or subtracted from the standard configuration, and then the total drag change may be turned into a percentage of the 10-square-foot drag increase.

1. TOW nose — 2.5*
2. ALE-39 chaff dispenser — 3.0*
3. APR-39 — 0.6*
4. AN/ALQ IR jammer — 0.5*
5. IR tailpipe — 1.0
6. (Two) Stinger missiles — 1.2
7. (Two) LAU-68 rockets (7-shot pods) — 1.4
8. (Two) LAU-61/69 rockets (19-shot pods) — 3.1
9. (Four) LAU-61/69 rockets (19-shot pods) — 7.7
10. (Two) 77-gallon fuel tanks — 3.0
11. (Two) 100-gallon fuel tanks — 3.0
12. GPU-2/A gun pod — 1.5
13. (Two) AIM-9 missiles (Sidewinder) — 3.0
14. (Two) CBU-55 FAE — 3.0
15. (Eight) TOW missiles — 5.0
16. (Eight) HELLFIRE missiles — 6.0
17. Mk 81 bomb — 0.8
18. Mk 82 bomb — 0.9
19. SUU-44/A flare dispenser — 1.2
20. M118 smoke grenade dispenser — 0.7
21. Mk 77 — 2.0
22. (Two) PMBR — 5.0

* Part of standard configuration as presented in this chapter.

Estimated drags will be revised to flight test values after NAVAIR test.

28.3 TORQUE AVAILABLE

Torque available is shown on each cruise chart and is presented at the top of the chart for a range of temperatures at one specific altitude. OAT and pressure altitude change the capability of the turboshaft engine to produce power at the rated MGT. Figure 28-1, sheets 1 through 21, shows 30-minute, 2-1/2-minute, and maximum continuous power available for single-engine operation; and 30-minute and maximum continuous power available for twin-engine operation whenever the power available is less than the 30-minute transmission limit (100 percent Q).

28.4 FUEL FLOW

Fuel flow is presented as individual lines for single-engine and twin-engine operations in the middle of each cruise chart. The corresponding pounds per hour scale is located along the upper right hand side of the chart.

Note

> Increase fuel flow 2 percent for heater on, 4 percent for anti-ice on, and 6 percent for both operating. Decrease range 3 percent for ECU on.

EXAMPLE: Find the single-engine continuous torque available and fuel flow for -15 °C OAT at sea level.

SOLUTION:

1. Select the cruise chart for sea level pressure altitude and temperatures between −25 °C and +5 °C (Figure 28-1, sheet 1).

2. Enter the TORQUE AVAILABLE OAT scale at −15 °C.

3. Move to the right and intersect the SINGLE ENGINE CONT TRQ line.

4. Drop down and read 74.5 percent Q torque available on the TORQUE REQUIRED scale.

5. Now, enter the SINGLE ENGINE fuel flow curve at 74.5 percent Q and move right to the FUEL FLOW scale and read 740 pounds per hour fuel flow.

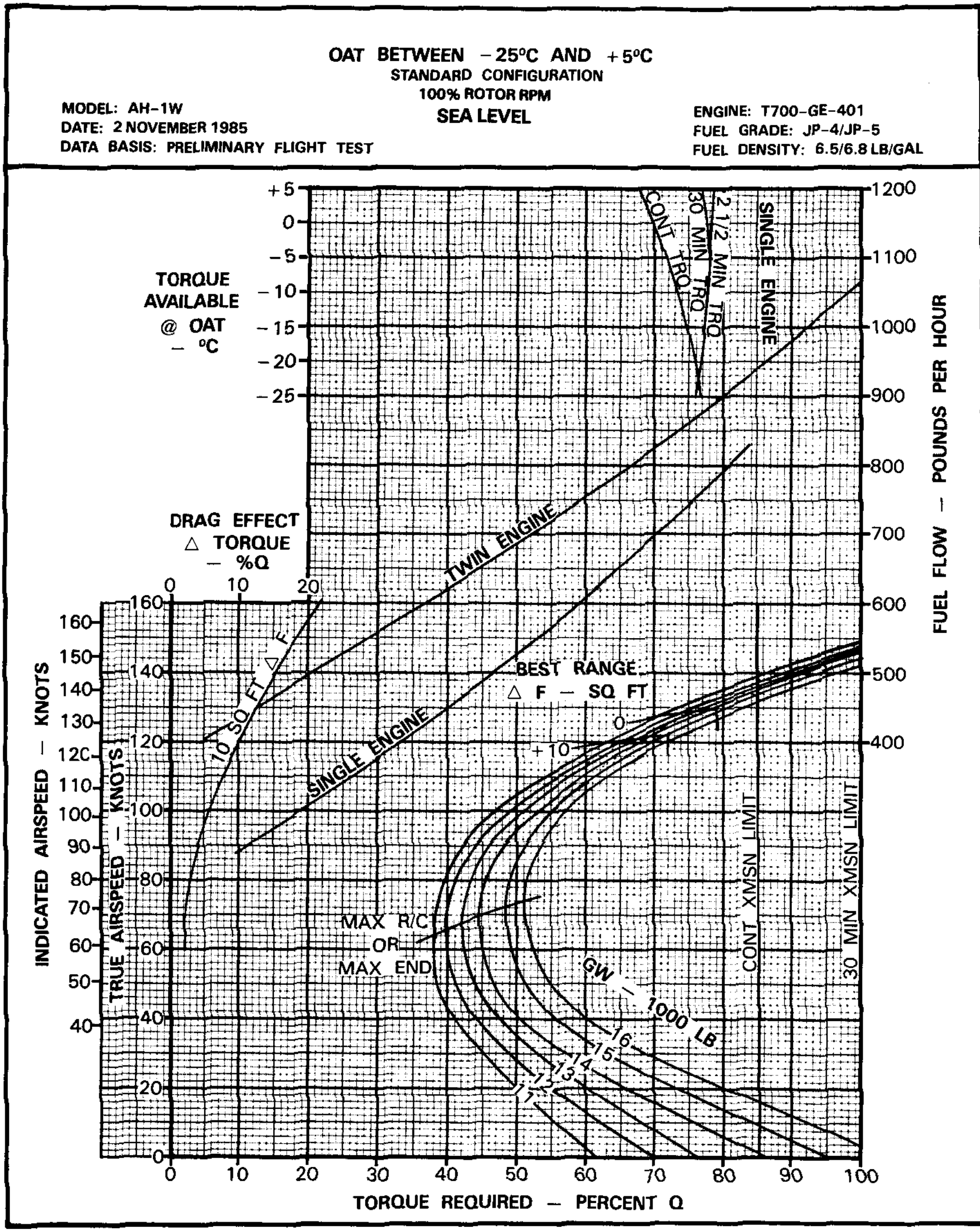

Figure 28-1. Cruise Performance (Sheet 1 of 21)

28.5 TORQUE REQUIRED

Torque required is presented for a standard configuration and at gross weights from 11,000 pounds every 1000 pounds to 16,000 pounds.

28.5.1 Hover Torque. Hover torque required can be determined by reading directly or interpolating between gross weights, using the 0 TRUE AIRSPEED line and the TORQUE REQUIRED scale on the bottom of the chart.

EXAMPLE: Find the torque required to hover a 14,750-pound helicopter out of ground effect at sea level and +20 °C.

SOLUTION:

1. Enter Figure 28-1, sheet 2, at 0 knots on the TRUE AIRSPEED (hover) scale.

2. Move right and interpolate between the 40,000-pound and the 15,000-pound GW curves for a 14,750-pound gross weight.

3. Read 95 percent Q TORQUE REQUIRED to hover.

28.5.2 Maximum Endurance/Rate of Climb. Torque required for maximum endurance or maximum rate of climb can be found by reading or interpolating between gross weights along the line that intersects the left-most part (minimum torque required) and each gross weight line.

EXAMPLE: Find the torque required and fuel flow for maximum endurance at sea level for a 15,000-pound helicopter at +20 °C.

SOLUTION:

1. Follow the 15,000-pound GW curve to the intersection of the maximum endurance (MAX END) line.

2. Drop down and read 48 percent Q minimum TORQUE REQUIRED.

3. Move up to the TWIN ENGINE fuel flow line.

4. Project right to the FUEL FLOW scale and read 688 POUNDS PER HOUR.

28.6 MAXIMUM LEVEL-FLIGHT AIRSPEED

Maximum level-flight airspeed including drag effect can be determined by utilizing the cruise charts.

EXAMPLE: Find the maximum continuous torque available, true airspeed, and twin-engine fuel flow at sea level, +20 °C OAT for a standard configuration at a gross weight of 14,000 pounds and a 5-square-foot delta drag effect.

SOLUTION:

1. Enter the upper chart (Figure 28-1, sheet 2) at 20 °C OAT and project right to the 85-percent Q line or TWIN ENGINE CONT TRQ curve, whichever occurs first.

2. Project down to the TWIN ENGINE fuel flow line and to the right and read 962 POUNDS PER HOUR.

3. Follow the 14,000-pound gross weight curve until it intersects the 85-percent Q line.

4. Project left and read 138 KTAS for maximum level-flight cruise airspeed at standard configuration.

5. Intersect the 10 SQ FT Δ F curve with the 138 KTAS line, project up and read 13 percent Q. Divide 13 percent Q by 2 (10 SQ FT ÷ 5 SQ FT) and get 6.5 percent Q.

6. Subtract 6.5 percent Q from 85 percent Q. At 78.5 percent Q and 14,000-pound gross weight, project left and read 134 KTAS maximum level-flight airspeed for 5-square-foot delta drag.

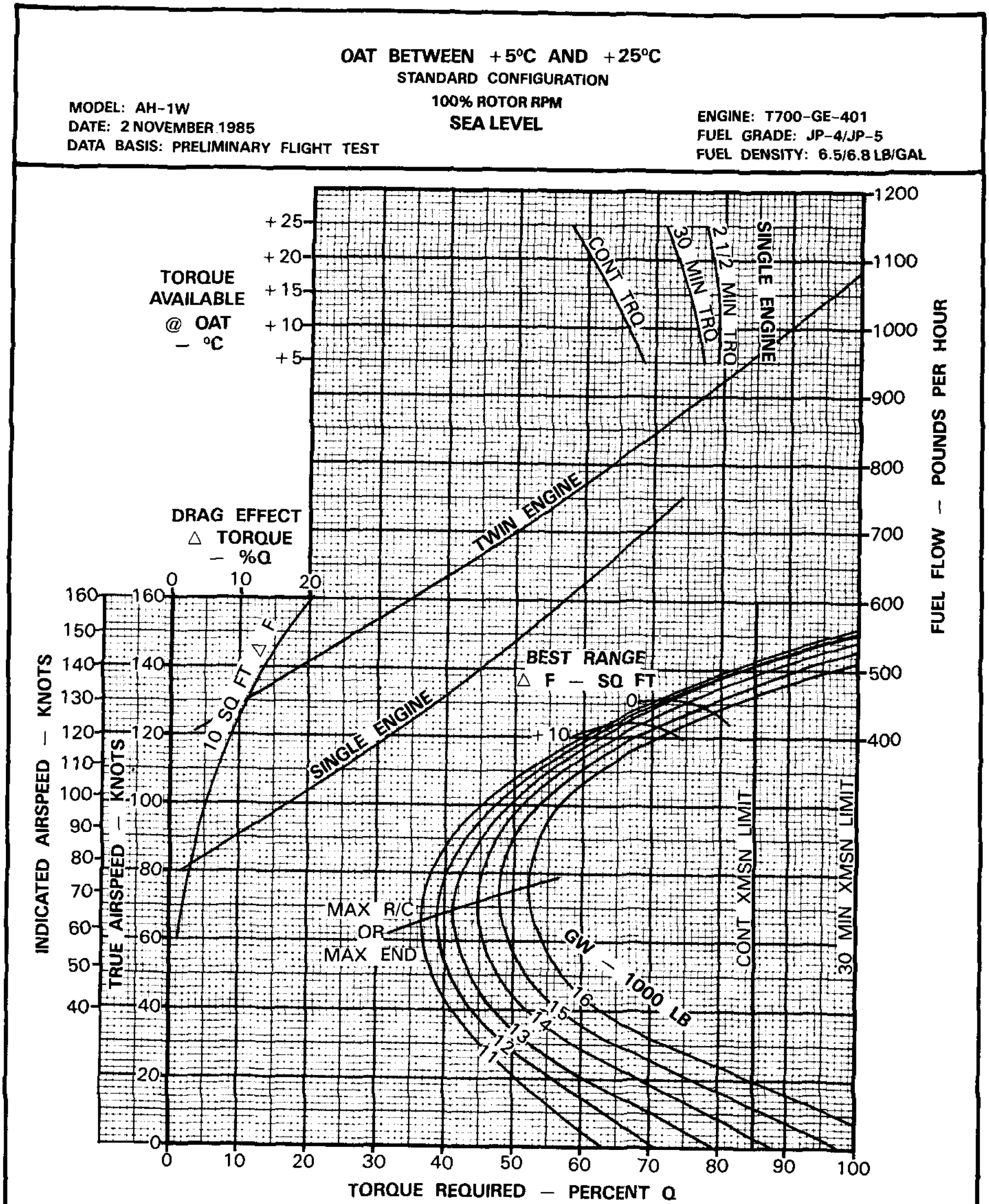

Figure 28-1. Cruise Performance (Sheet 2 of 21)

28.7 BEST RANGE

Best range is shown for 0- and 10-square-foot delta F drag. The delta F curves cross the gross weight (GW) lines near the middle-to-top part of the power required curves. For other than a standard configuration, it is necessary to interpolate between these two lines.

EXAMPLE: Find the torque required, twin-engine fuel flow, and true airspeed for best range at sea level and +30 °C OAT for a standard configuration (0 delta F) of a 15,000-pound helicopter.

SOLUTION:

1. Follow the 15,000-pound gross weight (GW) curve (Figure 28-1, sheet 3) until it intersects the 0 delta F BEST RANGE line.
2. Drop down and read 77.0 percent Q on the TORQUE REQUIRED scale for best range.
3. Move up to the TWIN ENGINE fuel flow line and project right to read 910 pounds per hour on the FUEL FLOW scale.
4. Project to the left to read 130 knots on the TRUE AIRSPEED scale.
5. Refer to Figure 28-3 to convert fuel flow and true airspeed to specific range.

EXAMPLE: Find the effect of a 5-square-foot delta F on maximum endurance and maximum range cruise for a 15,000-pound helicopter at sea level and +30 °C OAT.

SOLUTION:

1. Follow the 15,000-pound GW curve (Figure 28-1, sheet 3) to the intersection of the maximum endurance (MAX END) line.
2. Drop down to the TORQUE REQUIRED scale and read 49.0 percent Q torque required at 71 knots on the INDICATED AIRSPEED scale.
3. Enter the DRAG EFFECT plot and interpolate to find a 5-square-foot delta drag torque increase of 1.0 percent Q.
4. Add 1.0 percent Q to 49.0 percent Q to obtain 50.0 percent Q.
5. Follow the 15,000-pound GW curve to the 0- and +10-square-foot delta F lines and interpolate for a 5-square-foot delta F. Drop down to the TORQUE REQUIRED scale and read 74 percent Q for the best range and project left to read 127 knots on the INDICATED AIRSPEED SCALE.
6. Enter the DRAG EFFECT plot and interpolate to find a torque increase of 5 percent Q, so torque required is 79 percent Q at 127 KIAS.

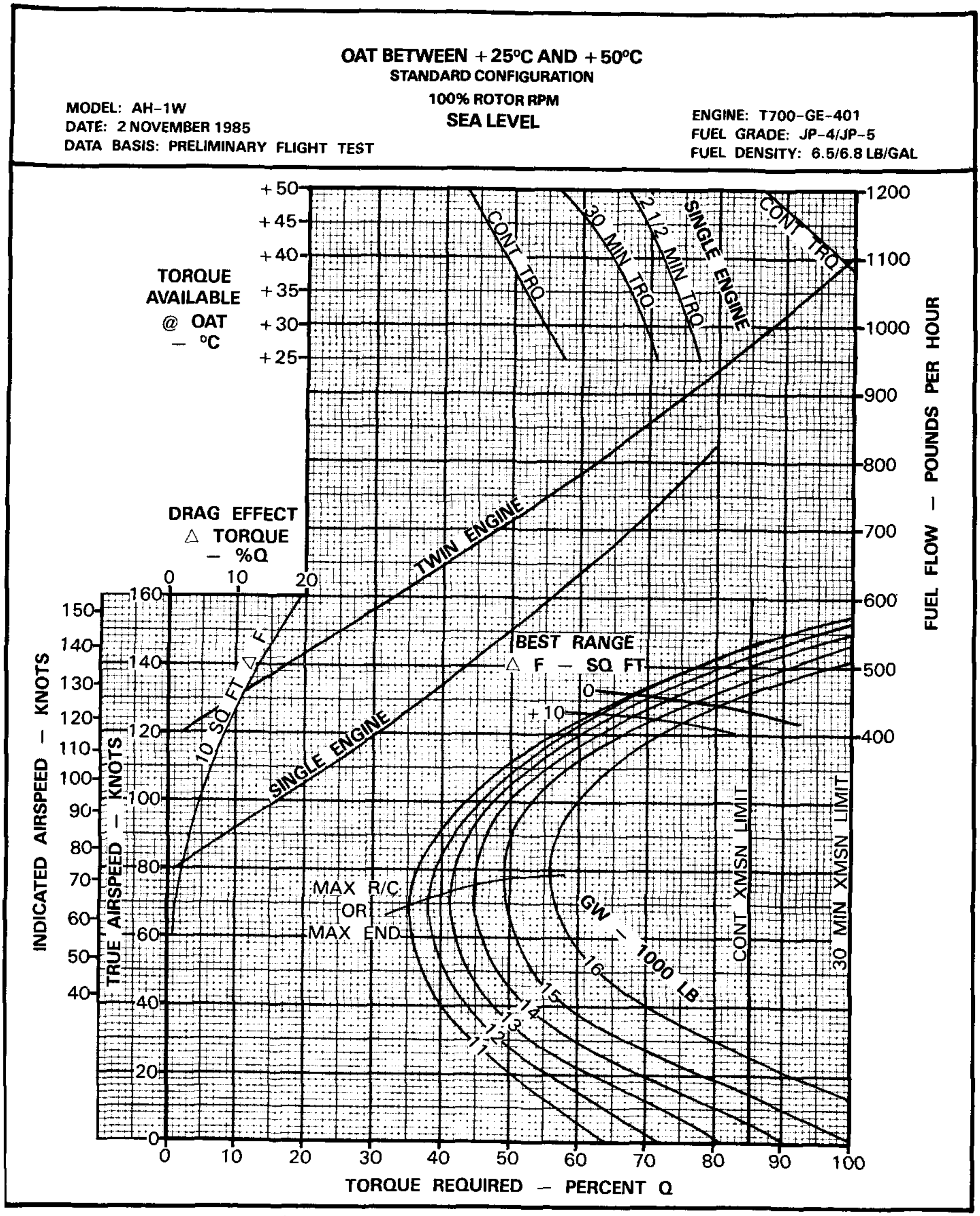

Figure 28-1. Cruise Performance (Sheet 3 of 21)

OAT BETWEEN −30°C AND 0°C
STANDARD CONFIGURATION
100% ROTOR RPM
2000 FEET

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

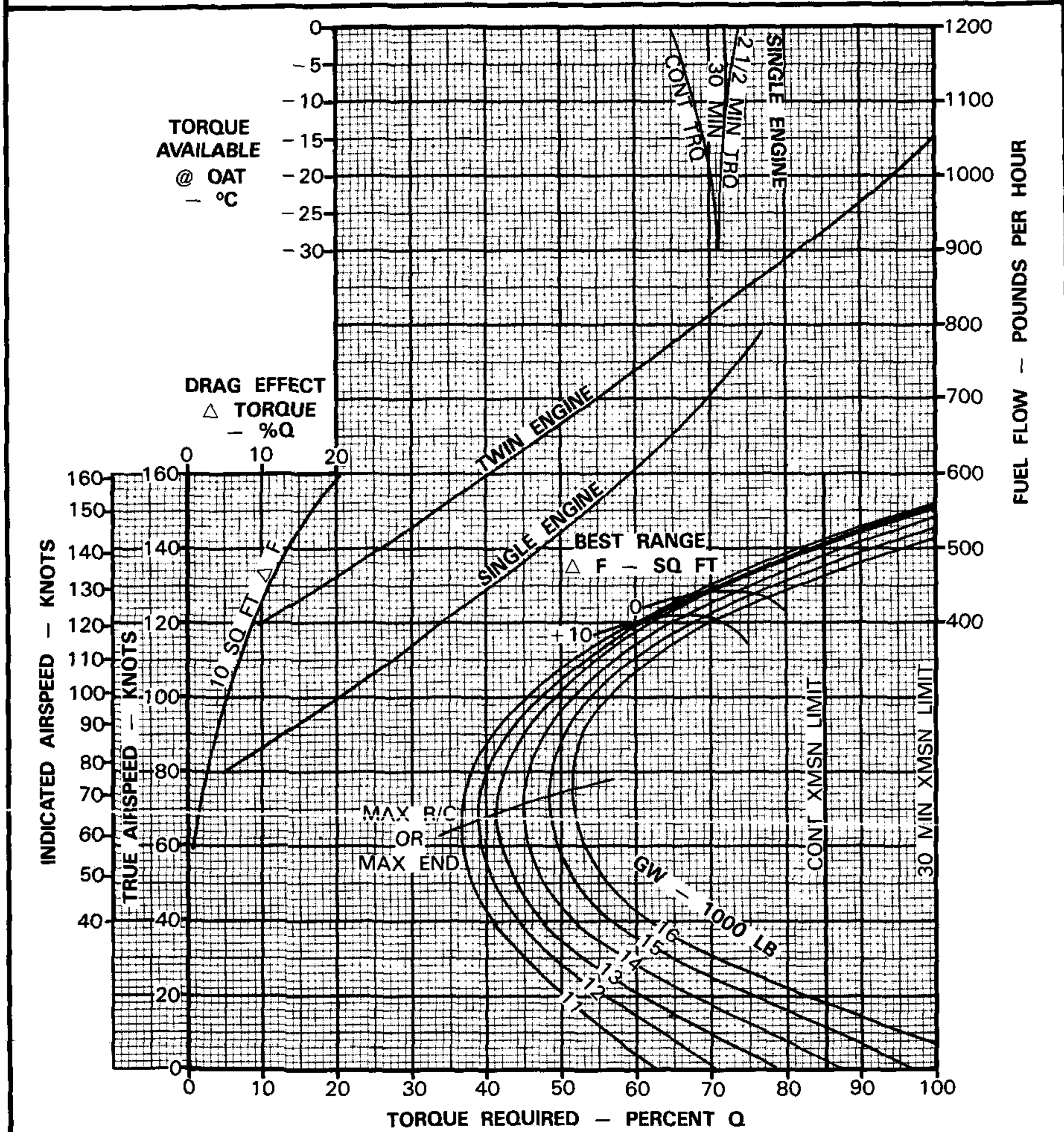

Figure 28-1. Cruise Performance (Sheet 4 of 21)

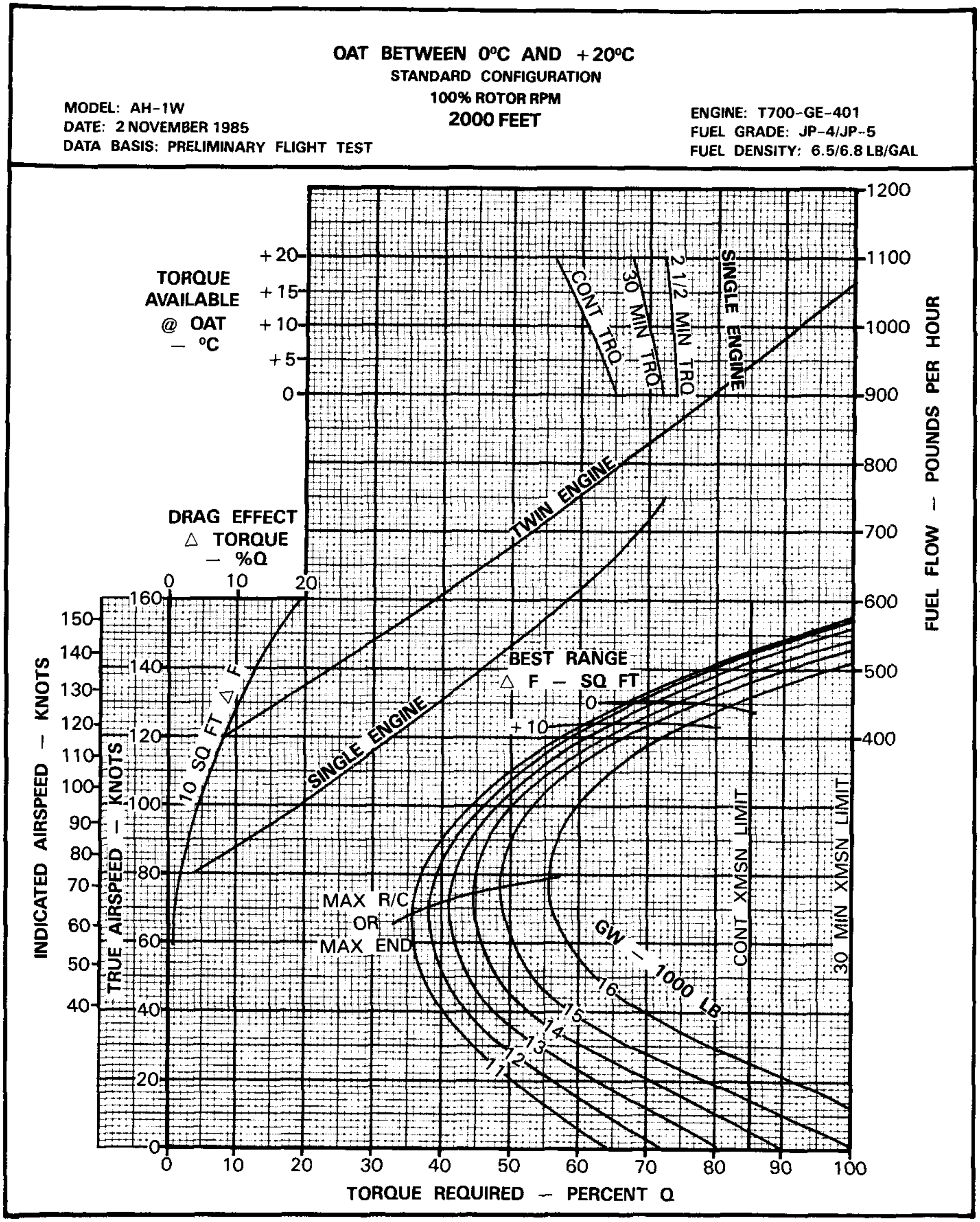

Figure 28-1. Cruise Performance (Sheet 5 of 21)

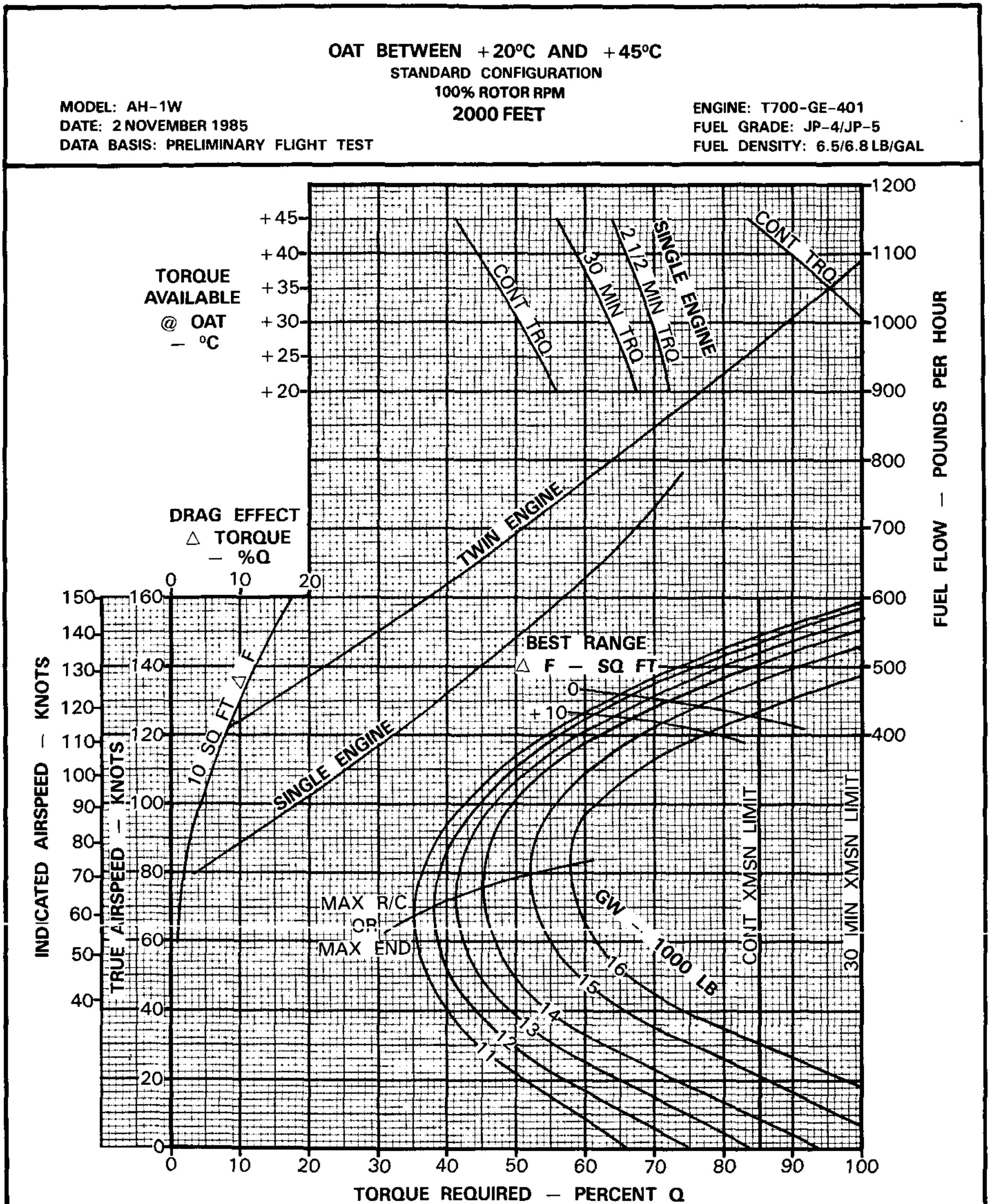

Figure 28-1. Cruise Performance (Sheet 6 of 21)

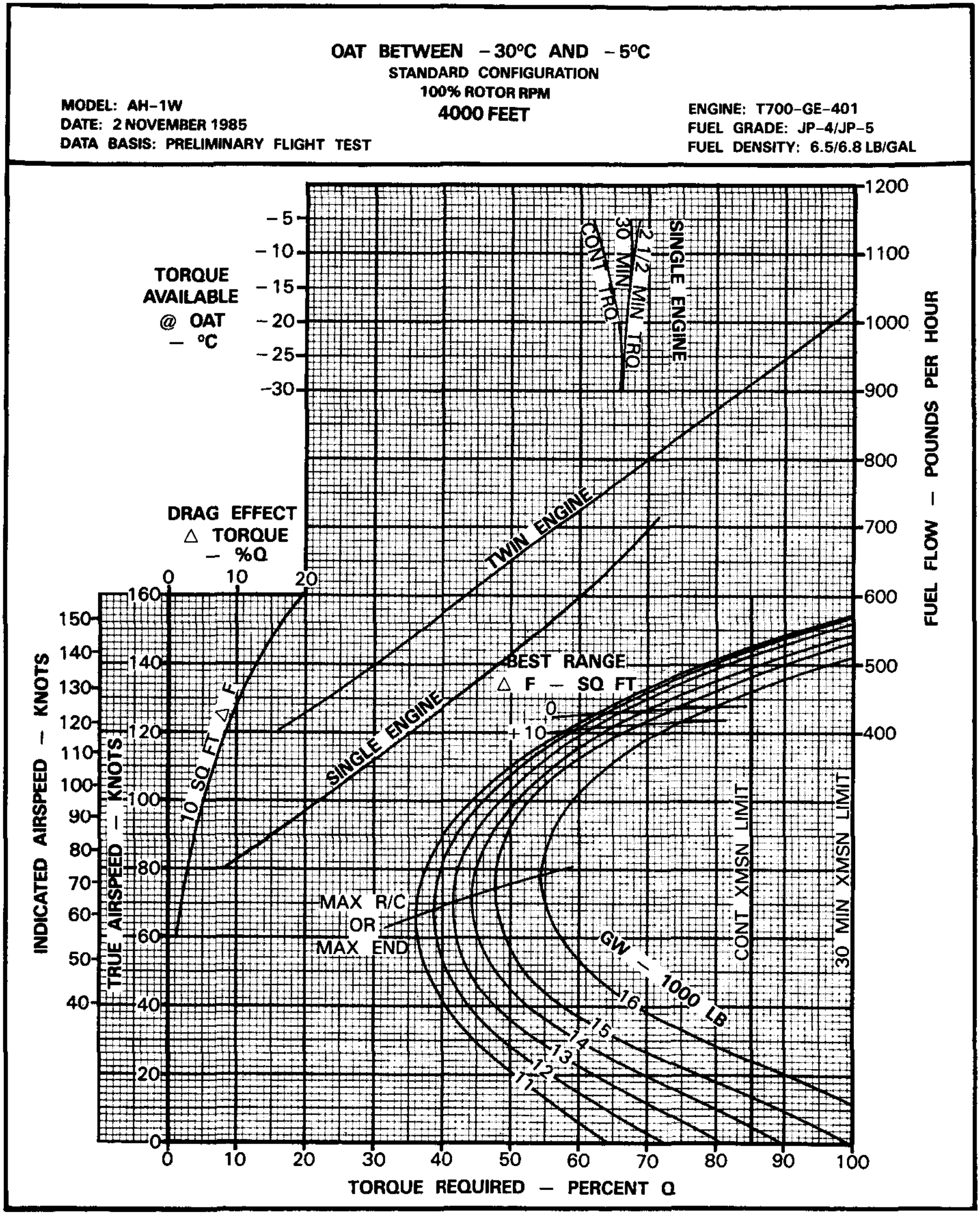

Figure 28-1. Cruise Performance (Sheet 7 of 21)

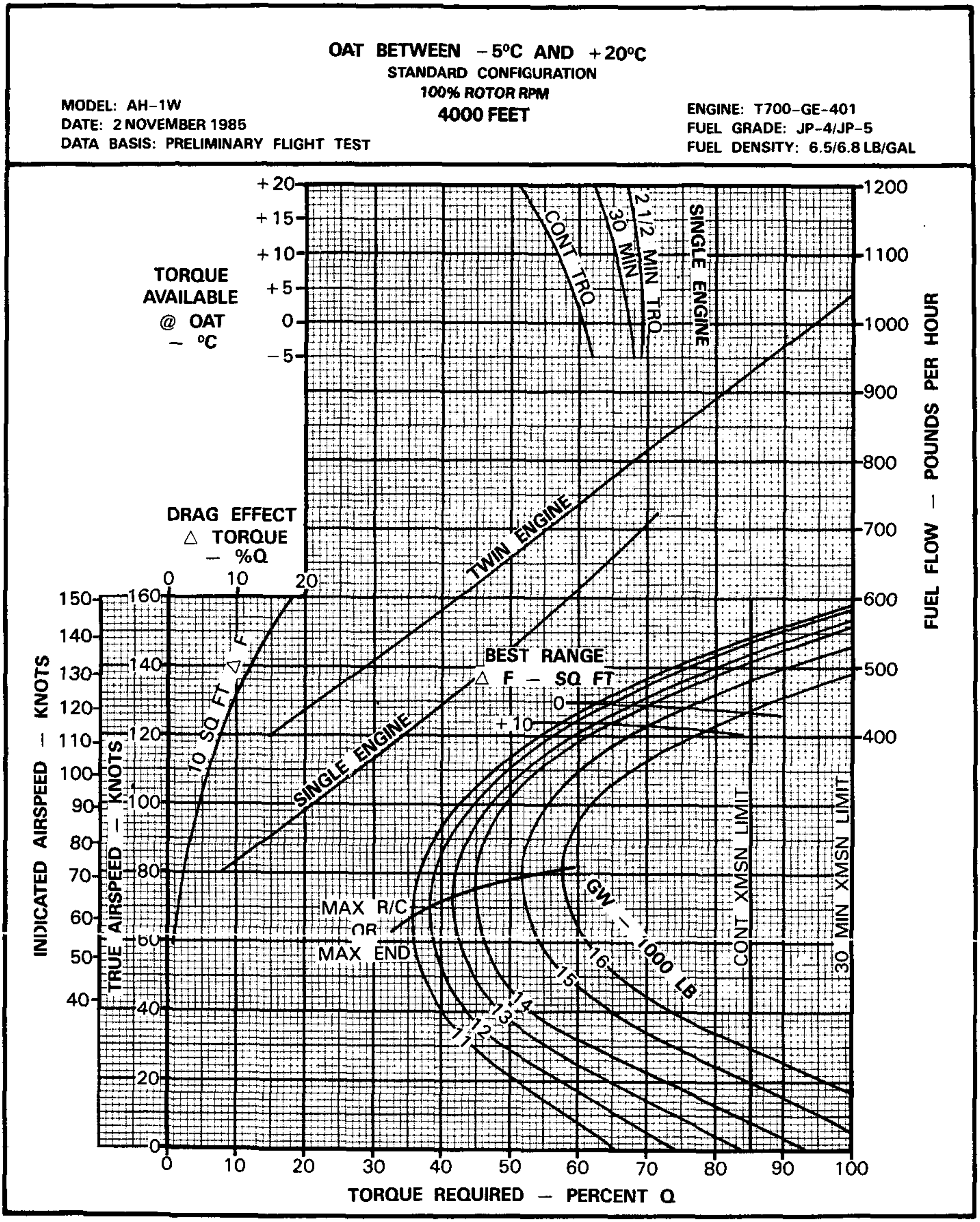

Figure 28-1. Cruise Performance (Sheet 8 of 21)

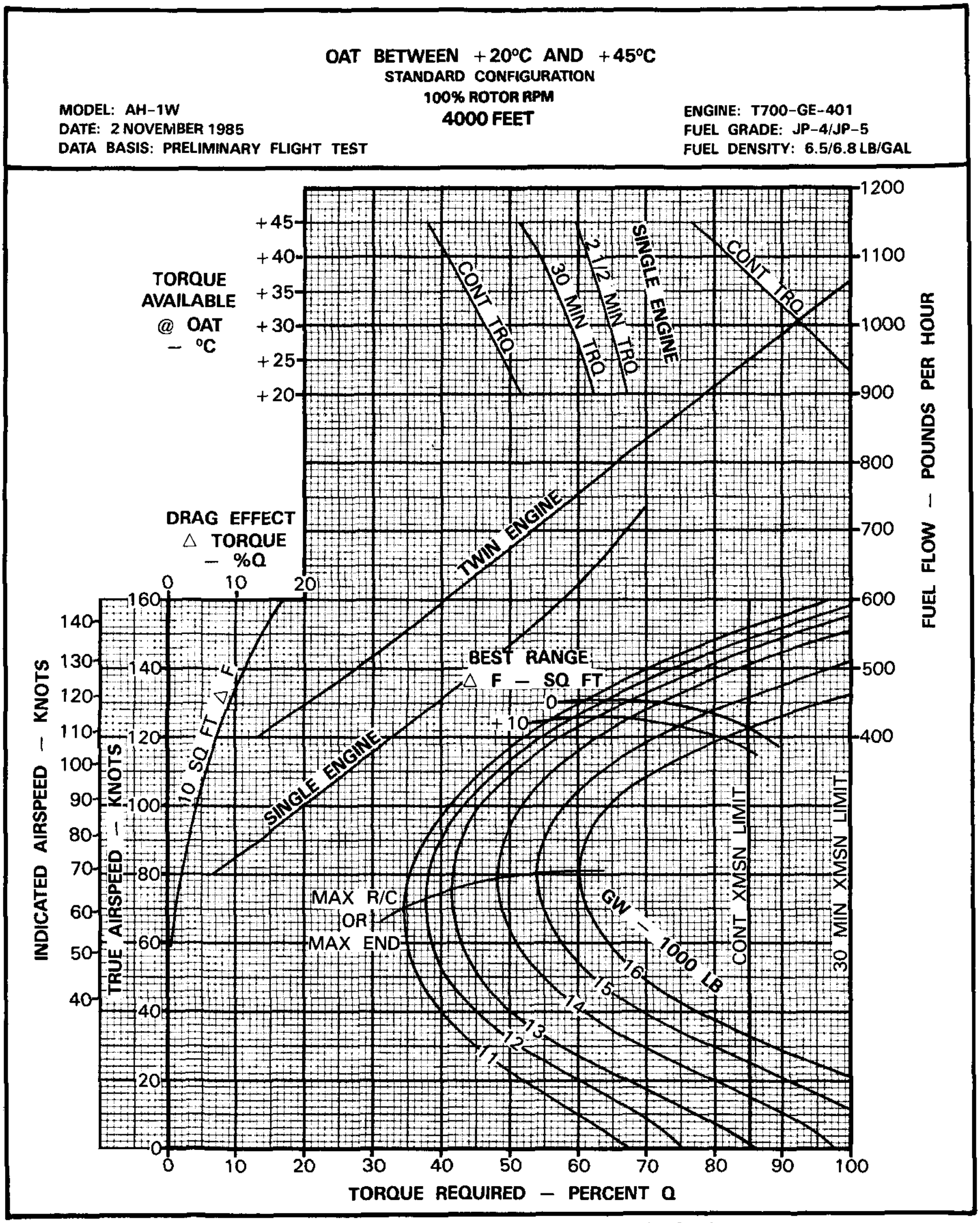

Figure 28-1. Cruise Performance (Sheet 9 of 21)

OAT BETWEEN -30°C AND -10°C
STANDARD CONFIGURATION
100% ROTOR RPM
6000 FEET

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

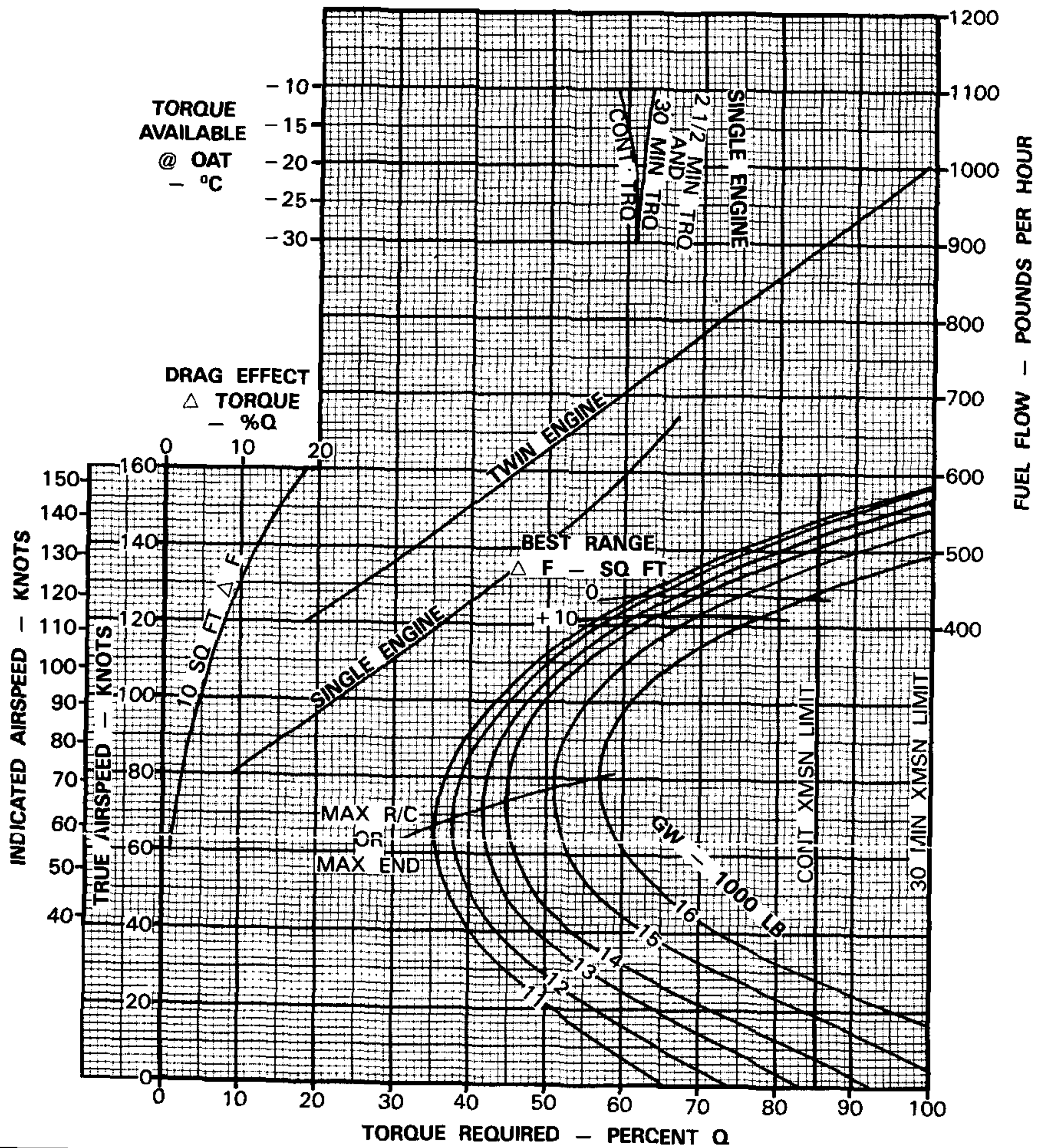

Figure 28-1. Cruise Performance (Sheet 10 of 21)

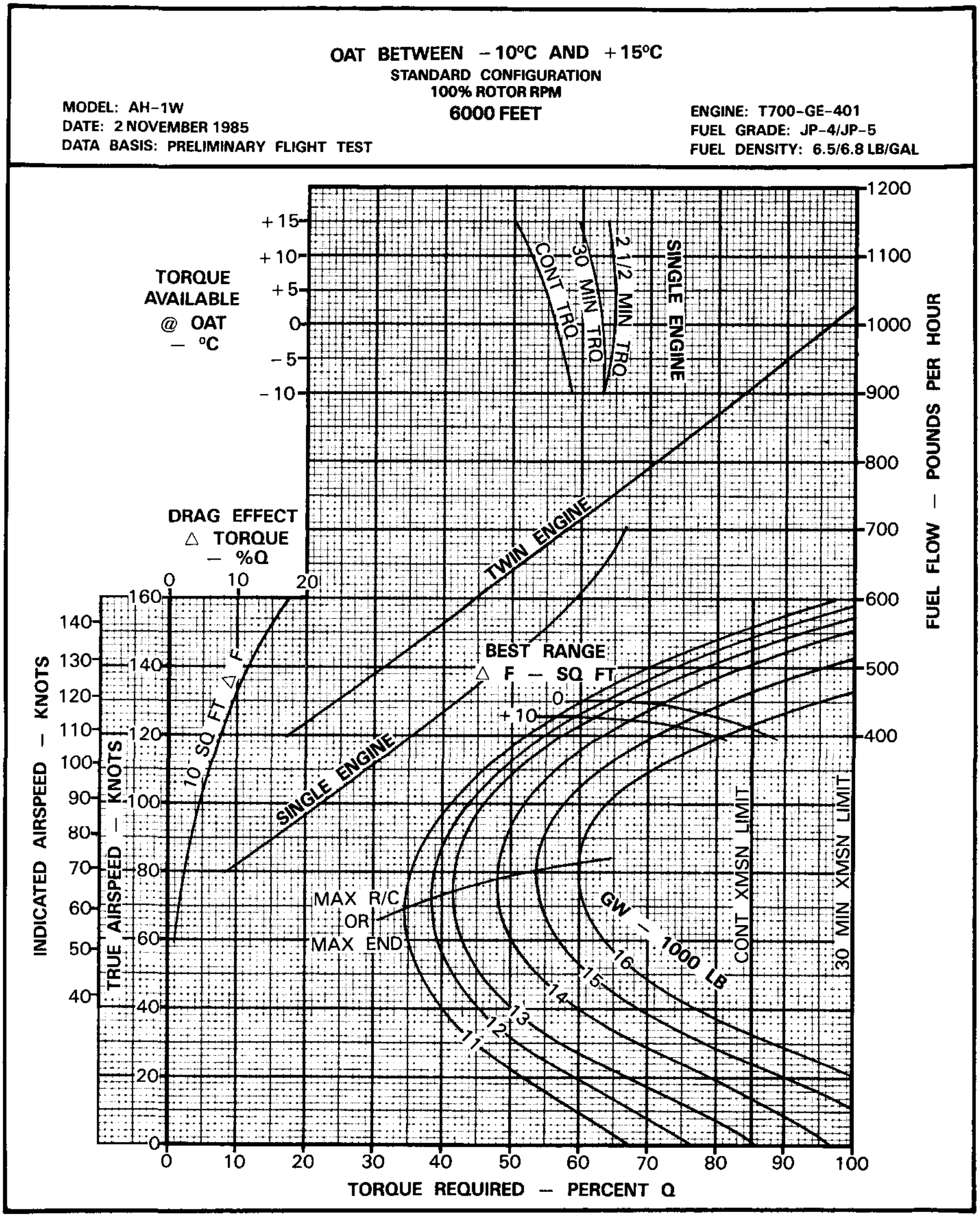

Figure 28-1. Cruise Performance (Sheet 11 of 21)

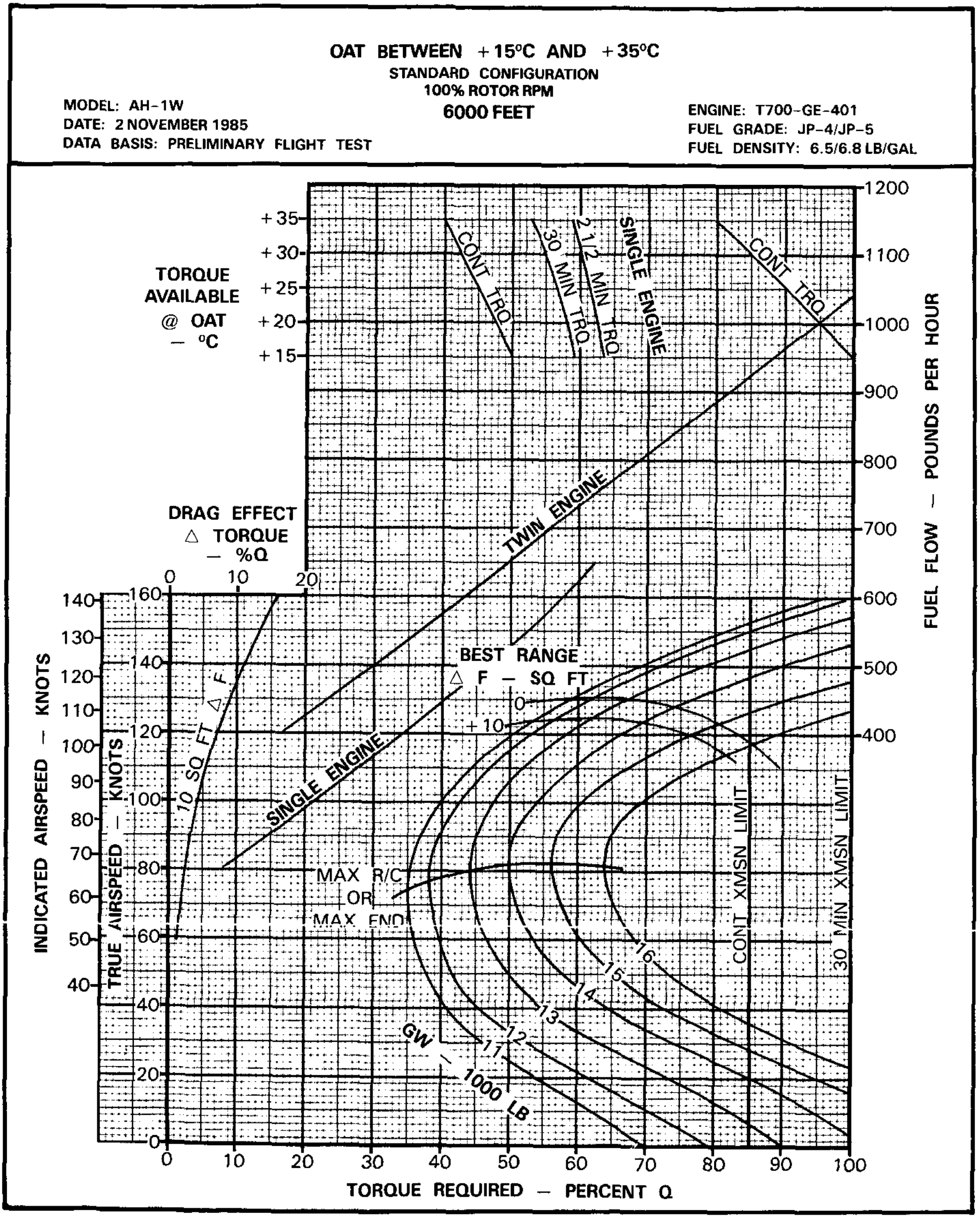

Figure 28-1. Cruise Performance (Sheet 12 of 21)

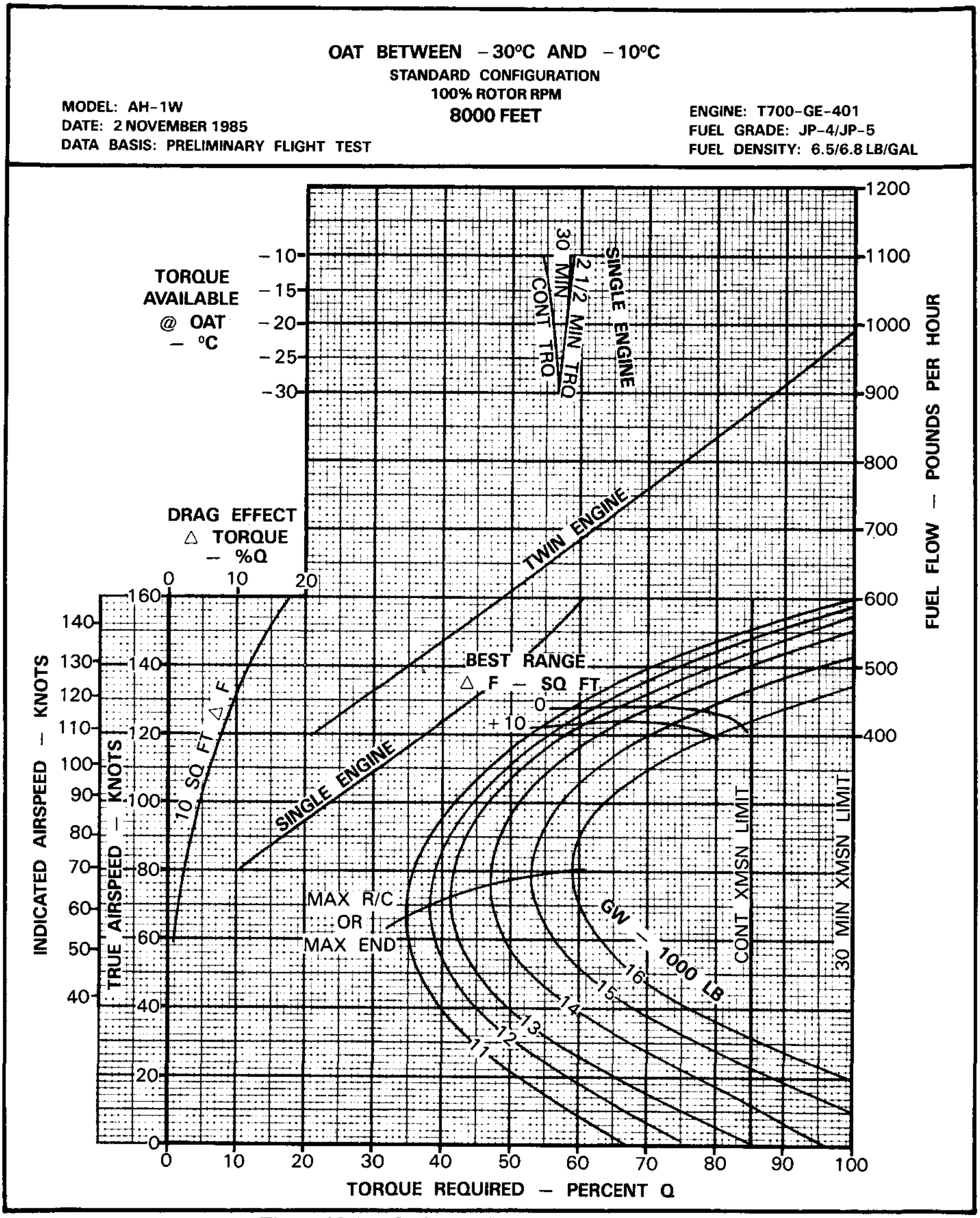

Figure 28-1. Cruise Performance (Sheet 13 of 21)

OAT BETWEEN −10°C AND +10°C
STANDARD CONFIGURATION
100% ROTOR RPM
8000 FEET

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

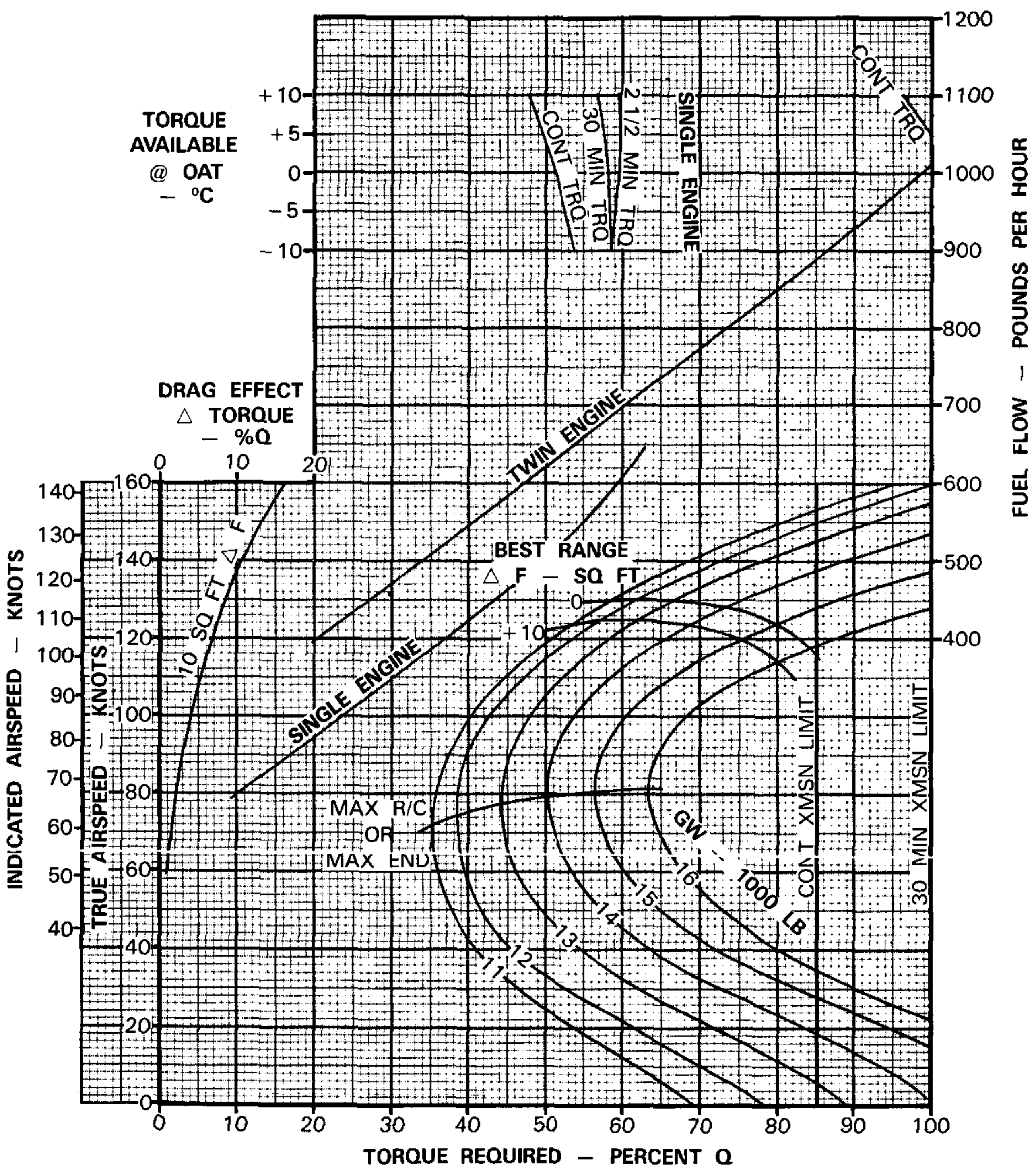

Figure 28-1. Cruise Performance (Sheet 14 of 21)

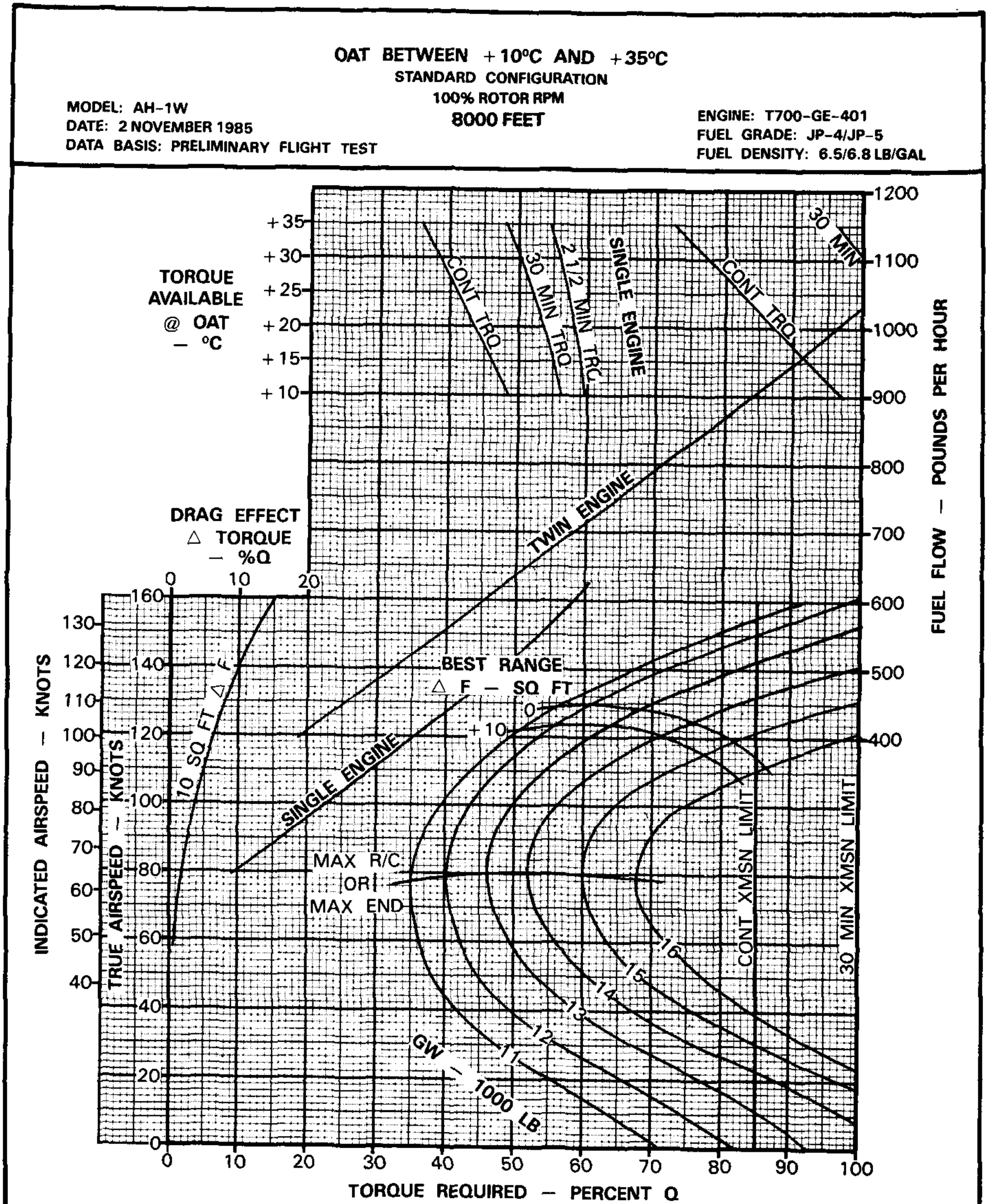

Figure 28-1. Cruise Performance (Sheet 15 of 21)

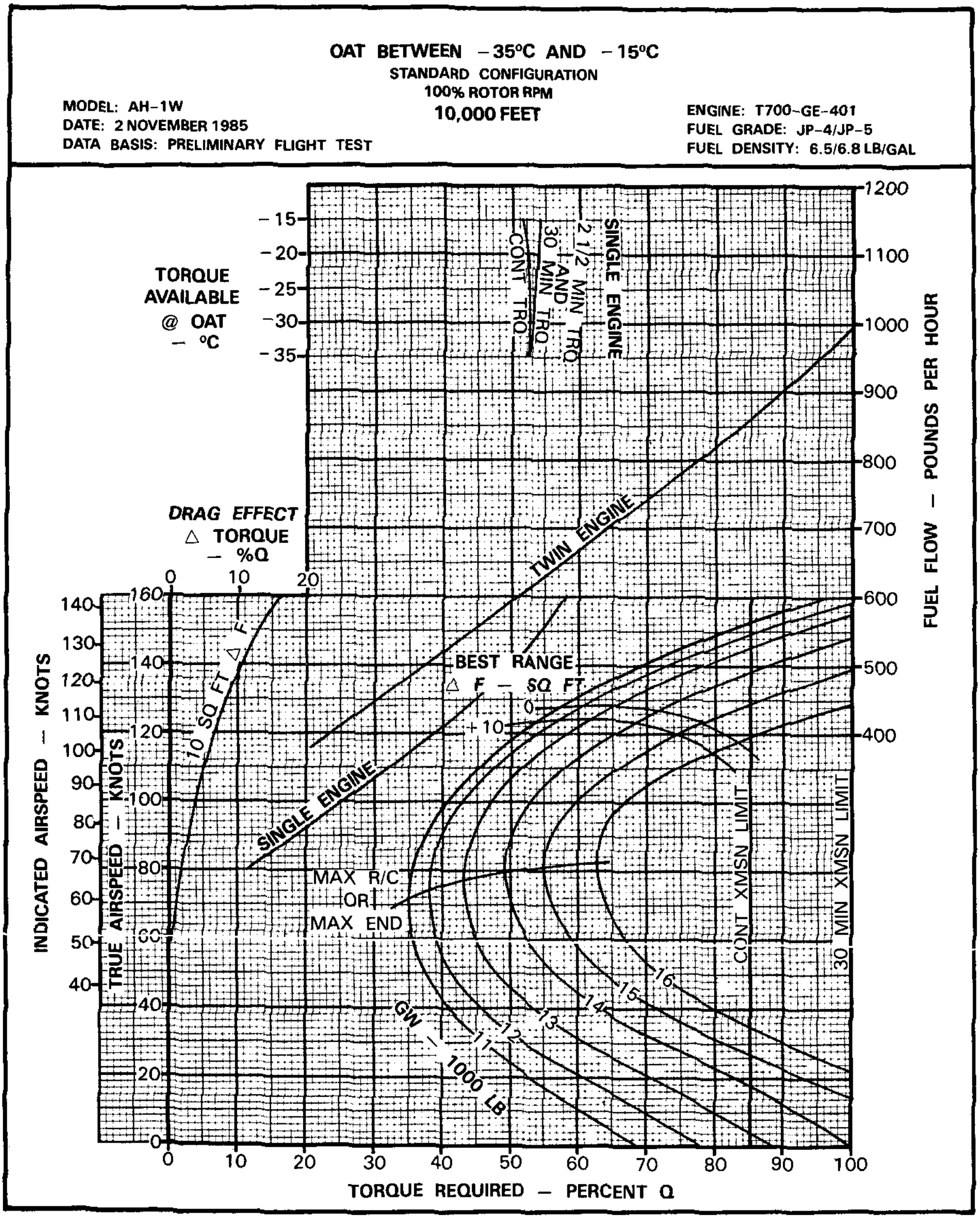

Figure 28-1. Cruise Performance (Sheet 16 of 21)

OAT BETWEEN −15°C AND +5°C
STANDARD CONFIGURATION
100% ROTOR RPM
10,000 FEET

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

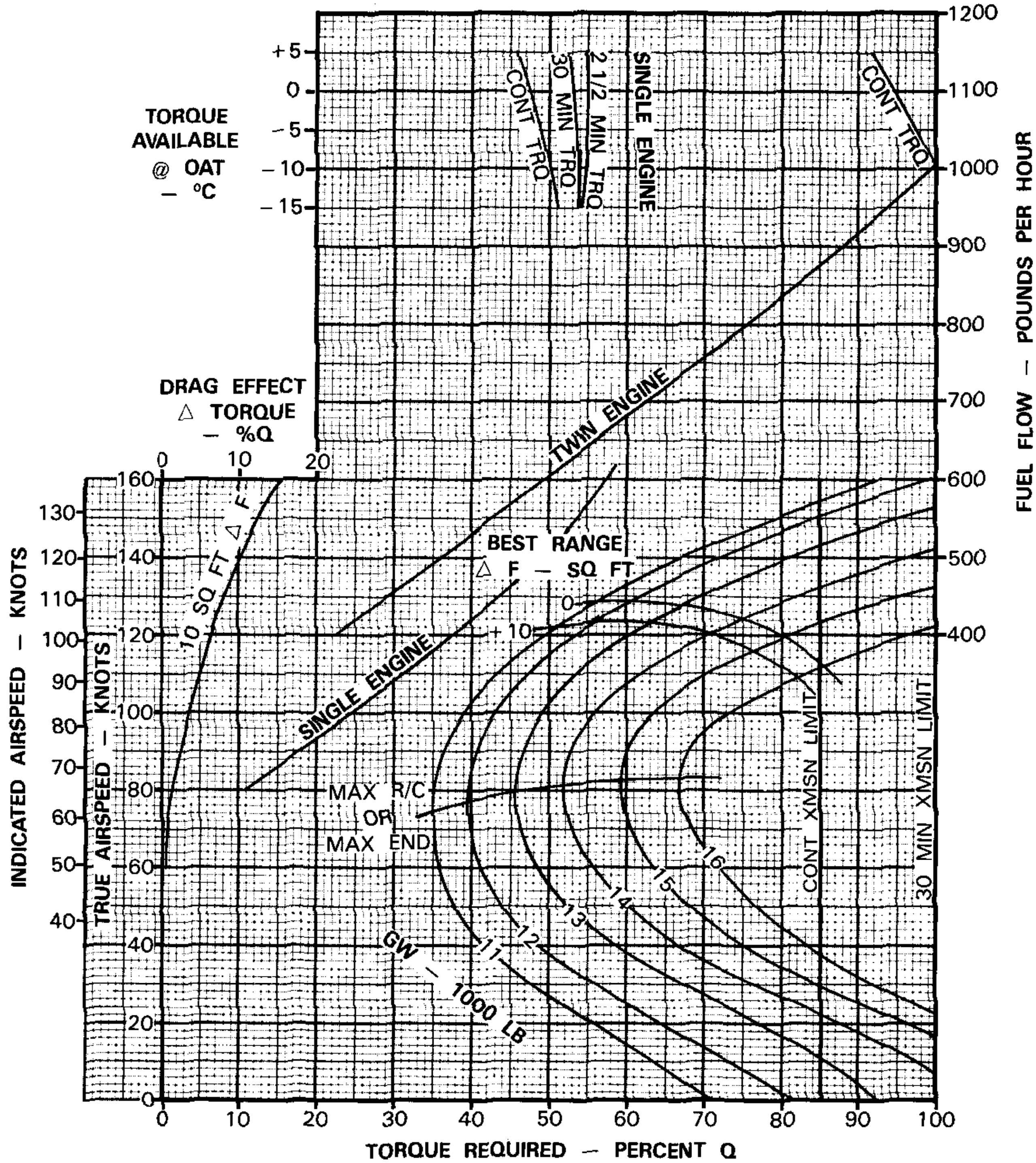

Figure 28-1. Cruise Performance (Sheet 17 of 21)

OAT BETWEEN +5°C AND +30°C
STANDARD CONFIGURATION
100% ROTOR RPM
10,000 FEET

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

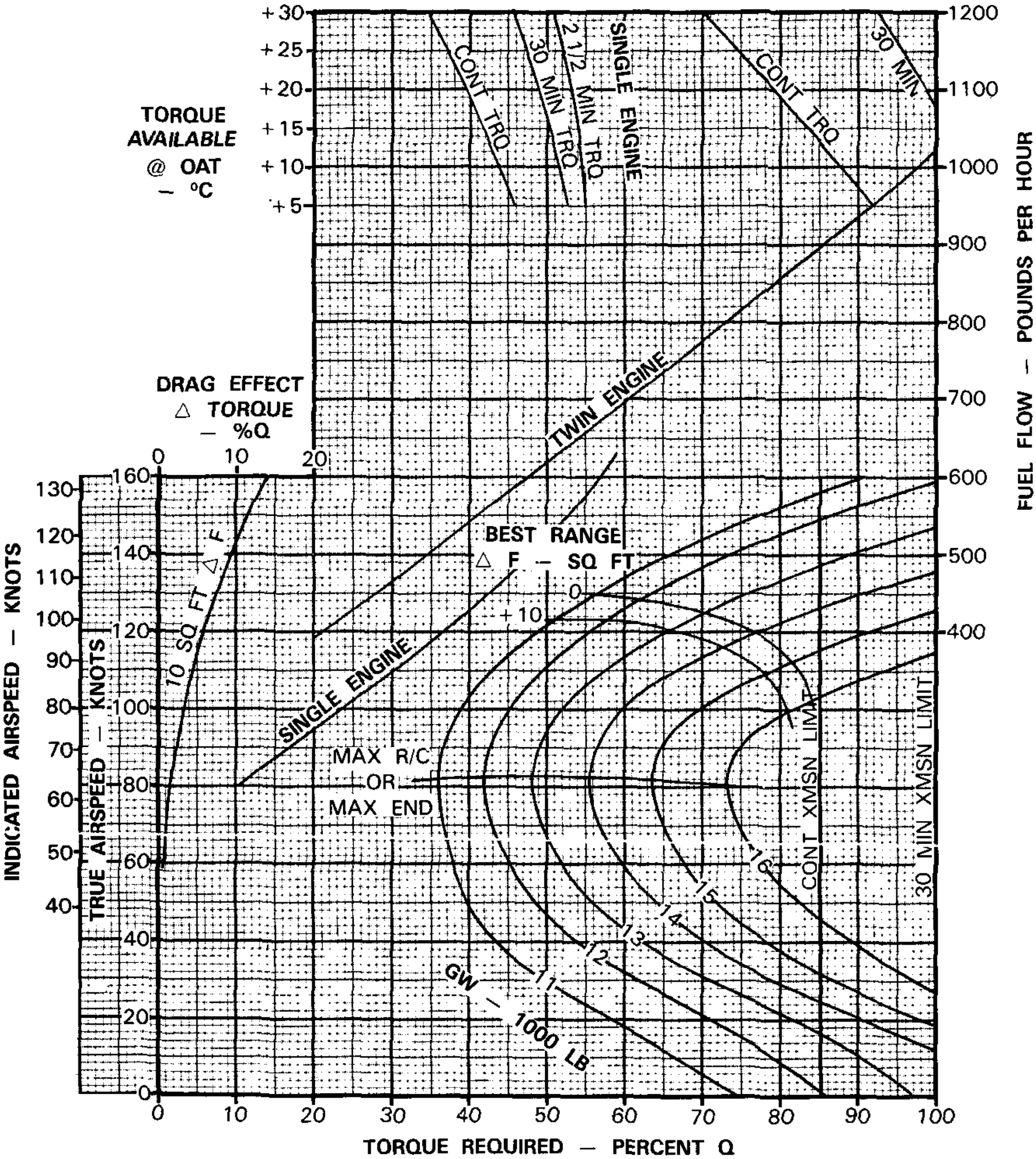

Figure 28-1. Cruise Performance (Sheet 18 of 21)

OAT BETWEEN −40°C AND −20°C
STANDARD CONFIGURATION
100% ROTOR RPM
12,000 FEET

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

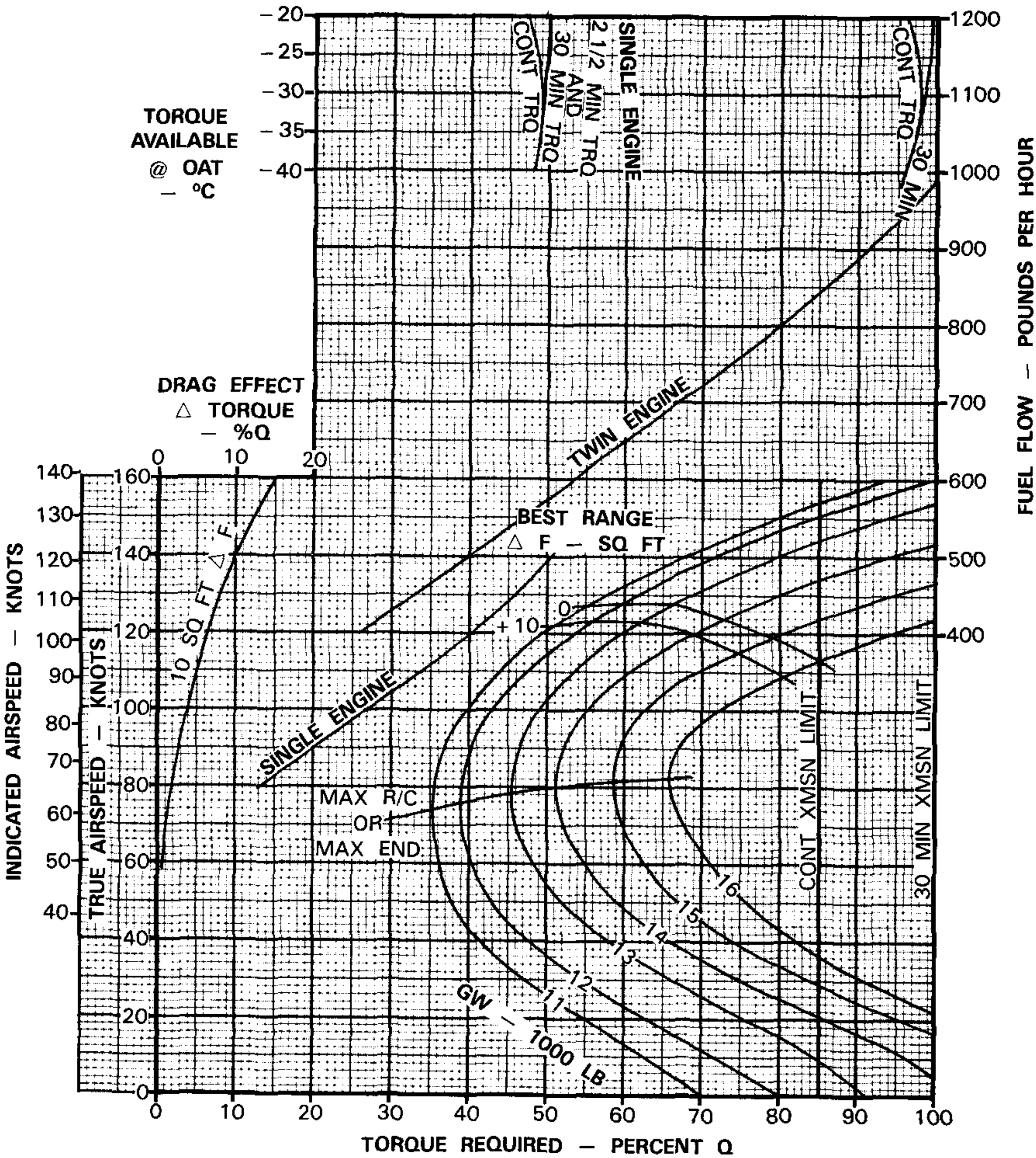

Figure 28-1. Cruise Performance (Sheet 19 of 21)

OAT BETWEEN −20°C AND 0°C
STANDARD CONFIGURATION
100% ROTOR RPM
12,000 FEET

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

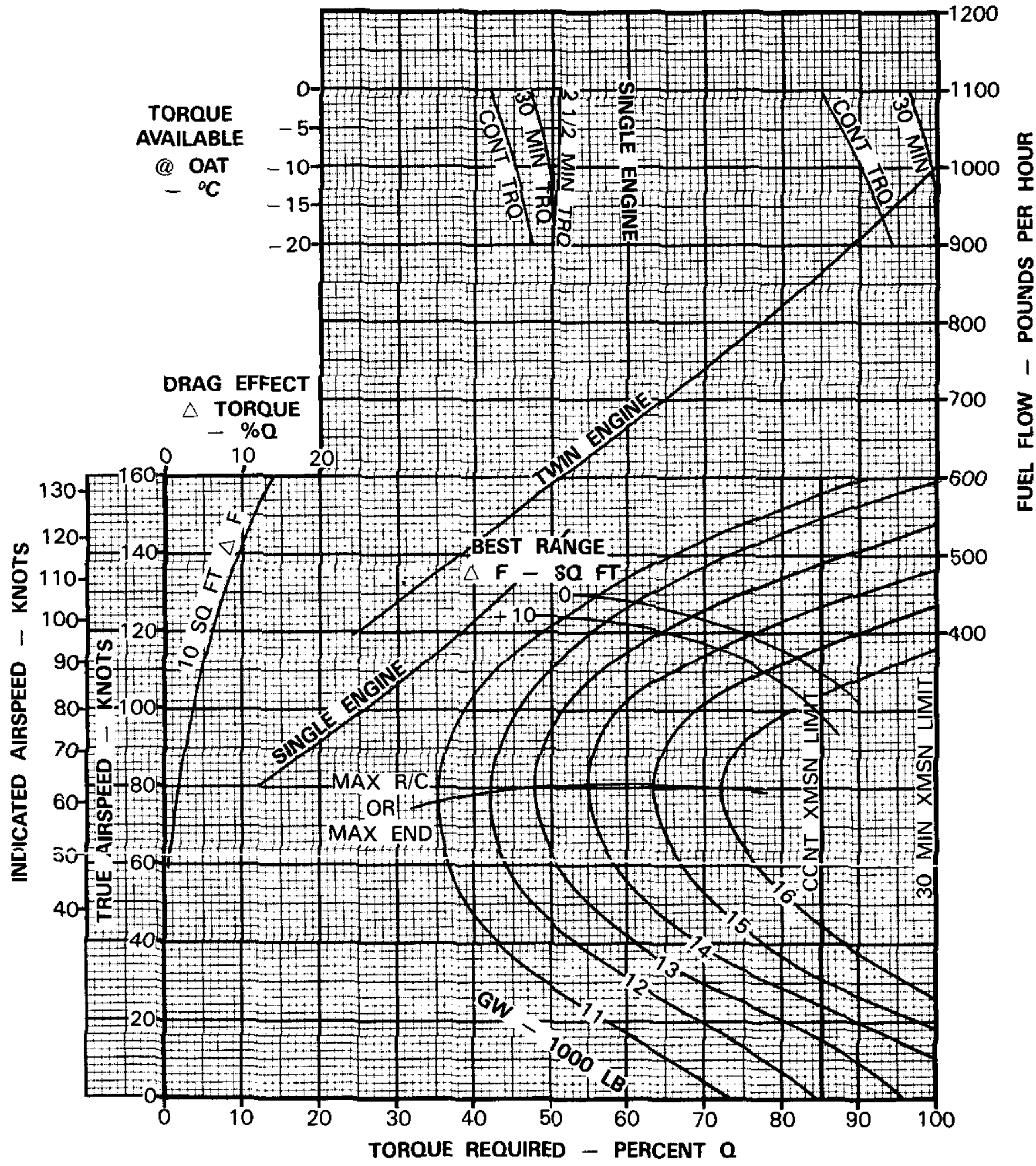

Figure 28-1. Cruise Performance (Sheet 20 of 21)

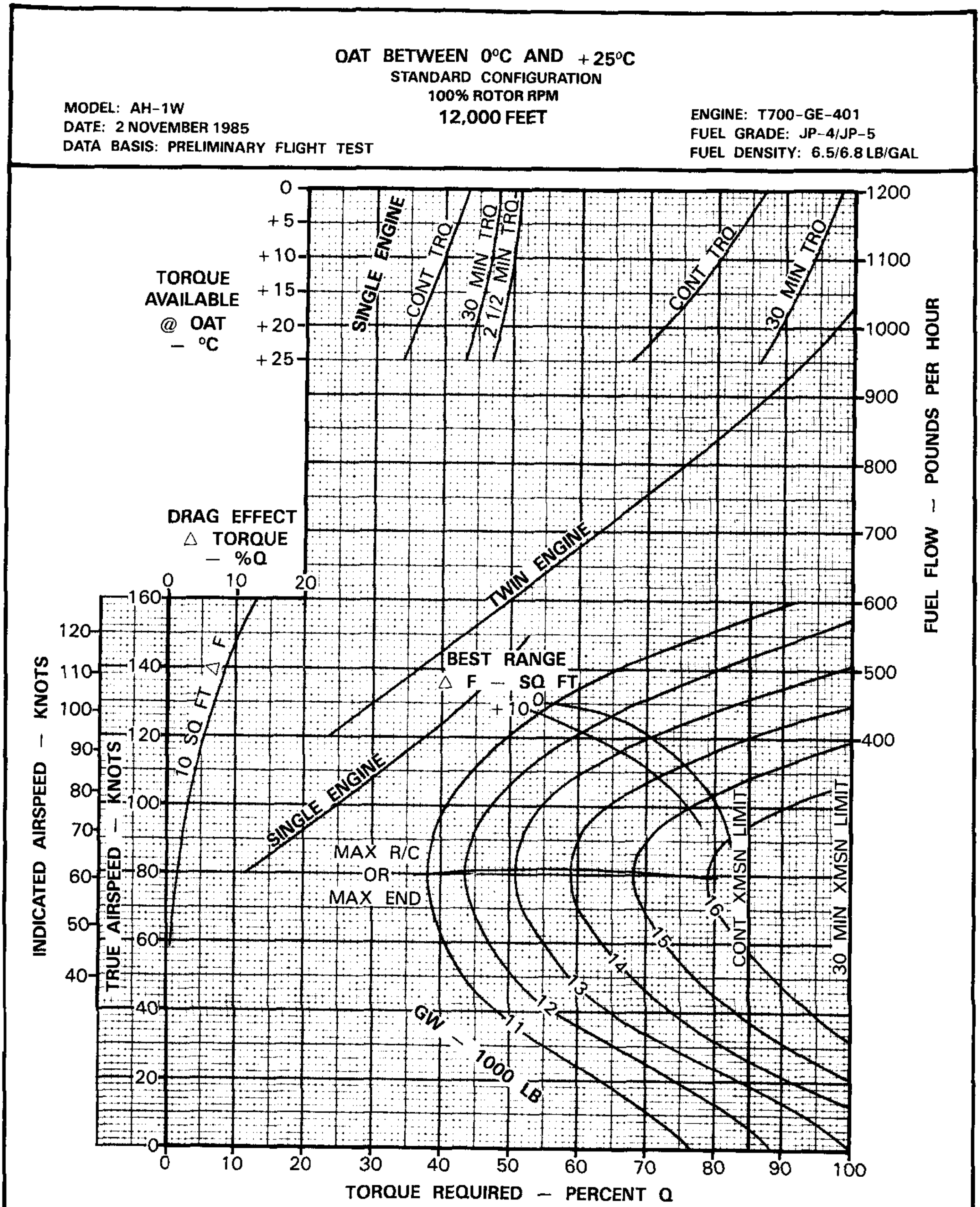

Figure 28-1. Cruise Performance (Sheet 21 of 21)

28.8 TIME AND RANGE VERSUS FUEL

The time and range versus fuel chart (Figure 28-2) shows the en route time and the distance that the helicopter can cover while in level cruise with calm winds. The only information needed is the cruise fuel, the fuel flow, and the cruise true airspeed.

EXAMPLE: Find the time en route and the distance covered while the helicopter consumes 2000 pounds of fuel at a rate of 600 pounds per hour while cruising at a true airspeed of 120 knots.

SOLUTION:

1. Enter Figure 28-2 at the upper left FUEL scale at 2000 pounds of fuel. Move horizontally to the right and read or interpolate for 600 pounds per hour fuel flow.
2. Drop to the TIME scale and read 200 minutes en route time.
3. Continue to drop and read or interpolate between the TRUE AIRSPEED lines for 120 knots. Then project left and read 400 nm on the RANGE scale.

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: CALCULATED DATA

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

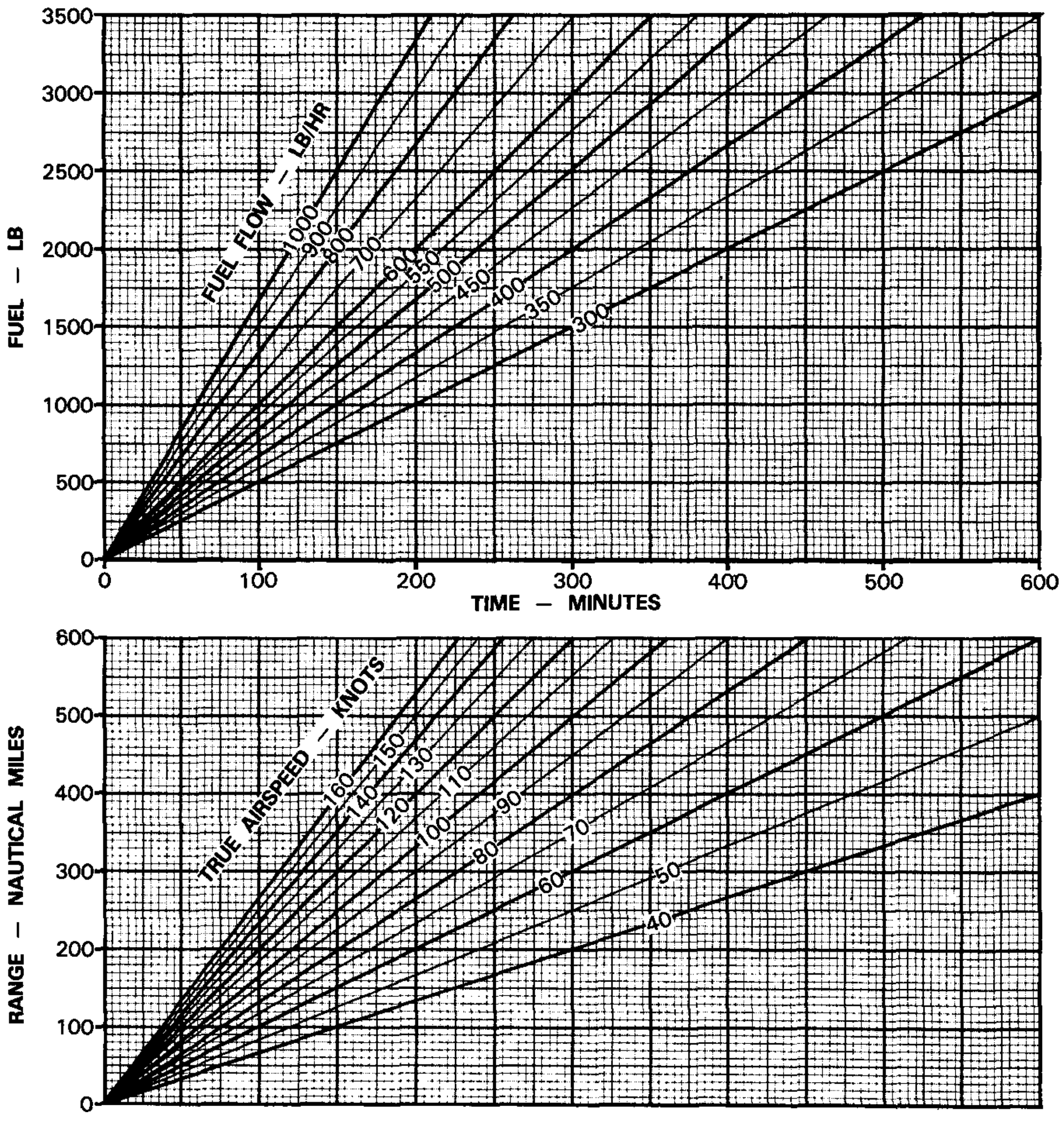

Figure 28-2. Time and Range Versus Fuel — 100 Percent Rotor Rpm

28.9 NAUTICAL MILES PER POUND OF FUEL

The nautical miles per pound of fuel chart (Figure 28-3) shows the nautical miles per pound of fuel that the helicopter will use during a given mission. The only information required is the fuel flow in pounds per hour and the cruise airspeed.

EXAMPLE: Find the nautical miles per pound of fuel of a helicopter that consumes fuel at a rate of 600 pounds per hour while cruising at a true airspeed of 120 knots.

SOLUTION:

1. Enter Figure 28-3 on the bottom FUEL FLOW scale at 600 pounds per hour fuel flow. Move straight upward and read or interpolate for 120 knots TRUE AIRSPEED.

2. Proceed left and read 0.20 NAUTICAL MILES PER POUND OF FUEL.

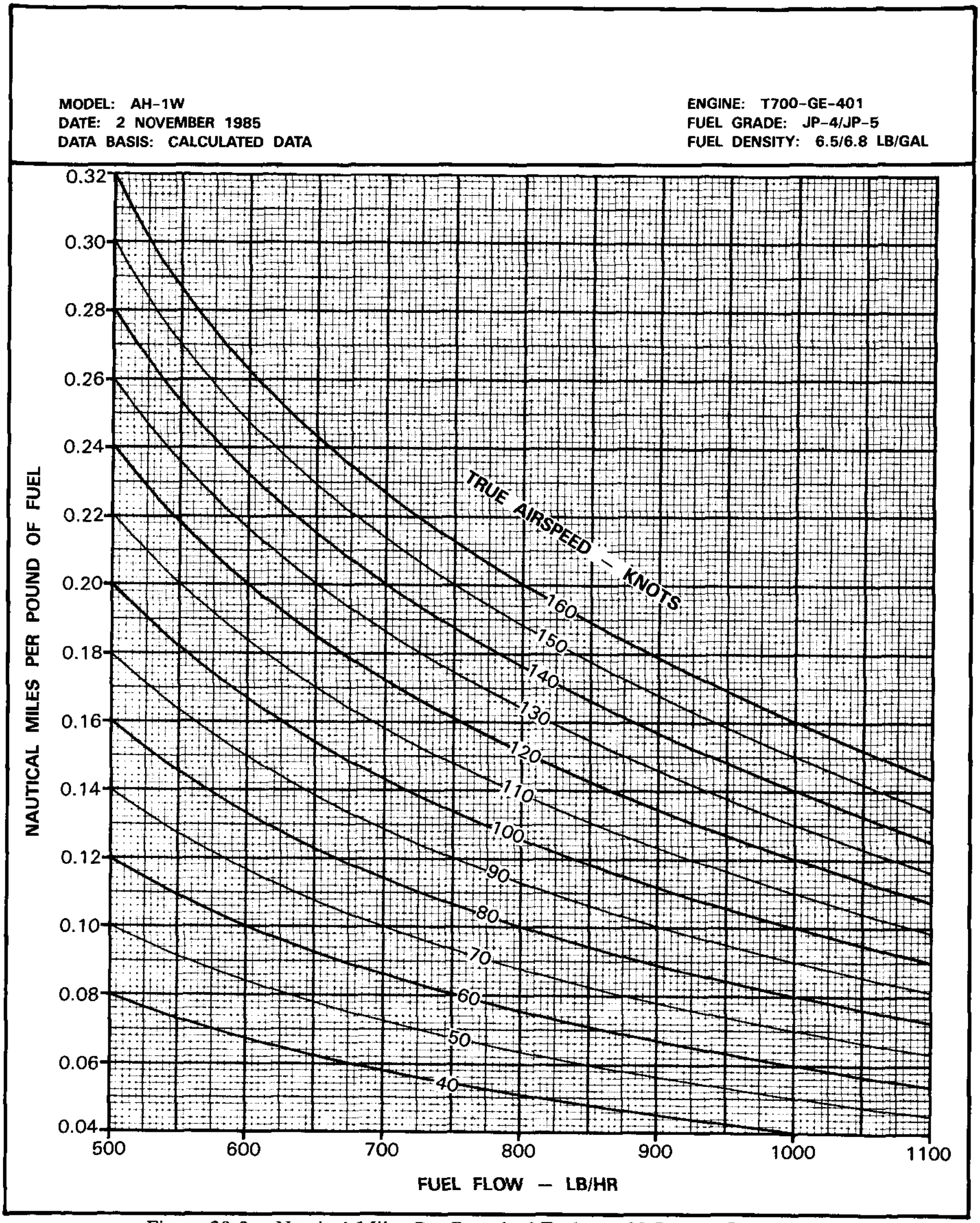

Figure 28-3. Nautical Miles Per Pound of Fuel — 100 Percent Rotor Rpm

28.10 OPTIMUM CRUISE ALTITUDE

The optimum cruise altitude chart (Figure 28-4) shows gross weight lines from 10,000 pounds every 1000 pounds to 16,000 pounds for pressure altitudes of sea level to 18,000 feet and OATs of –40 to +40 °C. Dashed lines with a standard day lapse rate are shown but are labeled only as "GUIDELINES." Optimum cruise altitude performance was calculated at long-range cruise speed and twin-engine power available.

EXAMPLE: Find the optimum cruise altitude of a 14,000-pound helicopter that is operating at a base altitude of 2000-foot pressure altitude and at an OAT of +1 °C.

SOLUTION:

1. Enter Figure 28-4 at 2000 feet on the PRESSURE ALTITUDE scale.

2. Move horizontally to the right to +1 °C on the OAT scale.

3. Following the trend of the GUIDELINES, project upwards to the 14,000-pound GROSS WEIGHT line.

4. Move horizontally to the left and read an optimum cruise altitude of 7500 feet on the PRESSURE ALTITUDE scale.

MODEL. AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

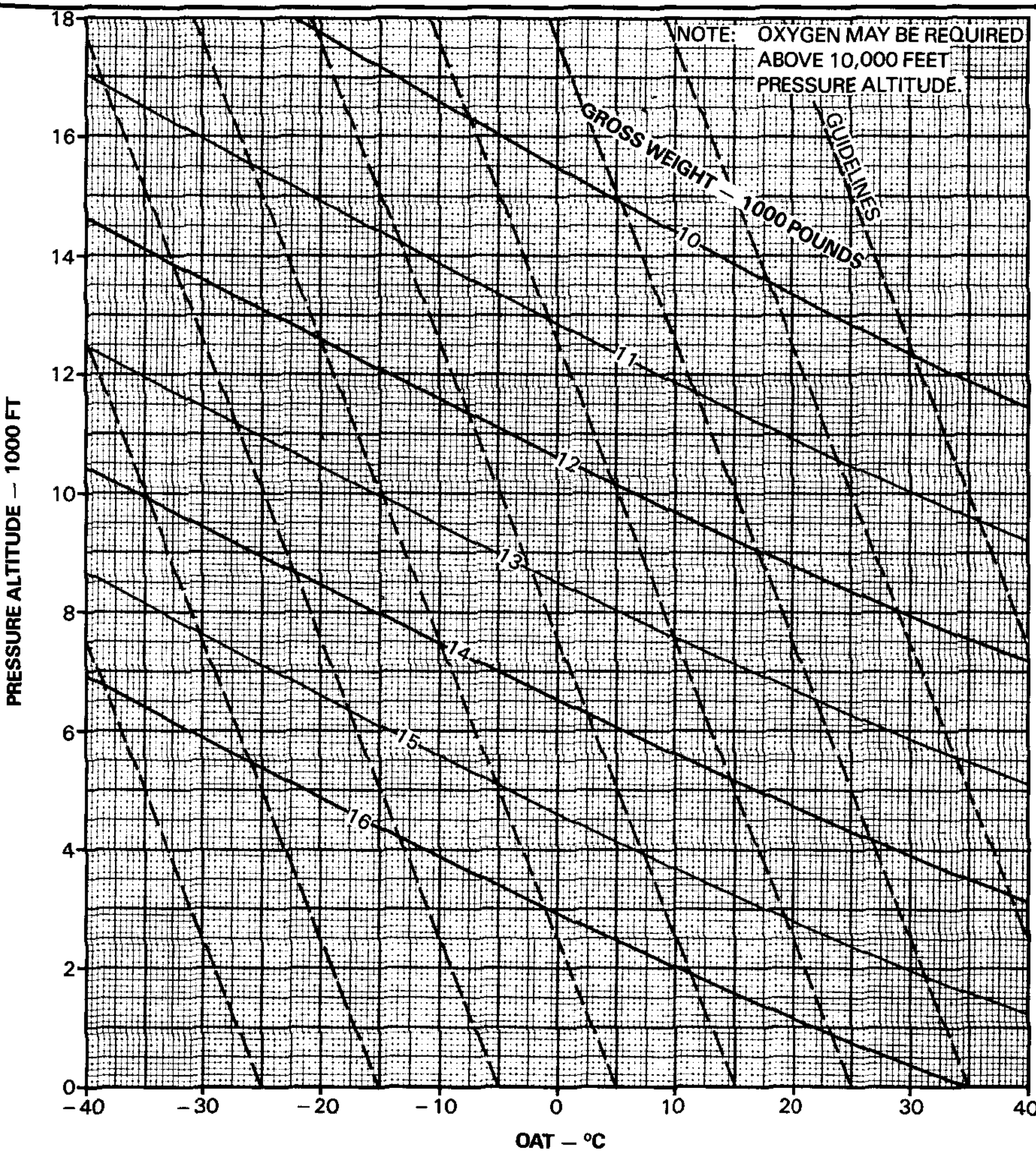

Figure 28-4. Optimum Cruise Altitude — Long-Range Cruise Speed — Two-Engine Operation — 100 Percent Rotor Rpm

CHAPTER 29

Emergency Operation

29.1 SINGLE-ENGINE MAXIMUM GROSS WEIGHT FOR HOVERING

The single-engine maximum gross weight for hovering charts (Figure 29-1, sheets 1 and 2), present data for single-engine operation. The charts show the maximum gross weight hover capability at a pressure altitude/OAT combination while at maximum torque available. The effect of skid height above ground is shown in sheet 1, and the effect of headwind is presented in sheet 2.

29.2 SINGLE-ENGINE CLIMB PERFORMANCE

The single-engine climb performance chart (Figure 29-2) represents a synthesis of the cruise performance charts to ease estimation of the climb portion of the flight plan. These charts show relationships between gross weight, initial and final altitude and temperatures, time to climb, distance traveled while climbing, and fuel expended while climbing. The chart is presented for immediate rated (30 minute) power available and may be used for all drag configurations. The chart represents climb performance at optimum conditions; that is, minimum power required and stated torque available. Climb is presented at 65 KIAS. Warmup and taxi fuel are not included in the fuel flow calculations. Climb performance is calculated for the 100-percent rotor rpm and 100-percent engine rpm. The charts are based upon a no-wind condition; therefore, the distance traveled will not be valid when winds are present.

29.3 SINGLE-ENGINE SERVICE CEILING

The single-engine service ceiling (Figure 29-3) is shown in 29-minute rated power available and is presented at 65 KIAS. This chart is for emergency situations where one engine is inoperative, and it is useful for planning missions or routes that do not require continuous operation of both engines in order to reach the desired destination.

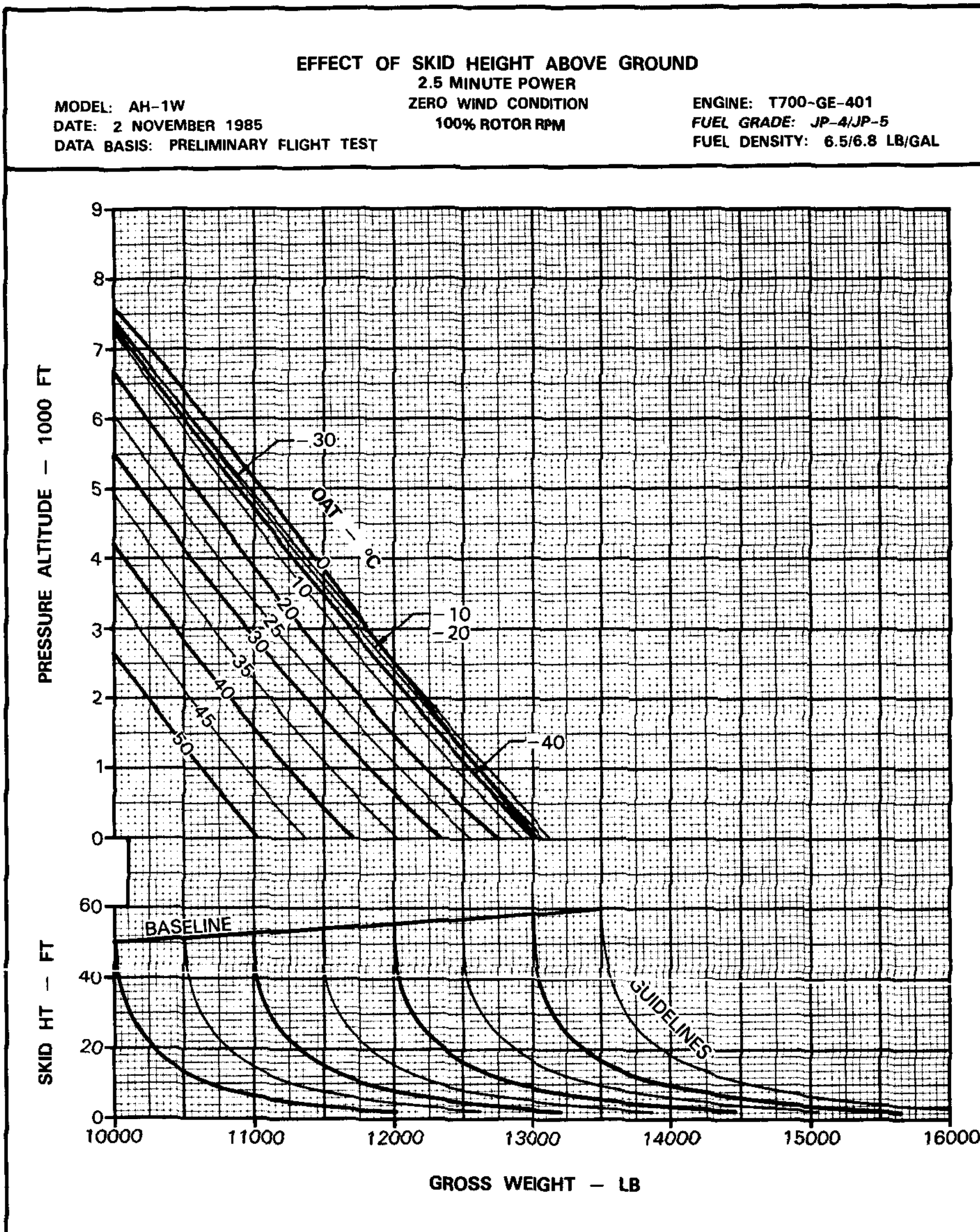

Figure 29-1. Single-Engine Maximum Gross Weight for Hovering (Sheet 1 of 2)

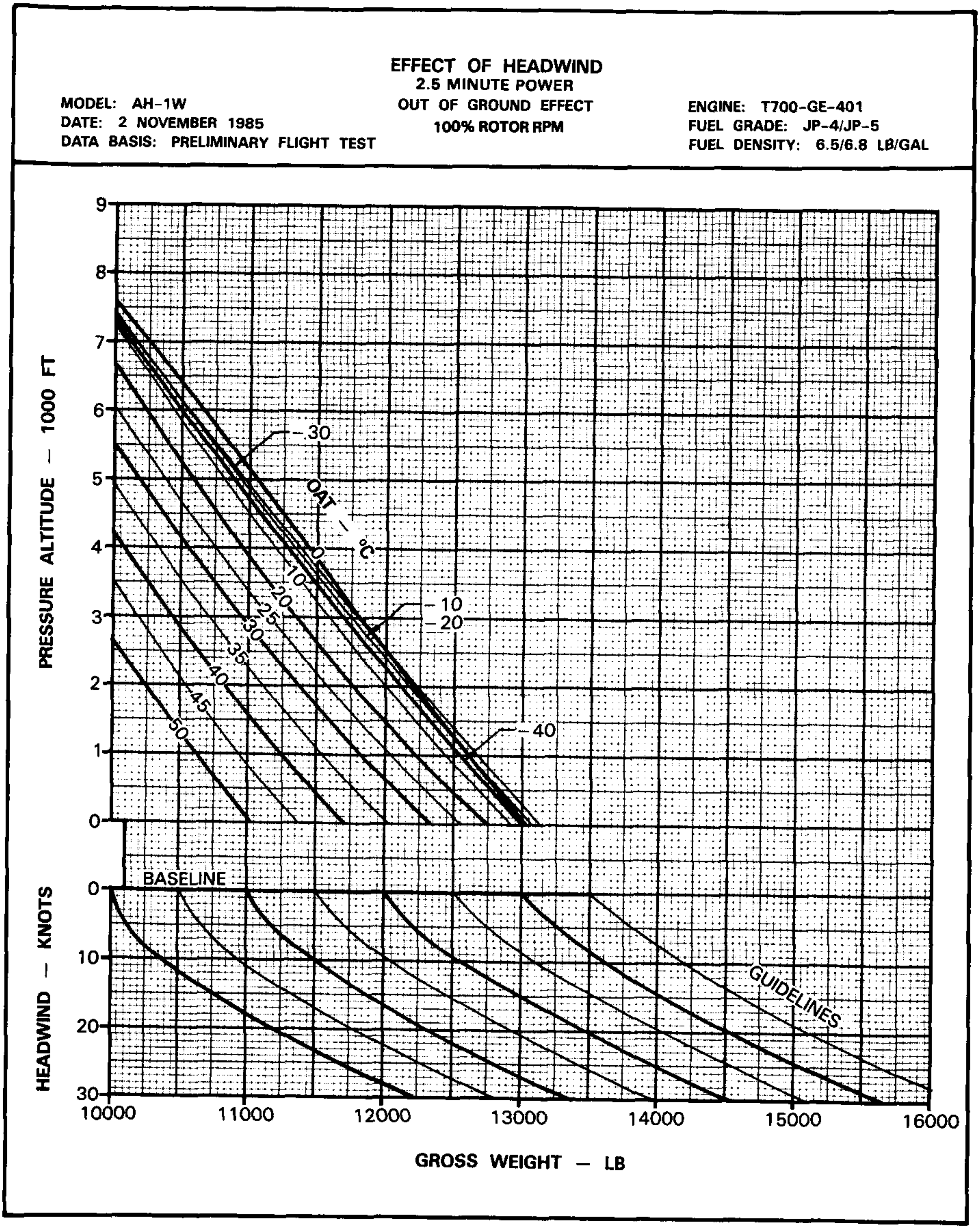

Figure 29-1. Single-Engine Maximum Gross Weight for Hovering (Sheet 2 of 2)

MODEL: AH-1W DATE: 2 NOVEMBER 1985 DATA BASIS: PRELIMINARY FLIGHT TEST	65 KIAS	ENGINE: T700-GE-401 FUEL GRADE: JP-4/JP-5 FUEL DENSITY: 6.5/6.8 LB/GAL

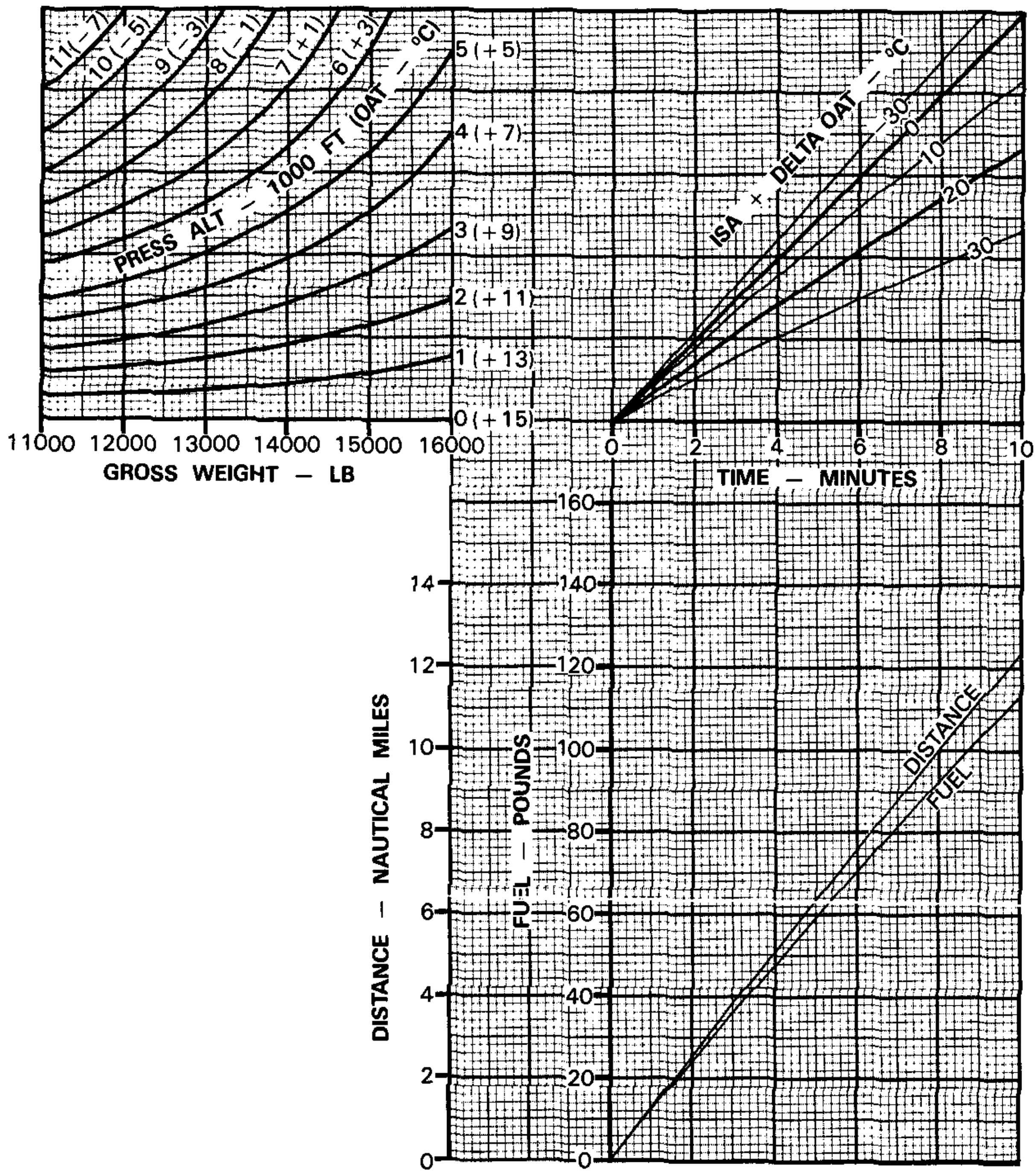

Figure 29-2. Single-Engine Climb Performance — 29-Minute Power —
All Configurations — 100-Percent Rotor Rpm — 65 KIAS

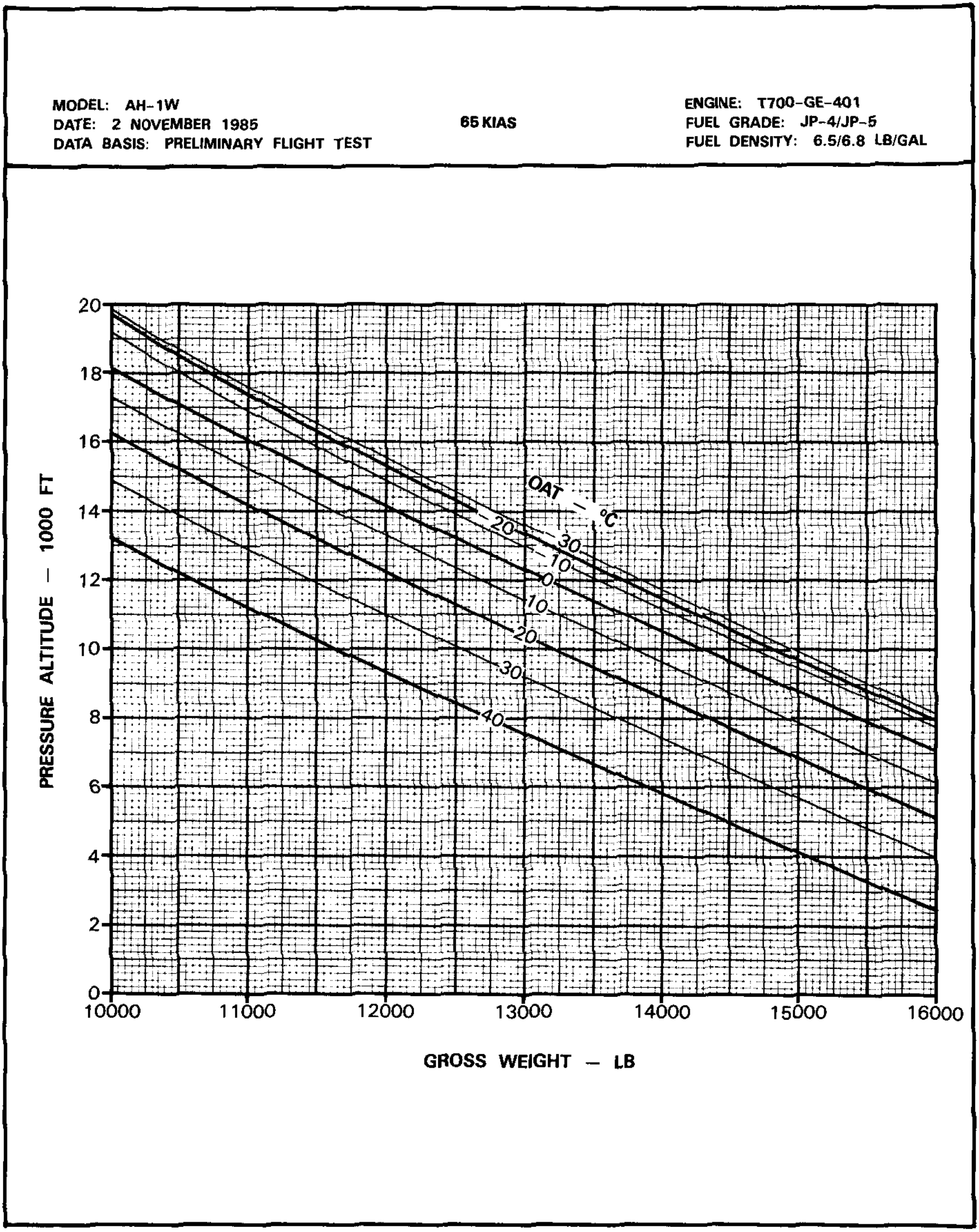

Figure 29-3. Single-Engine Service Ceiling — 29-Minute Power — All Configurations — 100-Percent Rotor Rpm — 65 KIAS

29.4 ABILITY TO MAINTAIN FLIGHT ON ONE ENGINE

The ability to maintain flight on one engine chart (Figure 29-4) presents both standard and standard + 10 square foot drag configurations for lines of gross weight as a function of pressure altitude and true airspeed at OATs of –20 °C, 0 °C, +20 °C, and +40 °C.

EXAMPLE: Determine the minimum and maximum airspeed (in terms of KTAS) for a 14,000-pound helicopter, standard configuration, with one engine inoperative at an altitude of 2000 feet, +10 °C.

SOLUTION:

1. Interpolation between 0 °C OAT and +20 °C is necessary in order to satisfy the +10 °C condition.

2. Enter Figure 29-4 at 2000 feet on the PRESSURE ALTITUDE scale for both the 0 °C and +20 °C charts. Read minimum and maximum airspeeds for each temperature.

AIRSPEED	0 °C OAT	+20 °C OAT
Minimum	16.0 KTAS	20.0 KTAS
Maximum	128.0 KTAS	125.0 KTAS

3. Divide the actual temperature by the delta temperature to obtain the interpolation factor (–10 °C/+20 °C) = 50 percent.

4. Interpolate for +10 °C minimum and maximum true airspeeds using a 50-percent interpolation factor.

   a. Minimum airspeed at +10 °C, 2000 feet = 18.0 KTAS.

   b. Maximum airspeed at +10 °C, 2000 feet = 126.5 KTAS.

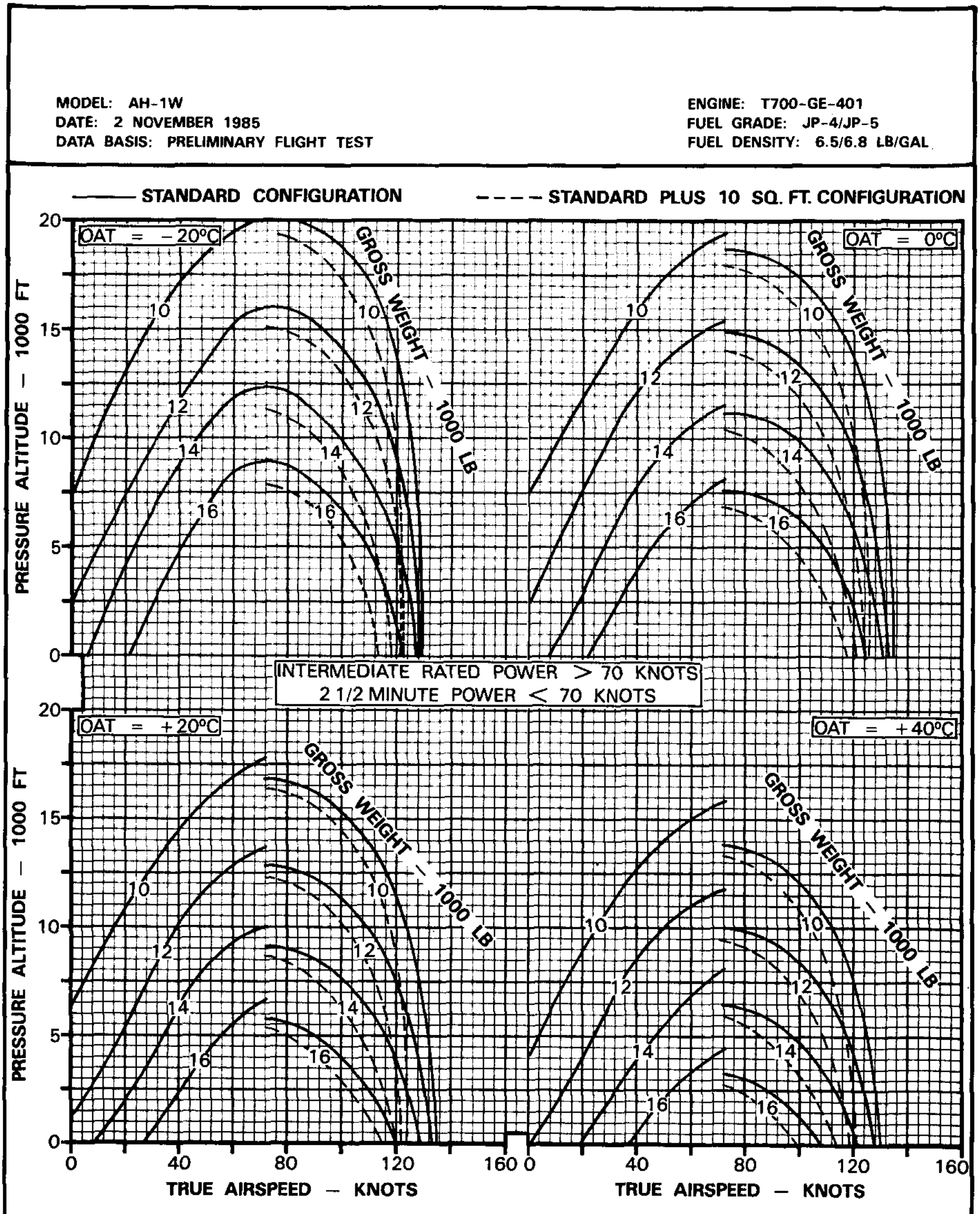

Figure 29-4. Ability to Maintain Flight on One Engine — 100 Percent Rotor Rpm

29.5 MINIMUM AIRSPEED FOR FLIGHT WITH ONE ENGINE

The minimum airspeed for flight with one engine chart (Figure 29-5) presents gross weight as a function of calibrated airspeed and OAT temperature for sea level and out of ground effect conditions.

EXAMPLE: Determine the minimum airspeed for a 14,000-pound helicopter operating on one engine at sea level, +10 °C OAT.

SOLUTION:

1. Enter Figure 29-5 at 14,000 pounds on the GROSS WEIGHT scale.

2. Move right to the +10 °C OAT line.

3. Drop down and read 12.0 KCAS.

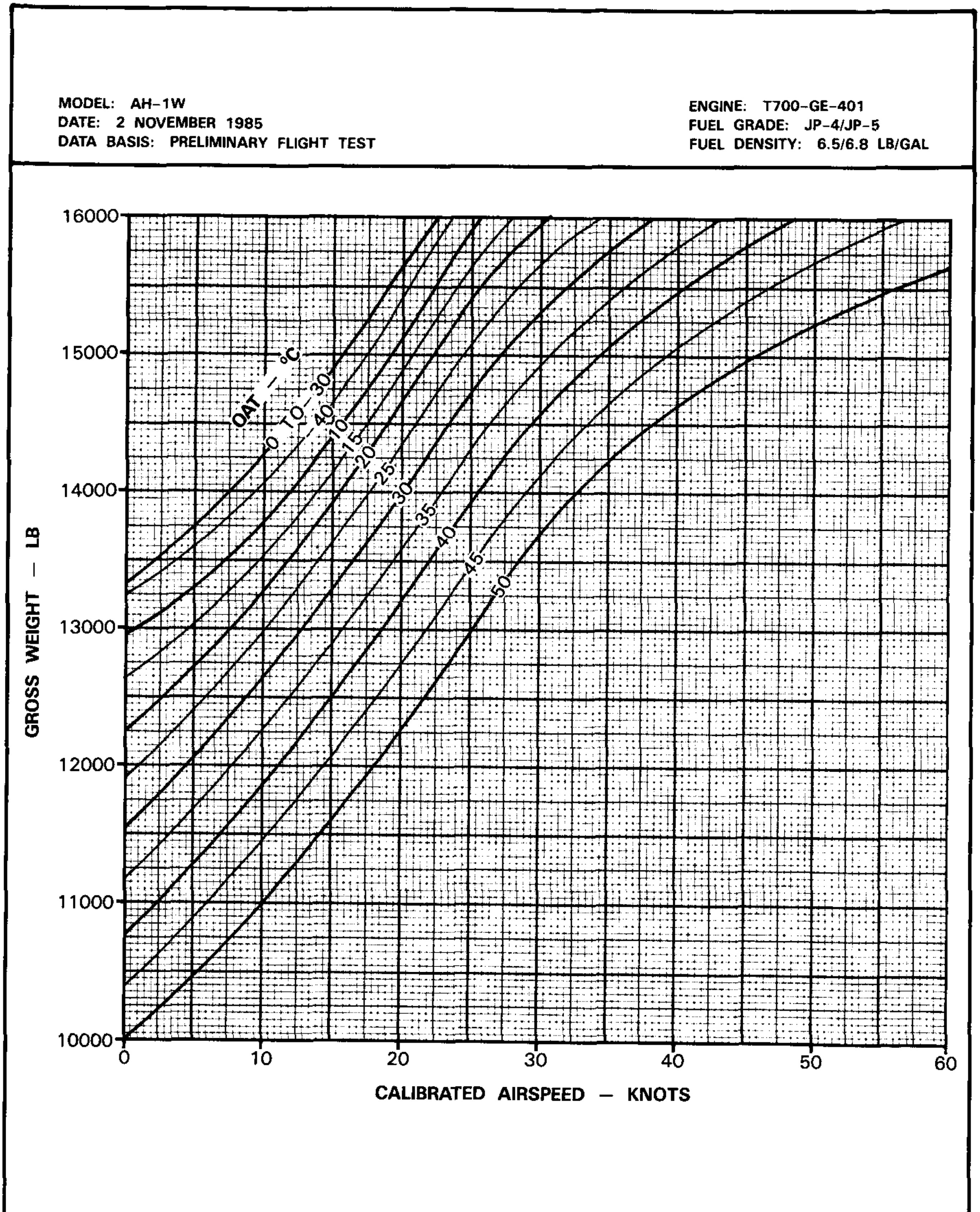

Figure 29-5. Minimum Airspeed for Flight With One Engine — Sea Level — Out of Ground Effect — 29-Minute Power — All Configurations — 100 Percent Rotor Rpm

CHAPTER 30

Special Charts

30.1 PRESSURE ALTITUDE

Pressure altitude is the altitude indicated on the altimeter when the barometric scale is set on 29.92. It is the height above the theoretical plane at which the air pressure is equal to 29.92 inches of mercury.

30.2 DENSITY ALTITUDE

Density altitude is an expression of the density of the air in terms of height above sea level; hence, the less dense the air, the higher the density altitude. For standard conditions of temperature and pressure, density altitude is the same as pressure altitude. As temperature increases above standard for any altitude, the density altitude will also increase to values higher than pressure altitude. Figure 30-1 expresses density altitude as a function of pressure altitude and temperature.

Note

Humidity affects density altitude. The higher the humidity, the higher the density altitude. This in fact could have an effect on torque required. Throughout this manual, add 100 feet of density altitude for each 10 percent increase in humidity above 40 percent.

The chart also includes the inverse of the square root of the density ratio (1/SQRT SIGMA PRIME), which is used to calculate TAS by the relation:

TAS = CAS × 1/SQRT SIGMA PRIME

EXAMPLE: If the ambient temperature is +7 °C (standard day) and the pressure altitude is 4000 feet, find the density altitude, 1/SQRT SIGMA PRIME, and the true airspeed for 125 KCAS and 133 KCAS.

SOLUTION:

1. Enter the bottom of the chart (Figure 30-1) at +7 °C on the OAT scale.
2. Move vertically upward to the 4000-foot PRESSURE ALTITUDE line.
3. From this point, move horizontally to the left and read a DENSITY ALTITUDE of 4000 feet and then move horizontally to the right and read the inverse of the square root of the density ratio (1/SQRT SIGMA PRIME) = 1.061.
4. Calculate KTAS for 125 KCAS and 133 KCAS.

KCAS	X	1/SQRT SIGMA PRIME	X	KTAS
125	X	1.061	=	132.6
133	X	1.061	=	141.1

NOTE
Density altitude should be increased by 100 feet for each 10% increment of relative humidity above 40%.

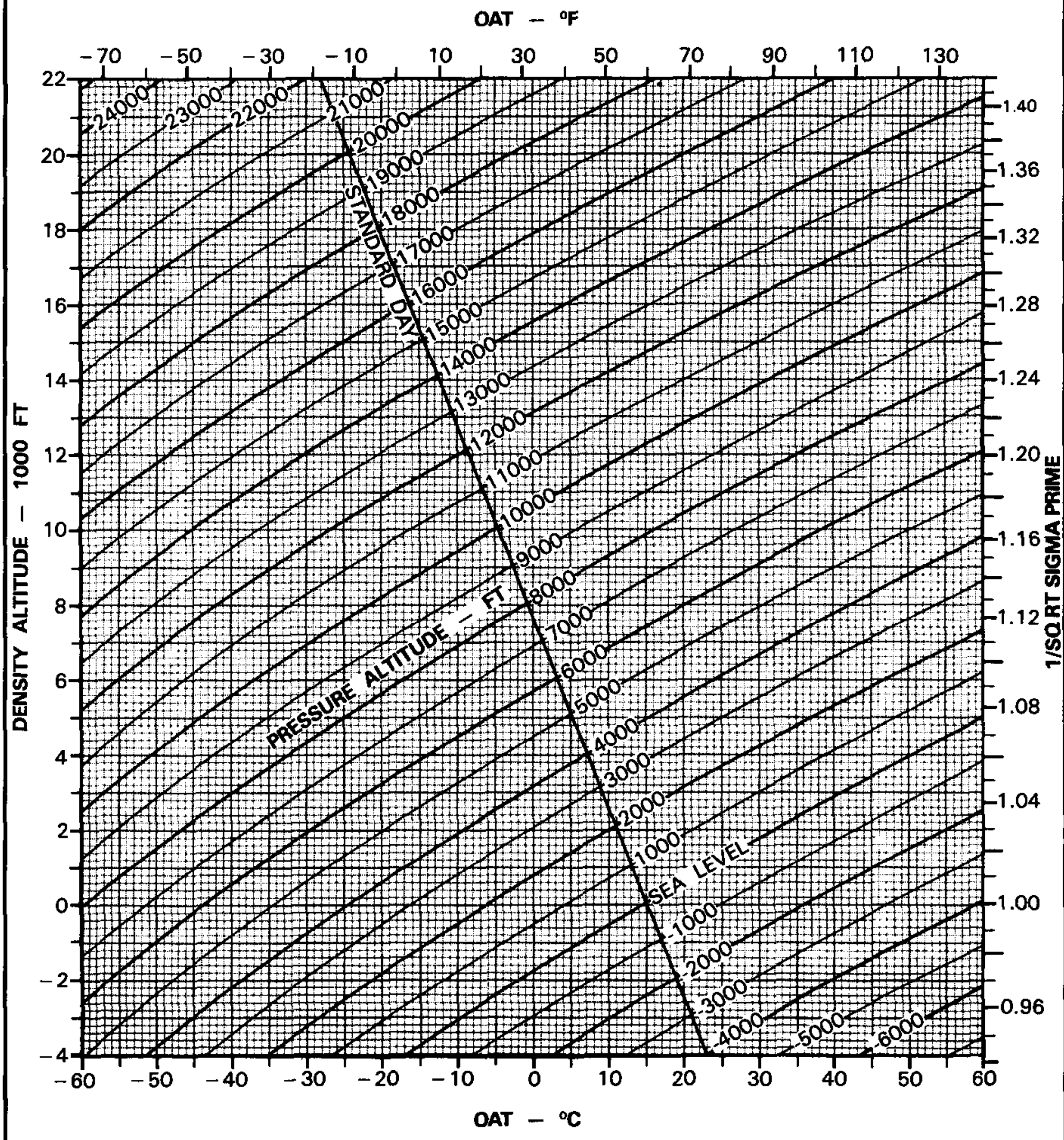

Figure 30-1. Density Altitude

30.3 TEMPERATURE CONVERSION

The temperature conversion chart (Figure 30-2) can be used to convert °F to °C or °C to °F, within a range of -60 to +60 °C or -76 to +140 °F.

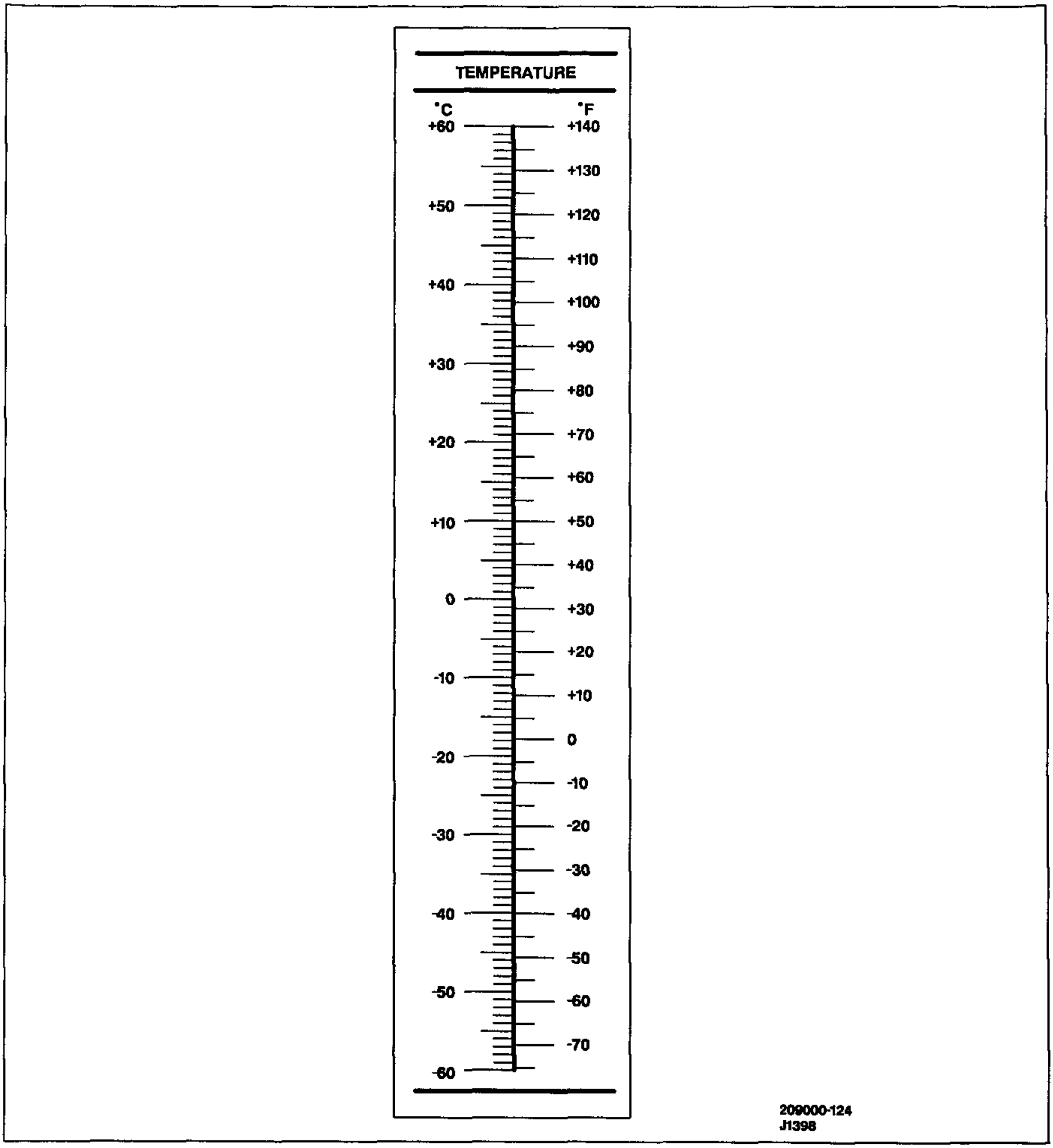

Figure 30-2. Temperature Conversion

30.4 SHAFT HORSEPOWER VERSUS TORQUE

The shaft horsepower versus torque chart (figure 30-3) provides a means for converting torque in percent Q to shp, and vice versa, for 100 percent rotor rpm.

EXAMPLE: *Determine the shp equivalent for a 37-percent torque (%Q) during single-engine operation, 100 percent rotor rpm.*

SOLUTION:

1. Enter the Figure 30-3 TORQUE scale at 37 percent Q for single-engine torque. Move up and intersect the BASELINE.

2. Move left, and read 770 SHAFT HORSEPOWER for single engine.

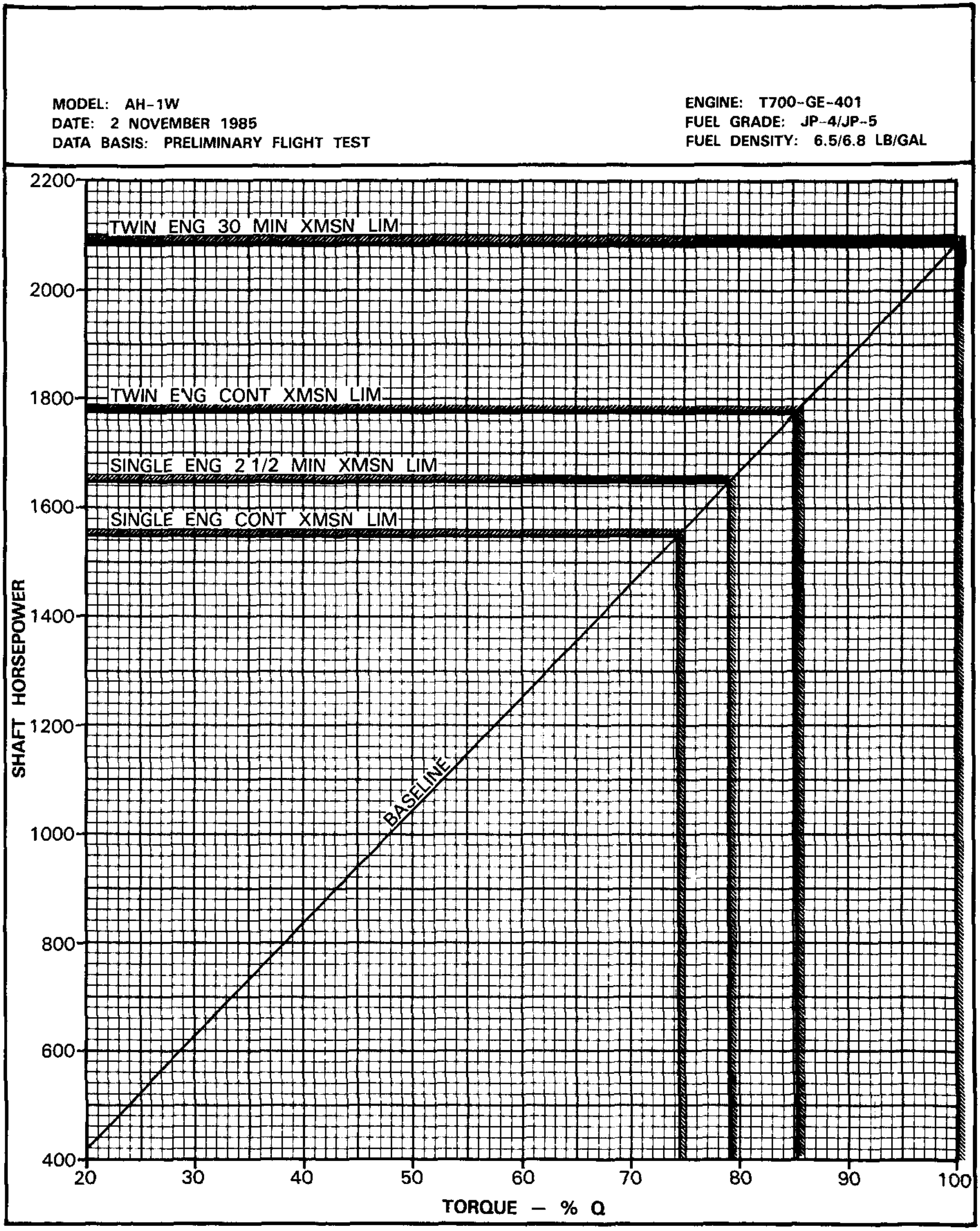

Figure 30-3. Shaft Horsepower Versus Torque — 100 Percent Rotor Rpm

30.5 AIRSPEED CALIBRATION

The airspeed calibration chart (Figure 30-4) converts calibrated airspeed to indicated airspeed and vice versa. Calibrated airspeed (KCAS) is indicated airspeed (KIAS) as read from the airspeed indicator and corrected for instrument error plus the installation correction. Corrections for cruise, climb, and autorotation are shown.

EXAMPLE: Convert 60.0 KCAS and 100.0 KCAS airspeed to equivalent KIAS airspeeds for a cruise condition.

SOLUTION:

1. Enter the Figure 30-4 CALIBRATED AIRSPEED scale at 60.0 KCAS and 100.0 KCAS. Move right to the CRUISE line.

2. Drop down and read:

60.0 KCAS = 58.0 KIAS

100.0 KCAS = 100.0 KIAS

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

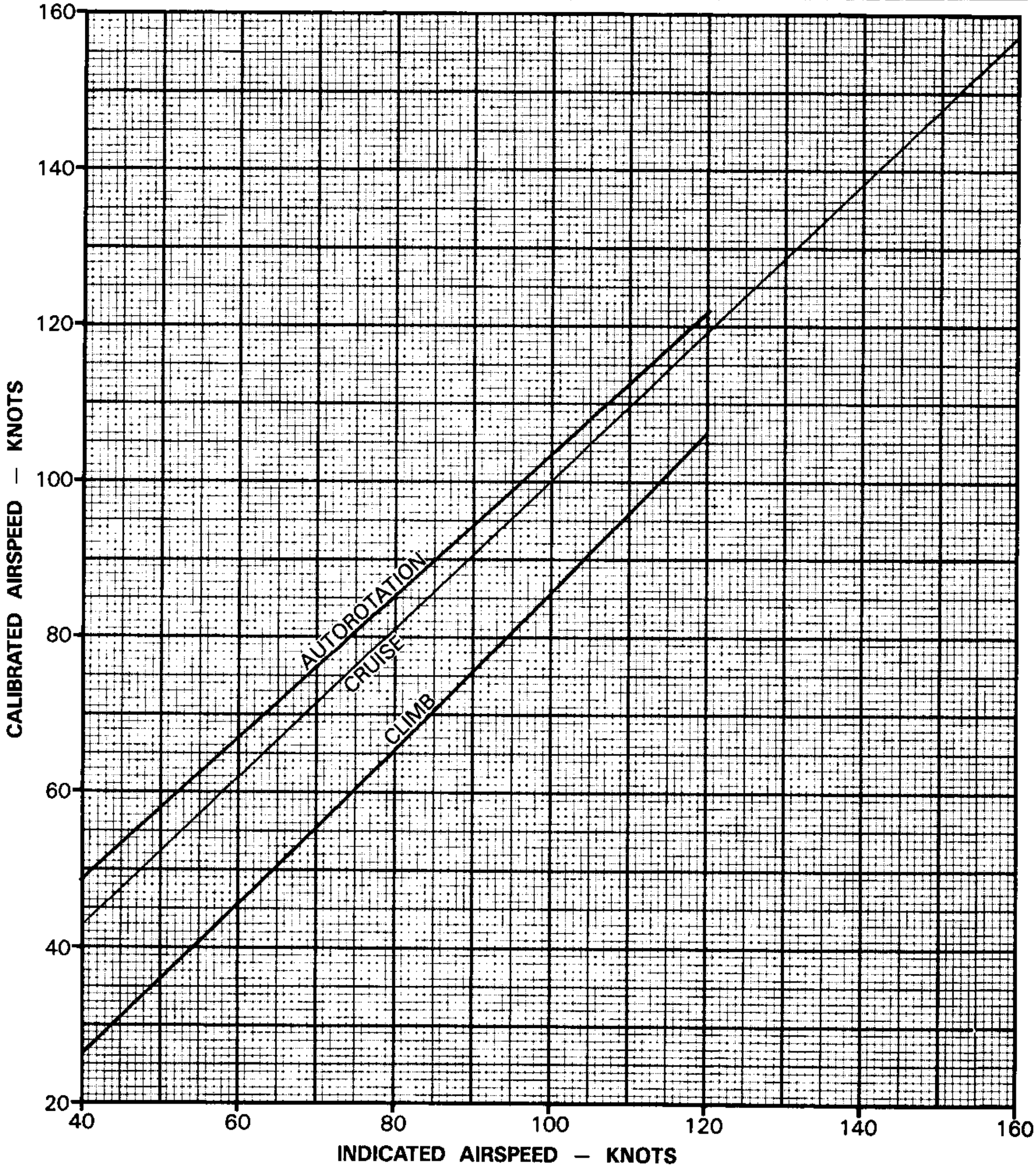

Figure 30-4. Airspeed Calibration — All Configurations

30.6 AUTOROTATION

The autorotation chart (Figure 30-5) shows the rate of descent and the glide ratio (horizontal distance covered by the helicopter, divided by the altitude lost by the helicopter in a fixed amount of time) for various indicated airspeeds.

The consideration of autorotational flight should include these points:

1. The last 500 feet of altitude should be reserved for the final maneuvering during landing.
2. Rate of descent is basically controlled by airspeed and rotor speed.
3. A high rotor speed will provide a large amount of rotor energy and lift that is needed during the flare and landing.
4. The effectiveness of the cyclic flare is dependent on:
    a. Entry rotor rpm
    b. Entry airspeed
    c. Rate and steepness of the flare
    d. Gross weight
    e. Density altitude
    f. Rate of descent
5. The effectiveness of collective pitch for landing is dependent on:
    a. Rotor rpm at application
    b. Gross weight
    c. Density altitude
    d. Rate of descent at application.

WARNING

Successful cyclic flares and landing maneuvers during autorotation require high rotor speeds.

The speed for maximum glide distance is 99.0 KIAS. The speed for minimum rate of descent or maximum time to descend is 66.0 KIAS.

EXAMPLE: Find the maximum glide distance and the rate of descent for 5000 feet AGL.

SOLUTION:

1. The SPEED FOR MAXIMUM GLIDE DISTANCE corresponds to the best GLIDE RATIO. The chart (Figure 30-5) shows that the highest glide ratio is 3.8.
2. Proceed to the upper portion of the chart and read a corresponding RATE OF DESCENT of 2550 fpm.
3. Multiply 3.8 by 4500 (5000 − 500) to get 17,100 feet. This is the maximum horizontal distance that the helicopter can glide with power off from 5000 feet AGL. Notice that 500 feet of altitude was reserved for final maneuver during landing.

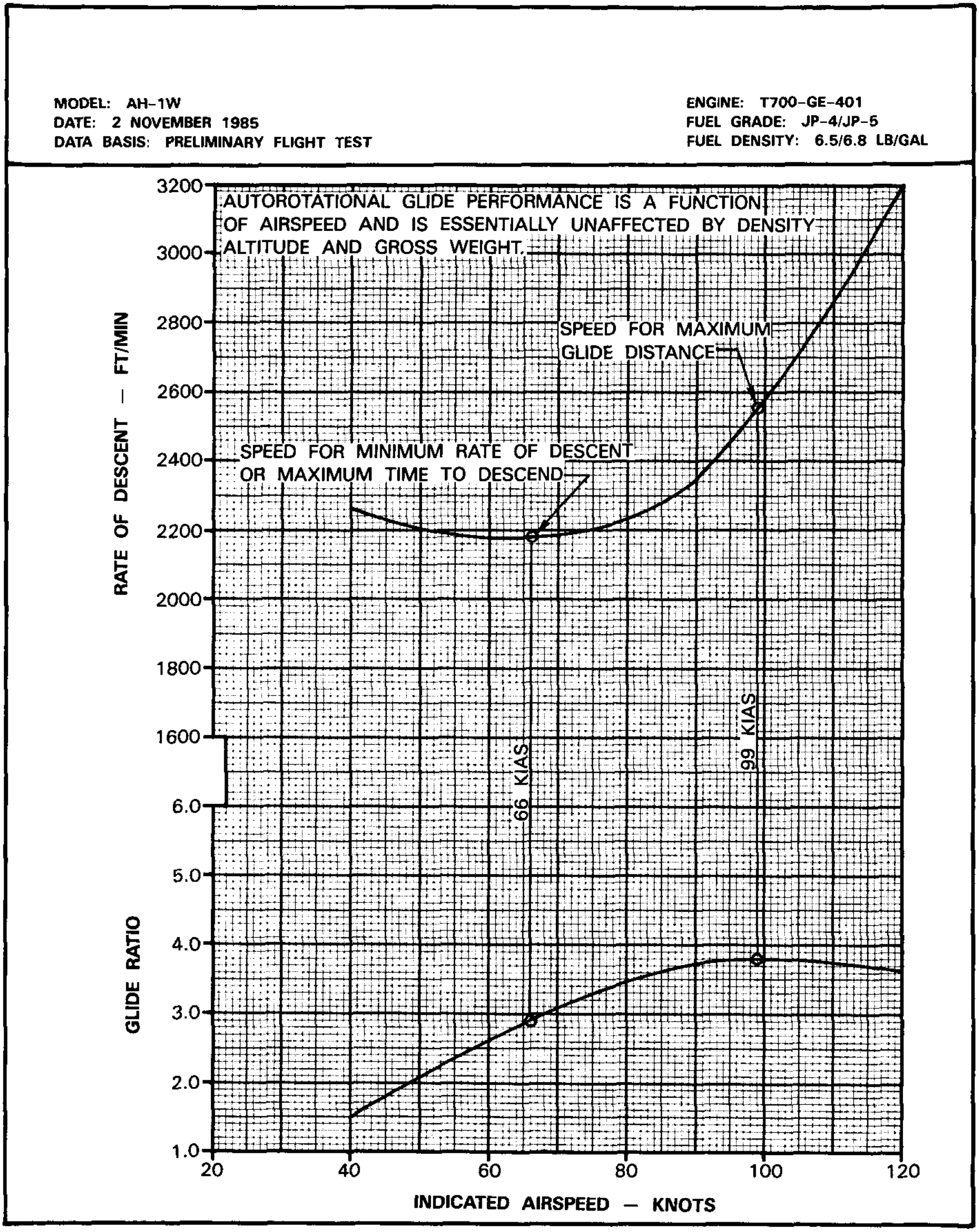

Figure 30-5. Autorotation — 100 Percent Rotor Rpm — Power Off

30.7 RADIUS OF TURN AT CONSTANT AIRSPEED

The radius of turn at constant airspeed chart (Figure 30-6) presents turn radius as a function of true airspeed and bank angle. The load factor is the inverse of the cosine of the bank angle.

EXAMPLE: Determine the bank angle and the turn radius while making a standard 3° per second turn at an airspeed of 90 KTAS.

SOLUTION:

1. Enter Figure 30-6 at 90 KTAS. Move up and intersect the standard 3° per second turn line.
2. Interpolate for approximately 14° on the BANK ANGLE line.
3. Move left and read a *TURN RADIUS* of 2900 feet.

EXAMPLE: Find the load factor (g) for a bank angle of 44°.

SOLUTION:

1. Enter the upper portion of the chart at a BANK ANGLE of 44°.
2. Move up and intersect the LOAD FACTOR line.
3. Project left and read a 1.4 load factor.

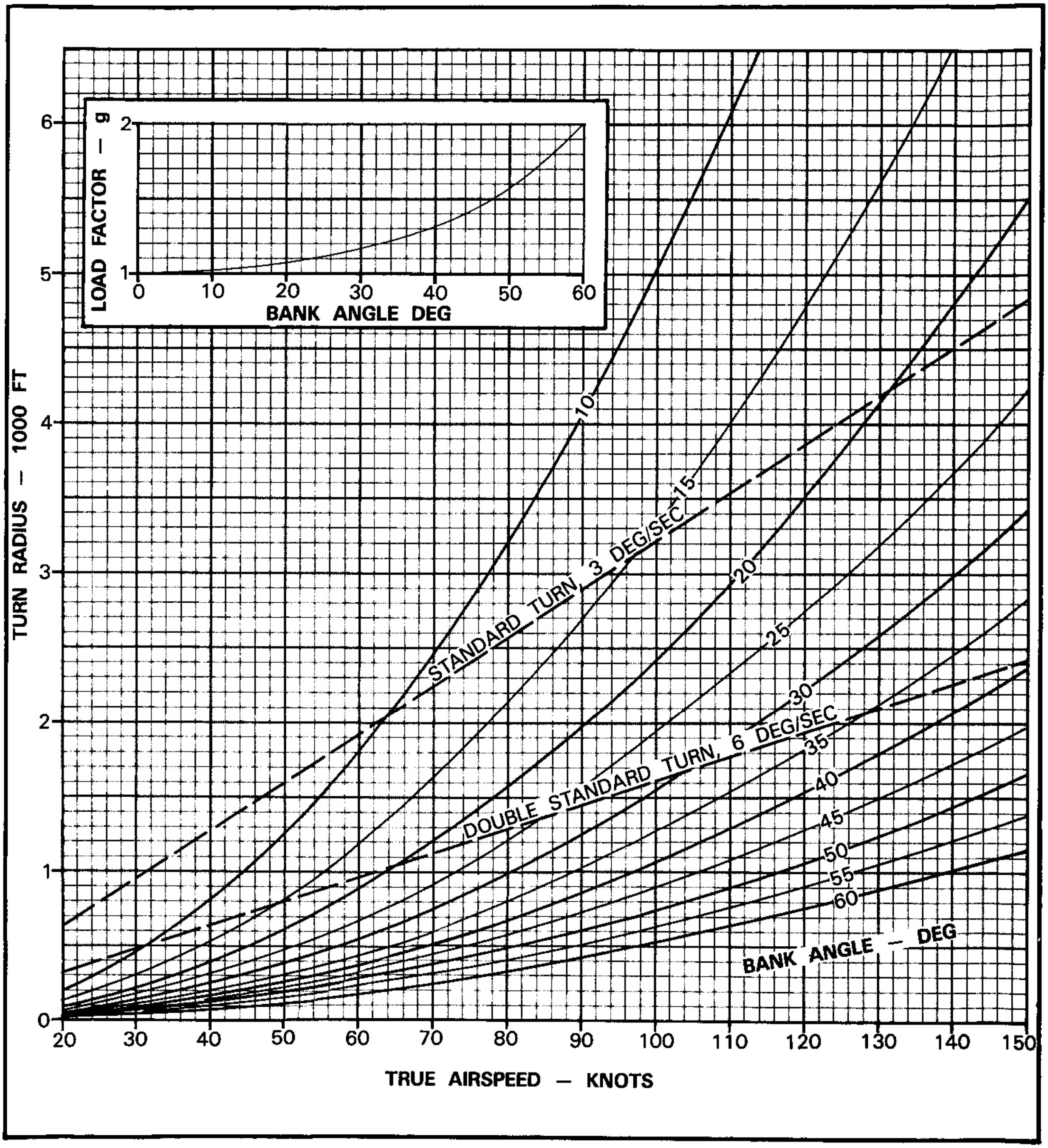

Figure 30-6. Radius of Turn at Constant Airspeed — 100 Percent Rotor Rpm

30.8 ARRESTING TURN HOVER CAPABILITY

The arresting turn hover capability charts (Figure 30-7, sheets 1 and 2) are shown for twin-engine operation at 31 minutes power available. Figure 30-7, sheets 1 and 2, is presented for OGE and IGE 5-foot skid height, respectively. A pedal input (tail rotor power) of approximately 5 percent delta shp above steady state hover power required was used to account for maneuvering flight. This result is about 0.6 radian per second or 35° per second initial capability of arresting hovering turn.

EXAMPLE: Find the +20° arresting turn hover capability (pressure altitude) for a 14,000-pound gross weight helicopter at OGE.

SOLUTION:

1. *Since the helicopter is operating at OGE, turn to Figure 30-7, sheet 1.*
2. Enter Figure 30-7, sheet 1, at 14,000 pounds on the GROSS WEIGHT scale. Move straight upward and intersect the +20 °C line.
3. Move horizontally to the left and read a hover ceiling of 3500 feet on the PRESSURE ALTITUDE scale.

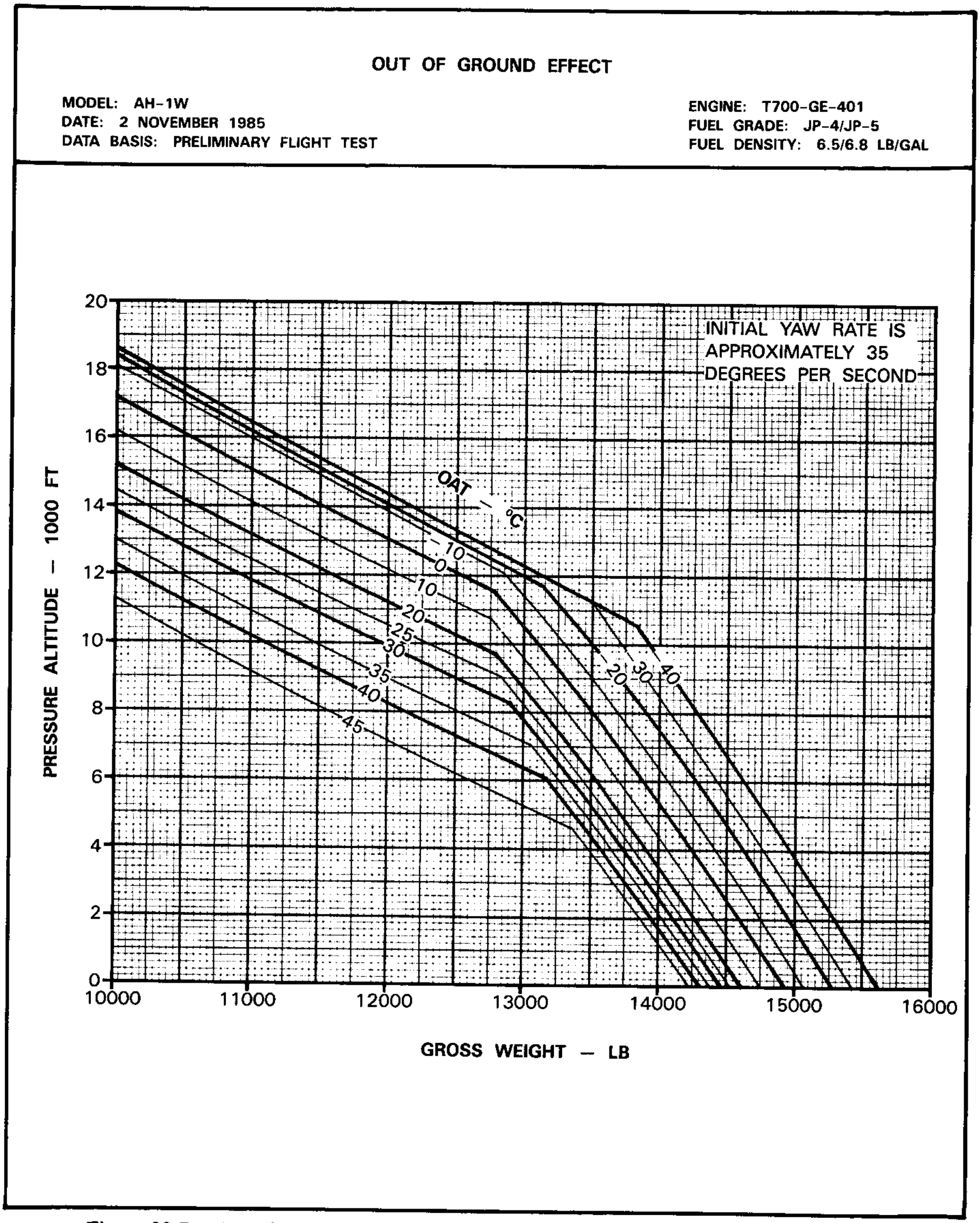

Figure 30-7. Arresting Turn Hover Capability — 100 Percent Rotor Rpm (Sheet 1 of 2)

IN GROUND EFFECT (5 FT. SKID HEIGHT)

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

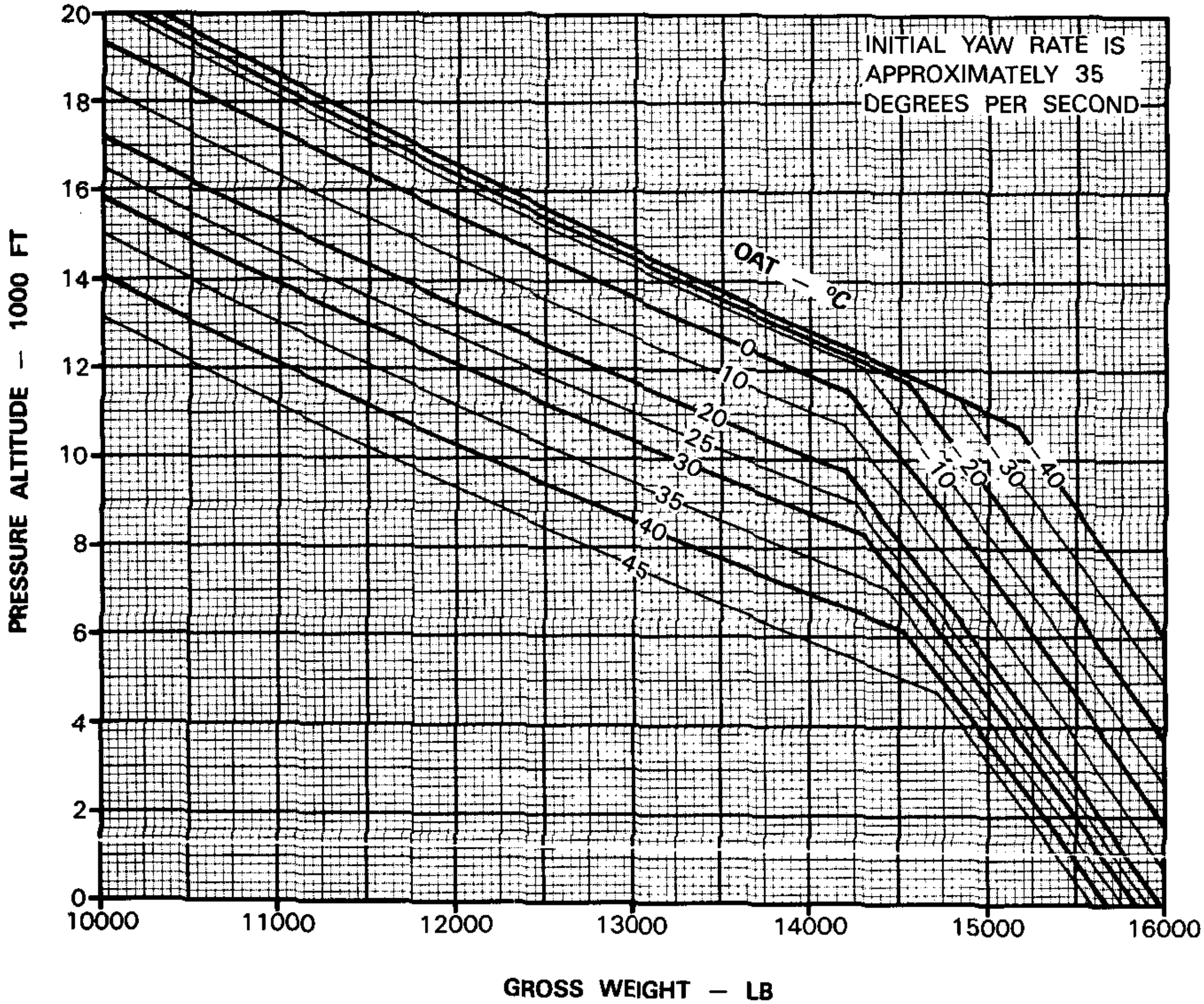

Figure 30-7. Arresting Turn Hover Capability — 100 Percent Rotor Rpm (Sheet 2 of 2)

CHAPTER 31

Nonminimum Specification Engine

31.1 NONMINIMUM SPECIFICATION ENGINE

Performance degradation is determined for deteriorated engines as follows:

1. Determine the percentage of deterioration from the power assurance chart (PART III, Chapter 10).

2. Use Figure 31-1 to determine if the degraded engine will affect power-related aircraft performance.

3. Refer to the following figures for performance degradation.

   a. Figure 31-2 for OEI and twin-engine hover ceiling, service ceiling, and range capability.

   b. Figure 31-3 for climb capability

   c. Figure 31-4 for speed capability.

31.2 CRITICAL ALTITUDE

After power available is obtained and it is determined from the power assurance chart that the power plant does not develop minimum specification power, the impact on performance must be ascertained. Figure 31-1 presents the critical altitude for twin-engine operation with 90 to 100 percent minimum specification engine power. Sheet 1 gives the critical altitude for a 30-minute power condition. Sheet 2 gives the critical altitude for a maximum continuous power condition. The critical altitude is defined as the altitude at which the transmission torque limit and the MGT or N_g limit are reached simultaneously. Below critical altitude, the aircraft is always transmission limited; that is, 2082 shp (100 percent Q) for 31-minute, twin-engine power or 1775 shp (85 percent Q) for twin-engine continuous operation. If ambient operational conditions are such that the aircraft is transmission limited, then the power related performance as shown in PART XI should not be deteriorated. If the engine power is less than minimum specification power, performance at low density altitudes may not decrease, with the exception of fuel flow, which always increases with a degraded engine. Generally, for each 3 percent below minimum specification power, fuel flow will increase 1 percent for a given shp.

EXAMPLE: It has been determined from the power assurance or topping chart that a given aircraft will produce 5 percent less than minimum specification power. Find the highest altitude at +40 °C at which hover performance will not be compromised for a 95-percent minimum specification engine.

SOLUTION:

1. Enter Figure 31-1, sheet 1, at +40 °C on the OAT scale.
2. Project right to the PERCENT MIN SPEC ENGINE curves and intersect the 95-percent minimum specification line.
3. Drop down and read a PRESSURE ALTITUDE of 2100 feet. All hover performance up to 2100 feet on a +40 °C day will be transmission limited; hence there is no change in hover performance as previously presented.

31.3 PERFORMANCE LOSS BECAUSE OF DETERIORATED ENGINE

Performance loss because of deteriorated engine is found in Figure 31-2.

30 MINUTE POWER

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

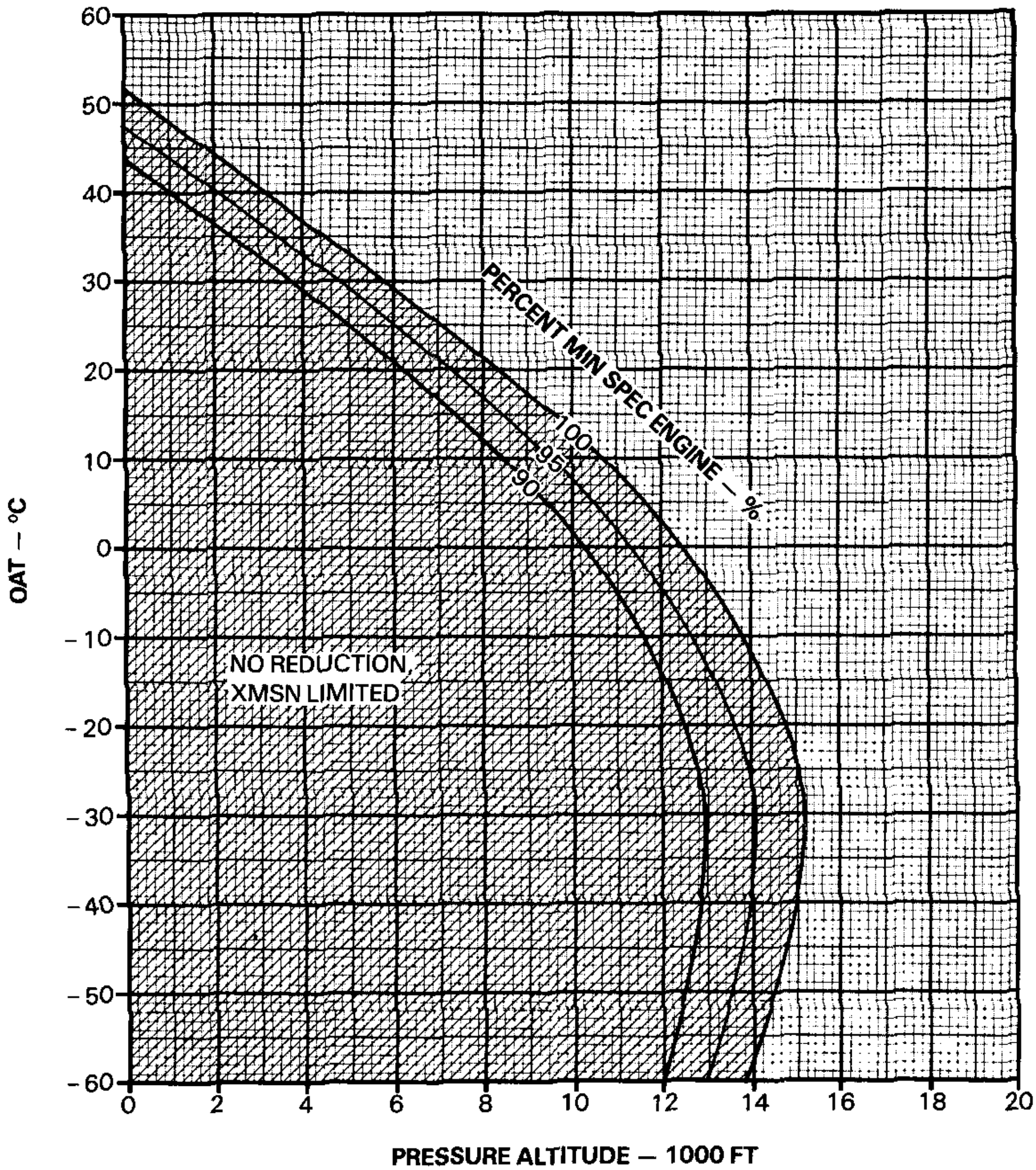

Figure 31-1. Critical Altitude (Sheet 1 of 2)

MAXIMUM CONTINUOUS POWER

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

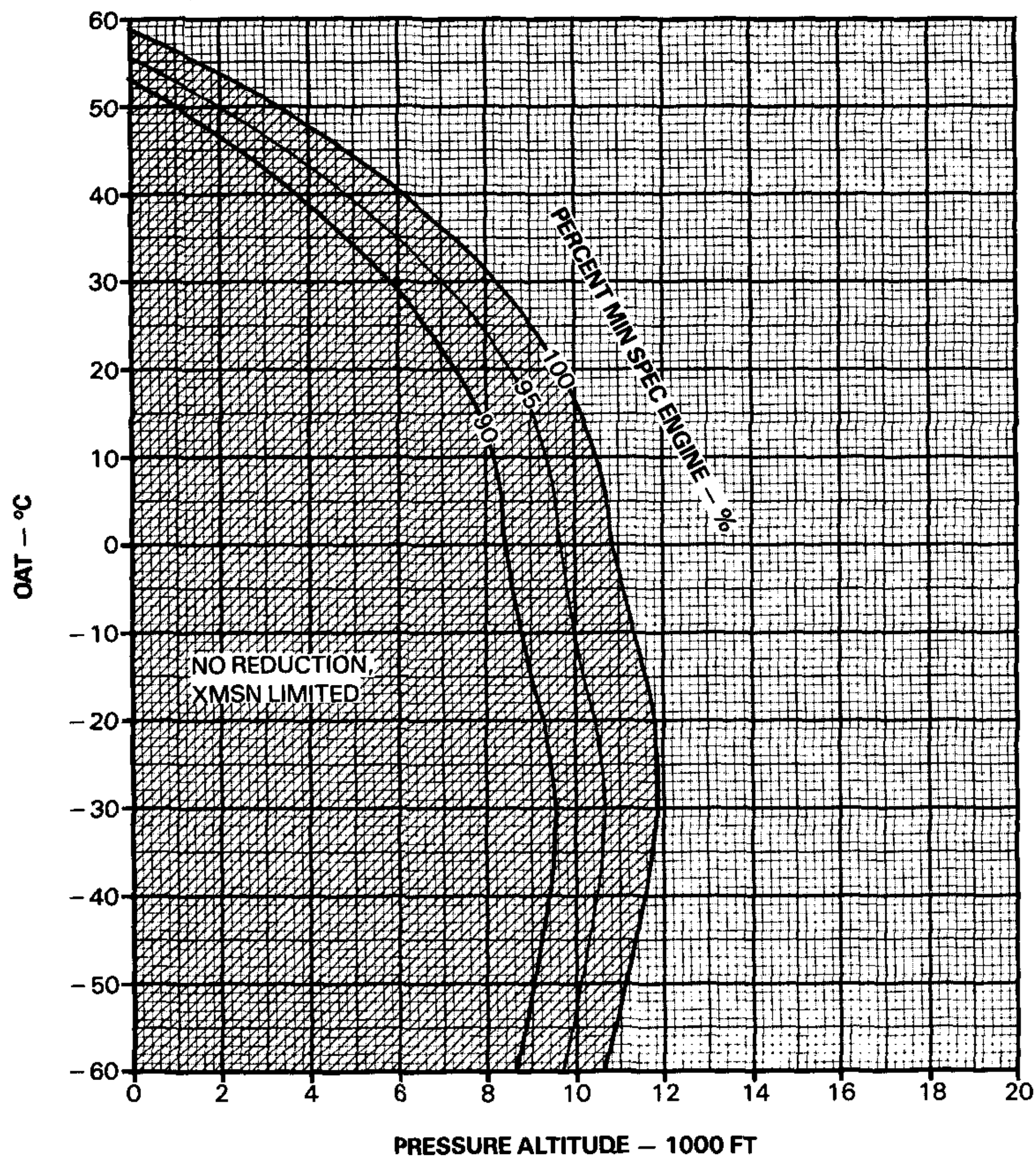

Figure 31-1. Critical Altitude (Sheet 2 of 2)

NONMINIMUM SPECIFICATION ENGINE

FOR EACH 1% POWER BELOW OEI OR TWIN MIN SPEC ENGINE, SUBTRACT 0.3% RANGE OR INCREASE FUEL FLOW BY 0.3%

FOR EACH 1% POWER BELOW MIN SPEC

CONDITION:	SUBTRACT (PRESSURE ALTITUDE)
TWIN ENGINE OPERATION	
SERVICE CEILING	120 FEET
HOVER OGE OR ARRESTING TURN HOVER CAPABILITY	150 FEET*
HOVER IGE OR ARRESTING TURN HOVER CAPABILITY	170 FEET*
ONE ENGINE INOPERATIVE	
SERVICE CEILING	150 FEET
HOVER	220 FEET

*ZERO LOSS IF TRANSMISSION LIMITED (SEE FIGURE 30-1)

209000-131
J1399

Figure 31-2. Performance Loss Because of Deteriorated Engine

31.4 CLIMB PERFORMANCE DETERIORATION

Maximum and vertical rate of climb reductions for deteriorated engines are presented in Figure 31-3. The reduction for twin-engine operation at 31-minute power is given in fpm. The reduction at maximum continuous power is 85 percent of the 31-minute values. Check the power assurance chart (PART III, Chapter 10) to determine the percent of deterioration. Check the critical altitude chart (Figure 31-1) to ensure that the helicopter is not transmission limited prior to determining climb performance deterioration.

EXAMPLE: Find the maximum and vertical rate of climb for a 12,000-pound helicopter with a 5-percent below minimum specification engine that is limited at twin-engine, 30-minute power.

SOLUTION:

1. Enter the bottom of Figure 31-3, DELTA TORQUE scale, at 5 percent below minimum specification.

2. Project up to intersect the 12,000-pound GROSS WEIGHT lines on the MAXIMUM RATE OF CLIMB and VERTICAL RATE OF CLIMB scales.

3. Move left to the DELTA RATE OF CLIMB scale and read a 220 fpm reduction in the maximum rate of climb and a 431 fpm reduction in the vertical rate of climb.

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

NOTE: AT MCP, REDUCTION WILL BE 85% OF VALUES SHOWN.

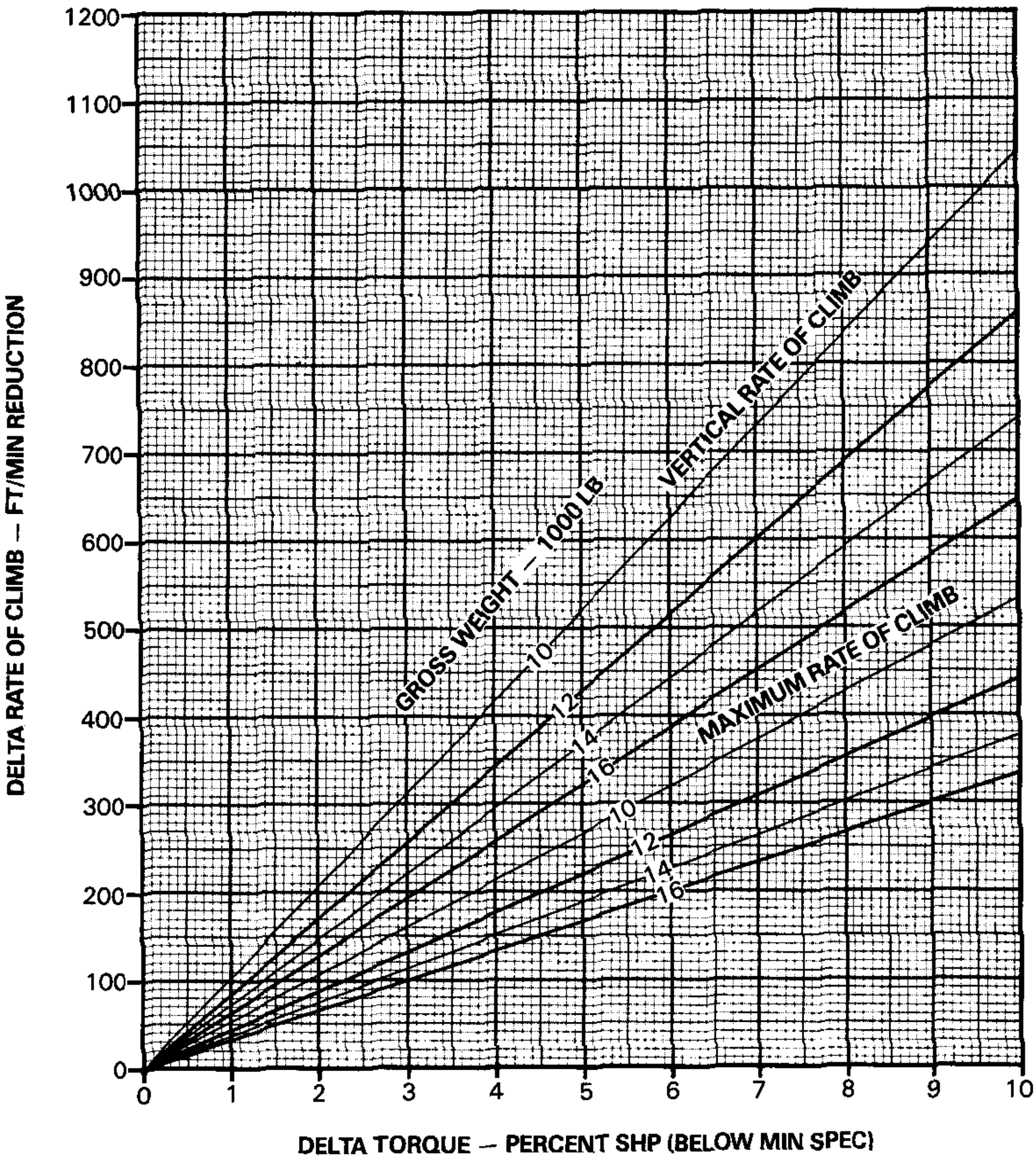

Figure 31-3. Climb Performance Deterioration — Maximum Loss for Less Than Minimum Specification Engine at Critical Altitude — Twin-Engine Operation — 31-Minute Power

31.5 CRUISE SPEED DETERIORATION

Cruise speed deterioration is a result of engine deterioration and is determined by use of the cruise speed deterioration chart (Figure 31-4). Curves representing 5 and 10 percent deterioration are shown to 31-minute and maximum continuous power. Deteriorations other than those plotted may be used by interpolation between the curves as necessary. The power assurance check (PART III, Chapter 10) is used to determine the percent of engine deterioration. The critical altitude chart (Figure 31-1) should be used to determine whether the helicopter is transmission limited prior to using the cruise speed deterioration chart. True airspeed for minimum specification performance is derived from the appropriate cruise chart (Figure 28-1).

EXAMPLE: Find the speed loss at twin-engine maximum continuous power for a 5-percent-below-minimum specification engine at an 8000-foot pressure altitude, +26 °C OAT, and standard configuration helicopter at 13,000-pound gross weight.

SOLUTION:

1. Locate the cruise chart, Figure 28-1, sheet 15.
2. Determine a cruise speed at 142 KTAS.
3. Enter Figure 3-14 TRUE AIRSPEED (MIN SPEC BASELINE) scale at 142 KTAS.
4. Project up to the 5-percent MCP engine deterioration curve.
5. Project left to the DELTA TRUE AIRSPEED REDUCTION scale and read approximately 3.5 knots less.

MODEL: AH-1W
DATE: 2 NOVEMBER 1985
DATA BASIS: PRELIMINARY FLIGHT TEST

ENGINE: T700-GE-401
FUEL GRADE: JP-4/JP-5
FUEL DENSITY: 6.5/6.8 LB/GAL

REFER TO FIGURE 30-1 FOR APPLICABILITY

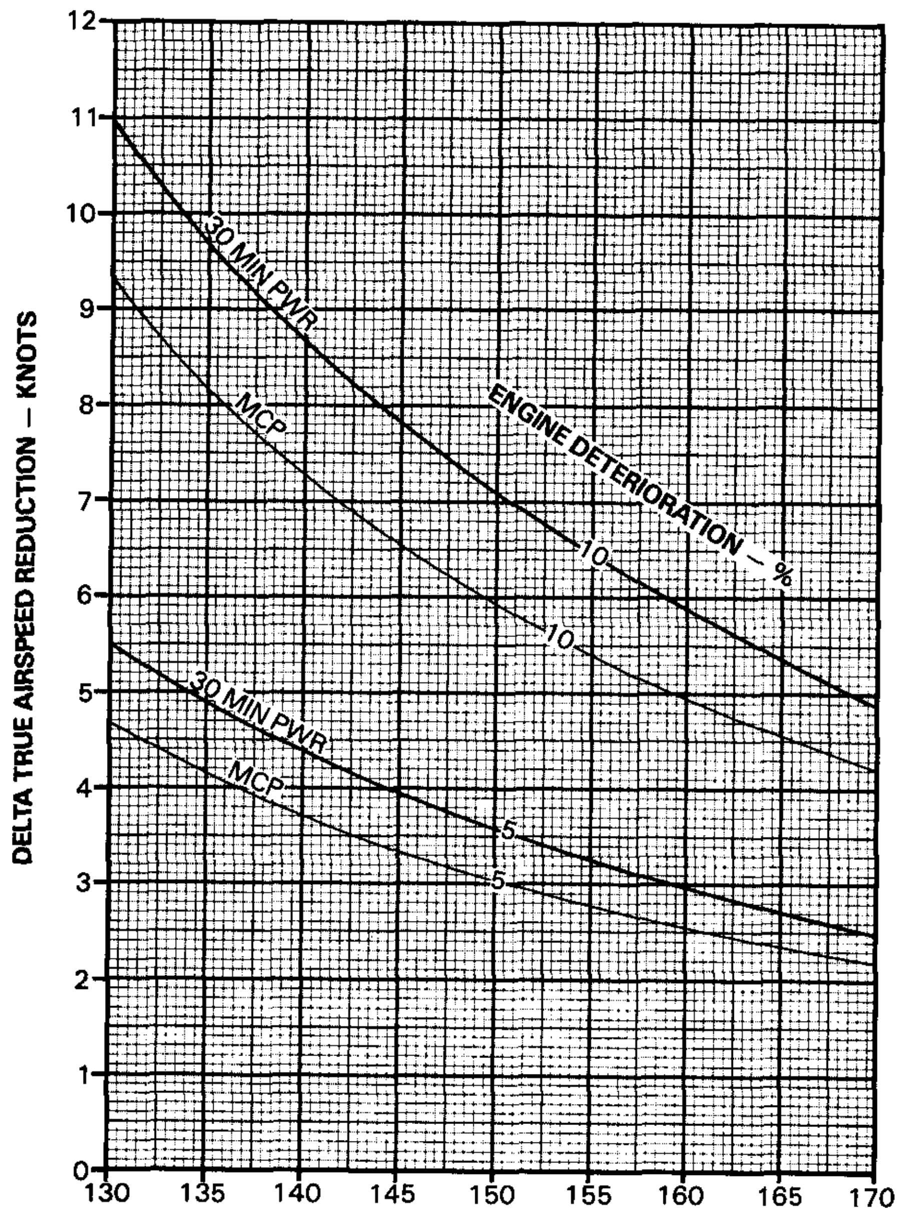

Figure 31-4. Cruise Speed Deterioration — Maximum Loss for Less Than Minimum Specification Engine at Critical Altitude — Twin-Engine Operation

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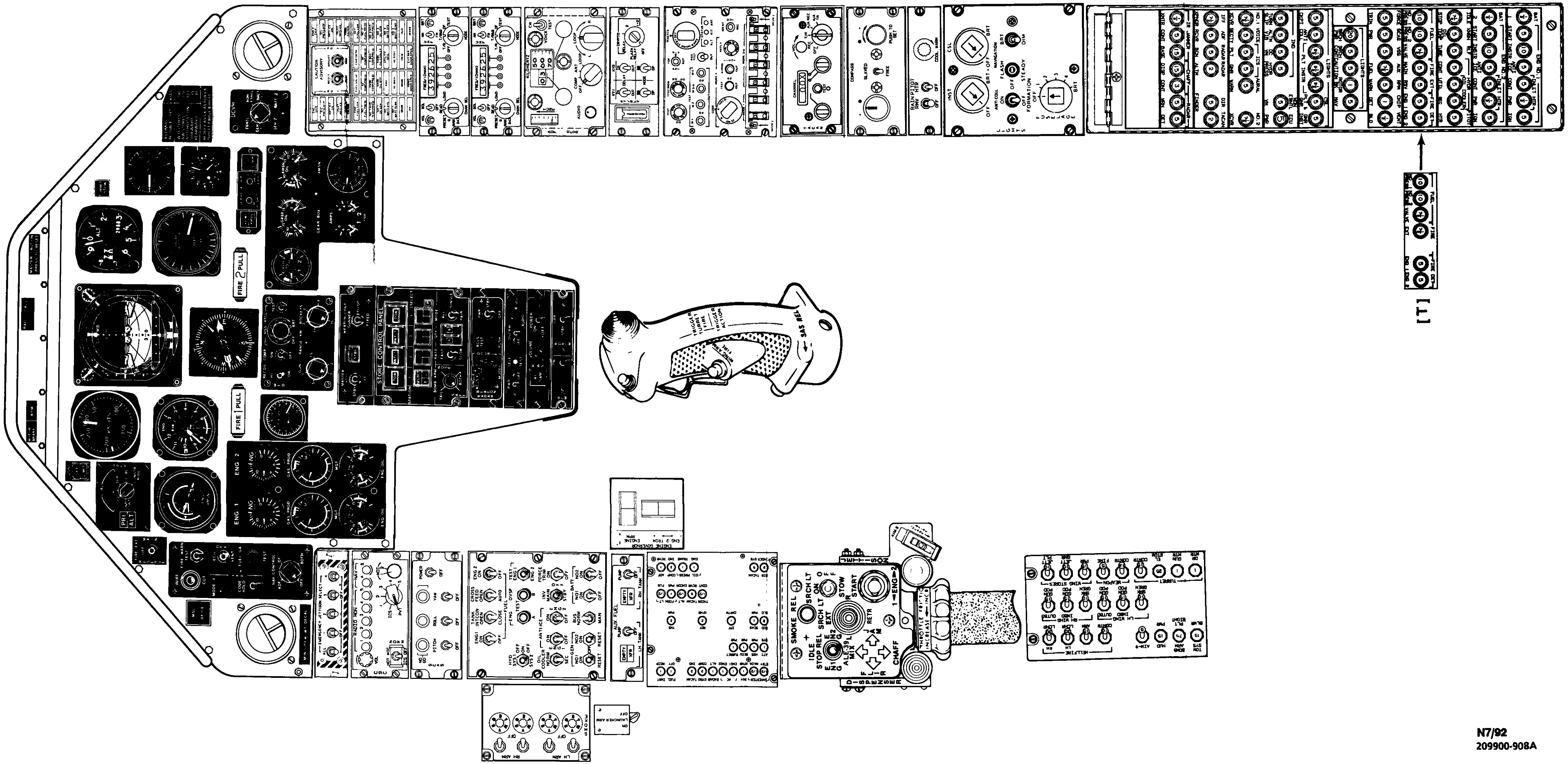

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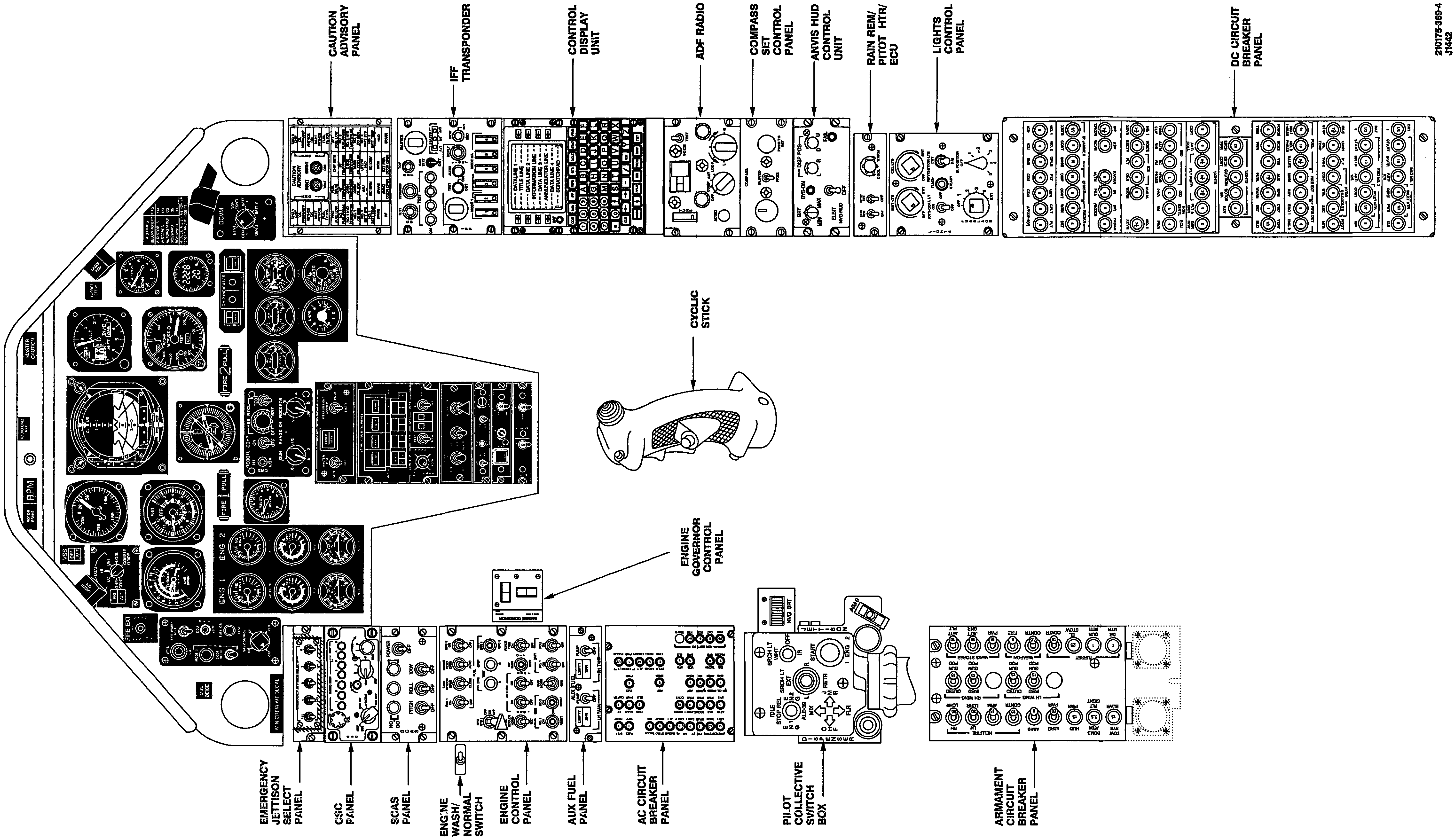
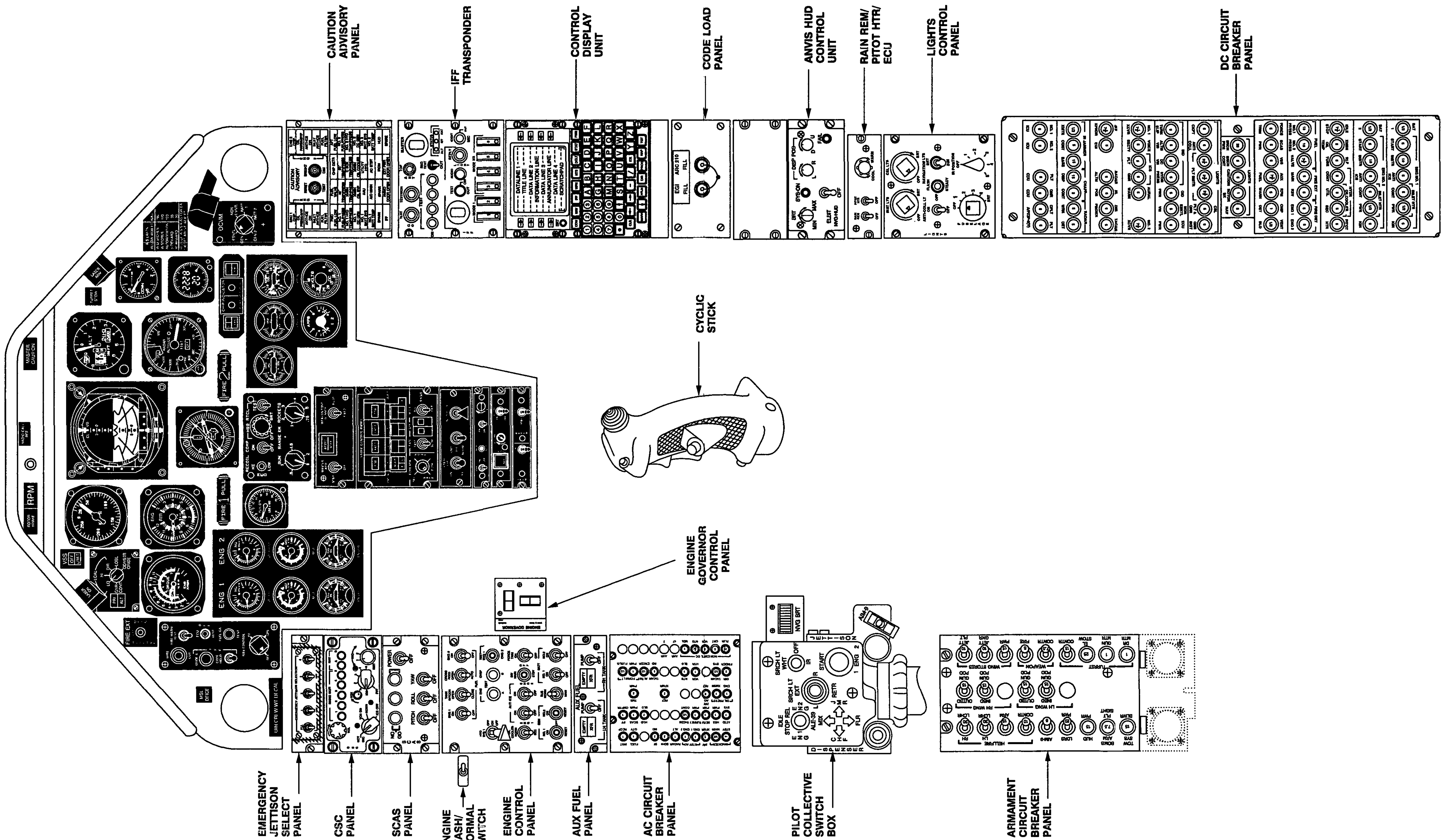
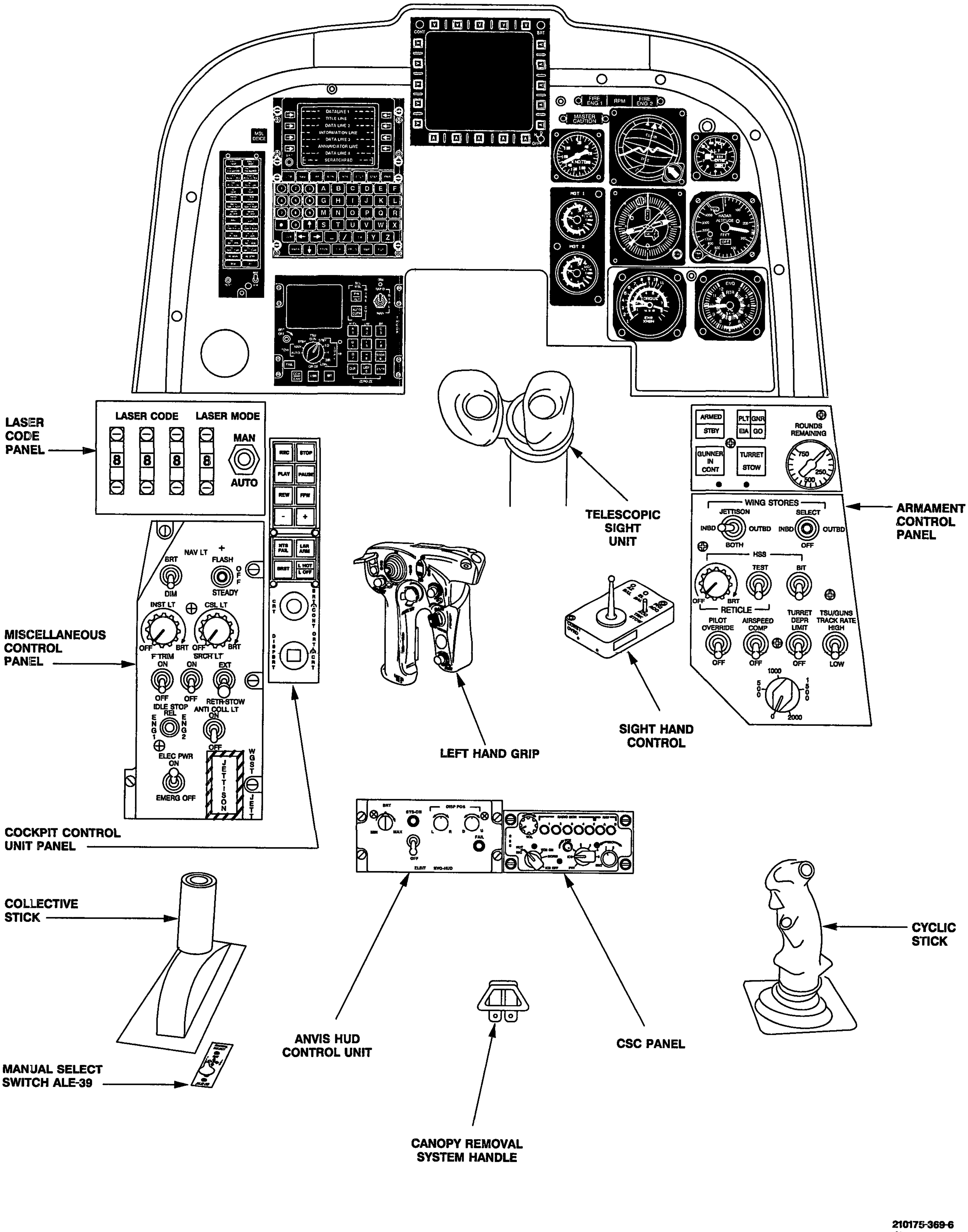
B Pilot Cockpit Layout



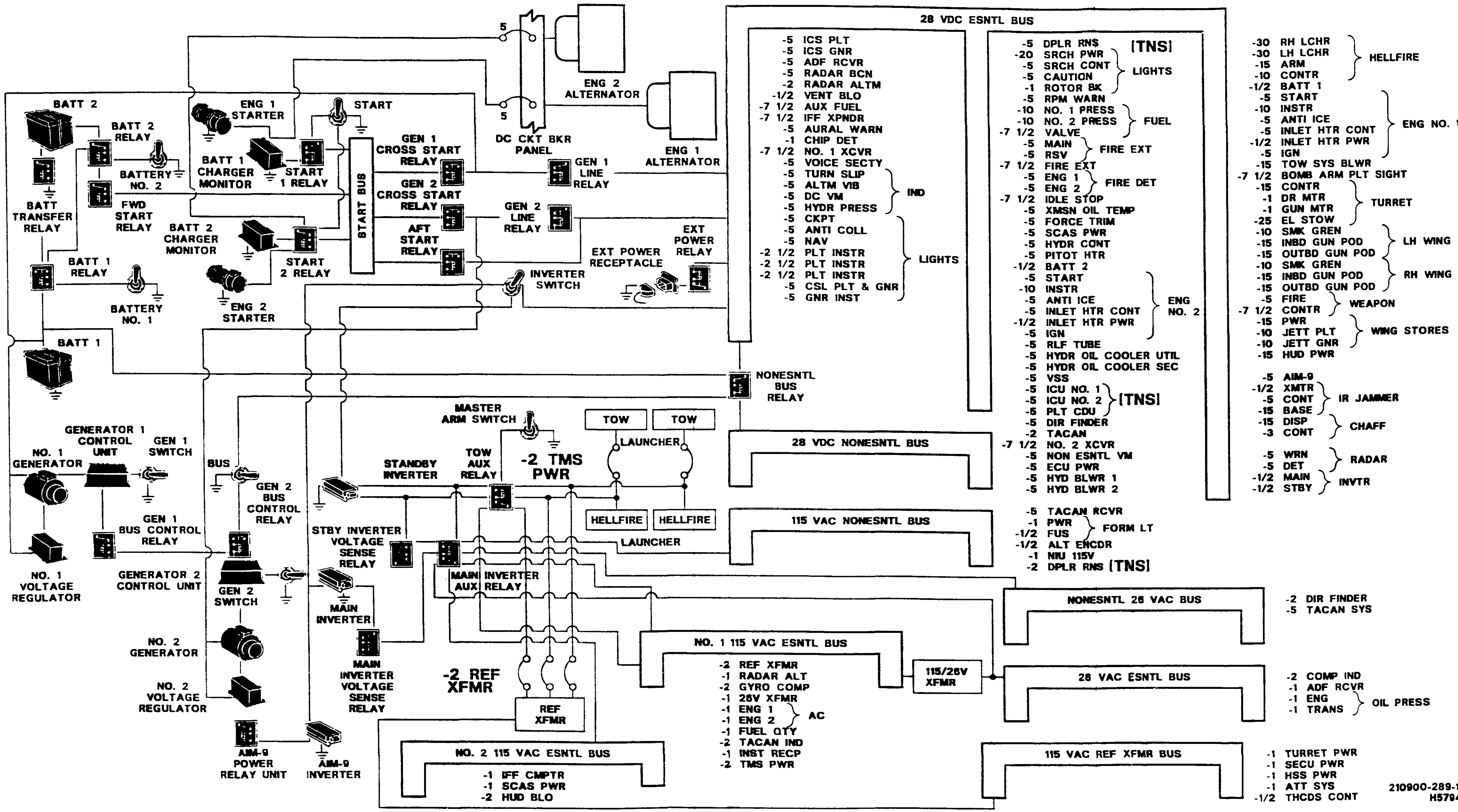
CM Pilot Cockpit Layout



CNU Pilot Cockpit Layout



CM CNU Copilot/Gunner Cockpit Layout



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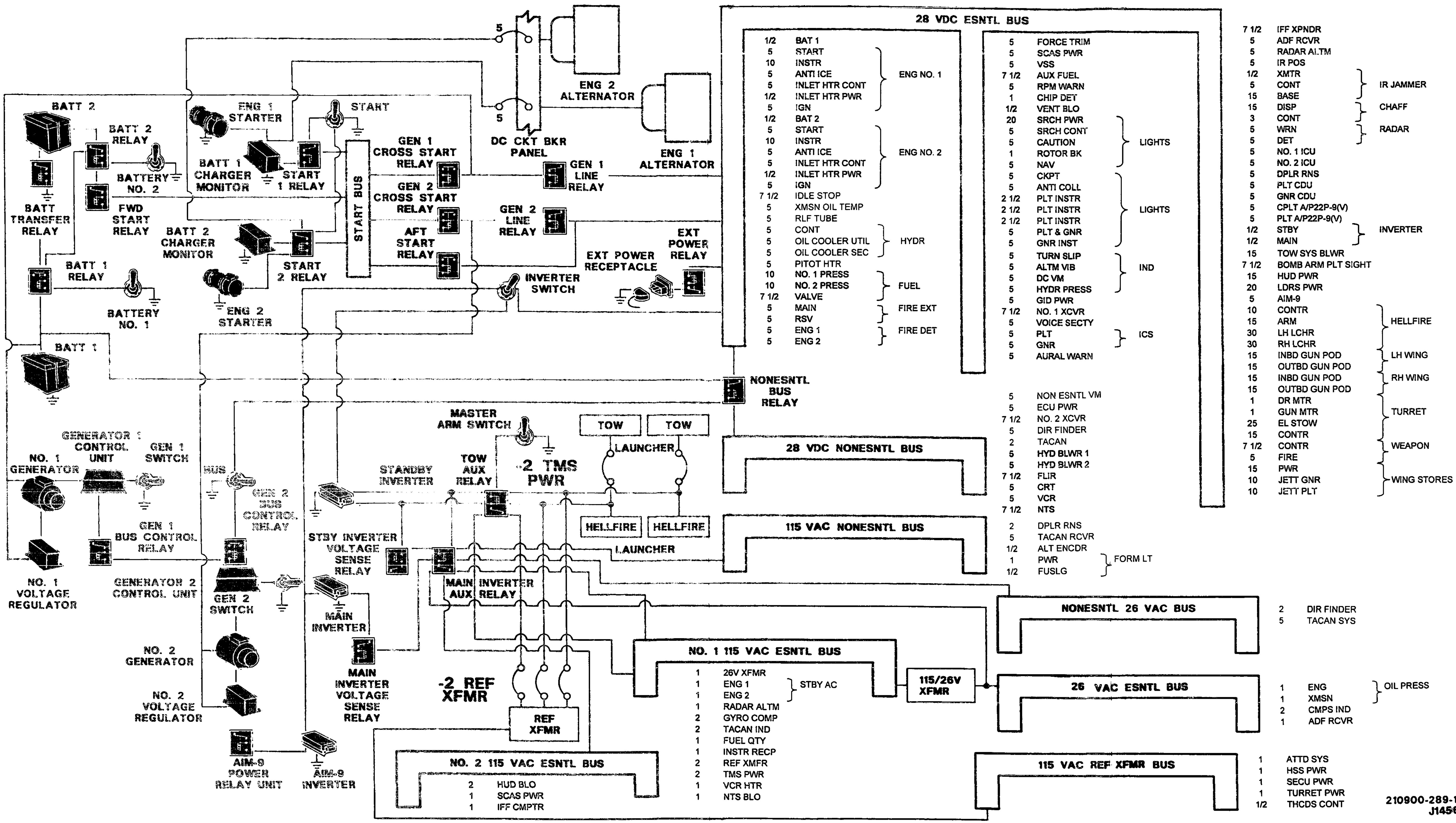
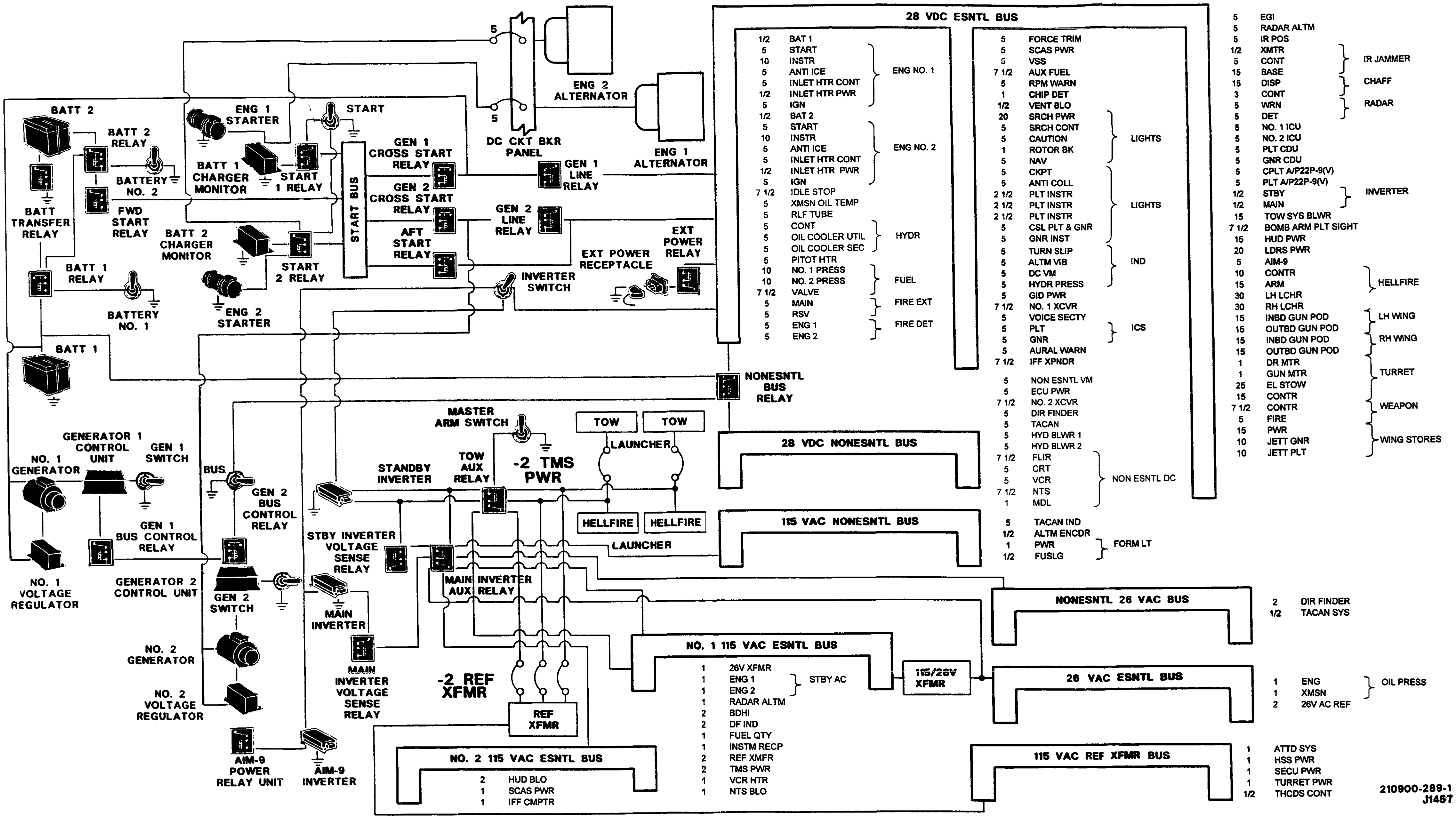
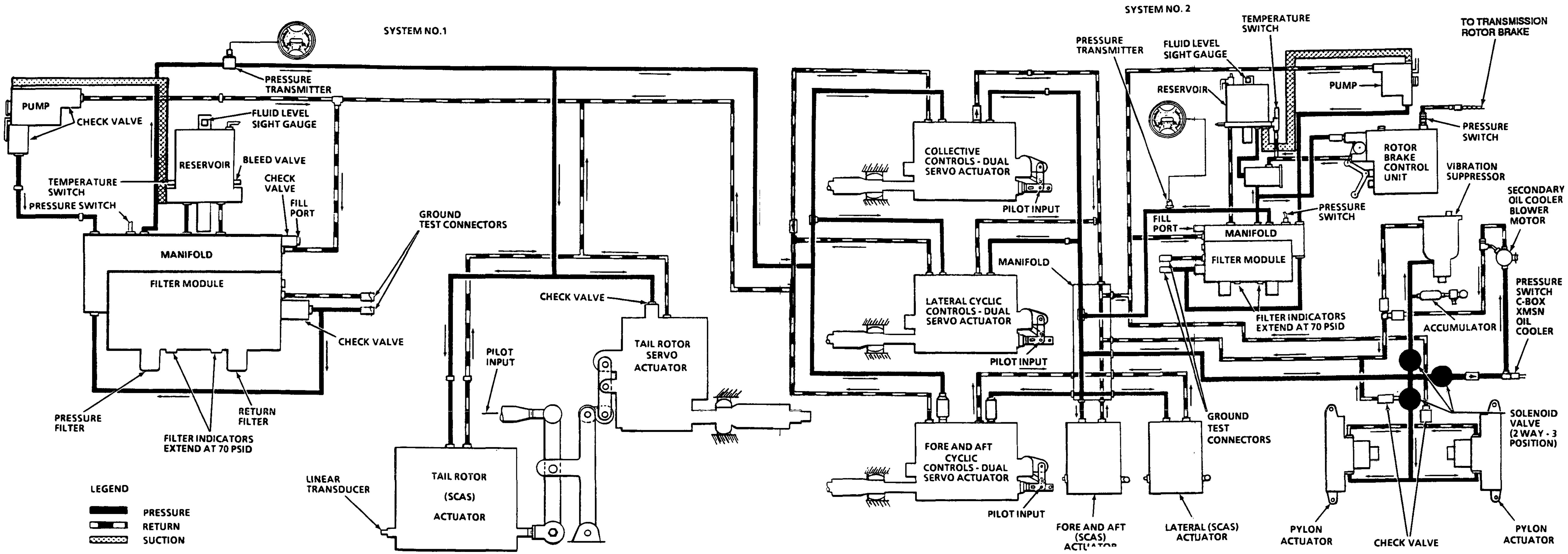


CM DC and AC Power Distribution



CNU DC and AC Power Distribution



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